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Report No. 10708

PROJECT COMPLETION REPORT

THAILAND

SECOND MAE MOH LIGNITE PROJECT
(LOAN 2407-TH)

JUNE 8, 1992

Industry and Energy Operations Division
Country Department I
East Asia and Pacific Regional Office

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CURRENCY EQUIVALENTS

Currency Unit	=	Thai baht (B)
US\$1.00	=	B 23.05 (SAR)
	=	B 24. 0 (Project Composite)

WEIGHTS AND MEASURES

1 meter (m)	=	3.281 feet (ft)
1 cubic meter (m ³)	=	35.315 cubic feet (ft ³)
	=	1.308 cubic yards (yd ³)
1 kilometer (km)	=	0.622 miles (mi)
1 bank cubic meter (bm ³)	=	1.308 bank cubic yards (byd ³)
1 kilogram (kg)	=	2.205 pounds
1 metric tonne (t)	=	1.1 short tons (st)
1 million metric tonne (mt)	=	10 ⁶ tonne
1 metric tonne per year (tpy)	=	1.1 short ton per year (stpy)
1 kilocalorie (kcal)	=	3.97 British thermal units (BTU)
1 kilocalorie per kilogram (kcal/kg)	=	1.805 British thermal units (BTU)
	=	per pound (BTU/lb)
1 kilovolt (kV)	=	1,000 volts
1 kilowatt (kW)	=	1,000 watts (W)
1 Megawatt (MW)	=	1,000 kilowatts (kW)
1 Gigawatthour (GWh)	=	1,000,000 kilowatthours

ABBREVIATIONS

ADAB	=	Australian Development Assistance Bureau
ADB	=	Asian Development Bank
DMR	=	Department of Mineral Resources
dwt	=	deadweight ton
EGAT	=	Electricity Generating Authority of Thailand
KfW	=	Kreditanstalt fur Wiederaufbau (F.R. Germany)
NEA	=	National Energy Administration
NESDB	=	National Economic and Social Development Board

THAI FISCAL YEAR

October 1 - September 30

of Director-General
Operations Evaluation

June 8, 1992

MEMORANDUM TO THE EXECUTIVE DIRECTORS AND THE PRESIDENT

SUBJECT: Project Completion Report on THAILAND
Second Mae Moh Lignite Project (Loan 2407-TH)

Attached, for information, is a copy of a report entitled "Project Completion Report on THAILAND - Second Mae Moh Lignite Project (Loan 2407-TH)" prepared by the East Asia and Pacific Regional Office. No audit of this project has been made by the Operations Evaluation Department at this time.



Attachment

PROJECT COMPLETION REPORT

THAILAND

SECOND MAE MOY LIGNITE PROJECT

(LOAN 2407-TH)

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PROJECT COMPLETION REPORT

THAILAND

SECOND MAE MOH LIGNITE PROJECT
(LOAN 2407-TH)

PREFACE

This is the Project Completion Report (PCR) for the Second Mae Moh Lignite Project in Thailand for which Loan 2407-TH in the amount of US\$59.1 million was approved on April 24, 1984. An amount of US\$44.1 million was canceled on December 23, 1986. The loan was closed on April 30, 1991 three years behind schedule. The last disbursement of US\$146,178 equivalent was made on August 6, 1991 making the total disbursement equivalent to US\$14,360,577.28. The balance of US\$639,442.72 was cancelled.

The PCR was jointly prepared by the Industry and Energy Operations Division, Department I of the East Asia and Pacific Region, and the Energy Division, Technical Department of the Asia Regional Office (Preface, Evaluation Summary, Parts I and III), and the Borrower (Part II).

Preparation of the PCR was started when the Borrower was requested to provide statistical data for Part III. In addition the PCR is based on the Staff Appraisal Report, the Loan and Project Agreements, supervision reports and correspondence in the Project Files.

PROJECT COMPLETION REPORT

THAILAND

SECOND MAE MOH LIGNITE PROJECT
(LOAN 2407-TH)

EVALUATION SUMMARY

Objectives

1. The project's main goal was to expand lignite mining capacity to 5.0 million tonnes per year in order to provide fuel to three additional 150 kW power generating plants (Units 5, 6 and 7) and increase total generating capacity to 825 kW. Other objectives were: (i) to reinforce economic pricing policies to ensure that planned lignite expansions are economically and financially justified and EGAT's mining operations are viable; (ii) to strengthen EGAT's technical and financial operations through technical assistance; and (iii) to minimize any adverse environmental impact of lignite-based electricity generation (Part I, para. 3.1).

Implementation Experiences

2. The project was successfully implemented ahead of schedule except for procurement delays, which were unrelated to the main project scope and were the cause of a three-year loan closing extension. The construction and commissioning of Nos. 5, 6 and 7 generating units was completed six months earlier than scheduled. Lignite production for these units was available when needed and has exceeded requirement to the present (end 1991).

3. The project experienced a major change in mining operations. Encouraging results from contracting out (to local contractors) overburden removal led EGAT to decide that it would contract out all overburden removal as well as a substantial proportion of innerburden removal and lignite handling. As a consequence, there was no need for EGAT to purchase the mining equipment it would have required had it carried out this work. Thus US\$41.1 million from the Bank loan was cancelled, leaving a loan amount of US\$15.0 million. The use of contractors for suitable mining operations has been successfully expanded. EGAT keeps losing trained personnel to contractors, but this is out weighed by competitive bidding for contracts (Part I, para. 5.1).

Results

4. The project achieved its main objectives: (i) lignite production has consistently exceeded power generation requirements; (ii) lignite transfer prices have been fixed in accordance with the Lignite Pricing Study; (iii) EGAT's training program continues to provide high quality staff for both itself and indirectly its mining contractors, (iv) villagers occupying mine

areas have been successfully and equitably resettled; (v) stack emission has been maintained below Bank guidelines; and (vi) satisfactory internal economic and financial rates of return have been achieved (see Part III, paras. 6.1 to 6.10 for details concerning the calculation of economic and financial rates of return).

Project Sustainability

5. The Mae Moh complex has already reached a generating capacity of 1725 MW, some 900 MW in excess of that attributable to the project. The mine has sufficient proven and economically mineable lignite (628 million tons) to support the presently planned expansion to 4425 MW peak generation capacity. This will enable mining and generation operations to continue until the year 2023 as planned. At that time there will then remain a further 524 (minimum) million tons of lignite to be exploited from the lower part of Mae Moh basin. It is reasonable to expect that the requisite skills, equipment and techniques will have been developed by the time these more difficult reserves are needed and can be economically recovered (Part I, para. 7.1).

Findings and Lessons Learned

6. EGAT has done an excellent job of managing the Mae Moh lignite mining complex while turning over to the private sector more than half the operations. In the process, mining unit costs have been reduced to about a third the original amount, much of it due to competitive bidding. The reduced lignite costs have not only benefitted EGAT and its customers, but in effect recoverable lignite reserves were increased by making more of the in-place deposits available at an economic cost. EGAT's success with having the private sector help exploit its lignite deposit could serve as a model for other Bank borrowers in similar circumstances (Part I, para. 6.6 and 9.1).

PROJECT COMPLETION REPORT

THAILAND

SECOND MAE MOH LIGNITE PROJECT (LOAN 2407-TH)

Part I

1. Project Identity

Project Name : Second Mae Moh Lignite Project
Loan No. : 2407-TH
RVP Unit : East Asia and Pacific Region
Country : Thailand
Sector : Energy
Subsector : Mining/Power

2. Background

2.1 EGAT started open pit lignite mining in a small way during 1973 to feed a fertilizer plant and a power generating plant, both no longer in service. In 1978 EGAT started a large scale lignite production program to supply three 50 MW power plants. The Bank's first lignite loan (Loan No. 1852-TH) which became effective in 1980 was designed to raise lignite production from an annual 1.0 tonnes to 2.8 tonnes, the amount needed for adding a fourth plant (150 MW). The second lignite project now under review was designed to raise production to 5.0 million tonnes per year.

2.2 The Mae Moh power and mine complex is located in north Thailand in Lampang Province, approximately 650 km north of Bangkok and 12 km east of the town of Lampang. The main land use in the area is commercial teakwood and tobacco cultivation; there is also some limited subsistence agriculture. Population density in the basin is low and the climate is tropical, with an average annual rainfall of 1,000 to 1,500 mm. The area is adequately served by paved roads and by a railway line which connects the site with the national rail system approximately 5 km to the south of Mae Moh.

2.3 At appraisal lignite reserves were determined to be ample and assured for the 825 MW generating capacity available on completion of the project as well as for future additional capacity. Lignite reserves with an average ash content of 22 percent and a calorific value of 2,700 kcal/kg were determined to be 814 million tonnes. However, due to restrictions on pit design because of slope instability, geological losses and other factors recoverable reserves were set at the much lower value of 451 million tonnes of mineable lignite. To illustrate the magnitude of these reserves, a further expansion to 1,725 MW (from the 825 MW at project completion) of power generating capacity would require 335 million tonnes over the plant's useful lifetime.

3. Project Objectives and Description

3.1 The project expanded lignite mining capacity to 5.0 million tonnes per year in order to provide fuel to three additional 150 kW power generating plants (Units 5, 6 and 7) and increase total generating capacity to 825 kW. Its main objectives were: (i) to reinforce economic pricing policies to ensure that planned lignite expansion are economically and financially justified and EGAT's mining operations are viable; (ii) to strengthen EGAT's technical and financial operations through technical assistance; and (iii) to minimize any adverse environmental impact of lignite based electricity generation.

3.2 The project comprised engineering, procurement and erection of mining and related equipment (mainly conveyor belts, semi-mobile crushers, off-highway trucks and auxiliary equipment, technical assistance, training and civil works for the required mining expansion.

4. Project Design and Organization

4.1 Project design was based on a thorough study of alternative mining plans and methods. Foreign mining experts helped EGAT prepare a mining and soil reclamation plan suitable for EGAT's current and future mining operations. The selected mining method was technically sound and presented minimal technical risks. It consisted of trucks and shovels in combination with semi-mobile crushers and conveyors. Alternative methods considered included bucket wheel excavators which were unsuitable for mining conditions at Mae Moh and mobile crushers which were considered technically risky.

4.2 With the experience gained in carrying out the first lignite project, EGAT was well prepared for the second project. Lignite mining operations and project implementation were well organized and professionally executed under the overall direction of the Lignite Mine Department. Project management and related responsibilities were delegated to the Directorate of the Department under the supervision of the Deputy Director.

5. Project Implementation

5.1 Construction and commissioning of the three project-related 150 MW generating units, numbers 5, 6 and 7, to raise total generating capacity to 825 MW, was completed by September 1985, six months earlier than originally anticipated in the appraisal report. Lignite production for these units was ahead of the appraisal scheduling and has continued to be in excess of generation requirements to the present time (1991), the overall Mae Moh generating capacity having now reached 1725 MW of the ultimately programmed 4725 MW. The major procurement item in the original project financing plan was an in-pit system for overburden crushing, transportation and dumping valued at US\$39.7 million, 67% of the total US\$59.1 million loan amount. However, successful experience in their first contracted-out overburden removal operation showed EGAT that major practical and financial benefits could be achieved by subcontracting. This subsequently led to a decision to contract-out virtually all of the overburden removal and a significant percentage of the interburden and lignite handling from then on. The decision to do so obviated the requirement for EGAT to procure the in-pit overburden

system, since the proposed contracts would require contractors to provide their own capital equipment. In consequence, the decision to contract-out resulted in EGAT's cancellation of 75% of the total loan in December 1986, some US\$44.1 million, effectively reducing the loan amount to US\$15.0 million. Although the procurement of most of the other project-related equipment was generally completed on time, the requirement for some minor items was lessened by the success of the contracting-out. Consequent delays in procurement resulted in the loan closing date being extended by a total of three years.

5.2 While the original EGAT project was based upon the then-anticipated lignite reserves of 150 million tonnes of lignite, a subsequent exploration program has increased the proven resource to almost 1,500 million tonnes and has prompted the continuous up-grading of the planned power generating capacity to its presently planned ultimate level of 4425 MW - 3600 MW greater than that planned within the Bank-financed project under discussion. This capacity would require the production of 628 million of the 1,152 million tonnes of lignite which are presently considered to be economically mineable at Mae Moh. Uncertainties regarding the technical feasibility of mining the remaining non-scheduled 524 million tonnes of lignite situated in the deepest part of the Mae Moh basin still remain to be resolved. Neither EGAT nor Coleman Associates, the Australian long-term mining consultants resident at Mae Moh, are able at this time to predict the practicability or economic viability of mining the 500 meter-deep center of the basin. Mae Moh's working ratio of overburden to lignite is, and will continue to be, an advantageously low 5 cu. m.

5.3 Increased expertise in equipment operation, repair and maintenance, coupled with the contracting-out of the major part of overburden removal, have resulted in a major increase in equipment availability and a consequent reduction in EGAT's future requirements for replacement shovels, trucks, bulldozers, etc. There is every reason to believe that continued success in contracting-out operations will inevitably result in the inclusion of even more of the operational sectors presently carried out by EGAT equipment and staff, in the newer contracts, thus leading to less capital equipment requirements for EGAT's mining directorate together with lower unit mining costs due to competition.

6. Project Results

6.1 The project clearly achieved its objective of assisting in the increase of Mae Moh's power generating capacity to a level of 825 MW (via a lignite production of 4.5 million tonnes) by 1986 rather than the 1987 forecast in the SAR. Further, generating units 8 and 9 were commissioned in 1989 and 1990. Lignite production has consistently exceeded requirements and has been able to provide an in-pit inventory of exposed (immediately accessible) in-situ lignite of approximately 14 million tonnes (1.5 years' present consumption) at peak demand. Current planning assumes the production of over 30 million tonnes of lignite per year for units 1-19 by the year 1998 which can already be confidently expected to be achievable.

6.2 EGAT's lignite transfer prices are fixed in accordance with the recommendations of the Lignite Pricing Study and are consistent with stated objectives to reflect the economic cost of imported coal and to provide for

the financial viability of EGAT's mining operations. The price is designed to cover production costs and includes a further margin to ensure the covering of debt servicing, replacement of fixed assets and EGAT's exploration expenses.

6.3 EGAT's training programs have been highly successful although the contracting-out of overburden removal has resulted in the 'poaching' of trained and experienced engineering staff and operators by the private contractors now involved at Mae Moh - a practice which is normal in similar situations worldwide. In effect, as the mine production becomes greater and overall technical staff requirements expand, EGAT continues to provide and train the majority of the engineering staff required by itself (voluntarily) and the contractors (involuntarily) despite reducing its own requirements by progressively contracting-out an increasingly high proportion of its field operations.

6.4 As it gained experience, EGAT has become more successful in the resettlement of villagers occupying the mining areas. The new resettlement townships to the south of Mae Moh are well established and the new inhabitants appear to be settling in satisfactorily. Roads, power and water supplies, drainage and communal and municipal buildings are in place and to a high standard. House building to traditional Thai design is assisted by EGAT and the buildings themselves are of a higher standard than those vacated in the villages disturbed by the mining operations. A model agricultural smallholding has been established by EGAT in the village in an attempt to encourage self-sufficiency but the scheme has reportedly had disappointing results since a large number of the displaced villagers are employed on the mine and feel no need to participate.

6.5 During project implementation and subsequently, average levels of sulfur dioxide and other stack emissions have not exceeded Bank guidelines. However, the addition of units 12 and 13 is expected to do so and EGAT will include wet scrubbers in their design and specifications. In addition, if it proves to be necessary, EGAT will retrofit units 10 and 11 with sorbent injection systems. Mine dust disturbance is minimized by water-spraying on haul roads and at conveyor transfer points. As areas of permanent overburden dumps are completed they are being graded and contoured and planted with trees in accordance with an approved final restoration master plan. Predetermined areas will be restored to agriculture with recovered topsoil. The mining pit itself will not be restored to previous surface levels but will be allowed to fill with water to form a large lake intended primarily for recreational purposes.

6.6 The project and its subsequent expansion has had and is having a substantial impact on what was previously a remote and rural area. The area is now served by well-maintained and modern road and rail facilities, and the mine/power station complex is providing direct employment for over 2,000 people and indirect employment for many others. The project has resulted in the formation of a well-trained, highly skilled and efficient workforce which can be used to expand EGAT's operations to other parts of Thailand in the future, e.g. to form the nucleus of the necessary workforce for the proposed lignite mine at Saba Yoi in southern Thailand. While the present planning envisages a completion of operations in 2023 and subsequent abandonment of the area by EGAT, improved mining techniques can be expected to have been

developed by that time to enable mining of the 500 million tonnes in the center of the basin. This would enable further stations to be constructed and extend the life of the complex and its associated benefit to the local community for many years.

6.7 The economic and financial rates of return calculated in the SAR and reevaluated in this PCR are tabulated below. The basis of the calculations and the variances between the SAR and PCR are explained in Part III, paras. 6.1-6.10 inclusive.

Economic Rate of Return (%)

	<u>SAR</u>	<u>Reevaluated</u>
Mine expansion only	17.2	16.0
Combined mine and power	14.3	12.6
Substitution basis	13.7	13.8

Financial Rate of Return (%)

	<u>SAR</u>	<u>Reevaluated</u>
Mine expansion only	9.2	15.9
Combined mine and power	12.0	9.1

7. Project Sustainability

7.1 The complex has already reached a generating capacity of 1725 MW, some 900 MW in excess of that related to the subject project. The mine has sufficient proven and economically mineable lignite (628 million tonnes) to support the presently planned expansion to a 4425 MW peak generation capacity. This will enable mining and generation operations to continue until the year 2023 as planned. At that time, there will then remain a further 524 (minimum) million tonnes of lignite to be exploited from the lower part of Mae Moh basin if experience of the present mining limits show that at least some portion of this is economic and practicable. With progressive development of equipment, skills and techniques, it should be possible to recover at least a good proportion of this deeper layer.

8. Bank Performance

8.1 The Bank can be considered to have performed efficiently and adequately throughout the project cycle. The fact that the majority of the loan was eventually canceled was due to a decision by EGAT, fully supported by the Bank, that must be regarded as the best possible outcome for the project. It resulted in a sizeable reduction in the mine's unit costs, reduced EGAT's future capital requirements at Mae Moh and provides continuing major opportunities for private sector participation in Thailand. EGAT intend to award earthmoving contracts worth, in total, approximately US\$4.0 billion by the year 2016.

9. Borrower's Performance and Project Relationship

9.1 The credit for the success of this project and the previous Mae Moh project is due, in the most part, to the skills and commitment of EGAT's mine directorate staff, both in their Bangkok headquarters and at the mine itself. The efficiency of the mine can now be favorably compared with any other successful international mining project--Bank financed or otherwise. A strong dedication to environmental protection is also clearly defined and evident at the mine and in the power station development. EGAT's project procurement department procedures and their communications with the Bank cannot be faulted and could advantageously be used as a model for other borrowers. Documentation is always timely and requests for information are promptly, courteously and efficiently fulfilled.

9.2 Relationships between EGAT and the Bank have been, and continue to be, close, cordial and technically profitable. The gradual move towards the transfer of major earth-moving operations, via contracts to the private sector inevitably means that less Bank assistance will be required on mining projects but should not affect the continuation of assistance in power-generation-related projects.

10. Project Documentation and Data

10.1 No problems were encountered in the project's documentation during the life of the project. In addition, EGAT's computerized MIS was instrumental in their ability to be able to provide essential relevant information on all aspects of technical and financial management in a timely fashion whenever it was requested or required.

PROJECT COMPLETION REPORT

THAILAND

SECOND MAE MOH LIGNITE PROJECT
(LOAN 2407-TH)

Part II PROJECT REVIEW FROM BORROWER'S PERSPECTIVE

1. Project Background

Due to the growth in energy demand and the world oil crisis during 1970, more power plants were envisaged and planned for construction. Thus, EGAT requested the first Mae Moh Lignite Project loan from the Bank under Loan No.1852-TH provided for the mine expansion for power plant unit 4 which was operated in March 1984. In operation of 4 units, lignite consumption was increased from 1.0 million tpy to 2.8 million tpy.

During this decade, further exploration of Mae Moh lignite deposit has been intensively carried out. Geological drilling results identified total geological lignite reserves of approximately 1,468.0 million tonnes at Mae Moh Mine which are sufficient to sustain 1725 MW (units 1-10) power generating capacity, for at least 30 years. In order to cope with the increase in power demand in the country and to reduce imported fuel oil in accordance with the Government's policy, EGAT further constructed power units 5-6-7 of 150 MW capacity each on the same site. Subsequent expansion of mine operation to produce lignite of 5.0 million tpy. was required for serving 7 power units at total 825 MW. capacity.

The long term mining plan was prepared by EGAT deciding to select trucks and shovels in combination with semi-mobile crusher with conveyor belt and stacker which was studied the most suitable mining method for Mae Moh Mine.

In seeking financial support for the project, EGAT requested the second Bank loan for the expansion of Mae Moh Mine for the power plant units 5-6-7. The Bank mission had appraised the project in 1983 and the Loan No.2407-TH Agreement at the estimated amount of US\$ 59.1 million was signed on November 9, 1984 covering the expenditure for engineering, procurement and erection of mining equipment.

2. Project Results

Considering the technical and overall implementation of the project, the performance can be assessed efficient and effective. The project yielded the positive results regarding the adequacy, the timeliness, and the satisfactory outputs which generally met the targets. The project evaluation and assessment to support the above concluded result is shown in the Summary Sheet for Project Review, and details of incremental financial and economic rates of return in Annexes 1,2 and 3.

Though the financial spending, in respect of the project cost and the loan, was regarded well managed, the timeliness of the disbursement from the loan was rather behind schedule which resulted in three time extensions of loan closing date, from originally April 30, 1988 to April 30, 1991.

SUMMARY SHEET FOR PROJECT REVIEW
AND COMPLETION REPORT

Project Title : SECOND MAE MOH LIGNITE PROJECT

Executing and Implementing Agency : ELECTRICITY GENERATING AUTHORITY
OF THAILAND (EGAT)

Loan Agency : INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT (IBRD)

Funding Sources	Investment Cost (US\$ million)	
	Original Planned	Actual
IBRD	59.1	14.361
KFW	16.8	16.276
ADAB	4.2	-
OTHERS (commercial banks)	10.0	-
EGAT & GOVERNMENT	159.7	45.306
Total	249.8	75.943

Project Commencement		Project Completion	
Planned	Actual	Original	Actual
1983	1983	1987	1989

A. OVERALL SUMMARY (PROJECT PERFORMANCE)

1. Project Purpose, Goal, and Accomplishment

EGAT's purpose to expand the mine to increase lignite production as substitution of imported oil was fulfilled. The coal supply to the seven lignite-fired power units at Mae Moh has greatly reduced the dependence on the fuel oil and has saved a large amount of budget during the plant operation. The goal to produce lignite of 5.0 million tonnes per year for power generation was also accomplished sooner than scheduled due to earlier operation of the additional units 5-6-7.

2. Financial Spending

The revised project cost for the mine expansion for power units 5-6-7 was estimated US\$ 86.240 million. The actual spending of US\$ 75.943 million was lower than planned by 12 per cent.

The revised funding sources for this project were in form of loan from the Bank, supplier's credit from KFW, Government contributions, and EGAT's own revenue.

Because of cancellation of waste handling system purchase, the originally agreed loan amount of US\$ 59.1 million was requested by EGAT to reduce to US\$ 15.0 million.

For disbursement, the loan amounts were mainly spent on equipment and engineering services. Upto August 6, 1991 the loan of US\$ 14,360,557.28 out of US\$ 15.0 million was disbursed. The final balance of US\$ 639,442.72 or 4.26% of the loan was cancelled due to the latest agreed closing date.

3. Lesson Learned

During the course of project implementation, EGAT have learned about the advantages of contracting out the overburden removal and the equipment maintenance work.

EGAT's original mining strategy was to carry out the overburden removal activities by its work force. However, after consideration of previous experience in contracting out the overburden removal, coincidentally with the Government's National Borrowing Plan and the Debt Ceiling Policy, EGAT, then revised the mine operation plan and decision was made to contract out the long-term overburden removal. According to this strategy, EGAT could reduce the investment cost for procurement of equipment and spare parts and meet the Government's policy in promoting the private firms to undertake the large scale contract.

The equipment maintenance contract could also solve the delay problem in waiting for spareparts and thus improve the overall maintenance performance. Besides, the increasing of staff could be controlled in line with EGAT's policy.

4. Conclusion

The project was executed successfully as the mine could produce lignite of 5.0 million tonnes per year for supply to all seven power units as planned.

With regard to the privatization policy, it is advantageous for EGAT in contracting out the overburden removal which resulted in considerable cost reduction. Besides, the invitation for competitive bidding, EGAT could gain benefit by getting the most reasonable price.

From the evaluation of economic impact, the incremental analysis based on two cases i.e. mine expansion only, and the combined mine and power development, the economic rates of return are 15.96% and 12.55% respectively which are lower than the original estimate in the SAR (case 1 = 17.20%, case 2 = 14.30% respectively), but still above the estimated opportunity cost of capital in Thailand of 12%.

It can be seen also in the financial impact analysis that the incremental rate of return of 15.85% for the mine expansion only is above the estimate in the SAR (9.20%) while 9.13% of the second case based on the combined mine and power development is lower than the estimate in the SAR (12.00%). However, they are still above the original estimates under the existing covenants which require to have the rate of return of at least 8%, by FY 1982 and thereafter.

According to the rate of return analysis, it could be assumed that the Mae Moh Mine Expansion Project for Power Units 5-6-7 is feasible.

B. EVALUATION AND ASSESSMENT OF PERFORMANCE, OF THE BORROWER
AND THE BANK AND EFFECTIVENESS OF THEIR RELATIONSHIP

Analysis	Evaluation and Assessment					
	Inadequate	Adequate	not timely	timely	Good	Excellen
<p>1. <u>Project Design and Implementation</u></p> <ul style="list-style-type: none"> - Project activities commensurate with inputs - Project output commensurate with activities - Design of the project logical, impact-oriented - Timeliness of project implementation - Compliance of project implementation with plan - Collaboration between institution involved in the project implementation 					<p>x</p> <p>x</p> <p>x</p> <p>x</p> <p>x</p> <p>x</p>	
<p>2. <u>Staff Inputs</u></p> <ul style="list-style-type: none"> - Sufficient EGAT staff involved - Sufficient IBRD staff involved 		<p>x</p> <p>x</p>			<p>x</p> <p>x</p>	

Analysis	Evaluation and Assessment					
	Inadequate	Adequate	not timely	timely	Good	Excellent
- Collaboration between project staff and staff of IBRD					x	
- Timeliness of availability of IBRD assistance				x		
3. <u>Consultancy Service</u>						
- Sufficient consultant input		x			x	
- Adequacy of job description performed		x			x	
- Consultant technically qualified for task					x	
- Quality and quantity of work of consultant					x	
- Collaboration between project staff and consultant					x	
4. <u>Financing</u>						
- Availability of loan at schedule				x		
- Timeliness of loan disbursed to the			x			

Analysis	Evaluation and Assessment					
	Inadequate	Adequate	not timely	timely	Good	Excellent
- Flexibility of loan given to the project					x	
5. <u>Materials and Equipment</u>						
- Materials requirement planned		x				
- Quality of project materials and equipment					x	
- Availability of project materials and equipment acquired				x		
- Timeliness of delivery of project materials and equipment				x		
- Timeliness of use of project materials and equipment				x		
6. <u>Project Relationship</u>						
- Collaborative relationship between the IBRD and EGAT					x	
- Collaborative relationship between EGAT and the assigned					x	

Analysis	Evaluation and Assessment					
	Inadequate	Adequate	not timely	timely	Good	Excellent
- Cooperation in technical aspect resolution solving					x	
<u>7. Project Environment</u>						
- Policy support from the Government					x	
- Implementational support and assistance from IBRD and the assigned consultants					x	
- Co-ordination with related government programs					x	
- Integration in economic/social policy					x	
<u>8. Project Outputs</u>						
- Timeliness of outputs produced				x		
- Availability of and accessibility to the outputs produced				x		

Analysis	Evaluation and Assessment					
	Inadequate	Adequate	not timely	timely	Good	Excellent
- Project objectives achieved as compared to the outputs					x	
- Commensurateness of planned project target with outputs produced						x
9. <u>Project Sustainability</u>						
- Adequacy of technical and administrative capability to continue maintaining the project		x				
- Government's continued power expansion and development policies		x				
- Beneficiaries receptiveness to the project						x

PROJECT COMPLETION REPORT

THAILAND

SECOND MAE MOH LIGNITE PROJECT
(LOAN 2407-TH)

Part III STATISTICAL INFORMATION

1. Related Bank Loan

1.1 Loan 2407-TH was a continuation of Bank lending in support of EGAT's lignite mining operations initiated by Loan 1852-TH described below:

Loan No. : 1852-TH
Title : Mae Moh Lignite Project
Purpose : Lignite production for electric power generation
Year of Approval : 1980
Status : Project was successfully completed and is operating satisfactorily
Comment : Project Completion Report was issued in December

2. Project Timetable

<u>Item</u>	<u>Date Planned</u>	<u>Date Actual</u>
First presented to the Bank	-	07/82
Preparation	-	07/82
Appraisal Mission	01/17/83	01/17/83
Negotiations	01/16/84	02/21/84
Board Approval	03/13/84	04/24/84
Loan Signature	-	11/09/84
Loan Effectiveness	-	02/19/85
Project Completion	04/30/87	01/31/87
Loan Closing	04/30/88	04/30/91

3. Loan Disbursement

Cumulative Estimated and Actual Disbursements
(US\$ million)

IBRD Fiscal Year and Semester	Actual Disburse- ments	Appraisal Estimate	Revised Estimate	Actual as % of Revised
<u>1984</u>				
December 31, 1983	-	3.4	-	-
June 30, 1984	-	4.6	-	-
<u>1985</u>				
December 31, 1984	-	7.8	-	-
June 30, 1985	0.15	17.9	0.15	100.0
<u>1986</u>				
December 31, 1985	0.15	33.4	0.15	100.0
June 30, 1986	0.29	50.7	0.15	193.0
<u>1987</u>				
December 31, 1986	0.32	57.2	0.15	213.0
June 30, 1987	0.32	59.1	0.15	213.0
<u>1988</u>				
December 31, 1987	0.32		0.15	213.0
June 30, 1988	0.34		0.46	73.9
<u>1989</u>				
December 31, 1988	1.83		3.63	50.4
June 30, 1989	6.71		11.57	58.0
<u>1990</u>				
December 31, 1989	10.38		14.69	70.7
June 30, 1990	12.66		15.00	84.4
<u>1991</u>				
December 31, 1990	13.34		-	88.9
June 30, 1991	13.82		-	92.1
August 6, 1991	14.36		-	95.7

The last disbursement of US\$146,178 equivalent was made on August 5, 1991.

4. Project Implementation

4.1 Annex 4 compares the scheduled project activities with the actual accomplishments. Implementation performance was generally satisfactory except for some procurement delays.

5. Project Costs and Financing

A. Comparison of Estimated and Final Project Costs /a
(US\$ Million)

	<u>Estimated</u>			<u>Final Cost</u>		
	<u>Foreign</u>	<u>Local</u>	<u>Total</u>	<u>Foreign</u>	<u>Local</u>	<u>Total</u>
Second Lignite Handling System (KFW)	19.728	-	19.728	19.204	-	19.204
Lignite Handling System-Ext.	6.930)	3.887/c)	17.440/c	5.701	0.762	6.463
mining Equipment	6.623))		8.355	3.539	11.894
and	-	1.527	1.527	-	0.775	0.775
ecological Drilling	-	3.257	3.257	-	3.033	3.033
river Diversion (Water Supply Management)	-	9.084	9.084	-	9.775	9.775
Engineering & Training	1.300	3.468/b	4.768/b	0.225	1.238	1.463
Civil Work	-	12.832	12.832	-	10.745	10.745
Import Duties	-	9.773	9.773	-	9.662	9.662
Interest During Construction	-	7.684	7.684	0	2.782	2.782
Bank Front End Fee	0.147	-	0.147	0.147	-	0.147
<u>Total</u>	<u>34.728</u>	<u>51.512</u>	<u>86.240</u>	<u>33.632</u>	<u>42.311</u>	<u>75.943</u>

/a The cost comparison is based on the reestimated project cost following cancellation of waste handling equipment and engaging local contractors for overburden removal. A comparison with the appraisal estimate is no longer meaningful.

1 Includ ed others.

2 Includ ed contingencies.

B. Project Financing
(US\$ Million)

	<u>Revised</u>			<u>Actual Funding</u>		
	<u>Local</u>	<u>Foreign</u>	<u>Total</u>	<u>Local</u>	<u>Foreign</u>	<u>Total</u>
<u>Equity</u>						
Government Tax Rebate						
Contributions	9.77	-	14.4	9.66	-	9.66
Internal Cash Generation (EGAT)	41.77	2.93	145.3			
ADAB Grant	-	-	-	32.65	2.99	35.64
<u>Total Equity</u>	<u>51.51</u>	<u>2.93</u>	<u>54.44</u>	<u>42.31</u>	<u>2.99</u>	<u>45.30</u>
<u>Long-Term Debt</u>						
IBRD	-	15.0	15.0	-	14.36	14.36
Germany (KfW)	-	16.8	16.8	-	16.28	16.28
<u>Total Long Term Debt</u>	<u>-</u>	<u>31.8</u>	<u>31.8</u>	<u>-</u>	<u>30.64</u>	<u>30.64</u>
<u>Total Financing Required</u>	<u>51.51</u>	<u>34.73</u>	<u>86.24</u>	<u>42.31</u>	<u>33.63</u>	<u>75.94</u>

6. Project Results

A. Direct Benefits

6.1 The mining expansion for Power Plans 5, 6 and 7 has created additional job opportunities, raised living standards and substantially improved the quality of life of the local population. About 370 families had to be resettled approximately 7 km to the west of the mining area. Each household received fair compensation along with a farm and family land plot. The resettlement area has developed into a good sized community complete with better roads, water supplies, electricity, market area, health center, primary school, recreation area and religion center.

B. Economic Impact

6.2 The economic rate of return on the project is reevaluated by adopting the same approach as used in the Staff Appraisal Report (SAR). The analyses are carried out in two separated bases:

- (a) on an incremental basis with and without the project, and
- (b) on a substitution basis whereby the relative benefits and costs of the mining and power development are compared to a coastal power plant burning imported coal under the assumption that a 450 MW coal-fired plant would substitute for the combined mining and power investment for Mae Moh Units 5-7.

6.3 For all calculations, cost and benefit streams are based on 1990 terms. Import duties, taxes and interest during construction are excluded. The analysis are made over the same study period as used in the SAR. The Manufacturing Unit Value (MUV) index was used to convert the foreign currency (FC) portion to 1990 terms while Public Fixed Capital Formation Deflator (PFCF) is used for the local currency (LC) portion.

Incremental Analysis

6.4 Economic rate of return estimates were made on the two cases:

- (a) Case 1 - Mine Expansion Only. The cost of mine expansion alone is compared to revenues from sale of lignite to the power plant at the lignite transfer price. Sales revenues are calculated based on the sales tonnage of lignite production of the mine. The actual value of lignite transfer price are used for year 1985 to 1990 and the estimated value is used for 1991 and assumed constant thereafter. The incremental capital cost contains only the investment for the mine expansion, the replacement expenditures of the mine equipments are omitted since the actual project cost of those equipments are difficult to analyze. Operation costs comprise EGAT operating costs together with the contractor costs for removal of overburden.
- (b) Case 2 - Combined Mine and Power Development. The combined cost of mine development and Power Units 5-7 are compared with incremental energy sales (GWh) generated from the power plants. The cost of lignite production is used to represent the fuel cost of the power plants. The sales revenues are calculated based on actual tariffs for year 1985 to 1990, and the estimate values of 1991 are used and assumed constant after that.

6.5 The economic rate of returns on the project based on the incremental basis of the two cases compared with the SAR results are:

	<u>SAR</u>	<u>Reevaluated</u>
Case 1	17.20	15.96
Case 2	14.30	12.55

The details of cost and benefit stream of each case is shown in Annex 2.

It can be seen that the reevaluated values of economic rates of return are slightly lower than the original estimate which is mainly the result of the lower lignite transfer price and power tariff and also the higher cost of Power Units 5-7.

Substitution Analysis

6.6 The economic rate of return based on a substitutional basis is made by analyzing the differential cash flow of the project mining operation combined with power development and the imported coal-fired plant. The benefit stream comprises the sales revenue from Mae Moh Power Units 5-7 and the 450 MW imported coal-fired plant. Both sales revenues are based on the same tariff rates.

6.7 The capital and operating costs for the proposed mine and power development at Mae Moh are the same as used in the Incremental Analysis. The capital and operating cost of the 450 MW imported coal-fired plant are allocated from the cost of the 700 MW Ao Phai Plant with the associated transmission system. The cost of coal is adopted from the CIF price estimated by Industry and Energy Operations Division of the IBRD on May 29, 1991 and included cost of inland transportation. The coal price of US\$54/ton is applied for the year 1985 to 1991 and assumed 0.9% p.a. increase in real terms from 1992 to 2006 and assumed constant after that.

6.8 The calculated economic rate of return based on substitutional basis compared with the SAR result is:

	<u>SAR</u>	<u>Reevaluated</u>
Economic Rate of Return	13.70	13.75

C. Financial Impact

6.9 The financial rates of return of the project are estimated on the incremental basis of:

- (a) the mine expansion only (Case 1), and
- (b) combined mine and power development (Units 5-7) which are designed as one package (Case 2).

The cost and benefit streams of the project are derived from the same approach as applied for the economic rate of return study, but the import duties, taxes and royalties are included.

6.10 The financial rates of returns of the two cases compared with the values calculated at the project appraisal are:

	<u>SAR</u>	<u>Reevaluated</u>
Case 1	9.20	15.85
Case 2	12.00	9.13

It can be seen that present financial rate of return for Case 1 is higher than previously estimated while Case 2 is lower. The main reason is that for Case 1 the capital and operating cost of mining is much lower while the total present value of sales revenue is slightly increased and for Case 2 the higher capital and operating cost of Power Units 5-7 bring down the financial rate of return of the whole package. The present value based on 1990 base year at 12 percent discount rate of each item can be compared below:

PRESENT VALUE AT 12 PERCENT
(US\$ million)

	Sales Revenues	<u>Capital Cost</u>		<u>Operating Cost</u>	
		Mine	Power	Mine	Power
<u>Case 1</u>					
SAR	454.8	157.9	-	339.8	-
PCR	466.9	149.8	-	280.6	-
<u>Case 2</u>					
SAR	1,148.9	157.9	582.6	339.8	102.6
PCR	1,272.1	149.8	773.1	280.6	247.0

7. Status of Covenants

Section	Covenant	Current Status	Remarks/ Actions
LA 3.06	EGAT to furnish the Bank with training programs in financial management and mine operation, and mine planning, by 09/30/84 and 03/31/85 respectively.	Training programs were furnished on time and training was carried out.	None
LA 3.08	EGAT to furnish Bank with report on geo-technical aspects of slope stability at Mae Moh by 01/31/85.	Report received.	None
LA 3.10	By 07/31/87 EGAT and the Bank will review the overburden contract and decide on its renewal, a new contract award or EGAT's undertaking of overburden removal.	Review completed 12/86. Bank agreed with EGAT proposal to award new contract and cancel EGAT procurement of overburden removal system.	None
LA 5.02	EGAT to continue to maintain separate accounts for mining operations.	In compliance.	None
LA 5.03	EGAT's accounts, including those of lignite mining operations, to be audited and auditor's report to be furnished to Bank by April 1 each year. Quarterly unaudited reports to be sent to the Bank.	Satisfactory.	None
LA 5.05 Side letter No. 1	Lignite price to be determined in agreement with the Bank. For FY84 and FY85 the price is to be increased by 2% p.a. In FY85 a review is to be carried out to set 1986 level. Reviews to be carried out every three years thereafter.	Since FY86 EGAT has determined the lignite transfer price annually by using the methodology in the Lignite Pricing Study.	None

Section	Covenant	Current Status	Remarks/
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Actions

LA 5.06	EGAT to achieve an annual rate of return of not less than 8% on average revalued fixed assets.	Changed to self-financing covenant (25%) as per 07/29/88.	Present self-financing ratio is 48% as of 09/30/90. No action required.
LA 5.07	EGAT to seek Bank's agreement if incurring of further debt would raise ratio of debt to equity above 1.5.	Currently this ratio is 1.16 (as of 09/30/90).	None
LA 5.08	Debt with original maturity of 5 years or less should not form more than 15% of EGAT's total debt.	Currently this is 1.67% (as of 09/30/90).	None
LA 5.09	EGAT to seek Bank's agreement if incurring of further debt for mining operations would raise Lignite Mine Department's ratio of debt to equity above 1.5.	Currently this ratio is 0.73 (as of 09/30/90).	None
GA 3.02	The government to take measures as required to produce, for the electricity sector as a whole, annual rates of return of no less than 8%.	Changed to self-financing covenant (25%) as per 07/29/88.	Present self-financing ratio is 48% as of 09/30/90. No action required.

8. Use of Bank Resources

A. Staff Inputs

Task	Input (Staffweeks)
Project Preparation	20.7
Project Appraisal	56.2
Loan Negotiation	11.7
Loan Processing	6.9
Project Supervision	54.4
Project Completion Report	2.8
Project Administration	2.4
<u>Total</u>	<u>155.1</u>

B. Missions

Stage of project cycle	Month/year	No. of persons	Days in field	Specialization /a	Performance rating /b	Type of problems /c
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Through appraisal

1.	07/82	4	16	ENG, EC, FA, FA	-	-
2.	01/83	2	14	FA, EC	-	-

Through effectiveness

1.	06/83	3	11	ENG, FA, FA	-	-
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Supervision /d

1.	04/84	2	12	FA, ENG	1	OA
2.	03/85	2	9	FA, ENG, ENG	2	OA, D
3.	10/85	2	5	FA, ENG	1	OA
4.	05/86	1	2	ENG	1	OA
5.	12/86	2	9	FA, ENG	1	OA
6.	03/87	1	4	ENG	1	OA
7.	07/87	1	3	ENG	1	OA
8.	11/88	1	7	ENG	1	OA
9.	07/89	2	5	ENG, ENG	1	OA

a E = Engineer, EC = Economist, FA = Financial Analyst.

1 = No or minor problems. 2 = Moderate problems.

D = Disbursement, OA = Overall status.

Supervision missions were generally combined with other businesses in the country, mainly Mae Moh I Project.

PROJECT COMPLETION REPORTTHAILANDSECOND MAE MOH LIGNITE PROJECT
(LOAN 2407-TH)Incremental Financial Rate of Return
Mae Moh Expansion - Cash Flow Streams
(US\$ Million, Constant 1990 Terms)

Period	Sales Tonnage (tons)	Transfer Price Const.1990 (US\$/ton)	Sales Revenues	Capital Costs	Operating Cost	Tax Rebate	Net Cash Flow
1978							
1979							
1980							
1981							
1982				1.96			-1.96
1983				34.65			-34.65
1984				51.17			-51.17
1985	1,293,105	30.27	39.33	15.46	19.50		4.37
1986	2,473,334	23.95	59.24	5.48	38.66		15.10
1987	2,959,740	19.87	58.82	5.57	42.00		11.25
1988	3,185,981	18.58	59.19	6.56	35.02		17.61
1989	3,212,962	19.67	63.19	17.58	34.42		11.18
1990	3,214,370	16.79	53.95	7.52	35.96		10.47
1991	3,000,000	17.14	51.42	2.23	25.84		23.35
1992	3,000,000	17.14	51.42	0.51	25.23		25.68
1993	3,000,000	17.14	51.42		35.56		15.87
1994	3,000,000	17.14	51.42		25.10		26.32
1995	3,000,000	17.14	51.42		30.51		20.91
1996	3,000,000	17.14	51.42		28.85		22.57
1997	3,000,000	17.14	51.42		28.07		23.35
1998	3,000,000	17.14	51.42		28.24		23.18
1999	3,000,000	17.14	51.42		32.29		19.14
2000	3,000,000	17.14	51.42		32.57		18.85
2001	3,000,000	17.14	51.42		37.47		13.95
2002	3,000,000	17.14	51.42		34.08		17.34
2003	3,000,000	17.14	51.42		35.49		15.93
2004	3,000,000	17.14	51.42		35.79		15.63
2005	3,000,000	17.14	51.42		28.08		23.34
2006	3,000,000	17.14	51.42		32.30		19.12
2007	3,000,000	17.14	51.42		32.68		18.74
2008	3,000,000	17.14	51.42		37.07		14.35
2009	3,000,000	17.14	51.42		36.43		14.99
Total	-	-	1,310.69	148.69	807.20		354.80

Financial Rate of Return = 15.85%

PROJECT COMPLETION REPORT

THAILAND

SECOND MAE MOH LIGNITE PROJECT
(LOAN 2407-TH)

Incremental Financial Rate of Return

Mae Moh Mine Expansion and Power Units (5-7)

Cash Flow Streams

(US\$ Million, Constant 1990 Terms)

Period	Power Sales (GWh)	Power Tariff (cents/kWh)	Sales Revenues	Capital Cost		Operating Cost		Net Cash Flow
				Mine	Power/a	Mine	Power	
1978					0.02			-0.02
1979					0.02			-0.02
1980					0.05			-0.05
1981					2.91			-2.91
1982				1.96	35.45			-37.41
1983				34.65	240.37			-275.02
1984				51.17	195.09			-246.26
1985	1,395.22	6.59	91.96	15.46	116.05	19.50	13.01	-72.06
1986	2,728.94	6.31	172.12	5.48	83.61	38.66	100.72	-56.36
1987	3,231.47	5.76	186.05	5.57	7.75	42.00	35.23	95.49
1988	3,391.11	5.16	174.82	6.56	2.23	35.02	19.02	111.99
1989	3,298.84	5.00	165.07	17.58	0.09	34.42	21.03	91.95
1990	3,399.27	4.89	166.19	7.52	0.06	35.96	18.76	103.89
1991	3,177.81	4.74	150.56	2.23		25.84	18.76	103.74
1992	2,748.15	4.74	130.21	0.51		25.23	18.76	85.71
1993	2,748.15	4.74	130.21			35.56	18.76	75.89
1994	2,748.15	4.74	130.21			25.10	18.76	86.35
1995	2,748.15	4.74	130.21			30.51	18.76	80.93
1996	2,748.15	4.74	130.21			28.85	18.76	82.60
1997	2,748.15	4.74	130.21			28.07	18.76	83.38
1998	2,748.15	4.74	130.21			28.24	18.76	83.21
1999	2,748.15	4.74	130.21			32.29	18.76	79.16
000	2,748.15	4.74	130.21			32.57	18.76	78.88
001	2,748.15	4.74	130.21			37.47	18.76	73.98
2002	2,748.15	4.74	130.21			34.08	18.76	77.36
2003	2,748.15	4.74	130.21			35.49	18.76	75.96
2004	2,748.15	4.74	130.21			35.79	18.76	75.66
2005	2,748.15	4.74	130.21			28.08	18.76	83.37
2006	2,748.15	4.74	130.21			32.30	18.76	79.15
2007	2,748.15	4.74	130.21			32.68	18.76	78.77
2008	2,748.15	4.74	130.21			37.07	18.76	74.38
2009	2,748.15	4.74	130.21			36.43	18.76	75.02
Total	-	-	3,450.48	148.69	683.70	807.20	564.18	1,246.71

Financial Rate of Return = 9.13%

Included cost of associated transmission system.

PROJECT COMPLETION REPORTTHAILANDSECOND MAE MOH LIGNITE PROJECT
(LOAN 2407-TH)Incremental Economic Rate of Return
Mae Moh Mine Expansion Only (Case 1)Cash Flow Streams
(US\$ Million, Constant 1990 Terms)

Period	Sales Tonnage (tons)	Transfer Price Const.1990 (US\$/ton)	Sales Revenues	Capital Costs	Operating Cost	Tax Rebate	Net Cash Flow
1978							
1979							
1980							
1981							
1982				1.51			-1.51
1983				33.98			-33.98
1984				40.57			-40.57
1985	1,299,105	23.29	30.25	13.32	13.52		3.41
1986	2,473,334	18.42	45.57	4.99	26.81		13.76
1987	2,959,740	15.29	45.24	5.02	29.13		11.10
1988	3,185,981	14.29	45.53	6.51	24.29		14.73
1989	3,212,962	15.13	48.60	14.90	23.87		9.83
1990	3,214,370	12.91	41.50	6.31	24.94		10.25
1991	3,000,000	13.18	39.55	1.88	18.09		19.59
1992	3,000,000	13.18	39.55	0.51	17.66		21.38
1993	3,000,000	13.18	39.55		24.89		14.66
1994	3,000,000	13.18	39.55		17.57		21.98
1995	3,000,000	13.18	39.55		21.36		18.19
1996	3,000,000	13.18	39.55		20.19		19.36
1997	3,000,000	13.18	39.55		19.65		19.90
1998	3,000,000	13.18	39.55		19.77		19.78
1999	3,000,000	13.18	39.55		22.60		16.95
2000	3,000,000	13.18	39.55		22.80		16.76
2001	3,000,000	13.18	39.55		26.23		13.32
2002	3,000,000	13.18	39.55		23.86		15.69
2003	3,000,000	13.18	39.55		24.85		14.71
2004	3,000,000	13.18	39.55		25.05		14.50
2005	3,000,000	13.18	39.55		19.65		19.90
2006	3,000,000	13.18	39.55		22.61		16.94
2007	3,000,000	13.18	39.55		22.88		16.68
2008	3,000,000	13.18	39.55		25.95		13.61
2009	3,000,000	13.18	39.55		25.50		14.05
<u>Total</u>	<u>-</u>	<u>-</u>	<u>1,008.22</u>	<u>129.50</u>	<u>563.71</u>		<u>315.01</u>

Economic Rate of Return = 15.96%

PROJECT COMPLETION REPORT

THAILAND

SECOND MAE MOH LIGNITE PROJECT
(LOAN 2407-TH)

Incremental Economic Rate of Return

Mae Moh Mine Expansion and Power Units (5-7)

Cash Flow Streams
(US\$ Million, Constant 1990 Terms)

Iod	Power Sales (GWh)	Power Tariff (cents/kWh)	Sales Revenues	Capital Cost		Operating Cost		Net Cash Flow
				Mine	Power/a	Mine	Power	
					0.02			-0.02
					0.02			-0.02
					0.05			-0.05
					2.91			-2.91
				1.51	34.35			-35.86
				33.98	224.80			-258.78
				40.57	176.81			-217.38
	1,395.22	6.59	91.96	13.32	109.10	13.52	9.10	-53.09
	2,728.94	6.31	172.12	4.99	80.10	26.81	70.51	-10.29
	3,231.47	5.76	186.05	5.02	6.77	29.13	24.66	120.47
	3,391.11	5.16	174.82	6.51	2.18	24.29	13.32	128.53
	3,298.84	5.00	165.07	14.90	0.11	23.87	14.72	111.46
	3,339.27	4.89	166.19	6.31	0.03	24.29	17.46	117.44
	3,177.81	4.74	150.56	1.88		18.09	17.46	113.13
	2,177.81	4.74	150.56	1.88		17.66	17.46	94.57
	2,748.15	4.74	130.21	0.51		24.89	17.46	87.85
	2,748.15	4.74	130.21			17.57	17.46	95.17
	2,748.15	4.74	130.21			21.36	17.46	91.38
	2,748.15	4.74	130.21			20.19	17.46	92.55
	2,748.15	4.74	130.21			19.65	17.46	93.09
	2,748.15	4.74	130.21			19.77	17.46	92.97
	2,748.15	4.74	130.21			22.60	17.46	90.14
	2,748.15	4.74	130.21			22.80	17.46	89.95
	2,748.15	4.74	130.21			26.23	17.46	86.51
	2,748.15	4.74	130.21			23.86	17.46	88.88
	2,748.15	4.74	130.21			24.85	17.46	87.90
	2,748.15	4.74	130.21			25.05	17.46	87.69
	2,748.15	4.74	130.21			19.65	17.46	93.09
	2,748.15	4.74	130.21			22.61	17.46	90.13
	2,748.15	4.74	130.21			22.88	17.46	89.87
	2,748.15	4.74	130.21			25.95	17.46	86.80
	2,748.15	4.74	130.21			25.50	17.46	87.24
	-	-	3,450.48	129.50	637.25	563.71	481.57	1,638.45

Economic Rate of Return = 12.55%

Included cost of associated transmission system.

PROJECT COMPLETION REPORTTHAILANDSECOND MAE MOH LIGNITE PROJECT
(LOAN 2407-TH)Economic Rate of Return on Differential Cash Flow /aCash Flow Streams
(US\$ Million, Constant 1990 Terms)

Period	Revenues	Revenues	Capital	Capital	Operating Cost		Coal	Net
	Lignite	Coal	Costs	Costs	Lignite	Coal		
	(+)	(-)	Lignite	Coal	(-)	(+)	(+)	(=)
			(-)	(+)				
1978			0.02					-0.02
1979			0.02					-0.02
1980			0.05	46.94				46.89
1981			2.91	36.21				33.30
1982			35.86	108.06				72.20
1983			258.78	171.72				-87.06
1984			217.38	85.37				-132.01
1985	91.96	177.86	122.42	27.22	22.63	13.14	62.50	-128.09
1986	172.12	172.12	85.09		97.32	13.14	62.65	-106.62
1987	186.05	186.05	11.79		53.79	13.14	73.75	21.30
1988	174.82	174.82	8.69		37.60	13.14	77.34	44.18
1989	165.07	165.07	15.01		38.60	13.14	75.29	34.82
1990	166.19	166.19	6.34		42.40	13.14	77.27	41.67
1991	150.56	150.56	1.88		35.55	13.14	72.24	47.95
1992	130.21	130.21	0.51		35.12	13.14	63.03	40.53
1993	130.21	130.21			42.35	13.14	63.58	34.37
1994	130.21	130.21			35.03	13.14	64.15	42.25
1995	130.21	130.21			38.82	13.14	64.73	39.04
1996	130.21	130.21			37.66	13.14	65.31	40.79
1997	130.21	130.21			37.11	13.14	66.89	41.91
1998	130.21	130.21			37.23	13.14	66.48	42.38
1999	130.21	130.21			40.06	13.14	67.08	40.15
2000	130.21	130.21			40.26	13.14	67.68	40.55
2001	130.21	130.21			43.69	13.14	68.28	37.72
2002	130.21	130.21			41.32	13.14	68.89	40.71
2003	130.21	130.21			42.31	13.14	69.52	40.35
2004	130.21	130.21			42.51	13.14	70.14	40.77
2005	130.21	130.21			37.12	13.14	70.77	46.79
2006	130.21	130.21			40.07	13.14	71.42	44.48
2007	130.21	130.21			40.34	13.14	71.42	44.21
2008	130.21	130.21			43.41	13.14	71.42	41.14
2009	130.21	130.21			42.96	13.14	71.42	41.59
Total	3,450.48	3,536.38	766.75	475.53	1,045.28	328.41	1,722.22	628.22

Economic Rate of Return = 13.75%

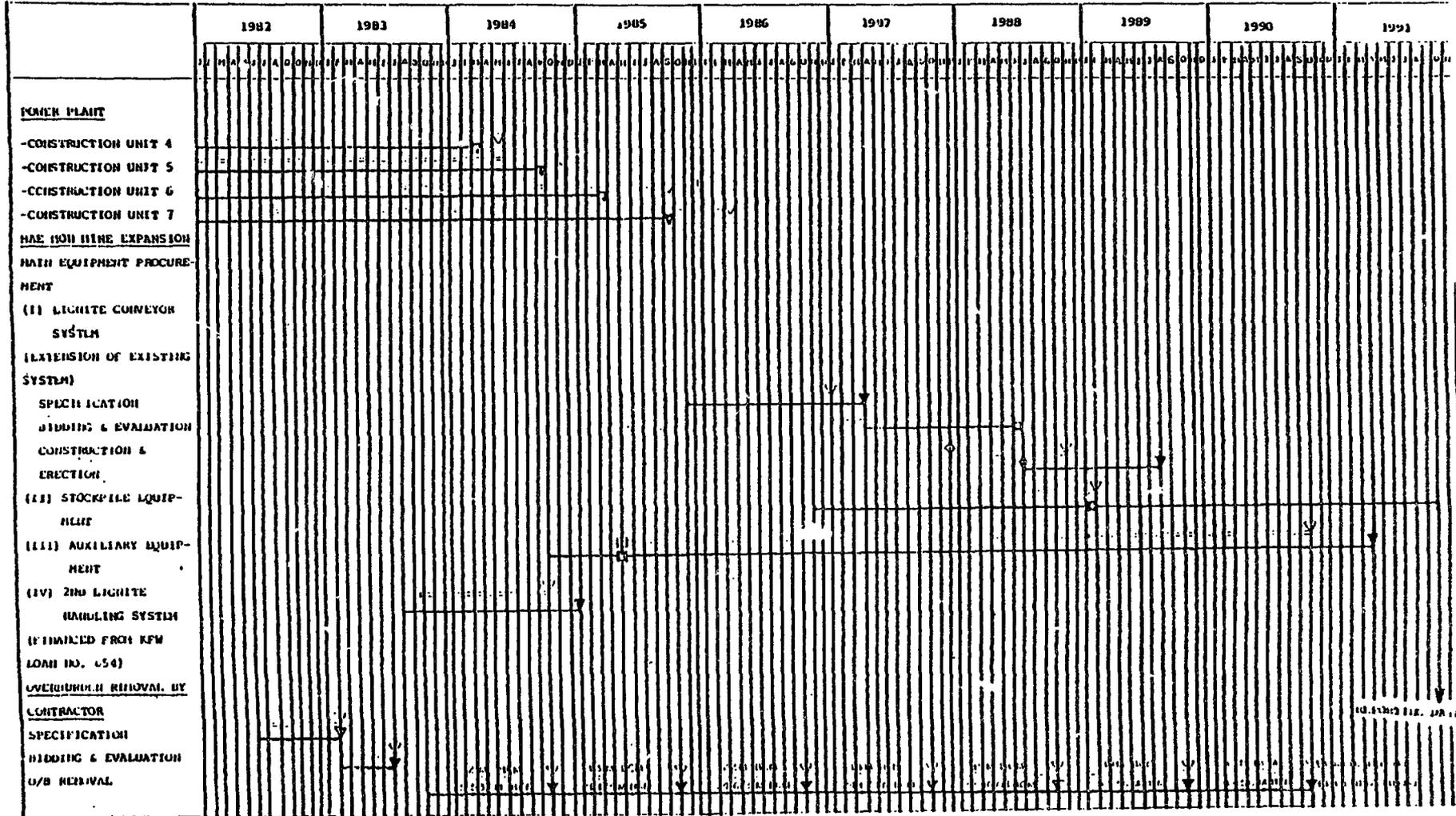
/a Lignite Project (Mae Moh) expansion and Power Units (5-7) compared with a coal-fired power plant.

THAILAND

SECOND MAE MOH LIGNITE PROJECT
(LOAN 2407-TH)

ANNEX 4

IMPLEMENTATION SCHEDULE



LEGEND (I) PLACE ORDER — SCHEDULE
 ◊ START ERECTION — ACTUAL
 ▽ COMPLETED