Supporting Pollution Controls and Sustainable Environmental Monitoring

Indonesia

Banjarmasin Coal-Fired Steam Power Plant Project

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1. Survey Content

1-1) Survey Objectives

The objective of this survey is to examine the impact that the "Banjarmasin Coal-Fired Steam Power Plant Project" has had on the environment since its completion and to make recommendations where necessary.

With regard to the nature of this survey, the following should be pointed out at the outset. The assessment guidelines adopted (in December 1991) at a senior-level meeting of the OECD Development Assistance Committee (DAC) consist of five items: relevance, effectiveness, efficiency, impact and sustainability; however, this survey is focused on the environmental impact of this development project as opposed to the project in its entirety.

It is conceivable that the results of the environmental impact survey will affect the overall assessment of the project when evaluated in terms of relevance, effectiveness, efficiency and sustainability items; however, in so far as this circumstance does not arise, this survey will not assess the project as a whole and will make no reference to its relevance or any other of the aforementioned items.

The purpose of this survey is to (1) specify, (2) measure, (3) analyze the significance of, (4) make suggestions/advise on lessons learned, and (5) where necessary, provide policy-based recommendations on "environmental changes resulting from the implementation of the project in question".

1-2) Summary of Project Covered by the Survey

Banjarmasin Coal-Fired Steam Power Plant Project (Loan agreement signed November 29, 1994; loan amount: 6,464 million yen)

The primary goals of Indonesia's sixth five-year development plan for the power sector are to improve the reliability of power supplies and to develop power sources in line with the government's policy to relinquish dependency on oil-powered generation. Power consumption in PLN (Perusahaan Umum Listrik Negara: the state electricity corporation) Region VI, which incorporates southeast Kalimantan, was forecast to average 14 percent during the five-year period spanning fiscal 1994 through 1998, and there was a need to develop power sources commensurate with demand. The region has abundant available resources of low-sulfur coal and approximately 80 percent of existing power (on the 1993 installed generating capacity base) was fueled by diesel, thus the development of base load power sources utilizing coal resources had also been deemed necessary from a perspective of the policy to shift power generation away from oil.

In this context, plans called for the Banjarmasin coal-fired power plant to be constructed in Asam-Asam, a village located in the borough of Jorong (Kecamatan Jorong), Tanah Laut Kabupaten, which is 123 kilometers south east of Banjarmasin, the provincial capital of South Kalimantan. This power plant is a mine head plant located in the Asam-Asam coal field, and was designed to be fueled by the very low-sulfur coal produced in this area.

The project was co-financed by the World Bank with the Overseas Economic Cooperation Fund (now the Japan Bank for International Cooperation: JBIC) extending a loan to cover the boilers and related facilities. Construction commenced at the end of 1995 and was scheduled for completion in July 1999; however, delays in contract fulfillment by some of the contractors pushed completion back to December 2000, and the power plant commenced full-scale operation at its installed capacity of 130MW (65MW × 2) in January 2001.

1-3) Survey Implementation System

The composition and responsibilities of the survey team are as detailed below (names marked with an asterisk were responsible for the field survey).

Yasutami Shimomura* (Professor, Graduate School of Environmental Management, Hosei University): summation and economic evaluation

Morio Kuninori (as above): economic evaluation

Yasuhiko Miyoshi (Senior Researcher, Tokyo Metropolitan Institute for Environmental Protection): environmental assessment

Tetsuhito Komeiji* (as above): environmental assessment

Five graduate students enrolled on the master's course in social science policy and research or environmental management at Hosei University Graduate School were involved in this survey (including the field survey) in an intern capacity, and were assigned various tasks. The results of their undertakings have been incorporated throughout this report.

1-4) Survey Schedule

Advance preparations undertaken in Tokyo were followed by a one-week visit to Indonesia in August 2003 (21-28), during which field surveys were undertaken in Jakarta, Banjarmasin, Asam-Asam and Plehari (the main municipality in Tanah Laut Kabupaten, some 50km northwest of Asam-Asam).

2. Access Methods

2-1) Basic Policy on Information / Data Collection

2-1-1) Principal features

The central aim of this survey was to ascertain the environmental impact (of the aforementioned project) as objectively as possible; and in this sense:

i) Efforts were made to collect quantitative data and the survey team took independent measurements with a view to avoiding excessive dependence on information and/or data provided by PLN.

ii) Efforts were made to collect information in regions adjacent to the plant in addition to information and/or data relating specifically to thermal power plants. These primarily consisted of a physical inspection of the Asam-Asam coal field, a hearing with staff of the National Plehari Hospital and interviews with ecologists stationed at Banjarmasin.

2-1-2) Main Sources of Information

The assessment work undertaken for this survey was broadly divided into an environmental impact assessment (from natural science perspectives) and a socio-economic evaluation, with the following information sources being common to the two processes.

1) Basic data supplied by JBIC: the feasibility study (F/S), the Environmental Impact Assessment (EIA), etc.

2) Responses to a questionnaire put to PLN

3) Results of independent measurements undertaken by external experts

4) Information and/or data obtained from hearings conducted locally

5) Official documents obtained locally: statistics obtained from the Central Bureau of Statistics in Jakarta and the South Kalimantan Bureau of Statistics, the annual report of the National Plehari Hospital

6) Results of observations in the field (including photographs)

7) Information and/or data from the PEDACS survey that was implemented ahead of the current survey

2-2) Independent Environmental Impact Measurement Techniques

Air and water pollutants were measured using the following methods.

2-2-1) Measurement of Atmospheric Pollutants: adjustments made to the passive sampler and measurement techniques

The atmospheric pollutants SO2, NO2, and O3 (ozone) were measured using a passive sampler brought in from Japan. The samples were adjusted according to the methods shown in Table 1.

Table 1: Composition of SO2, O3, NO2 measurement solutions and cultures used

Substance measured	Abbreviation	Composition of impregnated solutions	Filter Paper
SO2, O3	NaNO2+K2CO3	2% NaNO2 - 2% K2CO3 - 10% glycerine was dissolved in CH3OH/H2O(50/50)	φ47mm, ADVANTEC 51A
NO2	TEA+K2CO3	10% TEA - 2% K2CO3 - 10% glycerine was dissolved in CH3OH/H2O(50/50)	φ47mm, ADVANTEC 51A

The solutions were impregnated into the cultures, dried in a dessicator and stored until exposure testing.

The exposure sampler is shown in Photo 1.

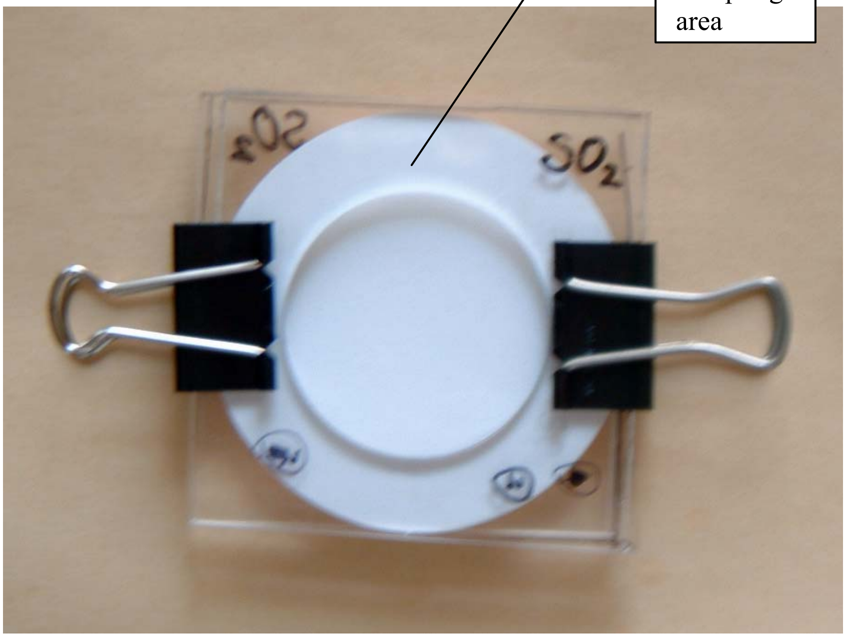

Photo 1: Passive sampler (the area inside the circle is the sampling section)

The samples were covered with Teflon filter paper (ADVANTEC polyflon filter PF100) and exposure testing conducted. After recovery, the samples were extracted into 20ml of deionized water and used for analysis.

Ion chromatography techniques were employed to analyze the samples. Analyzer: DIONEX DX-500; positive ion: eluent 18mMol methanesulfonic acid; flow rate: 1.0mL/min; columns: CG12A guard column, CS12A separation column. Negative ion: eluent 2.7mMol Na2CO3 + 0.03mMol NaHCO3; flow rate: 1.3mL/min; columns: AG12A guard column, AS12Aseparation column.

Passive samplers were installed at the locations shown in Figure 1.

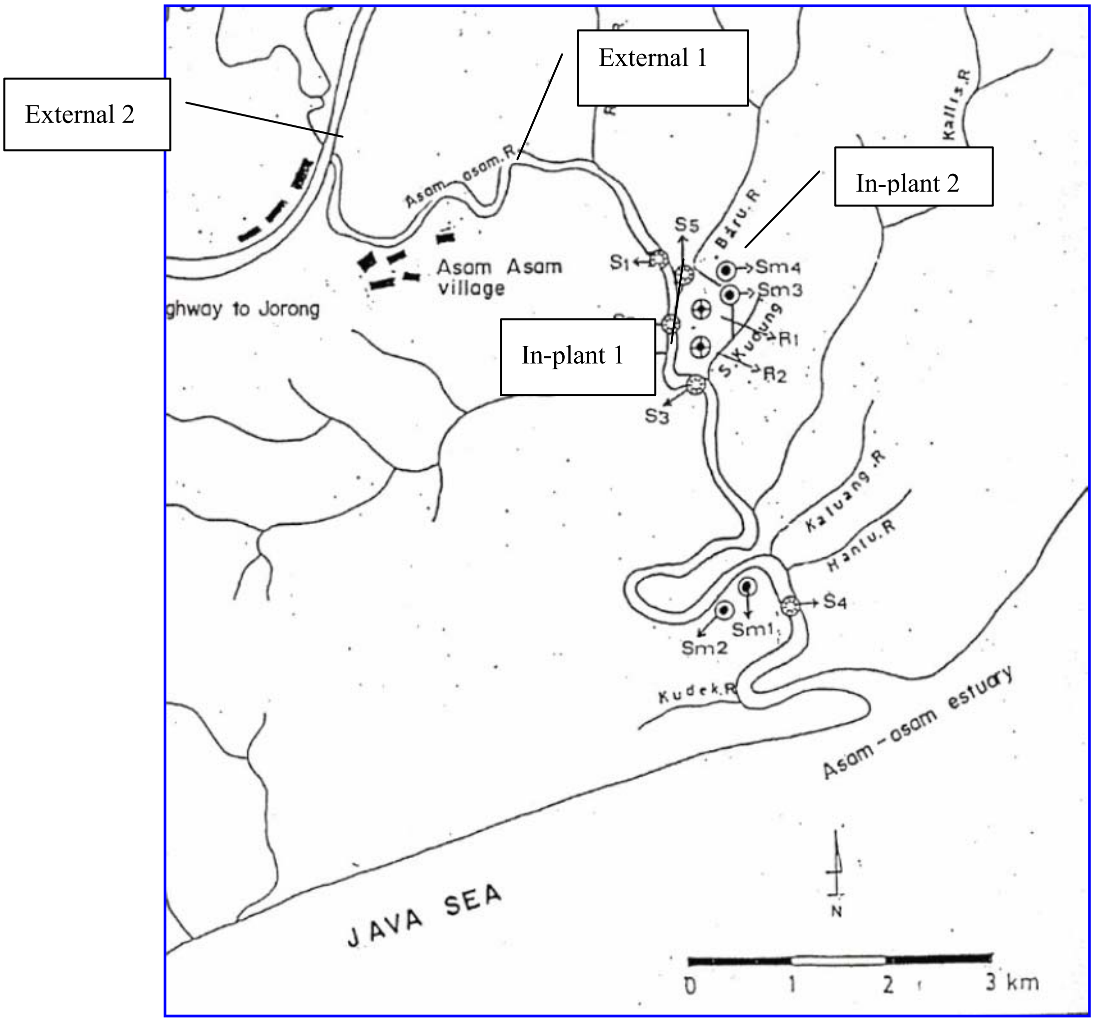

Figure 1: Locations of Passive samplers

2-2-2) Measurement of Water Quality: Pack Test Method

Water quality was measured using the pack test (a simple method of colorimetric analysis in which test water is sucked into a tube containing a coloring reagent, with the solution being compared against a standard color chart after the reaction takes place). All pack tests used were manufactured by Kyoritsu Chemical-Check Lab., Corporation. The specifications were as follows.

Table 2: Pack Test Specifications

Item	Measurement principle	Range	Response time
pH	Combination of pH indicators	pH1.6 - pH9.6	20 seconds
Hexavalent chromium (Cr^{6+})	Diphenylcarboydrazide (DPC) colorimetric assay method	0.05 - 2mgCr^{6+}/L (ppm)	1 minute

Zinc (Zn)	PAN colorimetric assay method	0 - 10mgZn/L (ppm)	3 minutes
Iron (Fe)	O-phenanthroline colorimetric assay method	0.2 - 10mgFe/L (ppm)	2 minutes
Iron (Fe) (low concentration)	Reduction and bathophenanthroline colorimetric assay method	0.05 - 2mgFe/L (ppm)	2 minutes
Manganese (Mn)	Potassium periodate colorimetric assay method	0.5 - 20mgMn/L (ppm)	30 seconds
Ammonium ion (NH_4^+)	Indophenol blue colorimetric assay method	0.2 - 10mgNH_4^+/L (ppm)	5 minutes
Nickel (Ni)	Dimethylgloxime colorimetric assay method	0.5 - 10mgMn/L (ppm)	2 minutes

Cited Literature:

1) Nishikawa Y., Taguchi K., Inoue K., and Yoshimura K. (2000): Investigating simple passive analysis of atmospheric gas components, Japan Society for Environmental Chemistry 10, 281-289.

2-3) Supplementary Theory on Access Methods: Socio-Economic Evaluation of Environmental Impact

In considering the economic and social aspects of environmental impacts produced by the project under investigation, there were numerous points requiring attention in terms of the methodology used. Accordingly, this report also focuses on examining the techniques used in socio-economic evaluation. Themes that are highly practical are dealt with as supplementary theory at the end of this report.

3. Validated Information / Data and Results of its Analysis

3-1) Atmosphere: Atmospheric SO2, NO2, O3 concentration measurement results

Atmospheric pollutants, specifically SO2, NO2 and SPM (suspended particulate matter: dust), are covered by environmental quality standards and accordingly, measuring their concentrations in areas proximal to thermal power plants and comparing them against the values stated in the preliminary EIA is critical to the scientific investigation of environmental changes that are contingent upon the operation of the power plant.

In addition to data on environmental concentrations, source data is also vital to environmental concentration predictions made using the diffusion model. To this end, every effort was made to obtain source data during the course of this survey. Data on measured concentrations of SO2, NO2 and SPM (dust) in flue gas were obtained. The results of SO2, NO2, and O3 measurements taken using the passive sampler are shown in Table 3.

Table 3: Results of SO2, NO2 and O3 measurements using the passive sampler

Observation point	Sampling time	Weather	Temp.	Wind direction	Wind speed	SO2	NO2	O3
N-passive in-plant 1	08231441-241507	Fine	32.5C	NE	1-2m	4.2	147.7	92.5
N-passive in-plant 2	08231518-241520	Fine	33.6C	ENE	2-3m	2.6	16.2	84.2
N-passive external 1, 2.15km	08231552-241538	Fine	33.2C	ENE	<1m	1.1	32.5	31.3
N-passive external 2, 4.0km	0231557-241554	Fine	33.3C	SE	1-2m	0.8	6.5	54.2
N-passive in-plant 1	08241507-251430	Fine	33.5C	ENE	2-3m	1.3	52.3	75.9
N-passive in-plant 2	08241520-251432	Fine	33.5C	ENE	2-3m	2.0	19.2	78.3
N-passive external 1, 2.15km	08241538-251435	Cloudy	34C	SE	2-3m	1.2	18.5	34.4
N-passive external 2, 4.0km	08241554-251441	Cloudy	33.5C	SE	3m	0.8	8.7	67.5

Notes:
Shaded sections indicate conditions exceeding Indonesia's environmental quality standards.
N-passive indicates the "Nishikawa simple sampler" for measuring the absolute concentrations of atmospheric gases.
A time reading of 08231441－241507, for example, means that sampling was performed between 14:41 on August 23 and 15:07 on August 24.

Surface winds during the measurements were NE – NNE and the in-plant 1 collection point (refer to Figure 1) was downwind. SO2 and NO2 concentrations tended to be higher downwind, i.e. at the in-plant 1 sampling point. NO2 concentrations observed at the in-plant 1 collection point were higher than the 0.045ppm level set under Indonesia's environmental quality standards. This is considered to be due to substantial NO2 emissions inside the power plant premises.

The measurement examples from 2002 given in Appendix 3 reveal ttd of SO2 ("traces", i.e. "minute amounts detected"; believed to be a misprint of "tr") and NO2 at a concentration of 74.8$\mu g/m^3$ at environmental measurement points U1-U4 located near the power plant; with concentrations being lower than environmental quality standards at all observation points.

As demonstrated by Appendix 4 (emissions standards, maximum forecast emissions), concentrations of SO2, NO2 and dust were all lower than the environmental quality standards in the preliminary assessment.

Furthermore, there are reports of numerous negative CO and SO2 concentrations (abnormal values) in the results of the flue gas concentration measurements given in Appendix 8 (flue gas concentrations measured in June – July 2003) and problems were observed with the accuracy control of measuring instruments. Notwithstanding the problems with accuracy control, it is assumed that, in general terms, emissions are lower than emissions standards.

3-2) Water Quality: Pack Test Measurement Results

Water quality was tested using pack tests in four locations: the coal storage yard, the (incinerated) ash retention yard, the Asam-Asam River sampling site, and the drainage lake for treated effluent. The results of the measurements are shown in Table 4.

Table 4: Pack Test Measurement Results (all figures excluding pH values are mg/L (ppm))

Item	Location			
	Coal storage yard reservoir	Ash retention yard reservoir	Asam-Asam River sampling site	Drainage lake for treated effluent
pH	7.5	9.0	8.5	9.0
Hexavalent chromium (Cr^{6+})	0.05>	0.05>	0.05>	0.05>
Zinc (Zn)	0.5>->0	0.5>->0	0.5>->0	0.5>->0
Iron (Fe)	0.2>	0.2>	0.2>	0.2>
Iron (Fe) (low concentration)	0.05>	0.05>	0.05>	0.05>
Manganese (Mn)	1.0>->0.5	>0.5	0.5>	0.5>
Ammonium ion (NH_4^{+})	0.16>	0.2>	0.16>	0.16>

Nickel (Ni)	0.5>	0.5>	0.5>	0.5>

Note 1: the lower limit for ammonium (NH_4^+) is 0.2 mg/L (ppm) where few concomitant substances exist, and 0.16 mg/L (ppm) where there are many concomitant substances.

Note 2: Shaded sections indicate levels that may be exceeding water emissions standards.

Table 4 indicates pH values approaching the upper limit and levels of manganese (Mn) that may be exceeding water emissions standards. Observation data on water quality given in Appendix 9 evidences a high maximum pH of 9.41 at the outlet, which is exceeding the standard value. A number of errors were recognized in entries believed to refer to the TSS (Total Suspended Solids) values for iron measurements. There were also cases in which data was missing for three weeks or more and problems were recognized with the management of water quality.

3-3) Coal: Source Data

The analytical values used for coal in the preliminary assessment are given in Appendix 5. A comparison with the data obtained during this survey (Appendix 6: PLN data) reveal both sulfur and ash contents to be higher than those in Appendix 5; specifically, sulfur content is almost double. According to the preliminary assessment, in order to clear Indonesia's environmental quality standards the sulfur content of coal should not exceed a certain level; however, the values obtained during this survey reveal the sulfur content to be at the upper limit. In Appendix 7 (coal analysis values during plant operation taken in October and December 2000), sulfur contents are all lower than the values envisaged in the preliminary assessment, which represents an improvement when viewed in terms of coal quality.

In this connection, it is worth noting that the coal sampler was moved from P.T. Arutmin to P.T. Jorong Barutama Greston (JBG). The coal is supplied from the same source, i.e. the Asam-Asam coal field, but the concession (the location of the mine) differs. The possibility of slight differences in coal quality from that analyzed at P.T. Arutmin at the preliminary assessment stage can thus not be eliminated.

3-4) Solid Waste: Coal Ash

Two major differences were found in connection with the treatment of fly ash, which accounts for the majority of ash discarded (F/S Executive Summary), when compared with arrangements made at the planning stage. Firstly, the length of time ash has been kept in the ash dump and secondly, the structure of retention facilities. Both are considered to have the potential to have a major impact on environmental conditions.

3-4-1) Ash Retention

The appraisal plans called for all ash to be collected by P.T. Arutmin – the coal supplier, and used to fill abandoned mines (which currently form craters) (EIA). However, the F/S contains records of difficulties in negotiations between PLN and P.T. Arutmin regarding coal prices suggesting that the prospects for contract negotiations were far from optimistic (F/S Executive Summary).

In consequence the supplier was switched to P.T. Jorong Barutama Greston (JBG), which meant that the ash was not collected. Currently, all waste ash is being stored in the ash dump. Moreover, preparations to expand the ash dump have been initiated to provide against limitations emerging in the capacity of the current dump site.

At this time, the results of water quality measurements taken in the retention yard reservoir reveal no evidence of any problems, but the possibility that levels are exceeding water emissions standards cannot be eliminated. Further, considerable amounts of dust were observed around the ash dump .

During a subsequent feedback seminar PLN stated that: “the dust on the road indicated is close to the site where ash is disposed of after temporary treatment; we are planning to carry out a study on full-scale landfill treatment this year. We are also looking into covering the current storage site to prevent flying dust.”

3-4-2) Structure of Retention Facilities

The original plans called for “a 4-meter-high peripheral levee”. This levee has not been constructed, which means that stored ash is liable to scatter in the wind or be washed away by rain. Power plant officials had insufficient knowledge or information to explain why the levee had not been constructed.

3-5) Ecosystem

In terms of the impact on flora and fauna (biota), plans called for “parameters and indices to be set, for PLN to undertake regular monitoring prior to and during construction and once the plant becomes operational, and to report to BAPEDAL”, however, in the hearing at the power plant that was conducted on the basis of our questionnaire (August 23, 2003), Mr. Krisna Mulawarman, the plant manager revealed that there was no data relating to the ecosystem, including biota. This revelation is believed to indicate that the above monitoring surveys have not been undertaken.

3-6) Environmental Monitoring System

Coal composition testing is being outsourced. The company charged with the testing, P.T. Geo Services, is headquartered in Bandung in the province of West Java and has a branch office in Banjarbaru, an administrative district on the outskirts of Banjarmasin.

Air and water quality are measured by PLN. It was confirmed that measurements are being taken systematically: air quality is monitored around the clock by the plant’s automatic control system, while the results of wastewater treatment are checked five times a day, with samples being sent to the Ministry of Health’s Environmental Health Laboratory (BTKL:Balai Teknik Kesehatan) once every three months for testing. However, minor managerial problems were noted, for example, the absence of more than three weeks worth of effluent monitoring data and so forth.

Under initial plans, the aforementioned (3-5) monitoring was to cover the region’s society, economy, culture and health, in addition to the ecosystem. No explanation on the undertaking of these monitoring activities was forthcoming from PLN at the hearing held at the power plant on August 23, 2003.

It was learned, however, that fifty scholarships have been awarded to outstanding students at local elementary schools with a view to contributing to the development of the region’s society.

3-7) Environmental Training

According to a memo submitted to the survey team by PLN, the Indonesian government’s Ministry of Environment offers an environmental training program every year and in 2003 two engineers (Mr. Heruyanto and Mr. Nurafik) were dispatched from the Asam-Asam power plant. In September 2003 eleven personnel were sent to receive ISO14001 training.

3-8) Involuntary Resettlement

On August 24, 2003 the survey team visited Jorong, a resettlement site, and interviewed the leader of the resettled residents, a Mr. Helmi, at his home. The team was accompanied by PLN officials, which may have had an impact on the outcome of the interview.

The current survey involved observations of the living conditions of resettled residents. Although our information is extremely limited, since the team obtained some minor suggestions these are outlined as findings in section 4-3).

The following facts were confirmed.

1) Residents were resettled in Jorong, the main town in the borough of Jorong (Kecamatan Jorong), which is located alongside the trunk road linking the provincial capital of Banjarmasin with Kotabaru, the main city on Laut Island on the east coast. It is also situated near the PLN company residence that has been provided for staff of the Asam-Asam power plant.

Accordingly, Jorong is the most economically active town and provides the most job opportunities in this region, which includes the village of Asam-Asam. This contrasts with the former residences, which were situated off the road some 30 kilometers from the commercial district of Jorong.

2) Thirty-six households were resettled, but a large number of occupants had already moved away from the area. Moreover, various information exists on the number of households that were resettled, thus this figure is not necessarily accurate. Mr. Helmi stated that sixteen households had been relocated and that twenty families had remained in the area.

3) The Helmi household (the residence provided was on loan; the family is living in a house they built themselves) has a sofa set, a TV, a component, a mobile phone and other assets, plus a helmet that looks like it would be used when riding a motorcycle. The family would appear to be living very well when their living conditions are compared to the living standards of their neighbors.

4. Findings

4-1) Environmental Impact Assessment

No obvious environmental impacts were confirmed during the course of the current environmental impact survey. However, since a number of problem areas that require attention were noted, the following sections will focus on these areas, primarily from a preventive perspective, outlining the findings of the survey team in reference to the analytical results detailed in section 3.

4-1-1) Atmosphere

When PLN measurements of air quality within plant precincts and surrounding areas are combined with those obtained independently by the survey team there is no evidence of any problems when the results are set against environmental quality standards. However, in the measurements taken by the survey team, NO2 levels at some locations exceeded Indonesia’s environmental quality standards for this pollutant. Since these were obtained from simple measurements, these figures should not be taken to indicate that there is an immediate problem; however, given the possibility that NO2 is leaking from the flue, it is hoped that PLN will continue to observe measurement results meticulously in the future.

Smoke from the stack is visible (to the human eye) and is faintly colored on occasion. This suggests that the dust particle collection function of the electrostatic precipitators is not sufficiently effective and it might be useful to call PLN’s attention to this matter.

During the ensuing feedback seminar PLN stated that: “The visible smoke being emitted from the stack that was pointed out at the last survey was probably a temporary phenomenon caused by the suspension of one of the electrostatic precipitators and current conditions preclude any problems in this area.”

4-1-2) Water Quality

The results of water quality measurements taken by the survey team suggest that levels of zinc and manganese may be exceeding water emissions standards. However, it should be noted that these results were also obtained from simple measurements and it would be inappropriate to cite these figures as evidence of an immediate problem. It is hoped that PLN will remain aware of the issue and track the measurements in the future.

By contrast, pH levels requiring attention were detected. The results of the measurements taken by the survey team evidenced high alkaline levels (pH 9.0) in the ash retention yard and the drainage lake for treated effluent, and PLN water quality monitoring data shows a highly alkaline value of 9.41 for the outlet (standard value threshold: 9.0). Under these conditions, there is a risk of ongoing corrosion to parts caused by alkaline wastewater. During the hearing with plant engineers it was pointed out that parts have to be replaced frequently due to corrosion.

The emergence of highly alkaline figures is possibly attributable to the introduction of numerous chemicals during the wastewater treatment process. Another conceivable cause is the incursion of seawater in the upper reaches of the Asam-Asam River, which dropped in August during the dry season (the pH of seawater is 8.0).

In order to investigate whether or not the latter, i.e. seawater incursion, is having an impact more in-depth surveys are necessary, including (i) tests on water quality at the intake point during the wet season, and (ii) tests on water quality between the mouth of the Asam-Asam River and the intake point during the dry season.

The distance between the river mouth and the power plant has been recorded as both 5 kilometers and 12 kilometers (EIA). Given that the relationship between the distance from the river mouth and altitude (elevation) are basic data when considering the impact of seawater incursion, ideally this relationship should be closely examined and rechecked.

Whatever the cause, whether it be use of chemicals or seawater incursion, it is necessary to examine the effects that highly alkaline water is having on facilities within the power plant. Should it be determined that it is having a major impact on plant facilities, then it must be assumed that this is having some effect on the “target achievement” and “sustainability” of this project. Consideration should also be given to the potential for water in the drainage lake and reservoirs to have an impact on the environment (although at this time the levels are not definitely exceeding the standard values).

In the event that tests evidence high alkalinity at the intake point on the Asam-Asam River during the wet season the problem cannot then be confined to seawater incursion and comprehensive consideration must be given to the ecosystem for the entire area in seeking the cause (of this phenomenon).

During the ensuing feedback seminar PLN stated that: “The high pH measurements should not represent a problem as the water is treated again after that check point.”

4-1-3) Coal

The sulfur content of the fuel coal is at the upper threshold required to conform to environmental quality standards, but this, of itself, will not lead to an immediate environmental problem. It is hoped that PLN will continue to monitor the measurements meticulously.

4-1-4) Solid Waste: Coal Ash

The details, including our survey findings, were outlined in the analysis results section (3-4). The long-term storage of large volumes of coal ash has the potential to lead to negative environmental effects, and accordingly, it is hoped that the ash will be returned to the Asam-Asam coal field in line with the original plans. Should this prove difficult, it will be necessary to examine effective ways of utilizing this byproduct. Research and development on the effective use of coal ash is already being undertaken in numerous fields, and in specific terms, it would be worth exploring its use in cement, aggregates, and fertilizers.

4-1-5) Ecosystem

Likewise, the details, including our survey findings, were outlined in the analysis results section (3-5).

4-2) Socio-Economic Evaluation

There is currently no evidence to suggest that the Banjarmasin coal-fired power plant is having any effect on outputs, asset prices, the landscape, ecosystem or natural resources in the surrounding area. Every attention has been paid to latent threats and probably impacts throughout this report.

However, as detailed hereunder, note should be taken of the high incidence of respiratory diseases among local residents. At this time, the verdict is that the problems caused by the power plant are not sufficiently serious to affect the health of the local population, but the dust being generated around the ash dump and along the (access) road to the coal field is affecting air quality and plant life. In this sense, attention must continue to be paid to the effects on the health of local residents.

4-2-1) Incidence of Respiratory Diseases in Surrounding Areas

The closest hospital to the village of Asam-Asam that has modern facilities is located some 50 kilometers to the northwest in Plehari, the main municipality in Tanah Laut Kabupaten. There is a health center in Jorong, which is located in the heart of the Jorong borough between Plehari and Asam-Asam, but there are no resident public health nurses (according to the hearing at the power plant). The Asam-Asam power plant has a resident physician, but it is unlikely that local residents can access him with any ease; the reality is that many residents are probably reliant on pharmacy visits or traditional folk remedies. However, according to official statistics, treatment at national hospitals accounts for the overwhelming majority among rural (and urban) populations in South Kalimantan and there are no tangible figures for folk remedies (Table 5). If these data are taken to be reliable then the situation in this province differs considerably from that across the country.

Table 5: Breakdown of Healthcare Practices in Rural Indonesia: Records of treatment received in 2002 (Unit: %)

	National	Private	Health	Midwife	Pharmacy	Folk	Other	Total

	hospitals	hospitals	centers			remedy		
South Kalimantan: Urban	57.1	36.8	1.5	0.0	1.0	0.0	3.6	100.0
South Kalimantan: Rural	70.7	19.2	6.2	0.0	3.9	0.0	0.0	100.0
Indonesia	4.2	30.3*	34.2	4.7	22.8	2.6	n.a.	100.0

*including clinics

Source: Welfare Statistics 2002, Central Statistics Bureau (Badan Pusat Statistik: BPS), Indonesia

As this demonstrates, Plehari hospital (official name: RSUD. Hadji Boejasin Plehari) plays a crucial rule in providing health services to the population of Tanah Laut, including the area around Asam-Asam village. RSUD is a national hospital that was built in 1973/74, it employs nine physicians (including one dentist and two female doctors), one pharmacist, and 90 medical assistants (including 53 nurses), and has 100 beds.

Outpatient and inpatient numbers together with the names of the major diseases are as shown in Table 6; these data were compiled from the hospital's annual report, which was obtained through the kindness of Mr. Yusuf, the hospital director. Despite evidence of some contagious diseases, such as tuberculosis, malaria and typhoid, an exceptionally large number of patients are suffering from respiratory and gastrointestinal diseases. According to the hospital director, gastrointestinal diseases are caused by poor sanitation, including insufficient access to safe water supplies; respiratory diseases are primarily caused by dust, bacteria, and air pollution from forest fires and the Asam-Asam coal field.

Table 6: Patient Numbers & Major Diseases Being Treated at RSUD (2002)

Inpatients		Outpatients	
Disease	Patient #	Disease	Patient #
Gastroenteritis	202	Upper respiratory inflammation	1841
Typhoid	177	Throat disease	770
Tuberculosis	70	Acute enteritis	491
Bronchial disorders	64	Dermatitis	359
Colic	56	Hypertension	330
Hypertension	55	Dyspepsia	297
Cerebral contusion	48	Dental disease	230

Dyspepsia	46	Gastritis	210
Cerebral hemorrhage (stroke)	36	Conjunctivitis	168
Pneumonia	32	Bronchitis	156
Malaria	31	Tuberculosis	144
Asphyxia	28	Bronchial disorders	115
Gastritis	22	Typhoid	100
Septicemia	20	Other	3,409
Hernia	15	Total	8,620
Hepatitis	11		
Other	826		
Total	1,739		

Source: Laporan Tahunan, RSUD. Hadji Boejasin Pelahari,2002

4-2-2) Environmental Destruction at the Asam-Asam Coal Field

At this point, it should be noted that the hospital director has been exposed to pollution from the coal field.

The Asam-Asam coal field extends 47 kilometers east to west along the coastline in southern Kalimantan and has reserves of 165 million tons; the Banjarmasin (coal-fired) power plant obtains fuel coal from the west Asam-Asam coal field (reserves of 49 million tons).

Coal from the Asam-Asam coal field is produced by open-cast mining. Open-cast mining, including that undertaken in other areas, generally causes massive environmental destruction. This holds true for the Asam-Asam coal field; specifically, (i) destruction of plant life during mining, and (ii) the dust generated when coal is pulverized and transported are serious problems. Miners work surrounded by coal dust without masks or other protective equipment.

No concrete data were obtained evidencing the effects on the health of the local population of the dust generated at the coal field, but since Mr. Yusuf, the director of RSUD, fundamentally recognizes a relationship between the two, it is likely that this opinion is shared by local experts. At the moment there is merely a basic understanding of this relationship, but given past experience in other areas, any change in conditions could lead to criticism of the coal field and the trends need to be monitored closely.

These circumstances represent two problems for the Asam-Asam power plant. Firstly, should the incidence of respiratory disease among local residents increase, even if the power plant is not labeled as the polluter, will it be able to remain detached from the coal field in its capacity as a user of fuel coal? Secondly, should a survey be undertaken to ascertain the damage to the health of the local population caused by the power plant as a means of verifying plant safety per se, it may prove difficult to obtain measurements separating forest fires as a major source of environmental pollution and the effects of the coal field from the power plant. Recommendations on responding to this issue will be dealt with in the conclusion to this report.

The Asam-Asam coal field was being mined before the Banjarmasin power plant was constructed and the potentially negative environmental effects from the coal field were already known when construction work began. In economic terms, this problem should probably be dealt with as one type of sunk cost for the power plant. However, viewed from a socio-political perspective, it is not appropriate to separate the coal field and the power plant. An environmental assessment of the power plant should be undertaken with an eye to its relationship with the coal field.

4-3) Findings Related to Involuntary Resettlement

Local non-governmental organizations (NGO) and universities were involved in planning the involuntary resettlement component of this project. Perhaps because such provisions were made, as the results of the field survey (3-8) demonstrated, no problems worthy of note have arisen in connection with the living conditions of the resettled residents.

Thirty-six households were resettled in consequence of the construction of the Banjarmasin power plant, which is a small-scale resettlement as compared to other projects, and it would be useful to highlight the features of the involuntary resettlement for this type of project by comparing it with other projects of a similar nature.

For comparison we have selected the Anpara B Thermal Power Station Construction Project (India, Phase I Loan Agreement: 1984), an ODA funded project that encountered problems with involuntary resettlement and that the evaluators have field experience of. This was also a coal-fired power plant, which, like Banjarmasin, is located at the mine head of a coal field. As shown below, the residential areas prior to and after resettlement at the Anpara B thermal power plant and the Banjarmasin thermal power plant had a number of features in common.

	Before resettlement	After resettlement
Anpara B	Remote farming village cut off from surrounding areas	Residential area alongside a trunk road
Banjarmasin	As above	As above

The living conditions of residents who were resettled in communities that border trunk roads and that offer them far greater and more numerous job opportunities have, in both cases, improved markedly over those of the resident groups that continue to live in the former areas. At the same time, in both cases, it is noteworthy that a large number of families have moved away from the site of resettlement.

The reasons for moving away are unlikely to be simple. There may be people who, having experienced life in a region of vital economic activity and awoken to the new opportunities it presents, are seeking new job opportunities. There may also be people who drop out unable to adapt to a living environment that differs to the one they have known. Whatever the case, given that the social impacts of relocation are believed to be complex, a sociological follow-up survey targeting individual households would likely produce valuable knowledge relating to involuntary resettlement.

5. Conclusions and Recommendations

As has been evidenced above, the Banjarmasin coal-fired power plant has not had any obviously negative effects on the environment to date. However, a number of points require attention, thus the following recommendations are made in reference to the sections on Analysis Results (3) and Findings (4).

5-1) Implementation of an "Special Assistance for Project Sustainability" survey on coal ash

The basic plan for the ash retention yard has been changed, which may lead to negative environmental effects. Accordingly, it is hoped that a survey on "operations to promote the effects of assistance" covering the following topics will be undertaken from a preventive perspective.

(1) A more in-depth study of conditions at the ash disposal yard and potential environmental effects

(2) Advice on a concrete plan to improve the ash disposal yard (specifically, the construction of a levee in accordance with the original plans)

(3) Advice on negotiations between JBG and PLN targeting the accomplishment of the original plans for the coal supplier to remove the ash and use it to fill abandoned mines.

(At the ensuing feedback seminar PLN commented that: "Since negotiations with the supplier regarding the use of ash to fill disused coal mines will take time, we want to look into measures, including options other than landfill, in parallel.")

(4) Should (3) prove problematic, technical/marketing advice on utilizing the ash in cement, aggregates, and/or fertilizers, etc.

(At the ensuing feedback seminar PLN commented that: "This option has been taken by other coal-fired power plants and private-sector businesses. However, there are no such businesses in this area and the incentive for a private-sector company to undertake a business premised on transporting the ash from here is an issue.")

5-2) Reminders to PLN

(1) Improve current coal ash storage conditions

(2) Investigate the causes of smoke (from the flue) and look into measures to improve the current situation

(3) Measure and analyze the pH of water used at the power plant and on the premises systematically and continuously
(4) Study the relationship between the use of high alkaline water and corrosion of plant facilities
(5) Improve the accuracy of environmental management
(6) Carry out a study on the ecosystem in surrounding areas

5-3) Recommendations to PLN on Environmental Destruction at the Asam-Asam Coal Field
Plant trees around the coal field in cooperation with JBG (independently if this should prove difficult). This will serve to mitigate environmental destruction at the coal field and be good for PR. (PLN's comment on the tree-planting recommendation at the ensuing feedback seminar was: "Under the Clean Area Program, in December 2003, 500 trees were planted on power plant premises and 63 trees were planted near residential areas.")

5-4) JBIC Survey Activities
(1) A research project on improvements in environmental economic assessment techniques covering low-development areas like South Kalimantan Province in developing countries.
(2) A follow-up survey project covering individual households targeting a detailed identification of the social effects of involuntary resettlement.

Supplementary Theory on Access Methods
In recent years there have been rapid developments in quantitative analysis techniques for evaluating the economics of environmental impact. These are generally known as "environmental economics assessment techniques".
Standard environmental economics assessment techniques focus on (i) changes in output, (ii) changes in asset prices, (iii) effects on the health (lives) of local residents, and (iv) effects on the landscape, ecosystem, natural resources, etc., produced by changes in the environment in the project area, and attempt to express this in financial and quantitative terms leading to a quantitative analysis.
When economic assessment techniques are applied it is necessary to consider the characteristics of the project in question, and with this project, due consideration must be given to its location.
The project is located near Asam-Asam village in Tanah Laut, which may reasonably be referred to as a remote region of Kalimantan, itself an outlying island. The purchasing power of residents in this region is comparatively low and social indicators such as healthcare/health are also at comparatively low levels. Under such circumstances, the economic and social costs were there to be any impact on the environment would be far greater as compared to in Jakarta or in a developed nation. On the other hand, project costs basically accumulated at international market prices through a process of international competition, thus the gap between other areas is likely to be comparatively small.

Given these conditions, the mechanical application of standard assessment techniques is problematic.

1) South Kalimantan in terms of its Socio-economic Indicators

As shown in Table 7, per capita production in South Kalimantan, where the Banjarmasin power plant is located, is on a par with the national average but is no more than around 20 percent of the figure for Metropolitan Jakarta. However, the poor population in rural communities is less than 10 percent (the percentage of the total population for which purchasing power is lower than the poverty line), and alongside Bali, this province has one of the lowest percentages of poor population in rural area of Indonesia (Table 8).

Table 7: Per capita production for the provinces / regions of Indonesia (2001)

	Per capita production (Rp. 000)	Vis-à-vis Metropolitan Jakarta (%)
Sumatra	6,588	25.1
Java & Bali	6,584	25.1
Kalimantan	11,242	42.8
South Kalimantan	5,878	22.4
Sulawesi	3,995	15.2
Jakarta	26,260	100.0
Indonesia	6,520	24.8

Source: Statistik Indonesia (Statistical Year Book of Indonesia) 2002, Badan Pusat Statistik

Table 8: Percentage of Rural Poor in Individual Provinces of Indonesia (2002)

Provinces with large poor populations	Papua	51.2%
	Maluku	42.8
	Gorontaro	35.5
Provinces with small poor populations	Bali	8.3
	South Kalimantan	9.6
	Jambi	10.8
Average for rural Indonesia		21.1

Source: as for above table

Note: the poverty line in South Kalimantan is Rp 84.5 thousand per person per month (2002)

Table 9 gives access to drinking water and percentage toilet ownership as parameters necessary to investigate the living conditions of rural communities in South Kalimantan. Although access to drinking water is significantly poor and absolute levels of toilet facilities are poor, the table demonstrates that this is average for rural Indonesia.

Table 9: Sanitary Conditions in Rural Households

	Percentage of households without drinking water facilities	Percentage of households without toilet facilities
South Kalimantan	42.9%	31.2%
South Sumatra	33.8	35.1
West Java	6.4	37.2
East Java	6.6	41.3
South Sulawesi	9.2	47.6
Average for rural Indonesia	14.1	35.8

Source: Statistik kesejahtaran Rakyat (Welfare Statistics) 2002, Badan Pusat Statistik

What points need to be considered when undertaking an environmental economic assessment of the rural population of South Kalimantan, a population that lives under such tough economic and social conditions?

2) Points to Remember in connection with Assessment Techniques

When applying environmental economic assessment techniques in developing countries there are three important points that require attention, as follows. We focus on the damage to health caused by atmospheric pollution, which has bearing on this project.

a) Assessment assumptions that are inconsistent with the reality in developing countries

This is a characteristic case, but the concept of the “value of a statistical life” is used to measure the monetary value of the impact of atmospheric pollution on human life. The basic concept is as follows. Work has different effects on a person’s health and life. Workers employed in more dangerous occupations demand a financial premium against risk; the employer is ready to pay this financial premium in order to secure workers. Under such circumstances, the wage rate is established on the premise that it is set as the function of “the risk of losing one’s life by being employed in work”; it changes in response to changes in the risk to life and is expressed as the value of a statistical life.

However, for rural populations in developing countries like that in South Kalimantan, underemployment predominates, and in this type of labor market, even supposing that a job will affect a person’s health or life, job opportunities in modern industries are extremely attractive. Despite undergoing the effects of dust on a day-to-day basis, truck driver jobs at the Asam-Asam coal field, for example, are considered an attractive means of learning skills and earning high wages.

Accordingly, applying a statistical life value to environmental changes that affect human lives among rural populations in developing countries that has been established on the same assumptions as those used in developed countries is problematic and it is necessary to seek more realistic assessment techniques that reflect the conditions locally.

b) Underestimating environmental costs

Negative environmental impacts that threaten the health of residents and can lead to loss of life are usually measured by (1) income lost due to hospitalization, sick leave, and death, etc. (opportunity loss), or (2) healthcare costs.

Looking at per capita production in South Kalimantan (Table 7), the cost measured in terms of opportunity loss is much lower as compared to similar cases in Jakarta and an even larger gap emerges if the figures are compared with those in developed countries. A similar relationship is believed to exist even in the level of healthcare costs. In consequence, the negative environmental effects of a project executed in South Kalimantan will be substantially underestimated when compared to a similar project implemented in Jakarta, for example, or in a developed country.

This factor needs to be corrected when considering the effects on human life of environmental degradation.

c) Increasing "human security costs"

Healthcare costs in remote areas of developing countries are much lower than in those in industrialized nations, but are likely to be high when weighed against the purchasing power of residents. This point can be confirmed in reference to the conditions in Tanah Laut.

The results of the hearing on healthcare costs in this area are outlined below. It should be noted that 1 yen is equivalent to 67 rupiah.

The hearing with staff at RSUD revealed that treatment for a cold at the hospital costs Rp. 13,000 (approx. 195 yen) if the patient pays using a coupon (Rp. 3,000) and purchases drugs over the counter (Rp. 10,000), but if the hospital issues a prescription, the minimum charge reaches Rp. 53,000 (approx. 790 yen). Incidentally, there are three types of room available at the hospital: third class (Rp. 15,000/day), second class (Rp. 100,000/day) and first class (Rp. 150,000/day) with hospitalization charges vary accordingly. There is a 10-fold difference between the most expensive and the cheapest rooms.

Mr. Helmi, the representative of the residents who were resettled with the construction of this project, said that he consults and receives drugs from a local nurse. This costs Rp. 20,000-25,000 (approx. 300-375 yen).

The poverty line in South Kalimantan (2002) is Rp. 84,500 per person per month (approx. 1,260 yen) and based on the results of interviews with local residents, the monthly salary of a skilled carpenter is estimated to be Rp. 500,000 (approx. 7,500 yen) and that of a civil servant to be Rp. 900,000 (approx. 13,400 yen).

For people with purchasing power that is only in the region of the poverty line, receiving a prescription from the hospital represents more than 60 percent of their monthly wage, thus even with a modern hospital located nearby it is unrealistic for them to receive necessary treatment. Just buying drugs from a nurse means parting with a quarter of their monthly salary. Even for a skilled carpenter, a single prescription from the hospital equates to more than 10 percent of the monthly wage.

Healthcare costs are undoubtedly much lower than in industrialized nations, but they represent an enormous outlay for people living on the budget of an average South Kalimantan household, particularly for the poor. Supposing that environmental damages affect the health of the local population, the damage to human security produced as a result would be much more severe than for people in developed countries who are protected by health insurance or even the residents of Jakarta who have greater spending power.

When assessing health damage in regions such as this it is not appropriate to handle healthcare costs in the same way as in other regions, and there is a need to develop assessment techniques that are consistent with the conditions in rural areas of developing countries.

[Outline of Feedback Seminar]

Date: February 12-14, 2004
Participants: BAPPENAS and PLN employees, etc.

In February 2004 the survey team paid a second visit to the PLN South Kalimantan project office – the executing agency – in order to exchange opinions on the results of this survey; the following comments were received.

1. 3-4-1) The dust on the road indicated is close to the site where ash is disposed of after temporary treatment; we are planning to carry out a study on full-scale landfill disposal of the ash during the current year. We are also looking into covering the current storage site to prevent flying dust.
2. 4-1-1) The visible smoke being emitted from the stack that was pointed out during the last survey was probably a temporary phenomenon caused by the suspension of one of the electrostatic precipitators and current conditions preclude any problems in this area.
3. 4-1-2) The high pH measurements should not represent a problem as the water is treated again after that check point.
4. 5-1) (3) Since negotiations with the supplier regarding the use of ash to fill disused coal mines will take time, we want to look into measures, including options other than landfill, in parallel.
5. 5-1) (4) Other coal-fired power plants and/or private-sector companies have elected to use the ash to manufacture construction materials, etc., but there are no such businesses in this area and the incentive for a private-sector company to undertake a business that is premised on transporting the ash from here is an issue.
6. 5-3) Under the Clean Area Program, in December 2003, 500 trees were planted on power plant premises and 63 trees were planted near residential areas.

Appendix 3 28 November 2002, POLITEKNIK KESEHATAN BANJARMASIN ANALISIS KUALITAS UDARA NOMOR:D1.02.02.3.1.437

No	Parameter	Satuan	Terminologi Waktu	Hasil Pengunkuran			
B.	Hasil Analisis			U1	U2	U3	U4
1	Dust	μg/m3	1 jam	55.6	166.7	111.1	166.7
2	SO_2	μg/m3	1 jam	ttd	ttd	ttd	ttd
3	NO_2	μg/m3	1 jam	33.5	42.4	74.8	68.7
4	CO	μg/m3	1 jam	3.23	2.15	1.24	3.o5
Believed to be the environmental concentration, EIA Fig 2		SO_2 ppm		Tr	Tr	Tr	Tr
		NO_2 ppm		0.01748343	0.022128281	0.039038	0.035854

Appendix 4 Results of Emission Calculations as listed in the "EIA Report" (24-hour value)

Item	660MW base* Max. predicted value	Environmental Quality Standard Value (μg/m3) Indonesian standard	International standard
SOx	136.8	260	500
NOx	88.2	92.5	100
Dust	3	260	500

* Breakdown of 660MW
65MW × 2 under current plan
65MW × 2 units under expansion plan
100MW × 2 units under expansion plan
100MW × 2 units under expansion plan

Source: JBIC data

Appendix 5 Total values for coal burned to produce SOx, NOx, dust emissions

Item	Data
Higher calorific v	4193 kcal/kg
Total water	34.55%(w%)
Carbon (C)	44.30%
Hydrogen (H)	3.00%
Nitrogen N)	0.79%
Sulfur (S)	0.23%
Oxygen (O)	14.13%
Ash	3.00%
Total	100%

Source: JBIC data

Appendix 6 Total values as obtained during this survey (2003.8.21-27)

Item	Data min, max (w%)	Data (typical=average)
Higher calorific v	4300 min	4300 kcal/kg
Total water	35.0 max	34.5%(w%)
Carbon (C)	45.1/49.5 min/max	46.73%
Hydrogen (H)	3.3/3.5 min/max	3.40%
Nitrogen (N)	0.5/0.9 min/max	0.70%
Sulfur (S)	0.7 max	0.50%
Oxygen (O)	13.9/15.1 min/max	14.40%
Ash	5.0 max	4.00%
Total		100%

Source: PLN-1(LAMPIRAN 1)

Ash Composition

Item	Data min, max (w%)	Data (typical=average)
SiO_2	16/49.5 min/max	25.2% (w%)
Fe_2O_3	10.6/62.5 min	28.2
Al_2O_3	4.0/17.4 min/max	11.3
CaO	1.9/30.8 min/max	9.2
MgO	1.5/20.5 min/max	5.6
Na_2O	0.1/0.3 min/max	0.1
K_2O	0.1/0.6 min/max	0.2
TiO_2	0.1/0.8 min/max	0.6
SO_3	2.7/20.5 min/max	8.2
P_2O_5	0.05/1.9 min/max	0.2
Ignition Loss		

Source: PLN-1(LAMPIRAN 1)

Appendix 7-1 Coal Analysis Values

Source: PT.GEOSERVICES LTD REF NO:003343, October 13, 2000

Item	Unit	Conditions	Results	Test Method
Deformation	℃	reducinng	1120	ASTM D-1857;87
C	%	dry ash free	72.23	ASTM D-3178;89
H	%	dry ash free	4.68	ASTM D-3178;89
N	%	dry ash free	1.16	ASTM D-3179;89
S	%	dry ash free	0.16	ASTM D-4239;97
O+error	%	dry ash free	21.77	by difference

Note: composite of samples collected between June and September

Appendix 7-2 Coal Analysis Values

Source: PT.GEOSERVICES LTD REF NO:003369, 8 December, 2000

Item	Unit	Conditions	Results	Test Method
Deformation	℃	reducinng	1120	ASTM D-1857;87
C	%	dry ash free	72.1	ASTM D-3178;89
H	%	dry ash free	4.74	ASTM D-3178;89
N	%	dry ash free	1.07	ASTM D-3179;89
S	%	dry ash free	0.19	ASTM D-4239;97
O+error	%	dry ash free	21.9	by difference

Note: composite of 6 samples taken in November

Appendix 8 Flue Gas Concentrations

Data up to 2003.6.19-7-9 (measurements taken at 9:00 and 19:00)

Item	Unit	Min.	Max.
H2O(Uap Air)	%	0.04	11.7
C	ppm	0	51
CO	ppm	-2	264
SO2	ppm	-4	323
NOx	ppm	2	123
Temp	℃	138	154
O2	%	4.6	20.2
Dust	mg/Nm3	1	339

Many of the gas concentrations are negative

Appendix 9 Wastewater Analysis Values

Measurments taken at 00:00, 05:00, 10:00, 14:00, 17:00, 20:00

Measured values between Jun. 29 - Aug. 12, 2003

(1) Inlet

	Min.	Max.	Suspended
pH	5.5	8.19	8/1-8/22
Iron	0.021	22*	
TSS	14	120	

* May be an entry error, i.e. the TSS value

(2) Outlet

	Min.	Max.	Suspended
pH	5.8	9.41	8/1-8/22
Iron	0.021	0.302	
TSS	8	100	

Appendix 10 Indonesian Wastewater Standard Values (Ministry of Population & Environment KEP-02/MENKLH 1988)

	Wastewater Standard			Air Quality Standard	
	Tight Grade Standard	Medium Grade Standard	Light Grade Standard		ppm = µg/m3
SOx	200mg/Nm3	250mg/Nm3	300mg/Nm3	24h 0.03ppm	2857.1
	70ppm	87.5ppm	105ppm	260µg/Nm3	
NOx	1700mg/Nm3	4600mg/Nm3	4600mg/Nm3	24hr 0.045ppm	1916.6
	828ppm	2240ppm	2240ppm	92.5µg/Nm3	
Dust	400mg/m3	500mg/m3	800mg/m3	24hr 260mg/m3	

Note: currently recorded as 300ppm, but the correct value is believed to be 0.03ppm.

Source: JBIC data

Appendix 11 Results of Maximum Concentrations Measurements (24-hour value, values recorded in the EPI report)

Atmospheric sta	3	3	4	5	Results
Wind speed m/s	1	2	1	1	6
SO2 µg/m3	138.8	99.12	9	23.24	66.3
Distance m	7419	7	7880	7880	6093
NOx µg/m3	88.24	63.92	5.8	14.93	87.2
Distance m	7419	4200	7880	7880	6093
Dust µg/m3	3	2.1	0.3	0.62	4
Distance m	7880	7880	7880	7880	6093

Source: JBIC data

Appendix 12 Quality of Source Water (1990 base) & Wastewater Emission Standards (1988 base)

Parameter		Unit	Water quality standard	Wastewater standard	
Physical			Max. allowable limit	Class 2	
Temperature		℃	Normal limit	38	
TSS		mg/L	1500	2000	
TDS		mg/L	—	200	
Turbidity		NTU	2,000-10,000		
Anorganic	Inorganic				
pH			5-9	6-9	
DO		mg/L	5		
BOD		mg/L			
NH3-N		mg/L	0.5	1	
NO3-N		mg/L	10	20	
NO2-N		mg/L	1	1	
S2		mg/L	nil	0.05	H2S
SO4		mg/L	400		
Cl		mg/L	600		
F		mg/L	1.5	0.05	
CN		mg/L	-	0.4	
Cd		mg/L	0.01		
Cr6		mg/L	0.05	0.1	total
Cu		mg/L	1	2	
Zn		mg/L	15	2	
Fe		mg/L	5	5	
Mn		mg/L	0.5		
Ba		mg/L	1	5	
Hg		mg/L	0.001	0.05	
As		mg/L	nil	2	
St		mg/L			
Se		mg/L	0.01	0.1	
Pb		mg/L	0.1	0.02	
Sn			-	0.1	
Co			-	0.2	
Cl2				2	

Source: JBIC data