A Report of the

Office of Energy
Bureau for Science and Technology
United States Agency for International Development

FINDINGS FROM A PREFEASIBILITY STUDY

ON THE MARKET FOR INNOVATIVE

ELECTRICITY GENERATION EQUIPMENT

IN INDONESIA

* FINAL REPORT *

Prepared By:
Lazar Enterprises, Inc.
Washington, D.C.
and
Bechtel National, Inc.
Arlington, Virginia

Conventional Energy Technical Assistance Project
Contract No. LAC-5724-C-00-5126-00

February 1991

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SUMMARY

The purpose of this document is to report the findings of a pre-feasibility study in Indonesia, sponsored by the Office of Energy, in the Agency for International Development's Bureau for Science and Technology. This study was conducted by representatives of Lazar Enterprises, Inc., Barnco International, Inc., Louisiana Machinery, and the Office of Energy's Conventional Energy Technical Assistance Project (CETA) to explore the need in the Indonesian oil industry for power generation technologies which offer cost-effective alternatives for producing electricity. The team members for this effort are provided in Appendix A. The aim of the study focused on the issue of whether or not the domestic market success of a particular U.S. energy technology, known as IN-GEN, could be replicated in an overseas market.

IN-GEN is a patented induction generator system which utilizes various waste fuels (natural gas from oil fields, methane gas from landfills, agricultural waste, or water treatment plants, among others) to produce low-cost and reliable electricity. Manufactured by Barnco International, based in Shreveport, Louisiana, IN-GEN is an innovative technology with proven results in the U.S. Oil Patch and positive developments in biomass applications. It is designed to operate in parallel with utility grids or with stand alone generators and may be used in all facets of power consumption, e.g., oil leases, industry, hotels, homes, and small villages. A more detailed technical discussion of IN-GEN's capabilities is presented in Appendix F.

Given this range of possible applications for IN-GEN, it was determined that Indonesia would be the most appropriate A.I.D.-assisted country in which to perform the pre-feasibility study, primarily due to the country's important role in the world oil industry. Indonesia is the strongest regional force in the petroleum production industry, responsible for more than 80 percent of all oil production in Southeast Asia. In 1990, based on a flow of 1.3 million barrels of oil per day, Indonesia was the thirteenth largest among world oil producers, and sixth largest among OPEC. The country is also the world's largest producer of liquefied natural gas (LNG), supplying 40 percent of the world market. Combined oil and gas exports constitute 50 percent of Indonesia's export revenues and 40 percent of the total government revenues. In keeping with its policy to sustain maximum export levels of crude, the Government of Indonesia (GOI) has been actively soliciting electricity generation technologies which enhance oil production operations, favoring those technologies which utilize non-petroleum fuels.

Another part of GOI's energy policy is responding to forecasts that in the coming decade, it is expected that Indonesia's national

electricity generating utility, Perusahaan Umum Listrik Negara (PLN), will encounter a major deficit in generating capacity. President Soeharto and top ministers are applying pressure to improve transmission and distribution performance and are seeking ways to strengthen existing capacity. Despite Indonesia's external debt situation - currently the world's fourth largest at $56 billion - GOI is devoting resources to integrate several different energy technologies into their energy plan.

While this study focused on primarily the Indonesian oil industry as the market for IN-GEN, the results of numerous interviews and meetings with GOI officials and private sector representatives showed good potential for applications of IN-GEN in commercial and residential sectors, as well as in manufacturing operations which utilize natural gas or biomass. Within the oil industry, specific companies and project sites were identified and visited. The information collected during these meetings with oil company executives and engineers confirmed the assumption that there is a need and a place for a technology like IN-GEN in the Indonesian oil industry. As an introductory market study phase, these sessions were successful in prompting useful comments and observations from selected oil companies which can now be used as reference points in preparing proposals and subsequent presentations.

Additionally, the data gathered from public sector organizations added significantly to the pre-feasibility study team's (team) findings. The team was well received by B.P.P. Teknologi (BPPT), the key GOI agency for assessment and application of technology, and got the full support and cooperation from the Office of Energy at the USAID Mission in Jakarta. Both of these groups corroborated the team's agenda for focusing on the oil industry as a primary market, but at the same time gave suggestions for applications which could be explored in other sectors. The issue of securing local representation to aid in this exploration (and to move ahead quickly with implementation of proposed projects) was urged also.

Heeding this advice, a segment of the study was devoted to finding the appropriate local partner to assist in maintaining contacts and assuring continuity in the process of introducing IN-GEN to Indonesia. At the time of this report, the team is in the final stages of negotiating an agreement with a highly recommended local trading company. Their experience in the energy technology field will be one of the necessary aspects to propel this study past the pre-feasibility stage.

The trip to Indonesia for this in-country study was made possible through funding from the Office of Energy in A.I.D. Creative input from CETA project personnel, and their effectiveness in drawing upon in-country contacts during the planning and

execution of this study, played a major role in the success of this effort as well.

BACKGROUND AND OBJECTIVES

Electrical costs of oil production are often the highest single operating cost component of a producing well. Any permanent, efficient method of reducing electrical costs is very attractive to operators. According to a Wall Street Journal article from January 4, 1991, just in the United States alone, 100,000 wells have been abandoned over the past five years. Going after the remainder of the crude was deemed too difficult and costly. Using conventional drilling methods, a typical well yields only 15% of its potential.

Speaking to this problem and to the overall health of the U.S. oil industry, in an article from The Dallas Morning News on February 1, 1990, Deputy Secretary Henson Moore urged the United States to keep its petroleum sector strong by finding ways to lower oil recovery costs through new technology. IN-GEN is such a technology. It provides the oil industry an innovative yet practical product which is not dependent on new drilling levels, is saleable on a cost avoidance approach and has a successful operating record.

Since the outbreak of the Persian Gulf War, energy technologies with features designed for operations in the oil industry will be playing an even more important role. The current oil pricing environment has created uncertainties in the global oil industry. At the same time, the reduction in oil supply from the Middle East has translated into opportunity for other oil producing countries. Thus, in most cases, the ability to meet the demand will depend on a combination of enhanced secondary recovery from existing wells and increased exploration of potential fields. For both types of operations, electricity is essential, but costs can be prohibitively expensive.

Nevertheless, the compelling economics of the higher price per barrel of crude has competitors scrambling to increase output. An annual survey conducted by Salomon Brothers predicts that the global energy industry will spend $52.1 billion on exploration and production this year, an increase of 13.8% over 1990. For several large U.S. oil companies, (including Amoco, Mobil, Philips, and Texaco), expenditures on their foreign recovery and exploration operations is estimated to increase by 25%.

Some of this increased spending will have an impact on Indonesia. As stated in a February 4, 1991 article from The New York Times, American and European companies will spend more than $4 billion in Indonesia in efforts to discover new fields and rejuvenate older ones. In fact, GOI is offering incentives to companies interested in recovering oil from fields that operators had all but deserted. These would be the types of projects in which a technology like IN-GEN could add significant value.

Although IN-GEN has not been tested outside of the United States, it is reasonable to assume that in overseas markets such as Indonesia it has the potential to perform equally as well as it has in the United States. Production processes in oil and gas operations worldwide do not vary dramatically. Testimonials from Mobil, Exxon, S.L. Loe Oil, and Bayou State Oil have given enthusiastic support of IN-GEN. The benefits these customers have pointed out about IN-GEN include:

- 24 MONTH PAYBACK, TYPICALLY
- SAFE AND RELIABLE POWER
- SELF-MONITORING
- SIMPLE TO MAINTAIN

Having these benefits in mind, and with the hope of gathering enough information to structure a more advanced feasibility study, the team focused on five principle objectives.

1) To identify applications for the IN-GEN system in the Indonesian petroleum sector which have the greatest potential of replicating the success of IN-GEN in the U.S. petroleum sector.

2) To investigate any technical adaptation necessary to make the IN-GEN system comply with Indonesian codes and standards.

3) To evaluate potential applications for IN-GEN in the renewable resources sector, particularly the use of Bio-Gas.

4) To investigate private investment and joint venture opportunities as well as possible project structures ranging from direct sale, licensing, to supplier agreements.

5) To assess project financing alternatives offered by international funding sources such as EXIM, A.I.D., OPIC, and World Bank.

During the course of the eight-day stay in Indonesia, these objectives served as a framework for meetings and discussions with both private and public entities involved with or interested in power-generation equipment. The sections that follow incorporate the findings based on these objectives.

GENERAL MARKET OVERVIEW

Oil Industry

Despite low labor costs in the Indonesian petroleum sector, producing a barrel of oil in Indonesia is still expensive. There are several hidden high costs in the production process. First, in order to operate complex oil-producing and power-generation equipment in the field, high-priced consultants or specialists must be paid to train field personnel. Second, even if the training is comprehensive, a lapse of discipline in monitoring such equipment can lead to major damage and sky-rocketing maintenance costs.

Therefore, any type of equipment that does not require training or sophistication is in high demand. Simplicity of operation of equipment related to oil production offers the oil companies a key cost-reduction feature. Since IN-GEN not only provides safe and reliable power, but is virtually self-monitoring and simple to maintain, it was viewed by several potential customers in the oil industry as an attractive alternative to the more complex synchronous generator systems.

After meeting with four major oil companies, it became clear that in at least two, if not three of them, there were applications for IN-GEN which would mirror the successful experience of IN-GEN in the U.S. petroleum sector. The Indonesian oil companies which have operations conducive to utilizing IN-GEN are Caltex, Unocal, and Mobil. Summaries of meetings with these companies, along with descriptions of the potential applications in their respective oil operations are outlined under Further Information.

Other Applications

The potential for IN-GEN in Indonesia is not limited to oil industry applications. There are many situations within urban and industrialized sectors, not to mention the marginalized, rural settings, where IN-GEN could offer an immediate and significant benefit. The need for an innovative and versatile power-generation system like IN-GEN in these sectors stems from the fact that PLN currently does not have the capacity to meet demand from the rapidly growing urban and industrial markets. In addition, PLN has the herculean task of trying to extend its rural electrification program to many remote areas within the 6,000 inhabited islands of Indonesia's 13,667 islands. The result of all this is a critical need for electricity, both in the short- and long-terms.

Even with the construction of seven power plants scheduled for completion by 1993-4, PLN does not expect to meet the rising demand for electricity. The private sector, which currently provides about half of Indonesia's electricity needs, has new power projects

on the horizon as well, but they will not be ready either to start operation until 1994. This power deficit problem was a recurring theme in meetings with various Indonesian government officials, private companies, and the Energy Office at the USAID Mission in Jakarta. In fact, a number of comments made during these discussions indicated that there is potential for IN-GEN to help solve this problem of unreliable and insufficient power supply in urban, industrial, and rural settings. It was suggested that specific installation sites for IN-GEN could range from hospitals, industrial estates, hotels, office parks, and residences, to sugar plantations, sawmills, and palm oil plantations.

IN-GEN's Operation

IN-GEN is adapted easily to any of these situations. Presently in Indonesia, the types of sites listed above receive their power either from PLN or from "stand alone" generators. Since the patented design of IN-GEN enables it to operate in parallel with utilities or generators, the installation and operation of IN-GEN does not create any complex technical problems. The electrical power thus produced by IN-GEN at the site (i.e. at the hospitals, office parks, sugar plantations, etc.) can then be utilized to meet existing electrical requirements in lieu of drawing on the existing power source.*

IN-GEN's induction generation process represents a net addition of capacity to the existing power source. The electricity that would have been used at the site where IN-GEN has just "taken over" is recaptured by the existing power source and subsequently redirected to other areas of need. Said another way, if an industrial park has a 500kw demand load and decides to install a 500kw IN-GEN system, that means the existing power source no longer has to supply 500kw to that park. The 500kw is produced for the park by IN-GEN without drawing any power from the existing power source. Therefore, the 500kw that the existing power source no longer has to supply to the park has the net effect of strengthening the existing power source by 500kw.

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*The existing power source refers to either PLN or a synchronous generator.

PROJECT STRUCTURE AND FINANCING

Pertamina and Production Sharing Contracts (PSCs)

Since the bulk of the efforts for this pre-feasibility study centered on applications for IN-GEN in the oil industry, most of the information pertaining to project structures and financing relates to oil and gas production activities. Pertamina is Indonesia's largest industrial enterprise and is involved in virtually all of these activities. Since 1967, Pertamina has functioned in coordination with foreign companies under production-sharing contracts (PSCs), and since 1971, Pertamina is accountable to a State Supervisory board. Within the framework of these PSCs, the foreign companies are required to finance all exploration, development and production costs associated with oil and gas resources, while Pertamina takes responsibility for the management of the operations.

Pertamina produces very little oil and gas through its own facilities. Therefore, foreign companies purchase the majority of equipment and services sold to the Indonesian oil industry. Regardless of selling to either Pertamina or to a PSC, the Indonesian Government (GOI) sets the tendering guidelines and makes the final determination on sales of serious magnitude. After the purchase, the contractor recovers its capital investment and all operating costs through revenues from crude oil production. Pertamina then claims 85%, of the remaining balance of oil production; the contractor receives the other 15%.

Partnership Options

Both Pertamina and PSCs must work through a local limited liability company to make any purchase. Therefore, establishing a relationship with an Indonesian company is essential for foreign companies with plans of selling petroleum equipment or services to Indonesia. This relationship can take the form of a temporary contract for a one-time sale, a sole agent/representative for an on-going presence and business relationship, or a joint venture. In some cases, due to certain GOI policies, joint ventures are the only way that foreign companies can get involved with bidding on projects. For example, it is required that all major suppliers of equipment to the oil industry form joint ventures, including a minimum investment plan of $1 million.

Tendering Process and Duty

The politics of the tendering process is summed up succinctly by the "The Petroleum Report - Indonesia," from the U.S. Embassy in Jakarta.

> All purchases of goods and services are done by tender and generally only vendors with a TDR (Tanda Daftar Rekanan Registered Vendor ID) are considered DRM's (Daftar Rekanan Mampu - qualified contractor) who can be invited to bid. A PSC writes its own tenders, but for procurement of goods and services over Rp. 1 billion ($600,000), the PSC must report the tender plan to Pertamina/BKKA (Foreign Contractors Regulating Agency). A PSC has the authority to decide the winner of a tender for the procurement of up to Rp. 1 billion ($600,000). Pertamina/BKKA has the authority to decide the winner of a tender/direct appointment for procurement of over Rp. 3 billion ($1.8 million). The Coordinating Minister for Economics and Finance (EKUIN) must approve tenders exceeding Rp. 3 billion ($1.8 million).

Other points to keep in mind are that even though tender awards are based on price and technical advantage, there are cases in which higher cost Indonesian equipment will be favored. Policy states that domestic goods and services must be used if available. The other is that once the equipment is purchased and has entered Indonesia, it is considered the property of Pertamina. If the imported equipment is deemed for operational purposes, or considered "main equipment," and is consigned to Pertamina, it can enter Indonesia duty free. Otherwise, depending on the circumstance, oil and gas equipment is subjected to import duties of 0% to 20%.

Financing Considerations

In order to market the equipment effectively, it is important to have contact established between the salesman/technical person representing the foreign company and the engineer who is in charge of outlining the tender requirements for the oil company. In the process of forming this relationship, the subject of financing tends to be one of the first topics discussed. For American companies, this represents a challenging aspect in doing business in Indonesia. Companies from other countries usually have less difficulty finding competitive financing for projects. For example, a representative from Trakindo commented that it is tough to compete for many of the PLN projects when Japanese and European firms are offering financing terms of 3% for 25 years with 7 years grace period. According to Roy Norry of Bechtel, the unfortunate reality is that having financing "in hand" is sometimes a more

important variable to a project's acceptance than the technology itself.

The following list provides a partial menu of financing possibilities for U.S. companies with energy-related projects. These particular programs, in the categories of Pre-Export Financial Assistance and Export Financing, offer some interesting avenues for a company like Barnco to pursue.

Investment/Project Financing and Insurance merit attention as well, but will not be examined until a later stage in the project development.

Pre-Export Financial Assistance

U.S. TRADE AND DEVELOPMENT PROGRAM (TDP): They provide funding for firms to carry out feasibility studies. Previously, funds were used exclusively for public sector projects, but the trend towards privatization has brought private sector projects to TDP's attention as well. Among the requirements to be eligible is a demonstrated potential for the project to generate exports on the order of 50 to 75 times the value of the U.S. government expenditure.

EXPORT-IMPORT BANK OF THE UNITED STATES (EXIMBANK): Through its Engineering Multiplier Program, Eximbank offers fixed-rate, medium term loans to help finance project-related feasibility studies and preconstruction design and engineering services up to $10 million. Companies working on feasibility studies have access to Eximbank's Exporter Credits, Guarantees and Insurance Programs, also.

A.I.D.'s PRIVATE-SECTOR ENERGY DEVELOPMENT (PSED): This program is designed by the Office of Energy to assist the private sector in participating in the solution of electric power shortages faced by developing countries. The program sponsors a PSED fund which provides financial support to private companies working on private-sector energy/power projects such as private power generation or cogeneration plants.

WORLD BANK: Energy Sector Management Assistance Project (ESMAP): This is a joint effort by the World Bank and the United Nations Development Program to make recommendations to solve energy problems in developing countries. ESMAP plays the role of a preinvestment facility to help implement proposed actions.

A.I.D.'s Biomass Energy Systems and Technology Project (BEST): The BEST project, designed by the Office of Energy, provides support for feasibility studies which can demonstrate a viable project and are developed jointly by a U.S. company and a host country participant.

Export Financing

EXIMBANK: Eximbank is quite active in Indonesia. They will provide credit or guarantees for up to 85 percent of the U.S. export value of each transaction. Foreign buyers must pay the U.S. seller 15 percent cash payment, which may be financed. Repayment terms usually range from between one and ten years. Eximbank also has a Working Capital Guarantee Program to provide exporters access to export-related working capital loans from commercial banks. These loans guaranteed by Eximbank are geared to small- to medium-sized exporters.

PRIVATE EXPORT FUNDING CORPORATION (PEFCO): PEFCO helps fill the gap where traditional financing sources have not provided service for U.S. exports, namely, large loans and long repayment periods. PEFCO offers customized features on their loans which range from $1 million to $225 million dollars, for five-to 22-year terms.

OVERSEAS PRIVATE INVESTMENT CORPORATION (OPIC): OPIC has a lease financing program that provides financial assistance to foreign leasing companies. The purpose is to promote U.S. productive equipment for projects that contribute to host-country development.

FURTHER INFORMATION

Additional Findings From Meetings

Summaries are presented here in chronological order. The style is somewhat abbreviated and informal, but the details and specific comments are included in order to emphasize the points and suggestions which emerged during these various sessions.

Complete information on the companies and government agencies discussed herein is provided in Appendix E.

Saturday, December 8: Marriot Hotel, Hong Kong

Two-hour breakfast meeting with Mr. Alexander Kouo, a senior consultant for Caterpillar Far East Limited (CFEL) based in Hong Kong. Expertise is in the area of contract negotiation. Discussed the issues of technology transfer, licensing agreements, and supplier contracts. Offered his opinion on the importance of finding a good local partner and spoke from experience on the difficulty of doing business in Indonesia.

Sunday, December 9: Hilton Hotel, Jakarta

Dr. Ernest Y. Lam introduced team to Dr. Peter A. Jezek from the Energy Office of the USAID Mission in Jakarta. Made a brief, informal presentation to Dr. Jezek to familiarize him further with IN-GEN and allow him to ask questions about the technology. Discussion continued over dinner during which time Dr. Jezek covered many topics of interest related to Indonesian politics, culture, economy, and energy policy. Corroborated assumptions that IN-GEN might have many applications in Indonesia - with oil industry being the best starting point.

Monday, December 10: Jakarta

9:00 - 11:00: Trakindo/Caterpillar

Met with top level representatives of Caterpillar and Trakindo Utama at the offices of Trakindo. Contacted on team's behalf by Caterpillar North America prior to trip departure. Purpose of meeting was to brief Trakindo on Barnco's technology, describe the relationship Barnco has with Louisiana Machinery (the Caterpillar dealer that supplies the engines for IN-GEN in the U.S.), and discuss to what extent Trakindo would become involved in helping Barnco introduce IN-GEN to Indonesian markets. Trakindo has an extensive service network within Indonesia and does about $400 million in sales annually.

11:00 - 12:00: Bechtel International, Inc.

Got acquainted with Mr. H.M. Wilson at Bechtel offices, which turned out to be headquarters during the trip. Mr. Wilson went over some of the contacts and meetings he had set up already. Discussed priorities regarding potential customers for IN-GEN, and Mr. Wilson responded by suggesting several companies whose operations might be similar to those using IN-GEN in the U.S. (See Appendix C)

2:30 - 4:30: Office of Energy, USAID Mission, Jakarta

Met with Mr. Edi Setianto and Dr. Jezek. Discussion centered on a detailed description of IN-GEN's capabilities and potential associated benefits to the development of Indonesia's energy sector from using IN-GEN. Mr. Setianto pointed out two factors which could be issues for implementing projects with IN-GEN. One is availability of gas at targeted sites; the other is gas distribution constraints. Commented that technical standards and product adaptation should not present problems. Oil industry standards are quite universal.

Tuesday, December 11: Jakarta

9:00 - 10:00: Caltex

Met with Mr. Pudhri, an engineer from the field who had just been transferred to corporate offices of Caltex in Jakarta. Discussed several gas turbine projects which Caltex was undertaking and wanted to know how IN-GEN would compare with such gas turbine systems. Learned that Caltex has over 100 fields operating on Sumatra. Mr. Pudhri posed the question of how Barnco could package a 21 megawatt steam turbine induction generator set to help reduce Caltex's need for gas turbines. Informed team that based on his experience, there were sites in the field where IN-GEN could take advantage of associated gas. Reiterated point that team should go to Rumbai, Pekambaru, Sumatra to visit the field operation of Caltex.

10:30 - 12:00: B.P.P. Teknologi (BPPT)

Government agency for assessment and application of technology in Indonesia. Procurement of power generation technology by the public sector must have the prior approval, or "Good Housekeeping Seal", from, BPPT. Endorsement from BPPT increases the likelihood that a given project will be accepted favorably.

Met with two senior advisors to BPPT, Dr. John Forgrieve and Dr. Dirk P. Lijesen, and several Indonesian engineers. Response

was favorable; a second meeting was called several days later with engineers from the power generation field.

Positive feedback from BPPT will be a useful reference in future meetings. For example, if a question comes up from Pertamina regarding the viability of the technology, Pertamina could be informed that the technology has already caught the attention of BPPT.

Wednesday, December 12: Jakarta

7:45 - 8:30: Arco

Arco's operations in Indonesia are mostly off-shore. Larry Asbury, senior vice president, did not see a good fit for IN-GEN in off-shore rig operations. Impressed with the technology, and tried to offer suggestions for pursuing other markets. For example, suggested a visit with McDermott Company in New Orleans to discuss concept of incorporating IN-GEN into the design of their off-shore platforms. Suggested to check with Hudbay, Arco's partner that has on-shore pumping fields. Lastly, as an aside, saw a possibility for IN-GEN in Arco's remote on-shore operation in Turkey.

9:00 - 10:00: Unocal

An important opportunity for IN-GEN with this company. Meeting with Rod Strid, a field operations engineer, and Wade O. Lundstrom, vice president LNG & operations, was very instructive. After introductory presentation, the team fielded a wide range of questions which hit on most of the objections that potential customers might have with a new technology. While Mr. Strid viewed IN-GEN as a potential solution to some of his problems in the field, Mr. Lundstrom resisted the notion that Unocal's existing systems could be simplified and made more cost-efficient by using IN-GEN in parallel with equipment currently used in field operations. At one point, after listening to Jim Barnes explain certain features of IN-GEN, Mr. Strid exclaimed, "That's incredible. There are definitely applications for this technology." Mr. Lundstrom did not agree with Mr. Strid's position. Experiencing this type of resistance was actually useful in terms of preparing for tough questions in future meetings.

10:30 - 12:00: Mobil Oil Indonesia

Mobil has some projects on the horizon for which they would have interest in discussing how IN-GEN could meet their needs. Team spoke with three of their engineering specialists who seemed quite intrigued with the idea of incorporating IN-GEN into development of some of their fields. Requested further technical

information on IN-GEN and expressed a desire to reconvene to discuss possible projects.

3:30: Caltex: Flight to Caltex field operations at Rumbai, Pekambaru.

Thursday, December 13: Rumbai

9:00 - 10:00: PT Caltex Pacific Indonesia

Started off visit by meeting with Carnie Block, a senior vice president at Caltex Sumatra. Described Caltex's expansive operations on Sumatra. Confirmed Mr. Pudhri's belief that much of the associated gas in the remote drilling areas could be utilized by IN-GEN to produce power for those operations. In addition, Mr. Block's interest peaked when he found out that IN-GEN has the capability of utilizing waste steam. Apparently, there are certain areas of their operations where steam escapes as a by-product.

Met senior mechanical engineer and two assistants. Spoke in detail about technical aspects of IN-GEN. Caltex has several projects, of varying magnitudes, in which IN-GEN might offer a viable alternative to their current plans.

12:00 - 4:00: Minas Field, Caltex

Mr. Block arranged for team to get out to the field. Minas Field is one of largest in the world. Management of the fields and the overall maintenance of the facilities are impressive. Met with senior power station supervisor who has been with Caltex for 30 years. One of his associates, also a supervisor, commented that Caltex is constantly expanding its operations and always looking for ways to increase power capacity. Caltex is currently undergoing a five-year 105 megawatt power project. First of five 21 megawatt gas turbine plants is under construction and will not be completed until late 1991. Marketing advantage here for IN-GEN, and operational benefit for Caltex, is that IN-GEN could be up and running in a much shorter timeframe.

Friday, December 14: Rumbai - Jakarta

A.M. - Spent the morning traveling back to Jakarta from Caltex.

12:00 - 2:00: John S. Griffith, P.E.

Bechtel engineer serving as a consultant to the engineering arm of PLN, known as PPE. Felt that for next trip, it would be well worthwhile to talk with Planning Division of PLN. PLN is being forced to cut back its service to many urban areas and Mr. Griffith thought that PLN would be very interested in finding quick, reliable solutions to their power crisis. In order to understand the workings of PLN's bureaucracy and how to present a project to them, Mr. Griffith suggested a meeting with Mr. Roy A. Norry before leaving Jakarta.

Saturday, December 15: Jakarta

8:00 - 10:30: P.T. Fajar Mas Murni (FMM)

Breakfast meeting with FMM President Ir. Abdulmadjid. FMM is a trading company which represents a multitude of foreign companies. Many of the products within FMM's areas of expertise relate to the power generation sector in Indonesia. Purpose of meeting was to determine if there might be potential for a good fit between FMM and Barnco. Both parties agreed that indeed there is potential for a business relationship. This process will include a site-visit by an engineer/salesman from FMM to see IN-GEN in operation in the Shreveport area.

Monday, December 17: Jakarta

9:00 - 10:00: Roy A. Norry

Manager for Bechtel project involved with PLN. Reiterated Mr. Griffith's point that PLN would be quite interested in hearing how IN-GEN might offer them a solution to their power generation and service problems. Commented that PLN is resistant to change.

Rural electrification program is of particular concern to PLN. Norry referred to the supplying of power to remote villages on widely dispersed islands as "a huge problem." Currently, PLN has around 80 varieties of synchronous, stand-alone generators operating in these areas where central grid lines cannot reach. Difficult and inefficient maintenance procedures lead to costly and time-consuming repairs on these synchronous sets. And in cases when a village needs more power, adding another synchronous unit requires complex and expensive paralleling equipment. Mr. Norry saw the possibility of IN-GEN helping to solve these types of problems for PIN.

Tuesday, December 18: Jakarta

10:00 - 11:00: BPP Teknologi (BPPT)

In this second meeting, spoke with BPPT's energy planning team coordinator, M.S. Budoyo G. and his colleague. Explained that BPPT assesses and promotes certain technologies, but does not give financing to projects. At close of meeting, however, Mr. Budoyo stated it would be possible for BPPT to provide technical support to Barnco and conduct a study related to a first installation of IN-GEN in Indonesia. Mr. Budoyo suggested that IN-GEN be packaged as a co-generation unit because demand for air conditioning and refrigeration is very high. He also believed that a natural market for IN-GEN would be in hospitals, hotels, and office buildings. Commented that at least in Jakarta, availability of gas should not be a problem because a natural gas pipeline already exists. (This comment conflicts with other information received about gas distribution and should be studied more closely).

Recommended Next Steps

The findings from this pre-feasibility study demonstrate that a large and diverse market for IN-GEN exists in Indonesia. The primary focus for further study and implementation of projects should be in the oil industry where applications most closely mirror the successes of IN-GEN in the U.S. Caltex, Unocal, and Mobil represent solid opportunities and should be pursued.

The economics of IN-GEN's advantages need to be worked out and tailored to each company's operations before any formal presentations are made. Specifically, companies are interested in knowing IN-GEN's cost per kilowatt generated and comparing that cost with the conventional generating sets in their operations. The advantages of IN-GEN's simplicity and adaptability will be even more attractive to these companies when they see numbers they can relate to in terms of cost savings.

Secondly, a coordinated effort to market IN-GEN simultaneously to PLN and to PLN's major customers (e.g. hospitals, office parks, hotels, and residences) shows potential to yield many projects. Again, a customized approach to each of these prospective markets will be the key to eliciting a positive response. Traditional users of captive power, such as industrial estates, sawmills, and palm oil and sugar plantations, deserve serious consideration as well within the context of any further study.

In each of these applications, IN-GEN has the capability of making a major impact in the market. It is a question of targeting the customers and providing a complete package which will satisfy their power-generating needs and offer competitive financing terms.

APPENDIX A

TEAM MEMBERS

The pre-feasibility team comprised the following people. They may be contacted at the addresses below.

James D. Barnes
President
Barnco International, Inc.
912 Kings Highway
Shreveport, LA 71104

Robert E. Ford
Executive Vice President
Lazar Enterprises, Inc.
Suite 404
1101 Connecticut Ave., N.W.
Washington, D.C. 20036

Ernest Y. Lam, Ph.D.
Manager
A.I.D. Conventional Energy Technical
Assistance Project (CETA)
Bechtel National, Inc.
Suite 914
1601 N. Kent Street
Arlington, VA 22209

Tracy W. Pendergrass
Engine Division Manager
Engine Division
Louisiana Machinery - A Caterpillar Dealer
5414 Kennon Lane
Bossier City, LA 71112

APPENDIX B

PRIORITY APPLICATIONS

1. OIL INDUSTRY: Utilization of Associated Gas/Steam on Site.

   A) Pertamina

   - Caltex
   - Unocal
   - Mobil

2. URBAN SECTOR: Substitution for/Addition to PLN or Synchronous Sets.

   - Hotels
   - Office Parks
   - Commercial Space
   - Hospitals
   - Residential Home Units

3. MANUFACTURING SECTOR: Utilization of Natural Gas, Steam, or Biomass.

   - Industrial Estates
   - Sawmills
   - Palm Oil Plants
   - Sugar Plantations

APPENDIX C

TARGETED OIL COMPANIES AND OPERATIONS

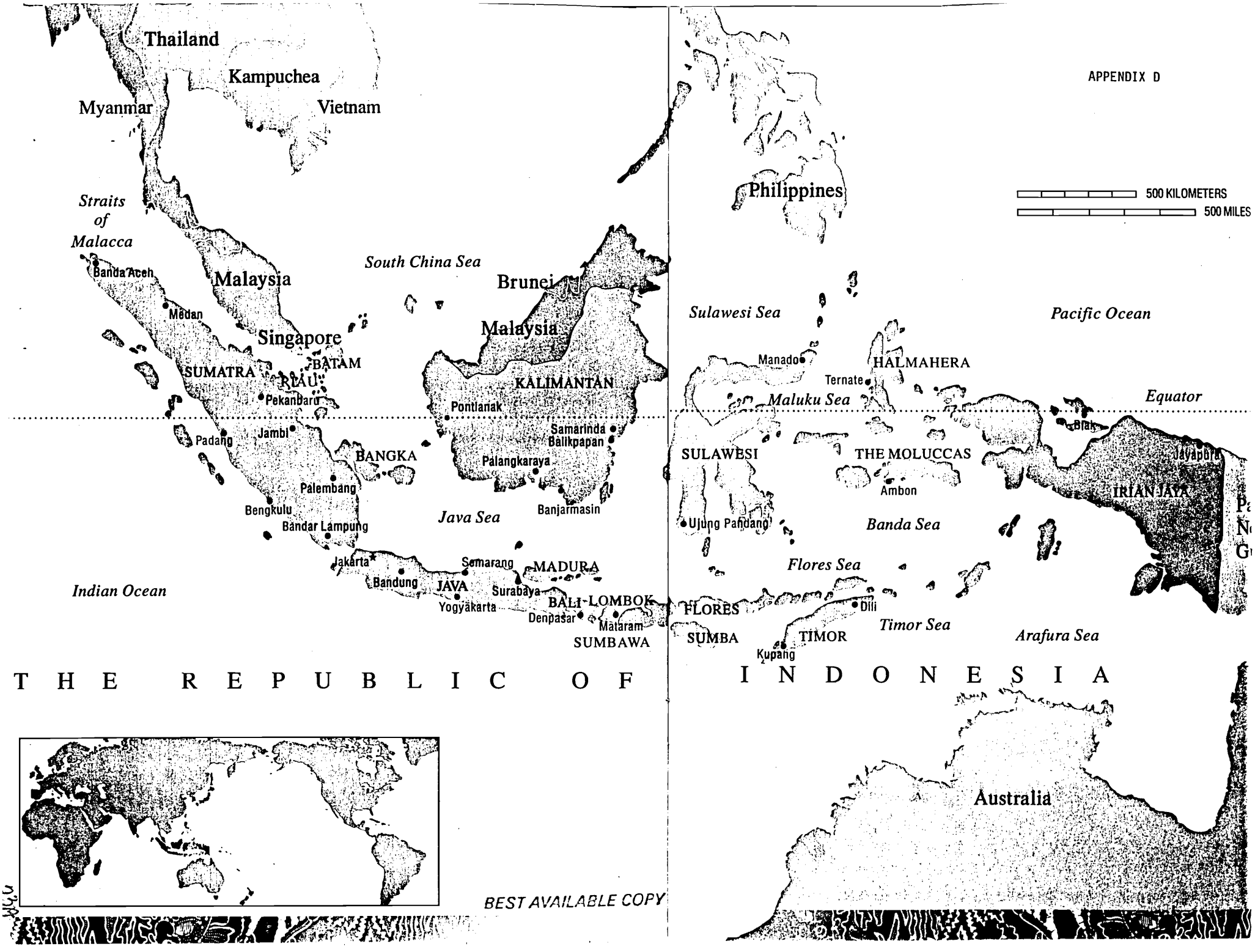
	COMPANIES (percent interest)	LOCATION
1.	Huffco (20%) Virginia (15.6%) Virginia Ind. (26.2%) Union Texas (26.3%) Ultramar Ind. (26.2%) Universe Tankships (7.5%)	E. Kalimantan Sanga-Sanga
2.	Unocal Indo. (100%)	E. Kalimantan Pasir, Balikpapan (On and Offshore)
3.	Caltex (100%)	C. Sumatra, Coastal Plain, Riau
4.	Caltex (90%) Pertamina (10%)	C. Sumatra, Mountain Front, Kuantan
5.	Mobil Oil (100%)	N. Sumatra, Pase Onshore, Aceh
6.	Trend Energy (25%) Sun Indo Oil (19.19%) BHP Petroleum (13.44%) TCR Barito oil (13.63%) Home energy (2.5%) Petro Canada (7.5%) Texaco (6.3%) Home oil (12.5%)	Ons. Barito B. S. Kalimantan
7.	Tesoro (100%)	NE Kalimantan, Ons. Tarakan
8.	Caltex (50%) Chevron (50%)	C.P.I. PSC Block, Riau Onshore

	COMPANIES (percent interest)	LOCATION
9.	Unocal (60%) Katy Petroleum (15%) Inpex Ltd. (25%)	C. Kalimantan Teweh
10.	Total (33.33%) Husky Oil (33.33%) ICI Petrol (16.67%) Brit Oil (16.67%)	Muara Kampar/Riau C. Sumatra
11.	Esso (100%)	Dumai Block C. Sumatra
12.	Occidental (100%)	Berau Block Irian Jaya
13.	Shell (100%)	Ons Off Asem-asem S. Kalimantan
14.	Pertamina (50%) Esso (25%) Mobil (25%)	Onshore Musi klingi S. Sumatra
15.	Pertamina (50%) Esso (25%) Mobil (25%)	Onshore Gundih Block E. Java
16.	Total (25 %) Inpex (25%) Pertamina (50%)	Ons. Tengah Block E. Kalimantan
17.	Pertamina (50%) Esso (25%) Mobil (25%)	Ons. Surulangun S. Sumatra
18.	Huffco (100%)	Brantas/E. Java
19.	Huffco (100%)	Kahayan/E. Kal.

APPENDIX D

MAP OF INDONESIA

APPENDIX D



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APPENDIX E

LIST OF CONTACTS

1. N. Lee Polhill
   Regional Sales Manager, Machines
   Caterpillar
   Medco Building, Ground Floor
   JI. Ampera Raya 20-Cilandak
   Jakarta 12560, Indonesia
   Tel: 7801567 - 7801577 - 7801586
   Fax: 7801560

2. Stephen Kilgallon Bsc
   Engine Department Manager
   PT. Trakindo Utama
   Cilandak Commercial Estate-Jakarta Selatan
   P.O. Box 2282/JKT
   Indonesia
   Tel: 7801093
   Fax: 7802114

3. Alexander Kouo
   Senior Consultant, Engine Sales Development
   Caterpillar Far East, Limited
   Level 8, One Pacific Place
   88 Queensway, Hong Kong
   Tel: 8480278
   Fax: 8480440

4. Dr. Peter A. Jezek
   Private Power Advisor
   USAID/ARD, American Embassy
   JI. Medan Merdeka Selatan 3-5
   Jakarta 10110
   Tel: 360-360 Ext. 2349
   Fax: 380-6694

5. J.M. Baxter
Sales Consultant
PT. Trakindo Utama
Cilandak Commercial Estate-Jakarta Selatan
P.O. Box 2282/jkt
Indonesia
Tel: 47136, 47297

6. K. Mulyohandoko
Assistant Sales Manager, Engines
Caterpillar, Commercial N.V.
MEDCO Building, Ground Floor
JI. Ampera Raya 20-Cilandak
Jakarta 12560, Indonesia
Tel: 7801567 - 7801577 - 7801586
Fax: 7801560

7. H.M. Wilson
Senior Regional Representative and Vice President Bechtel International, Inc.
P.O. Box 40/KBY/Summitmas Tower
Jakarta Selatan 12190, Indonesia
Tel: 520 1812
Fax: 520 0135

8. Arudji Phudry
JI. Kebon Sirih 52
Caltex
Jakarta, Indonesia
Tel: 380-3730

9. Dr. Dirk P. Lijesen
Senior Consultant
Agency for the Assessment and Application of Technology
BPP Teknologi Lt. 4
JI. M.H. Thamrin No. 8
P.O. Box 3664, Jakarta
Indonesia
Tel: 320382. 304. 2972
Fax: 324990

10. Dr. John Forgrieve
US Technical Advisor to the State Minister for Research and Technology
BPP Teknologi
JI. M.H. Thainrin No. 8
Jakarta Pusat
Indonesia
Tel: 328073-3042975
Fax: 362439. 324990

11. L.M. Asbury
Senior Vice President, Operations
Atlantic Richfield Indonesia, Inc.
PANIN Bank Building, Room 7-45
JI. Jendral Sudirman, Senayan
P.O. Box 1063/JKT
Jakarta 10010, Indonesia
Tel: 7397474
Telex: 011-47390

12. Rod Strid
Unocal Indonesia, Ltd.
Ratu Plaza Office Tower-5th Floor
P.O. Box 1264
JI. Jendral Sudinnan, Senayan
Jakarta 10012, Indonesia
Tel: 7397344
Telex: 47335

13. Wade O. Lundstrom
Vice President LNG & Operations
Unocal Indonesia, Ltd.
Ratu Plaza Office Tower- 7th Floor
P.O. Box 1264
JI. Jendral Sudirman, Senayan
Jakarta 10012, Indonesia
Tel: 7207481
Fax: 7391819

14. Marah Kerma Abas
Senior Staff Electrical Engineer
Mobil Oil Indonesia, Inc.
Ratu Plaza Bld. 21st Floor
JI. Jend, Sudirman
Post Bag 1400
Jakarta 10014, Indonesia
Tel: 720-2077
Fax: 720-2068

15. T. Mustafa Kamal
Project Engineer Specialist
Mobil Oil Indonesia, Inc.
Ratu Plaza Building
JI. Sudirman, P.O. Box 400
Jakarta, Indonesia
Tel: 7202077

16. R.L. Prowse
Associate Engineering Specialist
Mobil Oil Indonesia, Inc.
21st Floor, Ratu Plaza
JI. Jenderal Sudirman
Post Bag 1400
Jakarta Pusat, Indonesia
Tel: 720-2077
Fax: 7202068

17. Calmie R. Block
Senior Vice President Sumatra
PT Caltex Pacific Indonesia
Kebon Sirih 52
P.O. Box 1158
Jakarta 10110, Indonesia
Tel: 3803730
Fax: 377804

18. H.B. Rahardjo
Senior Mechanical Engineer
PT Caltex Pacific Indonesia
Kebon Sirih 52, P.O. Box 1158
Jakarta 10110, Indonesia
Tel: 3803730
Fax: 377804

19. Hari Purnomo
Mechanical Engineer
PT Caltex Pacific Indonesia
Kebon Sirih 52
P.O. Box 1158
Jakarta 10110, Indonesia
Tel: 3803730
Fax: 377804

20. Masri. Dj.
Sr. Power Station Supv.
PT Caltex Pacific Indonesia
Power Generation & Transmission Dept.
Power Station Minas
Pekan Baru- Sumatra
Tel: 21377 Ext. 8-300

21. Humayunbosha
District Manager Minas
PT Caltex Pacific Indonesia
Kebon Sirib 52, P.O. Box 1158
Jakarta 10110, Indonesia
Tel: 3803730
Fax: 377804

22. J. Hitipeuw
Superintendent Production-Petapahan
PT Caltex Pacific Indonesia
Kebon Sirih 52, P.O. Box 158
Jakarta 10110, Indonesia
Tel: 3803730

23. Yul S. Arifin
Sr. Supervisor Production-Zamrud & Pedada
PT Caltex Pacific Indonesia
Kebon Sirih 52, P.O. Box 1158
Jakarta 10110, Indonesia
Tel: 3803730
Fax: 377804

24. Busjra Eani
Senior Supervisor, Field Operation
Production Minas
Caltex Minas
Pekanbaru/Indonesia

25. John S. Griffith, P.E.
Bechtel International, Inc.
Summitmas Tower, 10th Floor
JI. Jend. Sudirman Kav. 61-62
Jakarta Selatan 12190, Indonesia
Tel: 520-1812
Fax: 520-0135

26. Ir. Abdulmadjid
President
P.T. Fajar Mas Mumi
JI. Let Jen Haryono M.T. 33
P.O. Box 195/KBY
Jakarta 12770, Indonesia
Tel: 7995208
Fax: 7996328

27. Roy A. Norry
Project Manager
Bechtel International, Inc.
Summitmas Tower, 10th Floor
JI. Jend. Sudirman Kav. 61-62
Jakarta Selatan 12190, Indonesia
Tel: 520-0245
Fax: 520-0135

28. Ir. M.S. Budoyo G. M. Eng
BPP Teknologi
Energy Planning Team Coordinator
BPPT Building, 6th Floor
JI. M.H. Thamrin 8
Jakarta 10340, Indonesia
Tel: 3042861 - 320510 - 4214533
Fax: 324990

APPENDIX F

TECHNICAL ASPECTS OF IN-GEN

A number of facilities throughout the world have energy resources that are not being used successfully such as waste lease gas, agricultural production of methane gas, and others. These energy sources are being vented to the atmosphere or used in a wasteful fashion. There are also oil leases that are becoming uneconomical to operate because of the cost of electrical power associated with artificial lift equipment.

What the IN-GEN System does is bring these two needs together to produce electrical power from energy sources such as waste gas. It also brings other benefits that make it desirable for use in oil production and/or biomass facilities.

The IN-GEN System consists of an induction AC generator driven by a prime mover such as a Caterpillar gas engine. The generator is simply an AC induction motor driven above its synchronous speed to deliver power out of the generator into the load.

The simplicity of the IN-GEN System centers on the fact that sophisticated synchronizing equipment is not required. IN-GEN is "excited" directly from the AC utility. It supplements the utility current by delivering current up to the load rating. The end result is a significant reduction in the utility power bill and cost-effective utilization of a waste fuel.

There are several keys that guide the potential user to consider the IN-GEN System. Among these are:

- Areas of high electric utility rate
- Areas of high power demand
- Areas of depleting oil resources
- Availability of free gas, vented or flared
- Availability of waste gas or flash gas
- Large pressure drops
- Waste by-products
- Biomass fuels

IN-GEN Components, System and Specifications

The IN-GEN system is a process employing a prime mover to drive an induction generator in parallel with a power grid or synchronous generators. The process is regulated by a control panel and has been protected by U.S. Patent #4,730,118 since March, 1988. System components may vary according to manufacturer and/or size. Energy efficiency may be increased through the addition of various waste heat recovery systems.

What is an Induction Generator?

An induction generator can be any induction motor driven over synchronous speed. This motor will generate power back into the electric system as the rotor speed is fractionally increased over synchronous speed until the motor is current limited.

The frequency of operations is controlled by the commercial power's frequency on the stator.

The Prime Movers

A large selection of prime movers is available for use in the IN-GEN System. Since most IN-GEN applications use gas from oil leases or methane gas from waste by-products, the standard Cat 3300/3400 series of engines, modified for use with gas, are used.

A more specific listing of the various applications and the type of fuel that is compatible with each prime mover is given below:

1. Reciprocating prime mover:

   Natural gas fuel
   - Oil and gas production facilities
   - Gas processing plants
   - Industrial plants
   - Commercial cogeneration systems

   Waste gas/flash gas fuel
   - Oil and gas production facilities
   - Gas processing plants
   - Industrial plants

   Biogas fuel
   - Agricultural operations (animal waste)
   - Landfill operations
   - Municipalities (wastewater treatment facilities)

2. Turbo-expander prime mover:

   Gas processing plants
   Methanol plants
   Industrial plants
   Municipalities

3. Steam turbine prime mover:

   Sawmills
   Manufacturing plants (waste incinerators)
   Agricultural operations (crop residues)

4. Gas turbine prime mover

   Commercial cogeneration systems
   Municipalities
   Industrial plants

Control Panel

The control panel consists of a relatively few number of components and include the input circuit breaker, power factor correcting capacitors, electrical power instruments and engine/generator power controller. The primary purpose of the control panel is to provide the proper connection of the induction generator, driven by the prime mover, to the existing power source, which can be either a commercial power bus or a synchronous generator, and to maintain this connection until electrical or mechanical faults occur.

The IN-GEN can be removed from service at any time by operator. The electrical faults that will cause the system to disconnect from the power source are either internal or external faults.

External Faults

The external electrical faults that will cause the IN-GEN to disconnect from the power source are:

- Phase loss
- Phase unbalance
- Phase reversal
- Undervoltage
- Overvoltage

If any phase fails to exhibit the proper current and voltage relations to each other sensing (sensing period of less than 10 seconds), the IN-GEN will disconnect itself

from the power source. The sensing period is adjustable for various applications and is shipped with a delay of approximately 15 seconds.

Internal Faults

Internal electrical faults that will cause the IN-GEN to disconnect from the power source include all of those listed for external electrical faults plus an absolute over-current condition. An adjustable delay exists to allow ride-through of all faults except absolute over-current.

The absolute over-current fault disconnect may be furnished with a start-up override to allow the connection of certain classes of prime movers whose RPM controls overshoot the control set point while ramping into speed. In all cases, following the settling out of this initial condition, the absolute over-current shutdown is not time delayed.

Mechanical Faults

The mechanical faults that will cause the IN-GEN to disconnect from the commercial power source include but are not limited to shaft breakage, coupling slip or loss, engine shutdowns due to low oil pressure, low oil level, high coolant temperature, fuel loss, etc.

Connection To Power Source (Utility Bus or Synchronous Generator)

The IN-GEN connection to the power source can be either manual or automatic and is switch-selectable by the operator. In either case, the prime mover must be previously started and in a reduced RPM mode, below synchronous speed of the generator.

When either of the start modes is selected, the fuel supply is opened and the prime mover accelerates towards its set point. As the generator is rotated at the synchronous speed, the system is connected to the power source and the delivery of current begins. As the speed increases to the desired level, the current increases proportionally. Following a delay, the power factor correction capacitors are connected to the utility bus.

Disconnecting From the Power Source

When it is desired to disconnect the IN-GEN from the power source either manually or through action of the control panel, the command is given and the generator terminals and the power factor correction capacitors are disconnected. The prime mover is automatically switched to the idle mode until engine cooling is

complete. After that period, the engine can be shutdown automatically or manually.

System Reconnection

Following a disconnection from the system, a time delay is required before the system can be restarted and reconnected due to utility company restrictions.

Power Company Interface (For U.S. Applications)

Because the passage of the Public Utility Regulatory Power Act (PURPA) that is regulated by the Federal Energy Regulatory Commission (FERC) allows small generators of electrical power to connect their sources to the public utility lines, no licensing with the IN-GEN System is required. The IN-GEN System acts in much the same fashion as an induction motor with circuit breaker except in this case, it delivers power to the load in conjunction with the utility line.

While it has the ability to do so, it generally is not set to deliver more current than the area load requires. Therefore, it will not deliver power back to the utility for the purpose of revenue production but will offset the power of the load normally delivered by the utility. In other words, it should be viewed as an expense reducer and not a revenue producer.

Another significant operating factor with the IN-GEN System is the fact that line synchronizing is automatically achieved when the generator is excited. This reduces the possibility of a utility line fault or similar occurrence.

To avoid any potential misunderstanding with the power company, it is advisable to communicate and inform them of the changes being made on the lease and the anticipated reduction in normal power requirements. Communication with the power company should be one of reinforcing the power company's integrity. Since the IN-GEN reduces the loading on the power lines in the area, more users can be supplied reliable power.

Load Interface

The loads typically found in oil and gas leases that utilize the IN-GEN System are electric submersible pumps, beam pumps, booster pumps and injection pumps. Occasionally, area lighting may also be found.

By analyzing the electric power bills, along with equipment ratings, a value of KVA and KW can be established for the lease under normal operating conditions. Considerations for inrush and

power factor also need to be considered. In most cases, the utility will be used for load startup to avoid oversizing the IN-GEN due to inrush currents of 5-7 times normal running currents. The IN-GEN will then be used to offset the normal load currents being consumed by the load under normal conditions.

Waste Heat Recovery

Since the gas/diesel engine converts the available fuel source at only a 35% conversion rate, the remaining 65% of energy resulting from the burnt fuel is either exhausted to the atmosphere or used in some productive way. From a conservation standpoint, the waste heat can be used in several ways on the lease for oil/water/gas separation or for other purposes.