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EVALUATION REPORT

OF THE

UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT
AND
AGENCY FOR ASSESSMENT AND APPLICATION OF TECHNOLOGY

PUSPIPTEK ENERGY RESEARCH LABORATORY (LSDE) PROJECT

submitted to

U.S.A.I.D. Mission Director
Jakarta, Indonesia

by

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EVALUATION ABSTRACT

The purpose of the project is to assist the Government of Indonesia (GOI) in establishing a viable, professional energy research laboratory and technology development center which conducts applied research, supports Indonesian energy-related industries, and provides the GOI and private industry with technical and economic feasibility analyses on potential energy programs, projects and technologies. The project has three major components: establishment of the laboratory and personnel training, commodities and equipment procurement, and technical assistance.

The project was initiated in 1982 as a seven-year collaborative effort between U.S.A.I.D. and the GOI. The project completion date has been extended to September 30, 1991. This evaluation was conducted from February 19 to March 6, 1989 by three energy specialists from the U.S.A. The evaluation team held meetings with individuals in A.I.D./Washington, U.S.A.I.D./Jakarta and the U.S. Embassy in Jakarta, and reviewed pertinent project documents. In Indonesia the team visited the laboratory and various private and GOI organizations and individuals that are or could in the future be connected with the laboratory. The evaluation team was asked to provide (1) a brief status report of the laboratory development to-date, (2) a statement of the laboratory objectives/targets to be achieved, and (3) a proposed plan of action including a statement of work for future technical assistance to the laboratory.

The major findings and conclusions are:

- The laboratory has been officially established by the GOI with staff provided, and the required support infrastructure has been put in place.

- The laboratory will be built with or without U.S.A.I.D. help according to the Indonesian officials interviewed.

- The technical development of the laboratory staff has been slow due to nonavailability of equipment and a lack of direction from all parties involved in the project.

- There needs to be a single contractor responsible for supplying the remaining TA services and the LSDE coal combustion facilities.

- With correct technical assistance and facilities the staff will be able to operate and conduct experiments.

- The proposed facilities will be used by both public and private institutions and organizations in Indonesia. There appears to be sufficient GOI, private and U.S. interest to sustain the laboratory and to justify U.S.A.I.D. participation.

- The laboratory can have a significant value to U.S. steam generation and coal preparation interests by promoting U.S. coal combustion technology and knowledge.

- The laboratory staff should be focused on specific tasks for the next several years and should participate in the design, fabrication, construction and start-up of the facilities.

- There will be a need for external technical assistance on a case-by-case basis to address specific objectives for an extended period of time after the project assistance completion date.

- The majority of the facilities could be fabricated and installed locally with the exception of instrumentation, controls and special rotating machinery. Indonesian companies also will need assistance with process design.

The following lessons were noted:

- "Host country" contracting and management was not appropriate for the project because the host country organization had no experience with operation or procurement of advanced energy and coal combustion technologies or with U.S. government procurement regulations. Time and funding allowed to complete the project was not sufficient to both transfer capabilities to conduct "host country" contracting and meet project objectives.

- Relying on a contractor that normally does not provide detailed design and procurement of major equipment (except for its own use) to advise a host country institution with no experience in performing these functions produced unsatisfactory results.

- The project arrangements to date have been cumbersome and have impeded progress. Multiple contracts and procurements have required multi-organization approvals.

EXECUTIVE SUMMARY

The overall objective of this project is to assist the Government of Indonesia (GOI) in establishing a viable, professional energy research and development laboratory which conducts applied research, supports energy-related industry, and assists the GOI and private industry with technical and economic feasibility analyses for energy programs, projects and technologies.

The PUSPIPTEK Energy Research Laboratory (LSDE) is a joint project between the U.S. Agency for International Development (U.S.A.I.D.) and the GOI. (Appendix A contains a complete list of abbreviations used in this report.) The project includes three major components: (1) establishment of the laboratory organization and training of the personnel, (2) procurement and set-up of necessary laboratory commodities and equipment, and (3) provision of technical assistance.

The evaluation team was asked to provide (1) a brief status report of the laboratory development to-date, (2) a statement of the laboratory objectives/targets to be achieved, and (3) a proposed plan of action including a statement of work for future technical assistance to the laboratory.

The evaluation team reviewed pertinent project reports including the technical specifications of the proposed laboratory equipment. The team also visited the existing laboratory facilities, staff, private industry and government officials and other laboratories set up under foreign assistance programs. Appendix B provides the team's schedule of meetings in Indonesia. The discussions and visits provided the team with background on the current status of laboratory development and on the likelihood of future technical assistance success.

Appendix C outlines activities to be undertaken by laboratory staff as laboratory facilities are being established. Appendix D contains a summary of team findings, conclusions and recommendations in tabular form. Appendix E provides a Statement of Work for future technical assistance.

Findings and Conclusions

A. Facilities and Technical Assistance

The combustion facilities specified are general in nature and, in the opinion of the team, not focused on the needs of the GOI. The facilities should be focused on the characterization of Indonesian coals, analysis of the combustion characteristics and application of the coals using different steam generation technologies, and the development and evaluation of clean coal combustion techniques. Selecting facilities for these purposes would provide the laboratory with short-term (three to five year) projects that address immediate needs of the Indonesian government and industry and that can be carried out by the existing staff. Success with these activities would establish the technical capabilities of the laboratory and

provide background for the technical personnel to carry out more advanced energy technology projects in the future.

At the end of the Battelle amended contract, the laboratory staff will have been provided adequate combustion science training. Future technical assistance should focus on the following areas: (1) research laboratory management; (2) experimental design and evaluation of results; (3) design, fabrication, construction and operation of research facilities; (4) facility instrumentation and controls; (5) facility repair and maintenance; and (6) project engineering and economic evaluation. (Appendix E provides Statement of Work.)

B. U.S.A.I.D. Continued Project Support

There appears to be sufficiently strong interest (private and governmental) both within Indonesia and the U.S. commercial sector to justify continued U.S.A.I.D. support. Coal ranks high in the GOI's future energy plans and the GOI views U.S. companies as the coal technology leaders. A laboratory built and supported technically by U.S.A.I.D. promotes U.S. technology in the areas of power generation, coal preparation and mining, coal cleaning, environmental controls, instrumentation and process controls, industrial steam production, and coal transport.

The laboratory will be sustained by both private and public institutions within Indonesia. Interest was shown in the use of the laboratory by PLN (power company) and other organizations (e.g., coal companies) including universities. Other laboratories built with foreign assistance have been sustained with minimal, if not zero, foreign assistance. Some examples of these are the Materials Lab (LUK), the Instrumentation and Metrology Lab (KIM), and the Metal Industry Development Center (MIDC).

The success of the aforementioned labs was largely due to having a sponsoring industry as the focus of initial services. For example, services to the aircraft industry helped establish the technical capabilities of the Materials Lab and in turn attracted other industrial customers. The team feels that a similar approach should be taken with the energy laboratory using the power company (PLN) and the coal companies as the initial sponsoring industries. Laboratory personnel have a strong financial incentive to market laboratory capabilities because they can receive salary bonuses for successfully attracting outside projects.

Several high-ranking Indonesian officials within the BPPT organization stated that construction of the laboratory will go ahead with or without the help of U.S.A.I.D. because of the high priority placed by the GOI on the use of coal for domestic energy generation. The GOI needs to gain experience with coal and coal combustion technologies in order to develop national policies on coal development and preferred technologies.

At this time, U.S. companies are in a particularly strong position because the national utility of Indonesia (PLN) has disqualified Japanese companies from the supply of coal-fired steam power generation equipment. U.S. coal exports are unlikely to be affected by the laboratory development since current U.S. coal exports to the Pacific Rim are minimal. Additionally, strong Australian and Chinese presence in the Pacific Rim coal market along with high U.S. transportation costs (most U.S. mines are located in the interior of the U.S.) mean U.S. support for development of the laboratory is unlikely to affect future U.S. coal export opportunities.

The laboratory will also provide the training and operational experience to permit future expansion into other alternate energy sources by the LSDE staff.

C. Select a Single Contractor

U.S.A.I.D. needs to select a single contractor to be responsible for the overall management of the project, the design and procurement of all required test facilities, and for providing or procuring overall technical assistance to the laboratory. The current lack of project progress can be attributed in large part to the complexity of current contracting arrangements and the use of "host country" contracting when the host country organization lacks experience with the technologies and services to be procured.

The use of a single contractor would relieve some of the project management burden from both U.S.A.I.D. and the GOI. A single contractor responsible for providing both facility selection, design procurment, and technical assistance would simplify U.S.A.I.D.'s project management and provide greater efficiency. The Mission needs to address the contractual and legal implications of this approach because it will require blending of loan and grant funds.

D. Personnel Training

The team feels that additional technical assistance for personnel training is required. Technical assistance can be broken down into two major categories: (1) short term and (2) long term. In the short term, the current laboratory personnel need to focus in specific areas on research that can be accomplished with available equipment. Short-term projects could include coal characterization and reactivity studies for Indonesian coals using the TGA and the surface area (BET) apparatus, coal analysis, and development of slagging and fouling characteristics using gravity fractionation and weak acid leaching techniques. These short-term experiments will keep the laboratory personnel current in coal characterization techniques, provide training using known experimental techniques, and provide useful results to the GOI. The recently initiated activities with ITB can provide opportunities for internships at existing coal-burning facilities.

Long-term technical assistance will be required in four major areas: (1) overall research laboratory management, (2) technical training of

laboratory personnel, (3) instrumentation and controls, and (4) facilities maintenance. Due to the staff's overall lack of experience with coal research, the team feels technical assistance is needed to guide the laboratory in planning research that is of value to GOI; help the laboratory keep up with current technology; and train the staff to design experiments, analyze data and evaluate results. Basic training for new staff to be added in the future can be provided by ITB.

The laboratory staff will require technical advisors to help design experiments and evaluate results. LSDE staff should be included in the facility design, fabrication, construction and overall project management. Not only will they gain knowledge that will assist in future research activities, but they will develop skills necessary to design and install future facilities without technical assistance from foreign donors.

E. Laboratory Facilities

The team recommends the following facilities in order of priority:

a. Coal Analytical Laboratory: This equipment was specified under the Battelle contract and will be used to characterize coals used during experiments. More specialized experiments can be performed to further enhance the understanding of combustion characteristics of Indonesian coals. The equipment has already been purchased and was scheduled for delivery to the laboratory in late March.

b. Coal Preparation Facilities: Without coal preparation equipment there can be no coal combustion experiments performed. Although the Battelle specification is adequate, there are also a number of other facilities in use in the U.S. with different, but acceptable, specifications.

c. Laboratory Support Facilities: These include items such as compressed air and cooling water supplies, start-up fuel (LPG), electrical supply, spare parts for valves, pipes, etc., computers and computer software, machine shop for lightweight routine maintenance, and tools.

d. One Dimensional Furnace: This facility will provide fundamental information about the combustion characteristics of different coals. The basic design supplied by Battelle was judged to be adequate although other equipment is used at other facilities in the U.S.

e. Pulverized Coal (PC) Fired Furnace: This facility should be built to simulate conditions in a pulverized coal fired steam boiler and have the ability to investigate slagging and fouling effects of coal ash. Given the current knowledge level and the planned use of coal for electric generation in Indonesia, this facility will be essential to the study of the use of Indonesian coals in boiler applications. It can help PLN determine which

coals are most suited to particular boilers, and it can help coal companies develop information for potential customers.

f. Fluidized Bed Combustor: This facility should be designed to study Indonesian coals in a fluidized bed environment. The facility should be able to determine burning rates, effects of coal particle sizes, allutriation, and environmental performance over a range of gas velocities. In addition, the facility should be able to provide information on basic design considerations such as whether to feed coal over or under the bed. This facility can also be used to examine combustion characteristics for other fuels such as peat, anthracite culm and mine tailings.

F. Schedule for Advisors

The team developed a schedule for remaining activities including the technical assistance requirements for each phase. Successful completion of the project will require four categories of technical assistance:

Technical Assistance Leader	18 Man-months
Project Engineer	36 Man-months
Coal Chemistry Analyst	12 Man-months
Instrumentation and Controls Engineer	9 Man-months

Detailed descriptions of the tasks to be performed in each category are provided in Appendix D. In summary, the Leader will be primarily responsible to provide advice to the Laboratory Director on laboratory management and overall program development. The Project Engineer will be responsible for scheduling and overseeing the design, fabrication and installation of the laboratory equipment and for training and integrating the LSDE staff. The Coal Chemistry Analyst will train the staff in the use of the coal chemistry equipment. The Instrumentation and Controls Engineer will supervise the installation and start-up of the instruments and controls and train LSDE staff in their use and maintenance.

The technical assistance required is available in many places in the United States. Certainly, commercial vendors such as Combustion Engineering, Babcock and Wilcox, Riley Stoker, and Foster Wheeler have such capabilities, as do government laboratories such as the Department of Energy Pittsburgh and Morgantown Energy Technology Centers and the national laboratories like Oak Ridge and Argonne, and universities with strong coal programs which include the University of North Dakota, Brigham Young, Penn State, MIT, Ohio State, University of Kentucky, and University of Illinois. The team recommends that priority for technical assistance be first with private industry, then government laboratories, and then qualified universities.

Recommendations for Future Action

The team was asked to recommend a course of action for successful completion of the project. First, the GOI and U.S.A.I.D. must decide to

accept or reject the Combustion Engineering facilities bid. If the decision is to reject the CE bid, the team recommends that a new statement of work be developed that includes not only facilities, but technical assistance. U.S.A.I.D./Jakarta will need help to develop a revised scope of work and evaluation criteria for contractor selection. Section 5.1 presents options for obtaining help. The revised SOW should not only specify facilities to be procured, but also technical assistance. Section 5.2 provides an outline for the revised SOW.

Once the revised SOW has been prepared, U.S.A.I.D. will need to decide how to complete the project. The team carefully compared the expected project schedule and costs for two approaches to project completion: Competitive procurement for the complete package or selection of a U.S. government laboratory to provide technical assistance and manage installation of facilities. Because government laboratories would need to subcontract competitively for the construction of the facilities, the team feels little, if any, time would be saved by working with a government lab. Either approach will likely extend the time required for poject completion approximately nine months beyond the current completion date of September 1991.

The team also estimated that the impact of the proposed schedule delay on project costs. The team believes that restructuring the bid will significantly reduce equipment costs since the selected contractor will use designs from their exisiting facilities, elminating concern about performance warranties for somebody else's design. We have estimated that providing the facilities recommended in this report will cost approximately $4.0 to $6.0 million. Additional funding required to help the Mission develop the new SOW and the contractor evaluation criteria and to maintain technical assistance at LSDE while the new contractor is selected will depend on how the Mission uses the existing agreement with Battelle that runs through September 1989. Costs are not likely to exceed $100,000.

1.0 INTRODUCTION

1.1 Purpose of the Energy Research Laboratory

The overall objective of this project is to assist the Government of Indonesia (GOI) in establishing a viable, professional energy research and development laboratory which conducts applied research, supports energy-related industry, and assists the GOI and private industry with technical and economic feasibility analyses for energy programs, projects and technologies.

The PUSPIPTEK Energy Research Laboratory (LSDE) is a joint project between the U.S. Agency for International Development (U.S.A.I.D.) and the GOI. (See Appendix A for complete list of abbreviations.) The project includes three major components: (1) establishment of the laboratory organization and training of the personnel, (2) procurement and set-up of necessary laboratory commodities and equipment, and (3) provision of technical assistance.

The concept of a national laboratory in which research on energy resources and technologies is conducted seems to be very appropriate for Indonesia as the nation continues its industrial development. This is especially true given the potential mix of energy resources that vary from renewable fuels (from biomass that is generated in the agricultural and pulp and paper industries) to the large reserves of fossil fuels of oil, gas and coal. Such a laboratory has the potential to contribute the information necessary for choosing the best economical mix of energy sources and technologies and to establish a coherent, long-range national energy policy. It is obvious that these facts contributed to the philosophy which was used as a back-drop when the vision of the national energy research laboratory was put forward in the late 1970s and were major factors in the decision by U.S.A.I.D. and the GOI to proceed with the LSDE in 1982.

The goal of the LSDE was and is to assist in the development of energy technologies that could be of value to the GOI. The situation in Indonesia requires that for the short term (3-5 years), LSDE help assess technologies and fuels while they develop their capabilities.

In 1982 U.S.A.I.D. negotiated an agreement with the GOI to establish the LSDE. Under the arrangement, the GOI, through their Ministry of Science and Technology Agency for Assessment and Application of Technology (BPPT), would take the actions necessary to assure adequate staffing and support for the operation of the laboratory including designation of a director, assignment of staff, and provision of building(s) to house facilities. Funds from U.S.A.I.D. would be loaned to the GOI for assistance in planning and establishing the

laboratory. BPPT would manage the procurement of necessary equipment and services with U.S.A.I.D. funds using U.S.A.I.D. "host country" contracting procedures.

In 1984 BPPT signed a contract with the Battelle Memorial Institute (BMI) to provide assistance in establishing the laboratory. Basically, BMI was to draft a master plan and an implementation plan and provide the necessary training to BPPT staff to operate the facilities and conduct research experiments. In turn, the GOI would furnish the necessary facilities and infrastructure in which to house the laboratory.

Although the master plan called for LSDE to eventually be in a position to conduct experiments in many alternate energy technologies, its initial focus was on renewables, photovoltaics and coal. BPPT received support from other donor countries to furnish some facilities. As time delays were encountered with the establishment of LSDE, U.S.A.I.D. support was shifted to emphasize coal.

LSDE is now an officially recognized entity within BPPT. As with several other of BPPT's facilities, the LSDE is located at the National Center for Research, Science and Technology (PUSPIPTEK) near Serpong, Indonesia.

1.2 Current Status of LSDE

Facilities/Equipment

The GOI has built several buildings in which to house the various research facilities, chemical and analytical laboratory, library, and LSDE staff. These buildings are adequate in size and layout to allow the installation of several research facilities as they become available. The laboratory space has been fitted with the major necessary services such as water and electricity. At this time it is expected that the laboratory equipment ordered under the BMI contract will be delivered in April or May, 1989 so that a modern analytical laboratory will soon be available. Although the equipment ordered was specified with the purpose of doing coal analyses, it should be more than adequate to do analysis of other fuels and some materials investigation.

In addition to the buildings, there currently exists at PUSPIPTEK an array of photovoltaics and solar thermal devices supplied by other donor countries. Some of these devices are instrumented with ongoing data collection. Analyses of other pieces of equipment have been completed and their operations discontinued because they were judged not yet economically feasible within the energy supply scheme of Indonesia. Also found at LSDE, but not operating, are a rice hull gasifier, a solar thermal-assisted water pump, a coal gasification pilot plant (although this does not officially belong to LSDE), and

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several other experimental devices. Because most of these experiments are finished, LSDE does not currently have adequate research facilities to conduct experiments.

Institution

The LSDE is an officially recognized entity within BPPT with a staff of about 100. A laboratory director is assigned who reports to the Minister of Science and Technology and Chairman of BPPT. There is an appropriated budget assigned to LSDE for its operation. However, there are no funds currently available for training, facilities and travel beyond those in the LSDE project under the U.S.A.I.D./BPPT agreement. The technical staff have been given a considerable amount of training in coal combustion technology, science, and facilities by BMI, both in the U.S. at its Columbus, Ohio facilities and in Indonesia through workshops and seminars. Staff training will continue under the BMI contract until its expiration date of September 30, 1989.

1.3 Purpose of Evaluation of LSDE Project

The evaluation team was asked to provide (1) a brief status report of the laboratory development to-date, (2) a statement of the laboratory development objectives/targets to be achieved, and (3) a proposed plan of action including a statement of work for future technical assistance to the laboratory.

The evaluation team reviewed pertinent project reports including the technical specifications of the proposed laboratory equipment. The team also visited the existing laboratory facilities, staff, private industry and government officials, and other laboratories set up under foreign assistance programs (see Appendix B). The discussions and visits provided the team with background on the current status of laboratory development and on the likelihood of future technical assistance success.

2.0 Project Issues

Given the length of time between project initiation and probable completion (currently the Project Action Completion Date is September 1991) the evaluation team considered several issues to see if the original objectives and desirability of the laboratory are still valid.

2.1 LSDE - Sustainability

Of concern in any project of this type is whether the effort can be sustained after the donor fulfills its obligation of funding and technical assistance. Several factors enter into the consideration of sustainability such as the long-term host

country's needs, potential clients for the results produced, flexibility of the facilities for conducting future research, and the ability to attract and retain competent staff.

It is the opinion of the evaluation team that, if the near-term focus continues to be on coal combustion research, the LSDE will be sustainable. This opinion was formed based on the discussion held with many GOI and private officials which yield the following:

(1) The major sponsor of the laboratory is the Ministry of Science and Technology/Agency for Assessment and Application of Technology, which has an active role in developing the GOI strategies for future energy use. With a major thrust toward the use of Indonesian coal, LSDE will be the only facility available to obtain complete coal characteristics (i.e., physical and combustion properties) needed for proper technology evaluation and deployment.

(2) There is historical precedent since other laboratories established by donor/host country agreements are being sustained by the GOI. Three examples of these are the Materials Testing Laboratory (LUK); the National Instrumentation, Calibration, and Standards Laboratory (KIM); and the Aerodynamic Testing Laboratory. These labs were established because of a strong technical need rather than a long-term strategic plan on the part of the GOI. Technical needs brought these facilities their first customers and helped establish their technical reputations that in turn attracted other clients. If LSDE is to be successful in future years, the team believes that a "patron" industry must be identified that needs its facilities and technical services. PLN and the coal companies of Indonesia could fulfill this role.

(3) In order to minimize their technical risk when obtaining a diverse and expanded choice of coal suppliers for future coal-fired steam/electric power stations, PLN will need and can use the results produced at LSDE. It is probable that the national coal company will be a cooperative partner with PLN in identifying supplies of coal acceptable to PLN. It is also possible that private coal companies in Indonesia will use the facilities to test coal reserves they plan to export.

Based on these observations, it appears that LSDE could have a significant impact on the GOI's policy for coal development and technology selection. However, it would be unrealistic to think that LSDE will have anything but a marginal impact on Indonesia's ability to develop their own technology for several years. (Three to five years is an optimistic estimate for any substantial effect.)

2.2 Commercial Value to U.S. Interests

The presence of a coal combustion research component in LSDE can significantly improve communication and cooperation between U.S. coal technology vendors and the GOI. It will have little, if any, impact on the ability of the U.S. to export coal to competing markets.

The U.S. power industry now has a presence in Indonesia through the Suralaya Steam Power Plant and the Paiton Steam Power Plant. The Suralaya Plant, which has two operating units of 400 MWe and two more under construction, is being constructed by Babcock and Wilcox through their Indonesia partner. The planned units at Paiton are currently to be built by Combustion Engineering and its Indonesian partner. Since the U.S. now has a competitive edge in Indonesia and is recognized as a leader in coal technology, the knowledge gained by the GOI through LSDE can further help to promote U.S. technology in the areas of:

- clean coal technologies;
- coal cleaning equipment;
- coal preparation equipment;
- coal transportation technology;
- electric and industrial steam production equipment;
- environmental control equipment for coal burning processes; and
- process and plant control equipment and instrumentation.

Because of an apparent growing awareness in Indonesia of the environmental implications of using coal for electric power production, LSDE can be used to assess environmental control equipment. U.S. companies are world leaders in environmental controls.

The prospect of LSDE producing data which may be used by producers of Indonesian coal to compete with the U.S. coal exports is a possibility. However, since the Indonesian coal will likely be competitive only in the Pacific Rim countries where the U.S. export market is either non-existent or minimal due to U.S. mine locations and strong competition from Australia and China, it is unlikely that U.S. coal exports will be affected.

2.3 LSDE - Potential Clients

Discussions with several GOI institutions gave a clear indication that LSDE can and will serve several clients. The increase in the number of coal-fired power plants for electricity production will probably require that PLN purchase coal from multiple sources, many of which will differ from that used in original plant designs. Since the performance of pulverized coal-fired (PC) furnaces is sensitive to small

variations in coal characteristics, it is obvious that PLN can greatly benefit from data generated at LSDE.

There are a number of other potential clients:

- ITB and other university research staff can use the facilities both for teaching and research.

- The BPPT staffs that are charged with making technology assessments will need data generated by LSDE to make informed decisions in their selection process.

- The Department of Mines and Energy Directorate of Coal can use the LSDE data to assess the quality of coals relative to boiler designs and performance before deciding on which reserves to open.

- Industrial coal users, such as the cement companies, can use the LSDE facilities to make technology choices and/or to improve their current operations.

- The State Ministry of Population and Life Environment can use the LSDE facilities to characterize potential emissions from coal combustion to investigate environmental impacts when considering sites for coal burning plants.

2.4 GOI Interest and Applicability

The LSDE facilities can have significant value to the GOI by supplying technical advice and input in several areas. There will be a need to classify Indonesian coals, not only for their physical characteristics, but for their chemical and combustion properties as well.

During the next few years as Indonesia's use of coal increases, the availability of data on coal characteristics will aid greatly in technology evaluation and will help set directions for "in-country" coal technology development. This data can also be used to help solve industry operational problems, aid industries in their coal selections, and perform environmental control assessments.

The presence of a national laboratory which is recognized as producing quality research results will promote efficient and clean use of coal as well as training for industry and educational institutions. LSDE should be encouraged to interact with other GOI institutions including cooperation on staff development and joint research projects. Potential cooperating institutions include (see Appendix A for abbreviations):

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Staff development and personnel exchange:

- ITB
- PLN
- Department of Mines and Energy
- MIDC
- BPPT - Instrumentation Laboratory (KIM)
  - Materials Testing Laboratory (LUK)
- Department of Population and Life Environment

Joint research projects:

- ITB
- PLN
- Department of Mines and Energy
- BPPT - Instrumentation Laboratory (KIM)
  - Materials Testing Laboratory (LUK)
- Department of Population and Life Environment
- Department of Industry

Even though several of these institutions can be considered clients of LSDE, their relationship can be strengthened by joint efforts involving respective staffs.

3.0 LSDE Facilities and Technical Assistance

The major focus of this investigation was on recommending actions that could be taken to move LSDE to an operating mode. Using funds remaining in the U.S.A.I.D. project to provide coal combustion research facilities to LSDE is a correct next step for U.S.A.I.D. given the current GOI emphasis on increased coal use. As part of their contract, BMI recommended a group of facilities typically needed to do fundamental coal characterization and combustion research. The team reviewed the BMI recommendations and made suggestions for changes given the current project status.

3.1 BMI Recommended Facilities

Based primarily on their experience at the Columbus, Ohio laboratory, BMI recommended the following facilities:

- coal preparation equipment for crushing, grinding, and transporting coal to the research facilities;

- chemical and analytical laboratory for characterizing coal physical and chemical properties, analyzing ash and combustion products, and analyzing experimental data;

- support services such as a machine shop for routine maintenance and modification, compressed air, potable and raw water, and a control room from which to run the facilities and conduct experiments;

- one-dimensional furnace for coal combustion studies;
- pulverized coal-fired furnace to simulate steam generator conditions;
- pulverized coal-fired furnace typical of industrial process heating, e.g., a cement kiln;
- fluidized-bed combustor of the fixed bed type; and
- fluidized-bed combustor of the circulating bed type.

Although BMI is correct in that this array of facilities would be typical of those used to support coal combustion research, it was apparent to the review team that (1) this array would probably not fit within the remaining available funds and (2) this array is too large and unfocused for a relatively inexperienced LSDE staff to begin to operate and manage.

3.2 Evaluation Team Recommended Facilities

Because of the need to devise an approach to move LSDE staff into facilities they could be expected to support and that would produce meaningful results in a relatively short time frame, the evaluation team recommends development of a smaller array of facilities. Based on interviews conducted and team experience with development and operation of public and private research facilities, the team recommends the following set of facilities in order of priority:

a. Coal Analytical Laboratory: This equipment is essential for the analysis of the characteristics of the coal used during experiments. In addition, specialized experiments could be performed which would further enhance the understanding of combustion characteristics of Indonesian coals. The equipment has been purchased and is being delivered in the near future to the laboratory. Additional equipment such as BET surface area apparatus would need to be purchased.

b. Coal Preparation Facilities: Without this equipment, there can be no coal combustion experiments performed. The equipment specified by Battelle is viewed by the team to have been adequate.

c. Laboratory Support Facilities: These include items such as compressed air and cooling water supplies; start-up fuel (LPG); electrical supply; spare parts for valves, pipes, etc.; computers and computer software; machine shop for lightweight routine maintenance; and tools. Several of the items mentioned have been procured although the heavy equipment for compressed air, water and fuel (LPG) supply are still needed.

d. One Dimensional Furnace: This facility would provide fundamental information that could be used to characterize the combustion characteristics of different coals. The team believes this facility should receive the highest priority after provision of the support facilities. The basic design supplied by Battelle was judged by the team to be adequate.

e. Pulverized Coal (PC) Fired Furnace: This facility should be built to simulate conditions in a pulverized coal-fired steam boiler with the ability to investigate slagging and fouling effects of the coal ash. Given the current knowledge level and use of coal for electric generation in Indonesia, this facility would also be essential in the study of Indonesian coals. Facilities of this type exist in the U.S. in most of the laboratories operated by commercial vendors.

f. Fluidized Bed Combustor: This facility should be designed to characterize Indonesian coals in a fluidized bed environment. The facility should be of simple design to determine burning rates, effects of coal particle sizes, allutriation, and environmental performance over a range of gas velocities. In addition, the facility should provide information of basic design considerations such as whether to feed coal over or under the bed. The facility could provide the GOI with information on the use of this advanced technology for a wide range of coals and other fuels such as peat, anthracite culm, and mine savings.

3.3 Technical Assistance for Personnel Training

Additional technical assistance for personnel training is required. Technical assistance can be broken down into two major categories: short term and long term. In the short term, the current laboratory personnel need to focus in specific areas of simple research that can be accomplished with available equipment.

Short-term projects could include coal characterization and reactivity studies using the TGA and the surface area (BET) apparatus, coal analysis, development of slagging and fouling characteristics using gravity fractionation and weak acid leaching techniques. These short-term experiments will keep the laboratory personnel current in coal characterization techniques, provide training using known experimental techniques, and provide useful results to the GOI. Expanded discussion of these activities can be found in Appendix C.

The chemistry laboratory of LSDE provides an important support function to the overall operation and success of LSDE. This laboratory performs all chemical analyses of coal, ash, and products of combustion providing LSDE staff with the

fundamental information for planning and carrying out their overall research program.

The chemistry laboratory personnel will require technical assistance during the initial operation of the laboratory. In the short term, some assistance may be able to be obtained from ITB and the Department of Mines and Energy.

Long-term technical assistance will be required in four major areas: (1) overall research laboratory management, (2) technical training of laboratory personnel, (3) instrumentation and controls, and (4) facilities maintenance. Due to the Indonesian staff's lack of experience with coal research, technical assistance is needed to guide the laboratory in planning research that is of value to the GOI; to help the laboratory keep up with current technology; and to train the staff to design experiments, analyze data and evaluate results.

The laboratory staff will require technical advisors to help design experiments and evaluate results. LSDE staff should be included in the facility design, fabrication, construction and overall project management. Not only will they gain knowledge that will assist in future research activities, but they will develop skills necessary to design and install future facilities without technical assistance from foreign donors.

In addition to assistance from ITB and the Department of Mines and Energy, the LSDE personnel working in the Chemical laboratory may need additional technical assistance. Tasks for a chemical analyst are described in Appendix E. The chemical analyst will instruct LSDE personnel on experimental and analytical techniques, specify additional laboratory analytical equipment, establish quality control and assurance procedures, and advise on safety and environmental issues.

The staff will also require assistance with instrumentation and controls. Particular attention should be paid to maintenance, repair and calibration of laboratory instruments. Introductory training will be provided by U.S. experts (the controls and instrumentation vendor). Subsequent training can be supplied by the ITB and the Instrumentation and Metrology Lab (KIM).

It is important that the facilities be maintained properly to insure valid data is obtained from experiments performed. Maintenance will be the primary responsibility of laboratory technicians. The Metal Industry Development Center (MIDC) has already provided some training for technicians. These technicians will probably need a refresher course once the equipment arrives. MIDC or other Indonesian institutions should be able to meet future needs for technician training.

The team recommends technical assistance be included as part of the overall scope of work developed to complete the project.

Technical assistance will be needed for the duration of the project and should be one criteria against which proposals are evaluated. A draft statement of work for remaining technical assistance is presented in Appendix E.

The key technical assistance needs could be met with two technical advisors. The first advisor should be an engineer that has managed research laboratories and coal combustion test facilities with at least ten years experience. This advisor will be needed for eighteen months to work with the LSDE director on planning and execution of research.

The second advisor should be a project engineer who has at least ten years experience with coal combustion and the conduct of research. The second advisor will be needed for the duration of the project from initial facilities design to start-up and for a year following start-up, for a total of 36 months. This advisor will oversee the design and fabrication of the experimental facilities and work with LSDE staff on a daily basis.

The technical assistance can be provided by commercial equipment vendors such as Combustion Engineering, Babcock and Wilcox, Foster Wheeler, and Riley Stoker. Government laboratories such as the Department of Energy (DOE) Pittsburgh and Morgantown Energy Technology Centers can also be used or national labs such as Argonne and Oak Ridge. Universities such as the University of North Dakota, Brigham Young, Penn State, MIT, Ohio State, University of Kentucky, and the University of Illinois also are possible sources for this technical assistance. The team recommends priority on the selection of technical assistance be given first to private industry, then to government laboratories, and then to qualified universities.

3.4 Schedule for Advisors

The team developed a schedule for remaining activities including the technical assistance requirements for each phase. Successful completion of the project will require four technical technical advisors:

Technical Assistance Leader	18 Man-months
Project Engineer	36 Man-months
Coal Chemistry Analyst	12 Man-months
Instrumentation and Controls Engineer	9 Man-months

Detailed descriptions of the tasks to be performed in each category are provided in Appendix E. In summary, the Leader will be primarily responsible to provide advice to the Laboratory Director on laboratory management and overall program development. The Project Engineer will be responsible for scheduling and overseeing the design, fabrication and installation of the laboratory equipment and for training and

integrating the LSDE staff. The Coal Chemistry Analyst will train the staff in the use of the coal chemistry equipment. The Instrumentation and Controls Engineer will supervise the installation and start-up of the instruments and controls and train LSDE staff in their use and maintenance.

4.0 Major Findings and Conclusions

After an intensive review of the project status and careful consideration of what future actions need to be taken, along with considering whether those actions represent ones which have a realistic chance of being implemented, the following represents the evaluation team's major findings and conclusions (see Appendix D):

- The GOI has officially established the laboratory and provided staff and the required support infrastructure.
- The laboratory will be built with or without U.S.A.I.D. help according to the Indonesian officials interviewed.
- The technical development of the laboratory staff has been slow due to nonavailability of equipment and a lack of direction from all parties involved in the project.
- There needs to be a single contractor responsible for supplying the remaining technical assistance services and the LSDE coal combustion facilities.
- With correct technical assistance and facilities, the staff will be able to operate and conduct experiments.
- The proposed facilities will be used by both public and private institutions and organizations in Indonesia. There appears to be sufficient GOI, private and U.S. interest to sustain the laboratory and to justify U.S.A.I.D. participation.
- The laboratory can have a significant value to U.S. steam generation and coal preparation interests by promoting U.S. coal combustion technology and knowledge.
- The laboratory staff should be focused on specific tasks for the next several years and should participate in the design, fabrication, construction and start-up of the facilities.
- There will be a need for external technical assistance on a case-by-case basis to address specific objectives for an extended period of time after the project assistance completion date.
- The majority of the facilities could be fabricated and installed locally with the exception of instrumentation, controls and special rotating machinery. Indonesian companies also will need assistance with process design.

The following lessons were noted:

- The project arrangements to-date have been cumbersome and have impeded progress. Multiple contracts and procurements have required multi-organization approvals. Relying on a contractor who normally does not provide detail design and procurement of major equipment except for its own use to advise a host country institution with no experience in performing these functions produced unsatisfactory results. "Host country" contracting and management were not appropriate for the project because the host country organization had no experience with operation or procurement of advanced energy and coal combustion technologies or with U.S. government procurement regulations.

5.0 Recommendations for Future Action

The team was asked to recommend a course of action for successful completion of the project. Figure 1 presents a flow chart that shows the decision points and options. First, the GOI and U.S.A.I.D. must decide to accept or reject the Combustion Engineering facilities bid. If the decision is to accept CE's full or partial quote, U.S.A.I.D. can proceed with procurement. If the decision is to reject the CE bid, the team recommends that a new statement of work be developed that includes not only facilities, but technical assistance.

5.1 Preparation of New Statement of Work

U.S.A.I.D./Jakarta will need help to develop a revised scope of work and evaluation criteria for contractor selection. The team recommends that U.S.A.I.D. secure a consultant to develop a revised SOW that includes contractor selection evaluation criteria. The options for procuring this consultant in order of priority are:

- Use a U.S.A.I.D./Jakarta purchase order to hire a company/consultant to develop the SOW. The team feels that the total cost will not exceed $25,000.

- Use an existing A.I.D./W contract to obtain support. A.I.D./W currently has contracts with Bechtel, Oak Ridge, and a number of other companies.

- Ask A.I.D./Washington to support development of the SOW.

- Use the existing Battelle contract to prepare SOW based on the evaluation team's outline of a desirable SOW with review by A.I.D./Washington or independent U.S. experts.

5.2 Revised Statement of Work Outline

The SOW should include not only facilities procurement, but also laboratory technical assistance. The following is an outline for the proposed statement of work:

- Provide fixed price costs for each facility proposed.

- Replicate existing U.S. facilities in Indonesia:

  - One Dimensional or Drop Tube Furnace
  - Slagging/Fouling Pulverized Coal Furnace
  - Coal Preparation
  - Fluidized Bed Combustor

- Explain each facility's purpose and flexibility and describe prior experience with its operation.

- List use of Indonesian subcontractors or joint venture partners.

- Provide plan for instrumentation and controls and common support facilities.

- Nominate technical assistance team and provide background and experience.

- Provide proposed schedule.

5.3 Impact on Project Schedule

The team evaluated the impact of its recommendations on project schedule and costs. The team's major recommendation is that a new SOW be drafted and a competitive bid process initiated if the CE bid is found unacceptable. The team estimates following this recommendation will increase the period of performance for the project beyond September 1991 by an additional nine (9) months and could increase project costs.

The team estimates that it will take a total of 14 weeks to prepare and receive all necessary approvals for the SOW, 10 weeks to advertise and receive bids, seven (7) weeks for evaluation and selection, and eight (8) weeks for negotiation and award, for a total of 39 weeks.

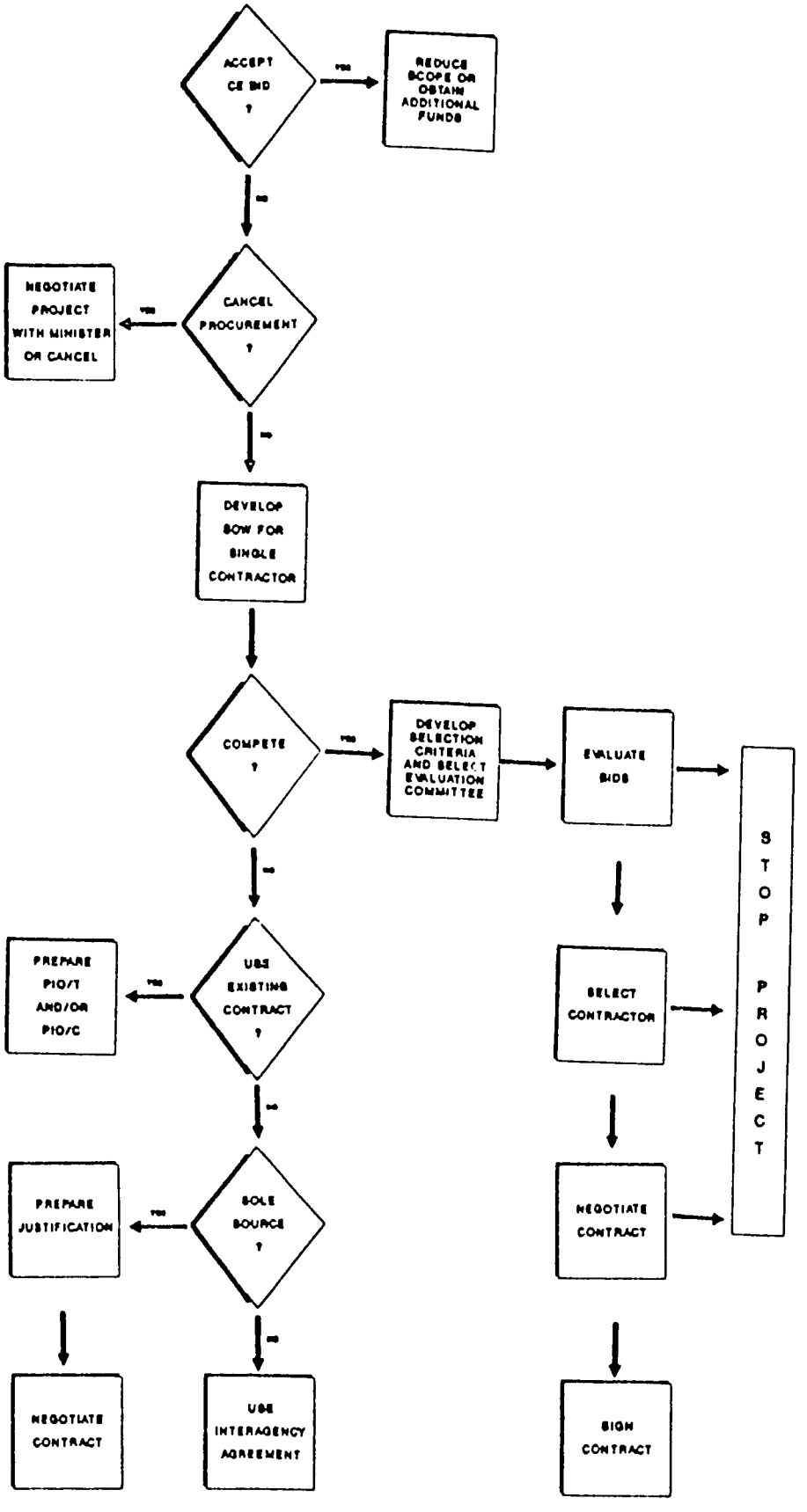
Additionally it is estimated that after the contractor is selected it will take 26 months until the facilities are in place and operating. Adding the contractor procurement period with the 26 months makes for a total project duration of 36 months. If the process outlined commences on April 1, 1989, it will require a project completion date of April 1, 1992, or an extension of the current project completion date by nine (9) months.

The team also evaluated the effect of its recommendation on project costs. The team feels the actual costs of facilities will be reduced since the selected contractor would be providing facilities which already exist and would not have to meet performance warranties on someone else's design. Providing the facilities recommended in this report would cost the project approximately $4,000K to $6,000K.

Some additional funds will be required because of the need to prepare a new SOW and contractor evaluation criteria. The team estimates these costs to be less than $100,000.

FIGURE 1

Decision Points for Completion of LSDE Project



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APPENDIX A

LIST OF ABBREVIATIONS

Included in the abbreviations are the commonly used English translation of the various Indonesian organizations referred to in this report.

BMI	- Battelle Memorial Institute
BPPT	- Agency for Assessment and Application of Technology
CE	- Combustion Engineering Company
GOI	- Government of Indonesia
ITB	- Bandung Institute of Technology
KIM	- Calibration, Instrumentation, and Metrology Laboratory at PUSPIPTEK
MIDC	- Metals Industry Development Center
LSDE	- Energy Research Laboratory at PUSPIPTEK
LUK	- Strength of Materials, Components, and Structures Laboratory at PUSPIPTEK
PC	- Pulverized-coal
PLN	- National Electric Utility
PIO/T	- Project Implementation Order/Technical Services
PUSPIPTEK	- The National Center for Research, Science, and Technology
SOW	- Statement of Work
U.S.A.I.D.	- United States Agency for International Development
U.S.	- United States

APPENDIX B

EVALUATION TEAM ITINERARY

PUSPIPTEK/LSDE Evaluation Team Schedule

Sat., Feb. 18		Messrs. Kokkinos & Kadyszewski arrive Jakarta, Borobudor Hotel.
Sun., Feb. 19		Dr. Michael High & wife arrive Jakarta, Borobudor Hotel.
	1600 - 1800	Meet with Bill Douglass & Edi Setianto at the hotel.
Mon., Feb. 20	0800 - 1500	Visit PUSPIPTEK Serpong. Meet with Dr. Panggabean, LSDE Director & Staff (Ir. Esti Herbawamukti, Ir. Agus, Ir. Indiah, Ir Hartiniati, Ir. Herliyani, Ir. Abu Bakar, Ir. Heru Wicaksono, Ir. Harry Nugroho, Ir. Rianto Marosin, Ir. Indra Dwitama, Ir. Nyoman Suharta, Drs. Dahlia, Ir. Hotma Tobing, Ir. Heru, Mr. Ruben Hardy). Tour LSDE Lab.
Tue., Feb. 21	0800 - 1000	Meeting with U.S.A.I.D. Staff (Bill Douglass and Edi Setianto).
	1030 - 1130	Meeting with Mr. Merrill, U.S.A.I.D. Director, Bruce O'Dell, Ned Greeley, Bill Douglass and Edi Setianto.
	0200 - 1430	Meet with Dr. Lijesen, BPPT Advisor and Dr. Forgrieve, Advisor to Chairman of BPPT.
	1500 - 1600	Meeting with U.S. Embassy officials (Dr. Jeff Lutz, Embassy Science Officer, ECON; Mr. Richard Watkin, ECON; and Mr. Jeff Hardee, FCS).
Wed., Feb. 22	0830 - 0930	Visit PT. Purna Bina Indonesia (PBI) Office to assess Local Companies' capability to design and fabricate combustion equipment. Meet Mr. Lynn Fister.
	1000 - 1100	Dr. Donald Hertzmark, IBRD Consultant.
	1130 - 1300	Meet Prof. Billy Judono, Special Advisor to Minister Habibie and the Coordinating Minister of EKUIN, Prof. Radius Prawiro, Ministry of Finance Building, Lapangan Banteng Gd. Utama 6th Floor.

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Thur., Feb. 23	0830 - 1000	Engineering Service Center PLN (potential client) Ir. Eddy Sutisna, Director and Ir. Bambang, Mechanical Chief Engineer (Tel. 5492770).
	1000 - 1300	Meet with Earl Brown, LSDE Consultant, Wisma Antara, 13th floor.
Fri., Feb. 24	1000 - 1130	Meet with Prof. Harsono Wiryosumarto, Deputy Chairman for Technology Development, BPPT Building, 15th floor.
	1520	Leave Jakarta for Bandung by train.
	1830	Arrive Bandung.
	1920	Arrive Savoy Homan Hotel.
Sat., Feb. 25	0800 - 1000	Visit ITB (Institute Technology Bandung). Meet Dr. Saswinadi Sasmojo, Dr. Tatang Henas, Dr. Kusmaryanto Kadiman, Mr. Robert Manurung.
	1030 - 1230	Visit Fa. TEHA, a local fabricator. Meet Mr. Amin.
Sun., Feb. 26		OPEN
Mon., Feb. 27	0730 - 1000	Visit Metal Industry Development Center (MIDC), a training facility under Dept. of Industry which has conducted LSDE Workshop personnel training. Meet Ir. Aslam, Head of Technology Division, Ir.
	1030 - 1100	Visit the Directorate of Mineral Resources Mineral Tech. Research Center (Drs. Suharto Umar) Telex No. 28337 - SDMBD.
	1200 - 1330	Visit the Mineral Technology Development Center.
	1400 - 1530	Visit Kertalaksana (Workshop - Typical Indonesia Medium Size Sheet Metal and Machining Shop (Ir. Deden Mulyadi) Fax No. 481583 - 002.
	1810	Leave Bandung for Jakarta.
	2020	Arrive Gambir station.
Tue., Feb. 28	0800 - 1600	Internal team discussion.
Wed., March 1	1000 - 1120	Visit Material Testing Lab, Serpong (Ir. Triwibowo and Drs. Dasminto).
	1300 - 1430	Visit to KIM Laboratory, Serpong (Ir. Iranto).
Thur., March 2	0830 - 0930	Babcock & Wilcox Indonesia (Mr. Pete Murphy).
Fri., March 3	1600 - 1700	Meet with Dr. Wardiman Djojonegoro, Dep. Chairman BPPT for Administration, BPPT Building, 4th floor.
	1900 - 2100	Reception at the Douglass' residence.

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Sat., March 4		Report preparation.
Sun., March 5		Report preparation.
Mon., March 6	0830 - 1000	Private Power Workshop, Borobudor Hotel.
	1030 - 1130	Presentation of team's findings at LSDE.
	1500 - 1630	Presentation of team's findings at U.S.A.I.D.
Tue., March 7	0800 - 1000	LSDE Combustion Workshop (Mike High).

APPENDIX C

RECOMMENDED NEAR-TERM LSDE ACTIONS

1. The technical staff should be formed into teams containing the best mix of engineers, chemists, economists, etc. possible to begin some coal characterization studies. These studies should use both laboratory equipment being received from the U.S. and that left from the Banko coal gasifier project. These teams should begin collecting coal samples from:

   a. that currently being used by PLN at Suralaya, including any non-Indonesian coals;

   b. those which are planned for use at Suralaya coming from operating mines at Sumatra and Kalimantan;

   c. the mines currently being specified for the Paiton PLN plant;

   d. the mines being opened in East, West, and South Kalimantan and South Sumatra;

   e. the mines in the South Kalimantan area where PLN is considering a circulating fluidized bed power plant instead of the planned hydro-electric plant; and

   f. that tested in the Directorate General of General Mining (PPTM) and Directorate of Mineral Resources (SDM) laboratories in Bandung.

   Retesting the laboratory samples from Bandung will allow the teams to verify that their results and procedures are correct.

2. The coals should be characterized, for example, for reactivity, ash fusion temperature, ash constituents, heating value (wet and dry), inherent moisture, volatiles, carbon content, hardness, and grindability. Two specific analyses that should be done are:

   a. Coal Reactivity

      - Use TGA apparatus to develop coal and char reactivity for collected coal samples.

      - Predict boiler turndown as a function of coal reactivity. To make these estimates, the teams will need results of the TGA analyses and the performance of known coals at a known site (Suralaya).

      - Develop techniques for measuring coal/char surface area. LSDE may need to buy a BET apparatus for these measurements. Again, analyze known and unknown coals.

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b. Coal Slagging/Fouling

- Characterize ash from coal samples for slagging and fouling on pulverized-coal fired boiler tubes. Perform laboratory analyses to examine ash constituents (pyrite, sodium, chlorine, etc.).

- Develop experimental techniques to enhance laboratory reputation and staff. For example, gravity fractionation techniques have been used to predict waterfall fouling due to pyrites in the coal. Weak acid leaching techniques have been used to establish alkali content that fouls convective section tubes. Selection of techniques to be developed and highlighted should be based on which problems PLN is likely to encounter as they expand use of coal for power generation and on which coal characteristics are most important to potential buyers of Indonesian coals in the Pacific basin.

3. The teams should be given the task to make some preliminary economic analyses comparing the competitiveness of pulverized versus fluidized-bed combusted coals for at least one of the representative coal samples for which their characterization studies have been performed. This will involve developing computer economic models consistent with Indonesian economic parameters.

4. The LSDE teams should combine to perform preliminary designs for sub-scale cold flow (plexiglass, wood, and metal) models of the expected facilities including a one-dimensional furnace (already designed by the LSDE staff); a P-C fired furnace; and a fluidized bed combustor furnace. The team recommends these be 1/4 to 1/3 scale of the sizes recommended by Battelle and used to study air flow and particle distribution and patterns. Such models can be used to guide the placing of instrumentation for the full-scale research facilities.

5. Develop the computer software necessary to perform all combustion calculations (mass and energy balances) for each of the planned facilities. The model should be able to calculate the products of combustion once inputs (fuel, air, etc.) are supplied. These models later will be used to check and verify data taken during experiments.

6. LSDE staff should be assigned an effort to develop a simplified combustion model for the one-dimensional furnace that they designed with Reuben Hardy. This model should be one-dimensional, steady-state, using published coal reaction rates for heat release, established mixing theories for the burner plume, and include an equilibrium chemistry for the products of combustion. Some consulting time from ITB may be required to get the staff started on this assignment.

To implement these recommended actions, the team proposes the following actions:

1. For items (1) and (2), the evaluation team suggests USAID form a management group including Dr. Panggebean, Mr. Hardy, Mr. Edi Setianto, Dr. Lijesen, and Dr. Saswinadi Sasmojo to create the teams and assign personnel to make contact with each organization from which coal samples should be obtained. The management group should estimate the costs of assembling the coal samples including travel (for funding by U.S.A.I.D.) and develop a plan to see that necessary procedures and paperwork for contacting cooperators are carried out.

   Contact should be made and an agreement reached with the Directorate of Mineral Resources, Mineral Technology Research Center's coal and mineral analysis laboratory in Bandung for one member of each team to go to Bandung for a week of training at the laboratory. An alternative to this would be to pay for a senior, trained analyst from the Research Center to be assigned to the LSDE chemical laboratory to help train the team members by beginning the coal analyses. This assignment could be implemented as one of Battelle's remaining tasks.

2. For items (3), (4), (5), and (6), the LSDE staff will need some consultation with an engineering organization. The management group should prepare a brief statement of work that can be used to procure help from Indonesian sources. The most obvious and preferable choice is the Institute of Technology at Bandung (ITB). There will need to be at least one chemical or mechanical engineering professor who is familiar with engineering economics and financial criteria including time value of money, inflation rates, discount factors, capital cost estimates, and payback (or rate of return); at least one chemical or mechanical engineering professor who can analyze one- and two-dimensional flow fields to perform mass flow, pressure drop and energy input/output calculations for equipment sizing, etc.; and occasional consulting with an instrument engineer to specify measuring devices. The faculty from ITB have these skills and already have an agreement with LSDE that could be amended and/or extended. The funding for these activities could become available if the Batelle contract were further amended to delete some of the lower priority items.

Each of the above activities should be assigned to one member of the management group to review and monitor progress on at least a weekly, if not daily, basis. It is important that progress is made on each activity.

APPENDIX D

SUMMARY OF MAJOR FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

1. Finding: The GOI has formally established a laboratory and assigned a director and staff. The GOI has also completed construction of the building to house laboratory equipment and assigned an operating budget for the laboratory.

   Conclusion: The GOI continues to be interested in laboratory development.

   Recommendation: U.S. government fulfill terms of original agreement or renegotiate agreement with the GOI to avoid damage to U.S./GOI relations.

2. Finding: Technical development of the laboratory staff has been slow due to lack of direction from all parties involved in the project and to non-availability of equipment.

   Conclusion: Existing contractual and institutional relationships have been unable to supply technical direction or facilities.

   Recommendation: Develop focused statement of work for remaining activities and obtain single contractor to provide both the remaining technical assistance for the energy laboratory and the LSDE coal combustion facilities.

3. Finding: Some staff have received training in basic combustion processes and are anxious to begin activities.

   Conclusion: Staff will be able to operate equipment and conduct experiments with correct technical assistance and facilities designed for specific functions.

   Recommendation: Involve staff in the design, fabrication, and construction of facilities and use specific projects to further staff training.

4. Finding: Strong demand exists within both public and private institutions for characterization of Indonesian coals, selection and adaptation of steam generation technologies for use with various Indonesian coals, and other potential outputs from the laboratory.

   Conclusion: Given successful development of LSDE capabilities, the laboratory will be sustained and can provide technical information needed to solve national problems.

Recommendation: Specify LSDE equipment to meet demand and define initial laboratory activities to support information needs of potential primary clients. Project should provide assistance to LSDE for development of cooperative agreements with primary clients.

5. Finding: Major investments in coal mining and coal-based power generation will be made in Indonesia during the next ten years.

   Conclusion: Technical information on use of coal for power generation will be valuable to Indonesia. Primary clients for the first five years should be power and coal mining companies.

   Recommendation: Project place priority on developing institutional relationships with power company and coal mining companies.

6. Finding: U.S. companies providing equipment and services for steam generation and coal preparation are active and competitive in Indonesian markets.

   Conclusion: U.S. participation in technical assistance to the laboratory will benefit U.S. commercial interests.

   Recommendation: Structure technical assistance, procurement of facilities, and initial project activities to include participation by U.S. commercial interests.

7. Finding: Indonesian companies are competitive with other potential suppliers for fabrication and installation of the majority of required facilities with the exception of instrumentation, controls, and special rotating machinery.

   Conclusion: Participation of Indonesian companies in fabrication and installation of laboratory facilities would enhance technology transfer.

   Recommendation: Project encourage participation of local contractors and fabricators.

8. Finding: Engineers currently assigned to LSDE are relatively inexperienced.

   Conclusion: Technical assistance will be required on a case-by-case basis after project assistance completion date.

   Recommendation: As project approaches completion date, U.S.A.I.D. should discuss use of the facility with other donors and with foreign and domestic commercial interests.

9. Finding: GOI concern with environmental issues associated with power generation is increasing.

Conclusion: Once technical capabilities exist, LSDE will be asked to provide technical information to help the GOI formulate environmental policies.

Recommendation: Facilities designed for LSDE be capable of assisting the GOI with formulation of environmental policy.

10. Finding: The GOI will be making major decisions on domestic use versus export of various grades of coal during the next five years.

Conclusion: LSDE can provide important technical information to support GOI policies.

Recommendation: Project include technical assistance to help LSDE develop information to assist the GOI coal development policy makers.

11. Finding: Several institutions exist in Indonesia with capabilities to provide technical assistance and training for laboratory activities (e.g., instrument calibration, technician training, chemical analysis, maintenance activities, upgrading of scientific skills of engineers, equipment operation).

Conclusion: A significant amount of technical assistance and training for the laboratory staff can be obtained in Indonesia with potentially significant cost savings.

Recommendation: Project include assistance to LSDE to establish working relationships with supporting institutions in Indonesia.

12. Finding: Structure of original and revised bid packages limited commercial interest in project and led to high quotation.

Conclusion: U.S.A.I.D. will be unable to obtain desired facilities with funds remaining in project.

Recommendation: Restructure bid to request bidders to present bids based on replication of proven existing U.S. facilities.

13. Finding: Metal Industries Development Center (MIDC) provided training for welding and operation of machine shop in advance of arrival of equipment.

Conclusion: Technicians will need refresher course once equipment arrives.

Recommendation: Project continuation include provision for refresher course for LSDE technicians.

PUSPIPTEK ENERGY RESEARCH LABORATORY PROJECT FINDINGS/CONCLUSIONS/RECOMMENDATIONS MATRIX

FINDINGS	CONCLUSIONS	RECOMMENDATIONS
1. GOI has formally established a laboratory and assigned a director and staff. The GOI has also completed construction of the building to house laboratory equipment and assigned an operating for the laboratory.	GOI continues to be interested in laboratory development.	U.S. government fulfill terms of original agreement or negotiate agreement with GOI to avoid damage to U.S./GOI relations.
2. Technical development of the laboratory staff has been slow due to lack of direction from all parties involved in the project and to non-availability of equipment.	Existing contractual and institutional relationships have been unable to supply direction or facilities.	Develop focused statement of work for remaining activities and obtain single contractor to provide both the remaining technical assistance for the energy laboratory and the LSDE coal combustion facilities.
3. BPPT has no experience with coal combustion research equipment and cannot oversight for host country contracting.	Successful completion of the project will be greatly hampered if USAID continues to use host country contracting.	Use alternate contracting arrangement to complete project.
4. Some staff have received training in basic combustion processes and are anxious to begin activities.	Staff will be able to operate equipment and conduct experience with correct technical assistance and facilities designed for specific functions.	Involve staff in the design, fabrication and construction of facilities and use specific projects to further staff training.

PUSPIPTEK ENERGY RESEARCH LABORATORY PROJECT FINDINGS/CONCLUSIONS/RECOMMENDATIONS MATRIX

FINDINGS	CONCLUSIONS	RECOMMENDATIONS
5. Strong demand exists within both public and private institutions for characterization of Indonesian coals, selection and adaptation of steam generation technologies for use with various Indonesian coals, and other potential outpust from the laboratory.	Given successful development of LSDE capabilities, the laboratory will be sustained and can provide technical information needed to solve national problems.	Specify LSDE equipment to be responsive to national concerns and define initial laboratory activities to support information needs of potential primary clients. Project should provide assistance to LSDE for development of cooperative agreements with primary clients.
6. Major investments in coal mining and coal-based power generation will be made in Indonesia during the next ten years.	Technical information on use of coal for power generation will valuable to Indonesia. Primary clients for first five years should be power and coal mining companies.	Place priority on developing institutional relationships with power company and coal mining companies.
7. U.S. companies providing equipment and services for steam generation and coal preparation are active and competitive in Indonesian markets.	U.S. participation in technical assistance to the laboratory will benefit U.S. commercial interests.	Structure technical assistance, procurement of facilities, and initial project activities to include participation by U.S. commercial interests.
8. ITB has capabilities to provide training in basic combustion for LSDE staff. ITB also has strong relationships with potential LSDE clients.	ITB can help train LSDE staff including interships trained staff with potential LSDE clients.	Continue training and outreach activities with ITB.

PUSPIPTEK ENERGY RESEARCH LABORATORY PROJECT FINDINGS/CONCLUSIONS/RECOMMENDATIONS MATRIX

FINDINGS	CONCLUSIONS	RECOMMENDATIONS
9. Indonesian companies are competitive with other potential suppliers for fabrication and installation of the majority of required facilities with the exception of instrumentation, controls, and special rotating machinery.	Participation of Indonesian companies in fabrication and installation of laboratory facilities would enhance technology transfer.	Use language in revised scope of work to encourage primary contractor to use local contractors and fabricators.
10. GOI concern with environmental issues associated with power generation is increasing.	Once technical capabilities exist, LSDE will be asked to provide technical information to help GOI formulate environmental policies.	Design facilities for LSDE to be capable of assisting GOI with formulation of environmental policy.
11. GOI will be making major decisions on domestic use versus export of various grades of coal during the next five years.	LSDE can provide important technical information to support GOI policies.	Include technical assistance to help LSDE develop information to assist GOI policy makers for coal development.
12. Several institutions exist in Indonesia with capabilities to provide technical assistance and training for laboratory activities (e.g. instrument calibration, technician training, chemical analysis, maintenance activities, upgrading of scientific skills of engineers, equipment operations.	A significant amount of technical assistance and training for the laboratory staff can be obtained in Indonesia with potentially significant cost savings.	Include assistance to LSDE to establish working relationships with supporting institutions in Indonesia.

PUSPIPTEK ENERGY RESEARCH LABORATORY PROJECT FINDINGS/CONCLUSIONS/RECOMMENDATIONS MATRIX

FINDINGS	CONCLUSIONS	RECOMMENDATIONS
13. Structure of original and revised bid packages limited commercial interest in project and led to high quotation.	USAID will be unable to obtained desired facilities with funds remaining in project.	Restructure bid to request bidders to present bids based on replication of proven existing U.S. facilities.
14. Metal Industries Development Center (MIDC) provided training for welding and operation of machine shop in advance of arrival of equipment.	Technicians will need refresher course once equipment arrives.	Project continuation include provision for refresher course for LSDE technicians.
15. Engineers currently assigned to LSDE are relatively inexperienced.	Technical assistance will be required on a case by case basis after project assistance completion date.	As project approaches completion date, USAID should discuss use of the facility with other donors and with foreign and domestic commercial interests.

APPENDIX E

STATEMENT OF WORK (SOW) FOR REMAINING TECHNICAL ASSISTANCE

1.0 Background

In 1982, the U.S. Agency for International Development (U.S.A.I.D.) in Jakarta entered into an agreement to assist the Government of Indonesia (GOI) in establishing a viable, professional energy research and development center which can (1) conduct applied research and technology development in the field of energy, (2) provide support to Indonesian energy-related industries, and 3) undertake technical and economic feasibility analysis on potential energy programs, projects and products.

The project intended to provide Technical Assistance (TA), facilities and equipment. The Battelle Memorial Institute was competitively selected as the TA contractor and a contract was signed in January 1985 and later extended to be effective through September 30, 1989. During this period Battelle developed a five-year master plan for the laboratory, prepared conceptual designs for the major test facilities and carried out training of laboratory personnel both in Indonesia and the United States. Battelle has declined participation in technical assistance beyond September 30, 1989.

The Energy Research Laboratory (LSDE) has been officially established by the GOI and made a permanent element of the Agency for the Assessment and Application of Technology (BPPT), directly responsible to its Chairman and possessing its own budget and staff allocation. At this time, there are 80 professional staff in LSDE, of whom 15 are currently studying abroad for advanced degrees under World Bank funding.

The staff has received the following training:

- In-country English language training
- Fuels and combustion training at Battelle
- Technical workshops held in Indonesia
- Research management training
- Technical workshops and conferences held abroad to expose staff to the state of development in the energy field
- Basic training in combustion from the Institute of Technology at Bandung (ITB)
- Basic machine shop and welding training from the Metal Industry Development Center (MIDC) in Bandung.

Additional training by Battelle and various local institutions is planned prior to completion of the existing Battelle contract. Additional training will be required to continue development of the staff so that LSDE may fulfill the original intent of its charter.

2.0 Technical Workscope

Technical assistance will focus on coal combustion and characterization, design and operation of facilities, design of experiments and evaluation of results. Technical assistance will be provided in the following specific areas:

- Combustion science and engineering
- Design and fabrication of experimental coal combustion facilities
- Instrumentation and controls for test facilities
- Analytical coal chemistry.

2.1 Technical Assistance - Leader

The primary purpose of this position is to assist the LSDE Director in the daily operation of the laboratory and to provide guidance in planning and executing research. Specifically the Technical Assistance Leader will:

- Assist the laboratory director in carrying out his duties by providing advice on laboratory strategic planning and staff training and development.

- Assist the laboratory director in establishing operating budgets, staffing levels, and research and development program areas with emphasis on evaluation of technologies for combustion of Indonesian coals, environmental impacts of burning Indonesian coal, and strategies for development of coal resources.

- Train staff on how coal combustion properties effect steam generator design, operation and maintenance.

- Assist the laboratory director in managing the daily activities of the laboratory.

- Assist the laboratory director in establishing links with laboratory users, clients and supporting institutions (e.g., PLN, ITB, MIDC, PPTM, LUK) and in preparing briefs to senior GOI officials on energy issues pertinent to Indonesian development.

- Assist the laboratory director with management of other energy areas being developed by the laboratory such as biomass and municipal waste combustion and photovoltaics.

The technical assistance leader should have an advanced degree in an engineering discipline and senior management experience at an energy laboratory that emphasized coal combustion.

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2.2 Technical Assistance - Project Engineer

The primary function of this position is to provide direct supervision of the LSDE staff responsible for the daily execution of experiments, evaluation of results, and assessments of technology. The Project Engineer will:

- Develop a detailed implementation plan with costs and schedules for design, fabrication and erection of facilities.

- Oversee the design and fabrication of the experimental facilities. The facilities consist of a coal preparation plant capable of processing approximately 500 pounds per hour, one-dimensional pulverized coal combustion facility, pulverized coal slagging and fouling 5.0 MBtu/hr test facility, analytical chemistry laboratory, 2x2 ft fluidized bed combustion test facility and associated controls.

- Have overall responsibility for budget, schedule and performance of the experimental facilities including supervising day-to-day maintenance and collecting and analyzing facility performance data.

- Train LSDE staff in project management by having them actively participate in the design, fabrication, construction and start-up of the test facilities.

- Assist LSDE staff in the design of specific experiments of value to the GOI and Indonesian industry emphasizing coal combustion issues, coal chemistry issues, and environmental impacts of coal combustion.

- Train LSDE staff in R&D project engineering by providing guidance in experimental design, operation of facilities, data analysis, and evaluation of results.

- Establish safety procedures for operation and maintenance of laboratory equipment.

- Provide support to the Laboratory Director and the Technical Assistance Leader in developing experimental programs of value to GOI and Indonesian industry.

The Technical Assistance Project Engineering should have an advanced degree in an engineering discipline and have experience in an energy laboratory with emphasis on coal combustion.

2.3 Technical Assistance - Chemical Analyst

The technical assistance for the chemical laboratory provides direct supervision of the LSDE staff assigned to the analytical laboratory. The Chemical Analyst will:

- Train LSDE staff in the experimental techniques, analytical procedures, and operation of equipment used in modern coal analytical laboratories.

- Provide recommendations to the Laboratory Director on future training needs of the chemical laboratory staff.

- Provide recommendations to the Laboratory Director on the procurement of additional laboratory analytical equipment.

- Establish quality control and assurance procedures for the laboratory.

- Establish safety procedures for the safe disposal of chemicals and advise the Laboratory Director on environmental issues affecting the LSDE property.

The Chemical Analyst should have an advanced degree in chemistry or analytical chemistry with special emphasis on coal chemistry.

2.4 Technical Assistance - Instrumentation and Controls Engineer

The Instrumentation and Controls Engineer will provide training and guidance to the LSDE staff in the area of facility instrumentation and controls. The I&C Engineer will:

- Supervise the design and fabrication of the necessary controls and instrumentation for the LSDE facilities.

- Train LSDE personnel in design, operation, maintenance and repair of controls and instrumentation for combustion facilities.

- Train LSDE engineers in the calibration of instruments and help the Laboratory Director develop relationship with Indonesian National Calibration and Instrumentation Laboratory (KIM-LIPI).

- Provide recommendations to the Laboratory Director on the need to procure additional instrumentation.

The Instrumentation and Controls Engineer should have a degree in electrical or mechanical engineering with emphasis on instrumentation and controls design for combustion facilities.

3.0 Level of Effort

Technical assistance personnel will be expected to provide assistance in Indonesia as follows:

° Technical Assistance Leader	18 man-months
° Project Engineer	3 man-years
° Chemical Laboratory	1 man-year
° Instrumentation and Controls	9 man-months