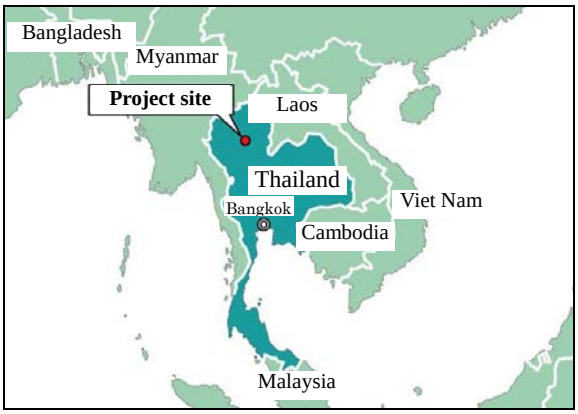
Thailand

Flue Gas Desulfurization Plant For Mae Moh Power Plant(Unit 8-11)

Report Date: August 2003

Field Survey: June - August 2003

1. Project Profile and Japan's ODA Loan



Location of Mae Moh Power Plant

Generators 8 thru 11 where desulphurization equipment was installed

1.1 Background

The amount of energy consumed in Thailand rose sharply accompanying the country's favorable economic growth, with commercial energy demand climbing by 55% during the 3 years from 1987 to 1990. Due to the combustion of fossil fuels during that time, there was a rapid increase in the emission of sulfur dioxide (SO_x[1]), nitrogen oxide (NOx), and suspended particulate matter (SPM), etc., and an air pollution problem developed. Above all, it was estimated that the power generation sector discharged approximately 60% of the SO_2 and just under 20% of the NOx in Thailand.

Mae Moh Power Plant currently consists of generators 1 through 11 with a capacity of 2,025MW. The plant is a large power plant that, in terms of capacity, comprises approximately 17% of the Electricity Generating Authority of Thailand (EGAT) total capacity (the total capacity of EGAT in June 1993 was 11,886MW), and in terms of the amount of power generated approximately 26% (FY1992) overall of EGAT. The fuel used is lignite, which is mined from the adjacent Mae Moh coalfield, and the character of the lignite is low calorie and high sulfur content. Consequently, when the lignite is combusted, emission of SO_2 is high, with an estimated annual emission of approximately 540,000 tons. It was important to draw up air pollution countermeasures because, in some cases, the concentration of SO_2 in the surrounding area exceeded environmental standards, and moreover, both the Mae Chaem and Lampang power plants were scheduled to be built in the neighboring area in the future. Also, it was planned to establish SO_2 emission standards for the plant in 1993, and so countermeasures to meet the planned standards became necessary.

In October 1992, an air pollution problem attributed to SO_2 became evident. Since strong anxiety

[1] SO_x refers to all sulfur oxides (sulfur dioxide (SO_2), sulfuric anhydride (SO_3), etc). SO_x is used to indicate emissions and concentration when discussing the operation of the desulphurization equipment, and SO_2 is used as the index for air monitoring.

developed concerning air pollution due to the burning of lignite at the power plant, it became necessary to take immediate measures for improvement. Moreover, downward adjustment in output was necessary particularly from November through April every year prior to implementing this project, but since it was forecast that the electric supply would become extremely delicate in two or three years following the appraisal, there was a need to bring the plant closer to full operation by installing desulphurization equipment immediately.

1.2 Objectives

The objective was to ensure a reduction in SO_2 emissions by installing flue gas desulphurization equipment (95% effective for desulphurization) that utilizes the wet lime scrubbing method in each of the generators 8 through 11 (each with an output of 300MW) at the existing Mae Moh Power Plant in Lampang Province in northern Thailand.

1.3 Project Scope

The scope of this project is as follows.

(1) Installation of flue gas desulphurization equipment (95% effective for desulphurization) that utilizes the wet lime scrubbing method (including engineering works and installation, etc.)

(2) Construction of related incidental facilities
- To boost the capacity of the coal ash conveyor
- To improve existing smokestacks
- To install power supply equipment for desulphurization equipment
- To improve instrumentation facilities, etc.

1.4 Borrower/Executing Agency

Electricity Generating Authority of Thailand (EGAT)

1.5 Outline of Loan Agreement

Loan Amount / Loan Disbursed Amount	15,924 million yen / 9,813 million yen
Exchange of Notes / Loan Agreement	September 1993 / September 1993
Terms and Conditions -Interest Rate -Repayment Period (Grace Period) -Procurement	 3.0% 25 years (7 years) General Untied
Final Disbursement Date	July 2001

2. Results and Evaluation

2.1 Relevance

At the time of the appraisal of this project, the air pollution problem due to thermal power generation in the area surrounding the Mae Moh Power Plant was evident, and incorporating environmental considerations in electricity development was important in order to comply with environmental law. Above all, the SO_2 emission problem at Mae Moh Power Plant was grave (as of 1991, the SO_2 emissions at the Mae Moh Power Plant accounted for 47% of all SO_2 emissions in

Thailand). As one countermeasure, the Government of Thailand was planning to install desulphurization equipment..

Today as well, environmental measures at thermal power plants (particularly SO_2 emissions reduction) are important for the Ministry of Natural Resources and Environment and for EGAT when it comes to complying with environmental law, and the relevance of this project, which aims to reduce SO_2 emissions, is maintained.

2.2 Efficiency

2.2.1 Output

The outputs were constructed mostly as planned.

2.2.2 Implementation Schedule

In the original plan, the project was scheduled from September 1993 to June 1996, but it actually extended from September 1993 to January 2001, a delay of approximately 4 and a half years.

The main reason for the delay was the deterioration, following the start of construction, in the financial state of the local contractor in charge of the installation work for the desulphurization equipment, which led to an interruption of construction. The executing agency was forced to terminate the contractor’s contract and undertake the remaining approximately 40% of the work itself.

2.2.3 Project Cost

The planned project cost was 26,952 million yen, but the actual cost was 16,767 million yen. The reasons for the decline in cost were efficient ordering through competitive bidding, etc., and adjustments in outputs.

2.3 Effectiveness

2.3.1 State of Operation

When verification is made of the operation indices of generators 8 through 11 where flue gas desulphurization equipment was installed, the desulphurization efficiency was 45.7% to 90.0% for all of the generators in 1998 and attained 97.0% to 98.1% in 2002, and so all of the generators (8 through 11) were achieving the planned level of 95% (Table 1).

Moreover, measurements of SOx emissions levels were 352 to 1,919 ppm in 1998 but improved to 67 to 105 ppm in 2002, below the standard maximum of 157 ppm (Figure 1).

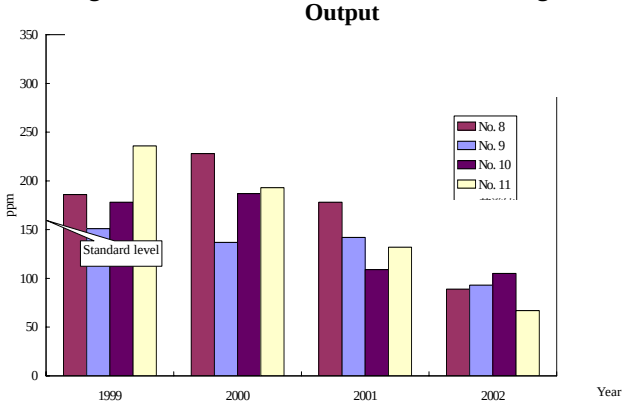
Looking at the operation time of generators 8 through 11, the operation time in 1998 was on average 6,176 hours, compared to the yearly goal of 7,000 hours, but in 2002 the operation time increased to an average of 7,356.

Table 1：Sox Removal Efficiency (unit: %)

Year	1998	1999	2000	2001	2002
Planned Level	**95**				
No. 8	77.6	94.3	93.1	94.7	97.3
No. 9	90.0	95.7	95.5	95.8	97.2
No. 10	45.7	95	94.2	96.8	97
No. 11	61.6	93.2	94.1	95.6	98.1

Source: EGAT

Figure 1: SOx Emissions Concentration during Rated Output



Source: EGAT data

2.3.2 Results of Air Monitoring

According to the report "Mae Moh Environmental Evaluation" (April 2002) by the Asian Development Bank, the level of air monitoring activities in the Mae Moh area is satisfactory overall, with visible improvement in the past several years and with the emission level of SO_2 reaching the same level as the average in Thailand. Likewise, even in the report of the Pollution Control Department (PCD), it is pointed out that the SO_2 problem in the Mae Moh area is greatly improved.

2.4 Impact

2.4.1 Spreading Experience with Desulphurization Equipment

At a seminar (July 1998) at Thailand's Ministry of Industry, a presentation was given on the experience of constructing and operating flue gas desulphurization equipment at the Mae Moh Power Plant. In addition, this experience is presented when the Mae Moh Power Plant hosts various observation teams from Thailand and abroad. Also, when flue gas desulphurization equipment is installed at other power plants in Thailand, engineers from the Mae Moh Power Plant provide guidance, and so technological experience involving installation and operation of flue gas desulphurization equipment is being transferred to other power plants.

2.4.4 Changes in Residents' Opinions and Physical Health

The level of SO_2 in the air dropped dramatically after installation of the flue gas desulphurization equipment, but changes in residents' health condition are still not clearly visible.

In the study implemented from 1994 to 2000 by Thailand's Ministry of Public Health, it is noted that chronic coughs in the Mae Moh area occurred at three times the normal rate, and it is pointed out that the reduction in SO_2 emissions following implementation of this project have not, at this time, led to a reduction in the risk of occurrence of respiratory illness. As one reason for this, the report points out that emissions of PM_{10} (suspended particulate matter) are at a high level. Removal of PM_{10} was not part of the plan in this project, but emissions of PM_{10} from generators 8 through 11 where flue gas desulphurization equipment was installed have dropped sharply since 1998 when trial operation began and in 2002 dropped to one-third of 1993 emissions.

2.5 Sustainability

2.5.1 Technical Capacity

EGAT has operated and managed multiple flue gas desulphurization equipment up to the present, and it is believed that EGAT possesses ample knowledge and experience in the technology.

In the latest evaluation study, it was confirmed that the operation and management plan, operation and management manual, and spare parts are in good order, and it was confirmed that training for staff at the training center in the power plant is being implemented.

2.5.2 Operation and Management System

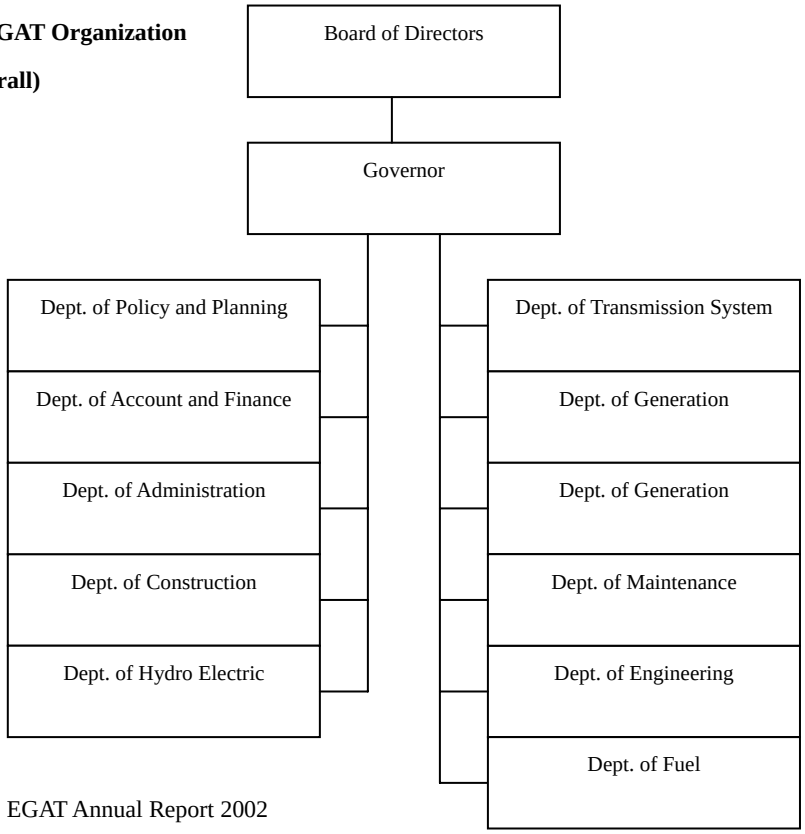
The EGAT organization is composed of five management bureaus and six operations departments under a board of directors and a governor (Figure 2). Mae Moh Power Plant is under the jurisdiction of the Electric Power Generation Department II in EGAT, shown in Figure 3. The operation of the desulphurization equipment financed by this project is handled by the Flue Gas Desulphurization Section in the Mae Moh Electric Power Generation Department, and operation and management is handled by the Power Plant Maintenance Section II in the Maintenance Management Department.

The Electric Power Generation Department has 151 staff members, and of those, 11 are engineers, 2 are chemists, 128 are technologists, and 10 are technicians. The Maintenance Management Department has 185 staff members, and of those, 17 are engineers, 104 are technologists, and 64 are technicians.

Also, in 1999 EGAT acquired ISO9000 and ISO14001 certification.

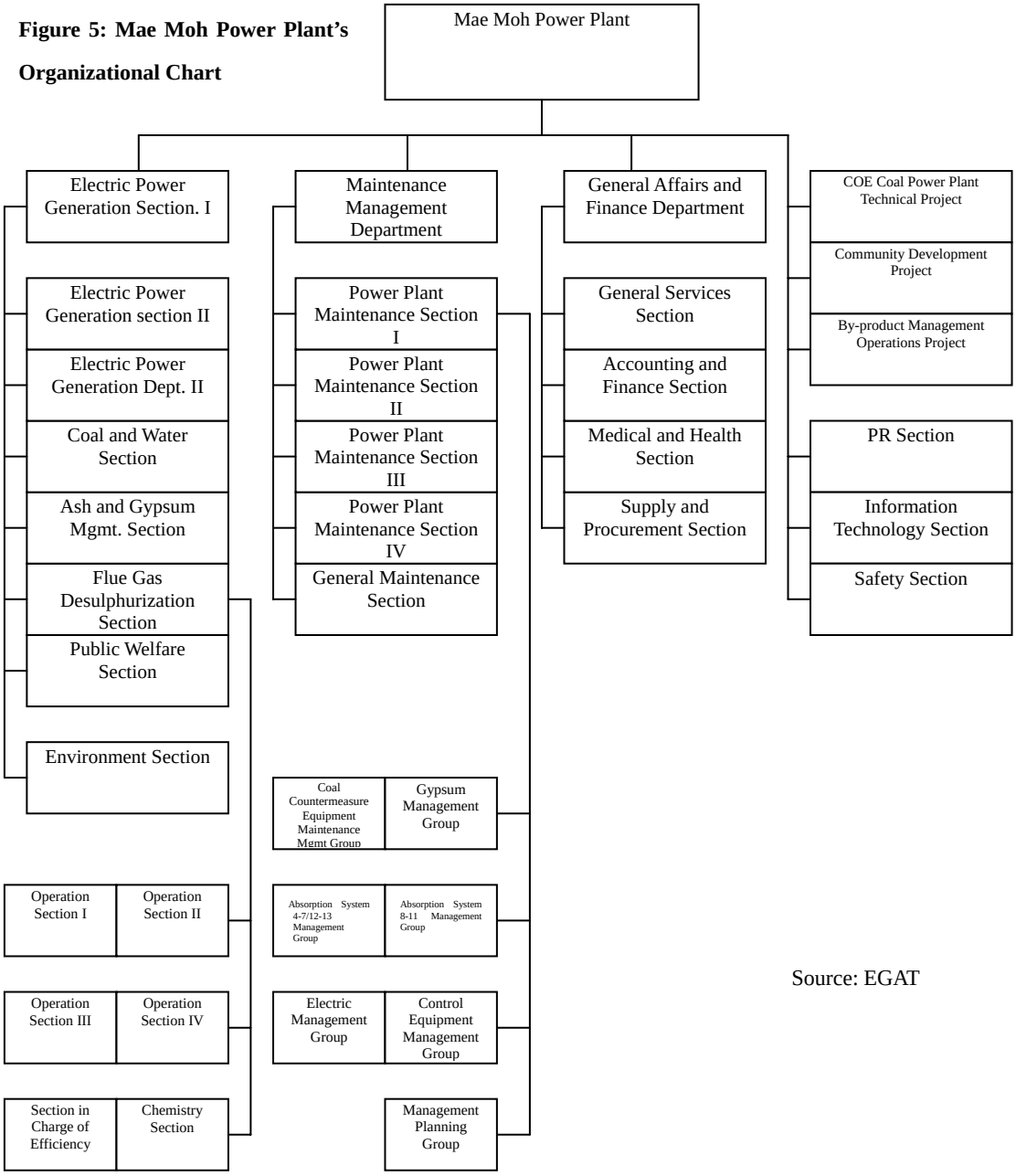
Furthermore, in accordance with the Thai Cabinet decision on August 20, 2002, EGAT will be incorporated and privatized between October 2003 and March 2004. According to the privatization schedule at the current time, as a first step EGAT is scheduled to switch a new organization composed of one holding company and three operations departments on October 1, 2003. The plan is to have the operations departments composed of (1) electric power generation and power transmission development, (2) operation and management of the power plant as well as fuel procurement, (3) operation and management of electric power transmission systems, systems control, and demand management. And finally, it is expected that the company will be listed on the stock exchange by the end of March 2004. Incidentally, currently as of August 2003, the process is in the stage of setting up a working group, as well as a steering committee managed by the EGAT governor and vice governor, for incorporation and privatization and is also selecting financial advisors and stock underwriters.

Figure 4: EGAT Organization Chart (Overall)



Source: EGAT Annual Report 2002

Figure 5: Mae Moh Power Plant's Organizational Chart



Source: EGAT

2.5.3 Financial Status

A The sales of EGAT overall are growing every year, and aside from 1999 when the basic accounting policy was changed and a loss was posted, EGAT has maintained as profit rate of approximately 3% to 9% (see Table 5). The turnover ratio of total liabilities and net worth has also climbed dramatically in the last two years.

Table 2: EGAT's Financial Indexes

Financial Performance (million baths)	1995	1996	1997	1998	1999	2000	2001	2002
Total assets	269,304	295,976	316,060	358,445	396,362	434,411	409,331	382,086
Current assets	30,337	48,280	38,407	46,361	54,690	66,010	65,196	72,101
Current liabilities	35,929	45,419	52,924	63,744	66,763	93,592	89,421	72,912
Total equity	95,928	116,824	101,046	119,032	106,341	122,320	134,099	146,082
Sales	95,247	108,835	125,376	146,572	134,225	160,992	185,072	207,101
Net income	18,960	27,093	12,828	20,310	-24,261	20,175	16,223	27,350
Financial Indexes (%)								
Net income (loss) as a percentage of total assets	7.04	9.15	4.06	5.67	-6.12	4.64	3.96	7.16
Net income (loss) as a percentage of sales	19.91	24.89	10.23	13.86	-18.07	12.53	8.77	13.21
Total assets turnover	35.37	36.77	39.67	40.89	33.86	37.06	45.21	54.20
Current ratio	0.84	1.06	0.73	0.73	0.82	0.71	0.73	0.99
Equity ratio	35.62	39.47	31.97	33.21	26.83	28.16	32.76	38.23

Source: EGAT Annual Report 1999, 2002.

3. Feedback

3.1 Lessons Learned

(1) In flue gas desulphurization installation projects, information concerning studies on air pollution not only due to SO_2 but also suspended particulate matter (PM_{10}) should be included in the project design.

3.2 Recommendations

None in particular.

Comparison of Original and Actual Scope

Item	Plan	Actual
(1) Output 1. Equipment for flue gas desulphurization by the wet lime scrubbing method 2. Construction of related incidental facilities ・ Boost capacity of coal ash conveyor ・ Improve existing smokestacks ・ Install power supply equipment for desulphurization equipment ・ Improve instrumentation facilities	Full set of equipment over 95% effective in desulphurization (including engineering works and installation, etc.) ・ Boost capacity of coal ash conveyor ・ Improve existing smokestacks ・ Install power supply equipment for desulphurization equipment ・ Improve instrumentation facilities	Almost as planned.
(2) Project Period 1. L/A Exchange 2. Bidding preparation, evaluation, negotiation 3. Design drafting, manufacture, shipping 4. Equipment installation 5. Engineering works 6.. Trial operation 8. Project completion	 July – September 1993 May – November 1993 February 1994 – November 1995 November 1994 – January 1996 April 1994 – November 1995 May 1993 – June 1996 February – April 1996 (unit 10, 11) April – June 1996 (unit 8, 9) June 1996	 December 7, 1993 July 1, 1993 - April 15, 1994 April 26, 1994 – December 2000 April 1995 – April 1998 October 1994 – May 1998 December 1997 to January 1999 July 1997 – January 1998 January 2001
(3) Project Cost Foreign currency Local currency Total ODA loan portion Exchange rate	 15,924 million yen 11,028 million yen (2,495 million bahts) 26,952 million yen 15,924 million yen 1 baht = 4.42 yen (as of June 1993)	 9,920 million yen 6,847 million yen (2,038 million bahts) 16,767 million yen 9,813 million yen 1 baht = 3.36 yen (average from 1995 to 2001)

Third Party Evaluator's Opinion on
Flue Gas Desulfurization Plant For Mae Moh Power Plant 8-11

Mr.Machima Kunjara Na Ayudhya
Director of the Board
Krung Thai Bank Public Company Limited

Relevance

Environmental measures at thermal power plant particularly SO_2 emissions reduction & control to conform with environmental laws, are key important success indication and performance for Ministry of Natural Resources & Environment and EGAT (Electricity Generating Authority of Thailand). This objective is acheivable and maintained according to the environmental laws under the project. Information for disclosure to the public about the project success and its feed back from the public are needed to be carried out to improve public image and create any betterment and prevent or to manage further risk of public confidence in EGAT's and the Government's.

Impact

The technology knowledges and experiences involved in the construction and the operations of the project together with uses of its equipments, have been transferred to other power plants, providing more benefit and value added to EGAT and the country as a whole.

Despite a significant drop in SO_2 emissions, still changes in residents' health condition are not clearly seen. Thailand's ministry of Public Health pointed out that reduction in SO_2 emissions following implementation of this project have not , at this time led to a reduction in the risk of occurrence of respiratory illness. As report points out that emissions of PM_{10} are at a high level, eventhough removal of PM_{10} was not part of the plan in this project and after installation of flue gas desulfurization equipment PM_{10} have dropped sharply to one-third of 1993 emissions, this project is criticized that it may not aims at the right objectives for solving the real problems.

Base on interview with other people interested in this project and involved in similar project in Thailand (an engineer in one the power producer companies in Thailand), this particular project has geographical site problem. Because the project located in crater like terrain where the flow of the air, particular in certain season, is badly difficult and not in normal condition as in other place. SO_2 emission, even in smaller proportion can still affects residents health condition. Moreover, the condition of the forest and water resource in the area are not much favourable to complement an improved air quality. It is believed that all future development projects have to consider how to improve the forest or green condition and water resources nearby to enhance relatively to the project objectives.

As Thai people concerns more to social and environmental awareness and responsibility of the enterprises in developing any project, one observation points out that the dust from lignite mine operation near by the project site causes PM_{10} problem.

Sustainability

Given the limited scope of the project objective for SO_2 emissions reduction to certain level, and the structure of EGAT organization doesn't change from the present (October 2004) where EGAT privatization plan and schedule is under reconsideration, sustainability of the project implementation will be well maintained. It is suggested that when this project be privatized, the conditions for improving SO_2 emission and other related pollution problems must be attached to the privatization agreement for better effectiveness and sustainability of the project as well.