PD-AAS-853
43907

UNCLASSIFIED

UNITED STATES INTERNATIONAL DEVELOPMENT COOPERATION AGENCY
AGENCY FOR INTERNATIONAL DEVELOPMENT
Washington, D. C. 20523

ROCAP

PROJECT PAPER

CENTRAL AMERICA ENERGY RESOURCES

AID/LAC/P-263

Project Number: 596-0134

UNCLASSIFIED

AGENCY FOR INTERNATIONAL DEVELOPMENT

PROJECT DATA SHEET

1. TRANSACTION CODE: A = Add, C = Change, D = Delete — Amendment Number

DOCUMENT CODE: 3

2. COUNTRY/ENTITY: Central America Regional

3. PROJECT NUMBER: 596-0134

4. BUREAU/OFFICE: LAC

5. PROJECT TITLE (maximum 40 characters): Central America Energy Resources

6. PROJECT ASSISTANCE COMPLETION DATE (PACD): MM 12 DD 31 YY 86

7. ESTIMATED DATE OF OBLIGATION (Under 'B.' below, enter 1, 2, 3, or 4)

A. Initial FY 85 B. Quarter 2 C. Final FY 86

8. COSTS ($000 OR EQUIVALENT $1 =)

A. FUNDING SOURCE	FIRST FY B. FX	C. L/C	D. Total	LIFE OF PROJECT E. FX	F. L/C	G. Total
AID Appropriated Total						
(Grant) $10,200	($10,200)	( )	( )	($10,200)	( )	($10,200)
(Loan)	( )	( )	( )	( )	( )	( )
Other U.S. 1.						
Other U.S. 2.						
Host Country						
Other Donor(s)						
TOTALS	$10,200			$10,200		$10,200

9. SCHEDULE OF AID FUNDING ($000)

A. APPROPRIATION	B. PRIMARY PURPOSE CODE	C. PRIMARY TECH. CODE 1. Grant	2. Loan	D. OBLIGATIONS TO DATE 1. Grant	2. Loan	E. AMOUNT APPROVED THIS ACTION 1. Grant	2. Loan	F. LIFE OF PROJECT 1. Grant	2. Loan
(1) ESF	740	960				$10,200		$10,200	
(2)									
(3)									
(4)									
TOTALS						$10,200		$10,200	

10. SECONDARY TECHNICAL CODES (maximum 6 codes of 3 positions each): 741, 742, 750, 751, 752

11. SECONDARY PURPOSE CODE: 970, 870, 820, 710

12. SPECIAL CONCERNS CODES (maximum 7 codes of 4 positions each)

A. Code

B. Amount

13. PROJECT PURPOSE (maximum 480 characters)

The purpose of the project is to introduce new technologies and assesment methodologies into the region that will alow each of the participating countries to better analyze their current and future energy needs, to develop non-traditional sources of energy such as geothermal and low grade coal and peat, and to more efficiently utilize the energy and mineral resources found in the region.

14. SCHEDULED EVALUATIONS

Interim MM 10 YY 85 MM 06 YY 86 Final MM 12 YY 86

15. SOURCE/ORIGIN OF GOODS AND SERVICES: [X] 000 [ ] 941 [X] Local [ ] Other (Specify)

16. AMENDMENTS/NATURE OF CHANGE PROPOSED (This is page 1 of a ____ page PP Amendment.)

17. APPROVED BY

Signature: Dwight B. Johnson

Title: Dwight B. Johnson, Director, LAC/DR

Date Signed: MM 02 DD 01 YY 85

18. DATE DOCUMENT RECEIVED IN AID/W, OR FOR AID/W DOCUMENTS, DATE OF DISTRIBUTION: MM DD YY

AID 1330-4 (8-79)

3/21/85

ACTION MEMORANDUM FOR THE ASSISTANT ADMINISTRATOR (LAC)

FROM : LAC/DR, Dwight B. Johnson

SUBJECT: Project Authorization, LAC/Bureau, Central America Energy Resources Project (596-0134)

Action: Your authorization is required for the Central America Energy Resources Project. A DAEC reviewed and approved the PP for this project on Friday, March 8, 1985.

Background and Description: The goal of this new $10.2 million ESF Grant Project is to improve the economic situation in Central America and help create employment through increased and more efficient utilization of the region's energy and natural resource endowment. The purpose of the project is to introduce new technologies and assessment methodologies into the region that will allow each of the participating countries to analyze better their current and future energy needs, to develop non-traditional sources of energy such as geothermal and low grade fossil fuel resources, and to utilize more efficiently the energy and mineral resources found throughout the region.

The Project will be implemented by the Los Alamos National Laboratory through a Participating Agency Service Agreement (PASA) with the Department of Energy.

Project Components: The project will be implemented in two phases. The initial phase ($5.2 million) will have two major components: 1) A regional energy situation analysis that will involve the collection and analysis of regional energy and resource data, construction of a standardized regional data base, and the development of long term planning models to assist in the formulation of energy and resource policy; 2) An alternative energy resource development component which will: a) provide assistance in the identification and use of geothermal resources to generate electricity; b) assess potential industrial and domestic uses for peat and low grade coal; and c) assess the feasibility of and demonstrate the use of low temperature geothermal heat for commercial and agro-industrial uses. Both components will involve the training of local technicians and scientists and the purchase of equipment which will make the participating countries self-sufficient in these areas over the long term.

Activities in Phase II ($5.0 million) of the project will derive primarily from the results of activities begun in Phase I. In general, these additional monies will be used to fund the expansion of geothermal and peat development activities, to conduct country specific mineral resource assessments, provide mineral sector profiles, and fund a study of energy conservation potential in the transportation sector in Central America. Before these Phase II funds are committed to any specific activity, Los Alamos and A.I.D. must reach agreement that a specific activity is appropriate and Los Alamos must submit an approved addendum/workplan/budget for inclusion in the amended Project Paper.

The DAEC approved this Project subject to minor modifications in the Project Paper (Statement of Work for Los Alamos) as developed jointly by Bureau staff and the Los Alamos project team. These modifications are as follows:

1. Reference to specific Universities, individuals, and private sector companies are not permitted under A.I.D. procurement regulations. All references to specific firms or institutions will be deleted.

2. Reference to the Costa Rica mineral reconnaissance component as a possible Phase II activity will include the caveat that future work will depend on the outcome of the planned April 1985 USGS meeting in Antigua, Guatemala and other preliminary work done during Phase I.

3. Before shipment of the well logging truck to Central America, a detailed management plan will be developed which specifies the provisions for maintenance, movement from one country to another, insurance and liability, and other factors pertinent to the efficient utilization of this equipment. Reference to the truck title being held by Los Alamos will be deleted. Title to the truck will remain with A.I.D. during the life of the project and a determination as to which Central American institution will receive final title to the equipment will be made during the course of the project.

4. Reference to the Advisory Committee will be followed by the statement that a final determination regarding the function and membership of this committee will be determined in future discussions between A.I.D. and Los Alamos.

5. Procedures will need to be developed to define the relationship between the various participating organizations. A Memorandum of Understanding (MOU) or other similar document as may be prescribed by GC/LAC will be signed with all of the major participating Central American agencies and organizations with the Bureau, the appropriate Mission, and Los Alamos as signatories. These documents will be designed to clarify the expected tasks and responsibilities of each of the participating parties. Wording to this effect will be included in Section IX, Overall Project Implementation.

6. Funding for Phases I and II of this project is currently $10.2 million with a PACD of 31 December 1986. The addition of other project activities and new funding will depend on the results of the first two project phases and will require an amendment to the Project Paper. Reference to activities beyond the first two phases will be deleted from the paper.

7. In addition to the periodic internal review and evaluation outlined in the Project Paper, there will be interim evaluations in November 1985 and again in June 1986. These evaluations will be conducted by a private, outside firm selected by AID.

8. The DAEC judged the "Energy Situation Analysis" component and the "Peat End Use" subcomponent to be over funded. The Bureau has suggested that Los Alamos submit revised, more detailed budgets justifying these expenses or reduce the budgets for these activities until it is clear that the proposed levels of effort are really needed. If Los Alamos elects the second alternative, the "contingency" line item will be increased accordingly and Los Alamos, with A.I.D. concurrence, will be able to draw on these monies to support any of the project activities as needs determine.

Also, the Costa Rican peat end use assessment subcomponent will be modified to include the condition that the "Feasibility Studies" will await the findings of the "Parametric Study of Economically Feasible End Uses", the "Peat Characterization", and the "Selection of Most Promising End Uses". It is important this component include an analysis of non-extractive peat uses, i.e., the long term economic and social benefits of leaving the peat in site and using it for agriculture, forestry, watershed management, and parks.

IV

Waivers:

OMB Circular A-76 Exemption: When submitting a PIO/T for the initiation of a PASA, the submitting Bureau is required to include with the submission a statement signed by the cognizant Assistant Administrator that the proposed agreement is exempt from the provisions of Circular A-76 because 1) it is for the provision of technical assistance and; 2) the facilities and resources of the other Federal agency (Department of Energy/Los Alamos in this case) are particularly suitable for the technical assistance being provided and are not competitive with private enterprise.

In this case, Los Alamos possesses the only well logging equipment of its kind. It is capable of conducting measurements in extremely high temperture geothermal wells. This makes Los Alamos unique in the geothermal research and development field. In addition, their expertise in the mineral research and peat research fields make them particularly suitable for implementing the other proposed project activities.

Payment of International Travel - Payment of international travel costs by participating governments, as required under Handbook 10, is not feasible for the subject Project given the severe shortages of foreign exchange occurring in each of the host countries. For this reason, we propose approval of payment of international travel costs with Project funds.

Handbook 10, Section 15B.b. allows for A.I.D. payment of international travel in the case of centrally funded programs if a waiver request by the initiating Office or Bureau has been approved by both the appropriate Geographic Bureau Assistant Administrator and the Mission Director (the Bureau is requesting a general waiver for this purpose from each of the participating Mission Directors).

Congressional Notification: A Congressional Notification was sent to the Hill on March 6, 1985 and expires on March 21, 1985.

Rcommendation:

That you approve the waivers and authorize the Project and that you sign the attached PIO/T.

Approved: [signature]

Disapproved: _____

Date: 3/21/85

TABLE OF CONTENTS

I. SUMMARY 1

II. PROJECT RATIONALE 3

A. Goal of the Project 3

B. Purpose 3

C. Objectives of the Project 4

III. THE CURRENT SITUATION: BACKGROUND TO PHASE I COMPONENTS

A. The Regional Macroeconomic Environment 5

B. The Regional Energy Situation 6

1. Overview 6

2. Country Specific

a. Guatemala 8

b. El Salvador 10

c. Honduras 11

d. Costa Rica 12

e. Panama 13

3. Summary 14

IV. PROJECT COMPONENTS

A. Energy Situation Analysis

1. Problem Statement 16

2. Project Component Description

a. Activities 16

b. Task Statement

1) Energy Situation Update 17

2) Data Collection and Computerization 17

3) Economic Analysis and Modeling 18

c. Coordination and Implementation Plan 19

d. Status at End of Phase I 20

e. Project Component Budget 21

f. Activity Schedule and Milestones 22

B. Analysis and Assessment of Non-Traditional Energy Resources

1. Regional Geothermal Energy Resources 23

a. Honduras Geothermal Reconnaissance

1) Problem Statement 23

2) Project Component Description

a) Activities 23

b) Task Statement

(1) Evaluation of Prior Work 25

(2) Acquire Existing Oil Well Data 26

(3) Field Investigations 26

(4) Sample Analyses 32

(5) Coordination with Proposed Italian Study 32

3) Coordination and Implementation Plan 33

4) Status at End of Phase I 35

5) Project Component Budget 37

6) Activity Schedule and Milestones 39

b. Miravalles Geothermal Development

1) Problem Statement 40

2) Project Description

a) Activities 41

b) Task Statement

(1) Well Logging Rig and High-Temperature Cable 41

(2) High-Temperature Downhole Logging Tools 42

(3) Training of Costa Rica Personnel

3) Coordination and Implementation Plan 43

4) Status at End of Phase I 44

5) Project Component Budget 46

6) Activity Schedule and Milestones 47

c. Costa Rica Reconnaissance
1) Problem Statement 48
2) Project Component Description
a) Activities 48
b) Task Statement
(1) Evaluation of Prior Work 50
(2) Field Investigations 50
(3) Sample Analysis 52
3) Coordination and Implementation Plan 54
4) Status at End of Phase I 56
5) Project Component Budget 58
6) Activity Schedule and Milestones 60
d. Support Equipment for Central America
1) Problem Statement 61
2) Project Component Description
a) Activities 61
b) Task Statement
(1) Self-Contained Logging Truck 62
(2) High-Temperature Downhole Logging Tools 64
(3) DC Resistivity System 65
(4) Audiomagnetotelluric (AMT) System 66
3) Coordination and Implementation Plan 67
4) Status at End of Phase I 68
5) Project Component Budget 70
6) Activity Schedule and Milestones 72
e. Direct Heat Applications in Central America
1) Problem Statement 73
2) Project Component Description
a) Activities 73
b) Task Statement

(1) Survey of Existing Process Heat Requirements 74
(2) Identification of the Most Promising Applications Of Geothermal Heat Use 74
(3) Feasibility Studies of Selected Applications and Regional Workshops 75
3) Coordination and Implementation Plan 76
4) Status at End of Phase I 76
5) Project Component Budget 77
6) Activity Schedule and Milestones 78
2. Costa Rican Peat End Use Assessment
a. Problem Statement 79
b. Project Component Description
1) Activities 82
2) Task Statement
a) Parametric Study of Economically Feasible End Uses 82
b) Peat End Use Experimentation 83
c) Selection of the Most Promising End Uses 84
d) Feasibility Studies of Selected End Uses 84
c. Coordination and Implementation Plan 85
d. Status at End of Phase I 86
e. Project Component Budget 87
f. Activity Schedule and Milestones 88
V. TRAINING 89
VI. UNPROGRAMMED CONTINGENCY 92
VII. PHASE I BUDGET SUMMARY 94

VIII PHASE II: EXTENDED FIRST-YEAR PROJECT COMPONENTS 95
A. Costa Rica Mineral Reconnaissance Components 95
B. Mineral Sector Profiles Component 96
C. Coal, Lignite and Peat Component 96
D. Equipment Maintenance Expenditures Components 97
E. Database Maintenance Component 97
F. Geothermal Support to El Salvador, Panama and Guatemala Component 97
H. Conservation and Fuel Substitution in the Transport Sector Component 98
I. Wind Energy Component 98
J. Bi Phase Energy System Geothermal Well Prover in Guatemala 98
IX OVERALL PROJECT IMPLEMENTATION 99
X ENVIROMENTAL IMPACT 106
XI REQUESTS FOR ASSISTANCE 107
ANNEX A INITIAL ENVIROMENTAL EXAMINATION
ANNEX B PROJECT CHECKLIST

Central America Energy Resources Project:
Plan for Concurrent Phases I and II

I. Summary

The Central America Energy Resources Project is a new LAC Bureau initiative designed to address the problems in Central America related to energy and mineral resource exploitation and utilization. The goal of the project is to improve the economic condition in Central America and help create employment through increased and more efficient utilization of the region's rich energy and natural resource endowment. The purpose of the project is to introduce new technologies into the region that will allow each of the participating countries to better analyze and assess their current and future energy needs, to develop non-traditional sources of energy such as geothermal and low-grade fossil fuel resources, and to more efficiently utilize the energy resources found throughout the region.

The entire Central American region is facing a severe economic crisis that, without concerted action, promises to worsen. One important causal factor in this crisis is the region's dependence on imported petroleum. In 1983 the countries of the region (excluding Nicaragua) imported approximately $1.0 billion worth of petroleum. This is approximately twenty percent of the region's total imports. The region's requirements for petroleum are expected to grow for the foreseeable future if economic growth and development are to be regained. Even at present levels of consumption the cost of oil imports is having a serious negative effect on the region's balance of trade and payments.

The countries of the region have been active in developing alternatives to this dependence on imported petroleum. Chief among the alternatives has been the partial development in the region of their considerable hydroelectric potential. However, this alternative has been extremely expensive requiring hundreds of millions of dollars of scarce foreign exchange to finance. Also, because of the of marked seasonal variation in rainfall, and because many of the region's hydroelectric

facilities are run-of-river the countries have continued to need to import large amounts of bunker fuel to supplement their hydroelectric facilities. It is estimated that even a best-case scenario will require that the region continues to depend on thermoelectric generating plants for approximately 30% of their electric generation. Add to this the heavy dependence on either electricity or petroleum based fuel of the regional industrial and transportation sectors and it becomes apparent that there is an urgent need to develop alternatives to petroleum to meet the energy needs of the region. Among alternatives which this project will examine, are geothermal, solar, biomass, wind and the use of low grade coal and peat.

Another paradoxical factor which frustrates economic growth in the region, is the dependence on imported industrial minerals and the general failure to develop indigenous mineral resources for use in domestic industries and for export. The region is known to possess significant mineral resources but little systematic work has been done to examine their precise location and feasibility of exploitation. Exacerbating the dual problems outlined above is a general lack of systematic data collection and analysis that would allow energy resource modeling in support of policy development.

To address all of these problems, the Bureau proposes a multiphase project that specifically targets several key concerns in the energy and mineral resource development area. The Project will be implemented by the Los Alamos National Laboratory through a Participating Agency Service Agreement (PASA) with the Department of Energy. Initial funding for this Project will be $10.2 million. The Project will be implemented in two concurrent phases. There will be two major components initiated during Phase I ($5.2 million) of the Project: 1) a regional energy situation analysis that will involve the collection and analysis of regional energy and resource data, construction of a database and development of long term planning models and to assist in the formulation of energy and resource policy. 2) An alternative energy resource development component which will: a) provide assistance in the

identification and use of geothermal resources to generate electricity; b) assess potential industrial and domestic uses for peat and low grade coal known to exist throughout the region; c) demonstrate the use of geothermal heat for commercial and industrial uses. Both components will involve the training of local technicians and scientists and the purchase of equipment making the participating countries self-sufficient in these activities over the long term.

Phase II ($5 million) of the Project will include additional geothermal and peat development activities, country specific mineral resource assessments, mineral sector profiles and a study of energy conservation potential in the transportation sector of the participating countries.

II. PROJECT RATIONALE

The limited development of indigenous energy and mineral resources in Central America together with the high cost of imported fuels are key ingredients in the economic stagnation that has plagued the region for the past five to eight years. The countries lack carefully constructed methodologies for assessing current and future energy needs and for electing from among several energy alternatives. There is also a lack of trained technicians. In addition, there is no comprehensive energy database for the region. Finally, the region has undeveloped energy and mineral resources that can make an important contribution. Chief among these are geothermal and peat.

A. Goal of the Project

The goal of the Central American Energy and Natural Resource Development Project is to improve the economic condition in Central America and help create employment through increased and more efficient utilization of the region's rich energy and natural resource endowment.

B. Purpose

The purpose of the Project is to introduce new technologies and assessment methodologies into the region that will allow each of the

participating countries to better analyze their current and future energy needs, to develop non-traditional sources of energy such as geothermal and low-grade fossil fuel resources, and to more efficiently utilize the energy and mineral resources found throughout the region.

C. Objectives of the Project

The following objectives will lead to achievement of the Project Purpose:

1. Identify, quantify and assess the natural resource endowment possessed by the countries of the region. This includes energy resources that can be used to substitute for presently imported energy sources, predominantly petroleum, as well as energy and other resources that could be used to decrease import of non-energy raw materials and increase revenues earned from export of both energy and non-energy materials.

2. Create an analytical framework that allows rapid comparisons of energy and mineral development options in terms of balance of trade, import substitution, direct cost, job creation, etc.

3. Through the activities identified in Objectives 1 and 2, build technical and managerial skills so that a self-sustaining economic development process is established. This objective will be achieved predominantly by on-the-job training associated with the project components, training workshops, sponsored graduate student participation and visits by regional technicians to Los Alamos.

4. Involve the local and US private sector so that the resource assessment and development activities lead to job creating investments in commercial and industrial activities based on the energy and other natural resources that will be identified.

III. THE CURRENT SITUATION: BACKGROUND TO PHASE I COMPONENTS

A. The Regional Macroeconomic Environment

During the 1960's and 1970's the countries of Central America were among the most dynamic and rapidly growing economies in Latin America. All five members of the Central American Common Market (CACM) have since experienced dramatic declines in GDP per capita from peak years that occurred during the late 70's and early 80's. High oil prices were among the most important causes for this economic decline as identified by the National Bipartisan Commission on Central America (the Jackson Plan). Another major cause for the declining per capita GDP identified by the Jackson Plan--excessive foreign debt--is exacerbated by the dramatically increased prices of imported oil. Indeed, the shortfall of export revenues caused by the oil price shocks resulted in the necessity for most Central American countries to curtail imports of consumer goods, raw materials, spare parts and capital goods. This, in turn, resulted in an acceleration of the economic downturn.

However, a return to economic growth will result in greater demand for imports, oil among them, unless something is done to alter the petroleum requirement/GDP ratio among Central American economies. A successful attempt to resume reasonable rates of GDP growth will require addressing both import substitution--particularly for petroleum--and export promotion, preferably new product exports since markets for traditional products seem unlikely to improve significantly in the near term. To improve productivity and stimulate economic growth the countries of the region must diversify and import foreign technology and machinery all of which will require increased energy inputs.

The project described in this paper will address these needs by: 1) identifying and assessing the potential for development of indigenous energy resources to substitute for imported petroleum and to provide the required growth in the energy sector; 2) providing the necessary data bases, computational hardware and software and analytical techniques for using the data to make comparisons among energy alternatives; 3) pro

viding training to establish and increase the ability of local experts to perform these activities themselves in the future; 4) providing better access to US technology and expertise through increased industrial sector involvement. This is consistent with a provision of the Jackson Plan that proposes reducing foreign exchange requirements for energy imports through the use of US technology to identify and assess indigenous resources.

B. The Regional Energy Situation

1. Overview. The critical energy situation in Central America is ironic in view of the wide diversity and large quantity of energy resources available. Currently, a little more than half the region's energy is supplied by petroleum, approximately one-quarter is supplied by firewood and other cellulose fuels, approximately ten percent is supplied by bagasse, while hydro and geothermal supply the remaining approximately fifteen percent. With only one country in the region--Guatemala--possessing petroleum reserves, the large dependence on petroleum is an obvious indicator of one of the region's most serious energy problems.

The region's energy resources are significant. Due to the steep terrain and high annual rainfall, theoretically developable hydroelectric resources are large. But development is very expensive and has certain practical limitations. Geothermal potential exists in all countries, but its full potential has not been established. El Salvador has significant capacity in geothermal and both Guatemala and Costa Rica are in the process of developing geothermal fields. It is likely that significantly more potential exists and geothermal will play an increasing role in Central America's energy future. Petroleum, as noted earlier, has been discovered in significant quantities only in Guatemala although several countries have undertaken some petroleum exploration. Coal exists throughout the region; although very little is known about the resource, based on available information, it is thought to be of generally low quality. A potentially developable deposit has been identified in Costa Rica. Although peat is an energy resource that is

likely to be found in abundance throughout the region, it was not given much attention prior to a study performed by Los Alamos scientists indicating that it might be a valuable resource for the region. Costa Rica and Belize are known to have numerous large peat deposits. Solar and biomass energy sources are available throughout the region and have both contributed to energy supply in the past. Due to the generally high cost of converting solar to useful energy, it will likely play a role in applications in isolated areas of the region.

Given present plans of electric utilities in the region, it appears that hydroelectric and geothermal generation of electricity will both increase in the future. The portion of total electric supply contributed by hydroelectric generation will increase as new facilities in Guatemala, Honduras and El Salvador come on line. However, these facilities will not yield the planned capacity additions hastening the time when yet more capacity must be installed. Serious technical problems and cost overruns on the facilities in Guatemala and Honduras and similar problems experienced by Costa Rica on its Arenal project may be changing the conventional wisdom in the region regarding the desirability of hydroelectricity. It is likely that petroleum consumption for electric power production will increase substantially unless technical, capital and financing constraints do not prevent installation of lower cost-per-unit output, but more capital-intensive hydro facilities. This is a very serious concern for utility planners in Central America and is one of the major reasons for Honduras' interest in geothermal energy. The key questions for electric energy planners then are: (1) What mix of hydro, geothermal and fossil-fueled thermal plants will be used to meet new capacity requirements, and, (2) Should new capacity be installed to allow early retirement of existing petroleum-fired electric generation?

As indicated, hydro offers a significant electric energy source in Central America. However, much of the existing capacity is in run-of-river facilities which, during the dry season, may not be able to operate at full capacity. Thermal stations may be required to fill energy shortfalls during the dry season. Impoundment projects can overcome

this problem but lead to other difficulties such as flooding of potentially valuable valley-bottom agricultural or forestry land, development of access roads thereby exacerbating the rate of deforestation, and erosion and premature siltation of dam structures. Given these difficulties, there is a role for other sources of electric energy to combine with hydro to supply the demand most economically.

If economic growth is regained in Central America, it is likely that petroleum consumption will increase. A key issue for the energy sector is the means by which it will be possible not only to minimize increases in petroleum consumption but also to substitute other fuel sources for petroleum. The transportation sector is a major user of petroleum. Some substitution of ethanol and/or methanol for gasoline may provide reductions in gasoline consumption. In some countries it may be possible to achieve substantial savings of petroleum through conservation in the industrial and commercial sectors. Direct use of geothermal fluids or use of residual geothermal fluids could also be significant in substituting away from petroleum in the industrial sector.

2. Country Specific

a. Guatemala. "Guatemala is the most favorably endowed country in Central America. Its agricultural resources, plus possible extensive petroleum and mineral resources, give its economy considerable potential for growth." (Agency for International Development, "Country Development Strategy Statement: Guatemala" April 1984.) While Guatemala is endowed with considerable natural and cultural wealth, this wealth has not been used in such a way as to provide a reasonable standard of living for many of its citizens. Guatemala's government has steered a course of fiscal responsibility and has thereby avoided the public sector deficit and external finance problems that are so serious for its companion republics. However, this fiscal responsibility has been purchased at the expense of economic well-being for much of its populace.

Total energy supply in Guatemala in 1977 according to the AID funded study "Energy and Development in Central America" performed by the MITRE Corporation (all subsequent energy statistics in this section were obtained from this report) was divided approximately as follows: petroleum 51%; firewood 35%; bagasse 10.7%; hydroelectric 3.3%. Of the 51% of energy supplied by petroleum, approximately 14% is consumed in thermal electric power generation and 31% is used directly, predominantly in the transportation sector. Of the total electricity supply, approximately 16% is from hydro facilities and the remainder, 84%, is supplied by thermal sources.

Because Guatemala is abundantly endowed with energy and other natural resources, proper development planning should yield significant benefits. Energy planning to develop the best mix of hydroelectric and geothermal resources for electricity generation is required. The theoretical capacity for hydroelectric power is substantial. It has been reported that the Instituto Nacional de Electrificacion (INDE) hopes to increase the percentage of hydro generation from its current three percent of load to sixty percent. It may be that much of this theoretical capacity cannot actually be developed due to engineering, economic and possibly other constraints. Geothermal electric power has been determined to be feasible at the Zunil site and plans exist to explore the Amatitlan site. More work should be done to prove the country-wide feasibility of geothermal electric power and other direct heat uses of geothermal fluids. Planning the integration of new geothermal and hydroelectric facilities with the existing electric supply capacity should be accomplished.

Significant oil and gas reserves have been discovered in the northcentral region of Guatemala. New techniques exist for planning the optimum exploitation of frontier oil fields and Guatemala's oil field planning should be made with the aid of these sophisticated new methods.

Peat and coal are known to exist, possibly in large quantities, in Guatemala. Market, end use and economic studies should be performed for Guatemala's situation as well as reconnaissance studies to identify the location, characteristics and quality of the peat and coal. In view of

the substantial portion of total energy provided by wood and the resultant deforestation, peat or coal prepared for use as a domestic fuel could significantly reduce deforestation in Guatamala.

This project document contains a proposal for a study of direct heat applications of geothermal fluids in Central America. Guatemala has been selected as the country in which more site specific feasibility studies for direct heat applications will be performed. To the degree that direct use of geothermal fluids can substitute for oil and gas used to generate process heat, this program activity area will advance the AID Mission's goal of balance of payments equilibrium. Requests have been made by representatives of Instituto Nacional de Electricidad (INDE) for assistance in geothermal developments. The energy situation analysis proposed in this plan will include Guatemala. The data collected in this effort will support the direct heat studies and other resource development activities.

b. El Salvador. Energy use in El Salvador is similar to that in Guatemala in percentage contribution of various sources to total supply. The major difference is that El Salvador has developed its geothermal resources to a much greater extent. In El Salvador, petroleum contributes about forty-five percent and bagasse and firewood contribute about thirty-eight percent together while hydro and geothermal contribute about ten percent and eight percent, respectively.

With the exception of Guatemala's petroleum resources, El Salvador possesses a similar range of energy resources. Hydro resources are estimated at a relatively low theoretical capacity of about 1,451 MW. Geothermal capacity is estimated at 720 MW with about 95 MW installed at present. The rest of the country has not been intensively explored for geothermal, but other sites have geologically interesting potential including Chipilapa and Berlin. There are no known petroleum, natural gas or coal deposits. Wind, solar and biomass represent significant resources but, wind and solar have not been widely exploited due to their high cost for central station power plant developments.

The energy situation analysis proposed in this document includes data collection and analysis for El Salvador. This will support resource assessment and identification activities for El Salvador. In particular, consultation and instrumentation activities in support of the development of the Ahuachapan field, direct use of geothermal fluids and energy conservation will be proposed. Programs in this area will contribute to the revitalization of the industrial sector and possibly to development of export industries, both important objectives in the AID Mission Country Development Strategy statement.

c. Honduras. Total energy consumption in Honduras comprises the following shares: petroleum contributes about forty-six percent, bagasse and firewood contribute forty-one percent and hydro contributes the remaining thirteen percent.

Honduran energy resources are similar to those of neighboring republics. Theoretical capacity for hydro development is moderately high for the region, with a large number of surface manifestations of geothermal activity identified but no systematic reconnaissance undertaken. Indications of oil reserves exist, but no commercial scale reserves have been identified. There appear to be no natural gas deposits. Reserves of lignite exist as do likely deposits of peat. Wind and solar may be additional resources, but data are limited. As in all Central American countries, sugar is a major export crop and bagasse is used to produce heat for the sugar refining process. Honduras has the largest forest resources in the region. Lumber and its products are a substantial export commodity.

Honduras is at a decision point with respect to new electrical generating capacity additions. The El Cajon dam will be completed at a cost significantly greater than estimated as well as significantly reduced rated capacity. Considering the rates of growth of electricity consumption in Honduras, officials of the Empresa Nacional de Energia Electrica (ENEE) urgently need to know whether geothermal electricity generation is feasible in Honduras. This is the rationale supporting

the proposed country-wide geothermal reconnaissance. As in all countries in the region, energy and economic planners require access to up-to-date statistics and will be assisted by the energy situation analysis proposed for Honduras.

d. Costa Rica. In many respects, Costa Rica is the most developed country in the region, yet it faces significant energy and economic problems. The country possesses a rich diversity of energy resources. Costa Rica ranks first among the six countries in the region in the development of hydro resources. Costa Rica also has significant theoretical geothermal potential, an estimated 720 MW, according to recent estimates by the AID funded MITRE Corporation study. The Mexican State Oil Company (PEMEX) was engaged in a controversial petroleum exploratory drilling program in Costa Rica, but has recently abandoned the effort. The discovery potential for petroleum is considered very low relative to that of other energy resources. Costa Rica does possess coal resources. Recent reports indicate that some of this coal may be worth mining. Costa Rica also possesses large resources of peat that have a variety of uses in energy, agriculture, chemicals and other industries. As with its neighbors, solar, biomass and wind energy sources could make marginal contributions to energy futures in Costa Rica.

Petroleum consumption makes up forty-five percent of the energy consumption in Costa Rica, bagasse and firewood make up approximately thirty percent, and hydro contributes the remaining twenty-five percent.

The proposal contains project activities in geothermal assessment, a peat end use study and an energy situation analysis. The geothermal work involves two separate but related activities: consultation in well logging and instrumentation and a country-wide reconnaissance of geothermal resources. Both activities fit into host country and AID mission priorities. The consultation at Miravalles is the result of a short-term mission made by two Los Alamos staff in the Spring of 1984. Specific requests have been made for this work by officials of the

Instituto Costarricense de Electricidad (ICE) and the Interamerican Development Bank (IDB) is aware of and supports the need for the project. The geothermal reconnaissance was suggested by AID/W personnel with need confirmed by IDB officials. Los Alamos concurs in the desirability of this activity.

Peat is a relatively unknown resource among Central American countries. When Los Alamos representatives visited Costa Rica as part of an Organization of American States (OAS) employment mission, the suggestion to energy planners and decision makers that there might be peat and that it might be a valuable energy resource was unknown. Since that time, a great deal of enthusiasm and commitment to examining this resource has been generated. Los Alamos conducted a short-term mission to Costa Rica in February 1984 to examine peat potential. This mission was funded by the IDB and coordinated with ICE and the Refinadora Costarricense del Petroleos (RECOPE). Based on the results of the mission, further field work is being recommended. RECOPE and the IDB both feel that this work is necessary; indeed, RECOPE now has the counterpart funds available to support its portion of the activity.

In many respects, the more complex the energy economy, the greater the need for up-to-date information and the means to process and analyze it. The complexity of the Costa Rican energy economy, and the many options and opportunities open to it make the energy situation analysis essential for Costa Rica.

e. Panama. At about seventy-five percent, petroleum provides by far the largest share of Panama's energy consumption. Hydro and firewood each provide about ten percent and the remaining five percent is provided by bagasse. Panama appears to have significant opportunities to substitute for petroleum consumption.

Panama possesses notable hydroelectric potential, a potential greater than that of El Salvador and almost equivalent to Honduras. A preliminary investigation of the potential for geothermal power had been estimated by the World Bank to be 400 MW. The IDB recently formed a

consultative group to develop a plan for examination of Panama's potential. While Panama transships a good deal of petroleum from the Atlantic to Pacific, it has not discovered indigenous sources. Natural gas is not known to exist in Panama either. Based on examination of soil maps and other sources of information, it is anticipated that Panama possesses peat resources. Solar, biomass and wind are potential contributors to Panamanian energy futures especially for small scale, dispersed uses.

The energy situation analysis is the only activity that is proposed during Phase I in Panama. The energy situation analysis will benefit not only energy planners in Panama but it will also contribute to a regional perspective.

3. Summary. Central American countries are blessed with a rich and diverse endowment of natural resources, including energy resources. The relatively high dependence on petroleum is due, as in developed countries, to the low price of oil up to 1973. As in developed countries, the key to an improved energy situation is the substitution, where technically and economically feasible, of indigenous energy sources for petroleum. The difficulty faced by most Central American countries is that replacement investment requires capital, an exceedingly scarce resource in Central American countries. In view of capital scarcity careful examination of energy options and opportunities is warranted.

Recent data indicate that for the region as a whole, more than fifty percent of electric generation capacity is in thermal facilities that mainly use petroleum based fuel sources. At present, approximately twenty percent of total energy consumption is provided by electricity. If all the petroleum based thermal generation were replaced by other indigenous sources, about ten percent of petroleum imports could be avoided. This may initially appear to be a small substitution. However, add petroleum consumption in the industrial sector, approximately another twenty percent, and in the residential sector, ten percent, which could be substituted by a combination of electrification, geo-

thermal for direct heat, coal, peat and conservation, and significant numbers emerge. To this could be added some substitution of methanol or ethanol in a mixture with gasoline.

The region is purported to have consumed 245,000 terajoules of petroleum in 1977. Assuming that a barrel of petroleum contains 6000 megajoules of energy, consumption in barrels was approximately 40.8 million barrels. At $30.00 per barrel, the region's oil import bill was over $1.2 billion. If all the thermal electricity generation, half the direct petroleum consumption in the industrial sector and half the direct consumption in the residential sector could be substituted, a saving of a little over $250 million annually could be realized. This would go a long way to providing much of the replacement capital required by the region to furnish the capital investment for petroleum substitution.

A second outstanding feature of the Central American energy economy is that firewood and other cellulose fibre sources are estimated to provide about one quarter of total energy consumption. This dramatic statistic suggests a deforestation problem of significant magnitude. Addressing this problem through a variety of means including examination of peat as an energy source may be an important contribution.

IV. PROJECT COMPONENTS

A. Energy Situation Analysis

1. Problem Statement. The most recent description of the energy situation in Central America was published in 1980 by the MITRE Corporation. It is based on 1970-1978 data. Consequently, MITRE's report does not cover the effects of the 1978-1979 increase in oil prices, the current decline in oil prices, the effect of additions to hydro generating capacity, the interconnection of electrical grids and other events which have affected the energy situation in the region in the past five years. As a result, an updated and expanded report of the current energy situation and future options is needed.

A second problem was articulated by government energy planners in Honduras and Guatemala during recent meetings by Los Alamos and AID personnel. Many of the countries lack comprehensive energy databases, trained personnel to implement systematic data collection, computerization and dissemination, and methodologies to assess current and future energy needs and how to supply those needs. The state of energy planning varies widely from country to country. All countries in the region have received guidance from OLADE on the standardization of energy balances. Some countries, such as Costa Rica, are relatively advanced in energy data computerization and modeling but most countries require assistance in energy data collection, storage, dissemination and in modeling.

2. Project Component Description.

a. Activities. This project component will provide an updated energy situation analysis for the region. The analysis will focus on changes that have occurred in the energy situation since 1978. It will identify areas in which energy data are lacking and will address how indigenous energy resource development can benefit the Central American countries. Upon completion of the energy situation analysis, we will respond to requests from the region for assistance in energy planning

by: 1) building a computerized database of relevant energy and economic data for countries that lack one; 2) transferring the database to energy planners in each country along with appropriate computer hardware and software and instructing counterparts in their use; 3) building regional institutional capabilities in energy planning methodologies through workshops and individual training; and 4) establishing periodic updating mechanisms for the database so that a reliable and current energy situation analysis can be completed without a massive effort.

The long-term goals of this project component are 1) development of sound national energy policies; 2) efficient energy use; and 3) provision of an analytical framework to measure the benefit of indigenous energy resource development.

b. Task Statement.

1) Energy Situation Update. This task will focus on rapid updating of the 1980 MITRE Corp. study. To accomplish this task, we will rely mainly upon energy data collected by OLADE, reports on energy balances published by the countries and brief visits to the region to obtain first-hand information on the energy situation. The report will highlight changes that have occurred in the energy situation since 1978 and will identify areas in which energy data are lacking. It will also address the potential benefits of indigenous energy resource development.

2) Data Collection and Computerization. This activity will begin concurrently with the preliminary analysis described above to computerize data and provide analysis, graphs and figures for the update of the MITRE report. This activity will then respond to needs expressed by energy planners in the region to assist in systematization of energy data collection, data computerization, and dissemination. Although OLADE methodology has been implemented to standardize energy balances in the region, most of the countries now require further assistance in data handling, dissemination and modeling. AID/CR provided assistance to the Direccion Sectoral de Energia to computerize Costa Rica's energy data

and to build an econometric model of energy supply and demand. The Costa Rican data system will be favored for application in other countries in the region, thus assuring standardization of energy data. This activity will involve more lengthy visits to the region, workshops and training on energy data collection, and use of personal computers. This subtask may also involve design and implementation of surveys to collect basic energy data that are lacking or out of date. Some project funds will be expended to purchase support hardware for a Los Alamos computer and personal computers and software for countries in the region. Databases will be constructed jointly with country counterparts and a copy of the database will reside in each country. Many of these activities will carry over into the second and later years of the project.

3) Economic Analysis and Modeling. To complement the database activities of subtask 2), Los Alamos economists with experts on energy planning and economic analysis from other national laboratories, universities and the private sector will develop appropriate methodologies for energy planning and forecasting in consultation with planners in the region. Consideration will be given to models currently in use at the World Bank, EPRI and the Interamerican Development Bank. Results of a study being conducted for AID by Oak Ridge National Laboratory that reexamines appropriate methods of energy planning and modeling for developing countries will also be considered in our selection of transferrable methodologies.

A technique that analyzes both the macro and micro effects of indigenous energy resource development will be recommended. It may incorporate methods already in use in some countries, such as the INVEST code developed for project evaluation and given to Costa Rica. Training and institution building will be individually tailored for the needs of each country. Where possible, workshops will be sponsored that involve energy planners from all countries to foster communication and to address regional issues, such as the benefits of electricity-sharing and joint use of petroleum refineries.

c. Coordination and Implementation Plan. The World Bank is presently conducting a survey of energy use and options for several developing countries. The report for Costa Rica has been published and provides an excellent source of information for that country. However, the World Bank has not conducted energy surveys in Guatemala, El Salvador, and Honduras and has no plan for such surveys. Although a survey may have been conducted in Panama a few years ago, they do not plan to issue a report on the subject. Thus, our energy situation analysis for the other countries will complement the World Bank's energy survey of Costa Rica. There are few other World Bank energy projects in the region at present. They have funded small projects related to oil exploration in Costa Rica and Honduras and they assist Panama in hydropower development.

In contrast, the IDB funds several energy-related projects in Latin America. Those that complement our energy situation analysis include: 1) training in energy supply and demand forecasting and energy policy analysis at the Comision Ejecutiva Hidroelectrica del Rio Lempa of El Salvador (CEL); 2) assistance in hydropower develpment in Panama and Honduras; 3) feasibility studies for geothermal development at Miravalles in Costa Rica; 4) construction of the Zunil geothermal electric power plant at Zunil in Guatemala; and 5) the initial assessment of peat resources of Costa Rica that was conducted by Los Alamos. Most of the IDB activities will provide energy data; in addition, the personnel being trained in energy policy analysis will provide valuable counterparts for us in El Salvador.

The work will be performed by the following personnel as needed: Dr. Anthony Burris, Robert Drake, Steven Booth, Wayne Hardie, Myrle Johnson, Anthony Montoya, Don Morris, Dr. Fred Roach, Dr. Donna Smith, Linda Trocki, Annette Turpin, and Dr. Ken Williamson, assisted by a counterpart in the appropriate ministry or direccion in each country.

Los Alamos has established a working relationship with the Direccion Sectoral de Energia and ICE of Costa Rica, Consejo Superior de Planificacion Economics (CONSUPLANE) and ENNE in Honduras and INDE and the Ministry of Energy and Mines in Guatemala. Dr. Verne Loose and Linda Trocki of Los Alamos will visit El Salvador, Panama, and OLADE soon to establish working relationships in these countries or organizations. Subtasks 1) and 3) will be coordinated by Linda Trocki and Subtask 2) by Myrle Johnson. Experts on energy in developing countries from other national laboratories, universities, and private and non-profit organizations will be invited to participate in our activities as consultants.

Subtask 1) will be completed within the first eight months of the project. Subtasks 2) and 3) are ongoing activities. Databases will be ready for transfer to all countries and training in their use will take place in Year 2 of the project. Los Alamos will assume the responsibility for regular updating and maintenance of the database over a period of at least five years. The major accomplishments of Subtask 3) will take place in Years 2 and 3 of the project.

d. Status at End of Phase 1

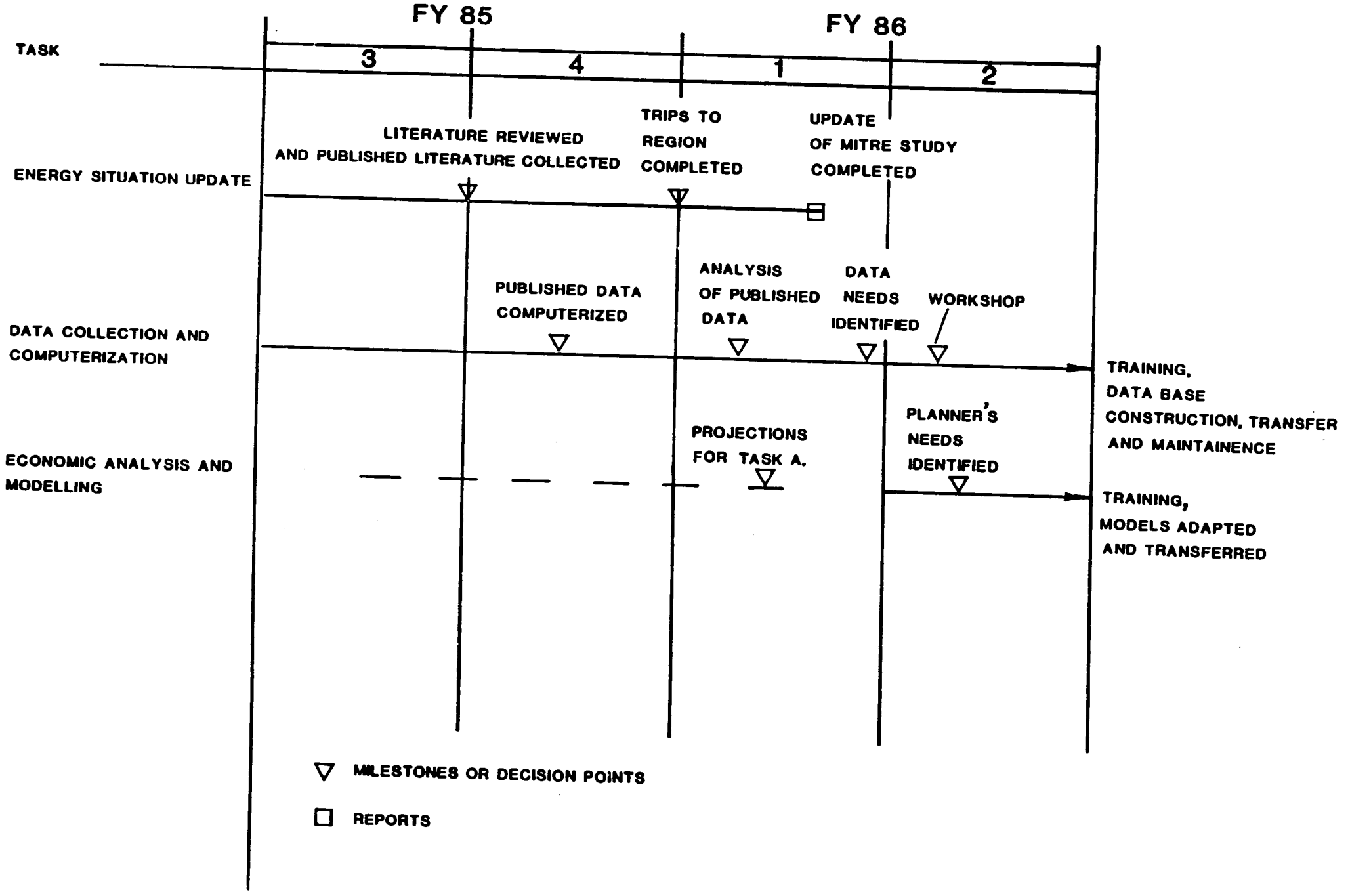
- Update of MITRE study completed and report published.
- Workshop held to disseminate results of the Energy Situation Update and to discuss energy problems and data needs.
- Regional counterparts and training needs identified.
- Computerization of readily available data completed in a framework compatible with the one in use in Costa Rica.
- Basic energy data requirements identified and surveys designed to collect missing data or to update old data.
- Maps for resource and infrastructure atlas completed in preliminary form.

e. Estimated Energy Situation Analysis Project Component Budget

Projected Budget for Energy Situation Update			$K
Economist base salary (50K/FTE/Yr)	2 FTE	100	
Fringe @ 25% of base salary		25	
Burden @ 77% of base + fringe		96	221
Travel			
Air fare (15 round-trips, Albuquerque to Central American capital city)		15.0	
Intercountry air fare		6.1	
Per diem (average $75/person-day x 105 person-days)		7.8	
Local and field expense		1.1	30
Projected Budget for Data Collection and Computerization			
Data processing hardware and software costs			170
Travel			
Air fare (10 round trips - Albuquerque to Central American capital city)		10.0	
Per diem (average $75/person-day x 140 person-days)		10.5	
Local and field expense		1.2	25
Workshop			30
Projected Budget for Economic Analysis and Modeling			
Economist base salary (50K/FTE/Yr)	0.5 FTE	25	
Fringe @ 25% of base salary		6.3	
Burden @ 77% of base salary plus fringe		24	55.3
	Subtotal for Year 1:		531.3

f. Activity Schedule and Milestones. The Schedule for the tasks described is shown on the accompanying milestone chart.

ENERGY SITUATION ANALYSIS
ACTIVITY SCHEDULE AND MILESTONES



B. Analysis and Assessment of Nontraditional Energy Resources

1. Regional Geothermal Energy Resources. El Salvador currently generates substantial amounts of electrical power from their indigenous geothermal resources. In the early 1980's, El Salvador was producing over 40% of its electricity from the geothermal power plant at Ahuachapan. As part of a $55,000,000 project with the Interamerican Development Bank, Guatemala is developing the well field for a geothermal power plant at Zunil while concurrently investigating the geothermal potential in other areas of the country. A total of six geothermal production wells have been drilled in the Miravalles field in Costa Rica as part of a $100,000,000 project to develop a 55 MW power plant. Efforts to identify and develop the geothermal potential of Honduras have been minimal compared with activities in other Central American countries. The IDB is forming a consultative group to oversee geothermal studies in Panama. These activities provide adequate testimony to the enormous geothermal energy potential of Central America.

a. Honduras Geothermal Reconnaissance

1) Problem Statement. Efforts to identify and develop the geothermal potential of Honduras have been minimal compared with activities in other Central American countries. The proposed geothermal reconnaissance would provide the scientific data necessary to quantify the resource potential of Honduras and allow power plant developments to start paralleling similar efforts in Costa Rica and Guatemala. With the increasing cost of hydroelectric power resulting from the El Cajon project, geothermal energy development in Honduras could have a very positive effect on future expansions of the electrical power grid.

2) Project Component Description

a) Activities. Honduras has been the site of limited geothermal surveys and research for the last eight years. Surface manifestations such as hot springs, active faulting, and some Quaternary volcanoes have justified these surveys. Previous surveys have concentrated

mostly on the chemistry and temperatures of thermal waters, a logical first step. Empresa Nacional de Energia Electrica (ENEE) has published data from a systematic sampling of thermal waters in the country and identified areas for further study. The hot springs at Pavana have been studied using electrical resistivity techniques. The work proposed by Los Alamos builds on previous work but provides a more comprehensive, integrated approach than has been conducted in the past.

The ultimate objective is to determine the geoscience, engineering, and economic feasibility of developing the geothermal energy resources of Honduras for electrical power generation. In accordance with the OLADE methodology, the technical sequence of events is to:

(1) Perform a limited country wide geology, volcanology, and geochemical reconnaissance.

(2) Perform a prefeasibility investigation in selected areas of the country including extensive geophysical surveys.

(3) Perform a feasibility investigation in the highest priority geothermal areas including the drilling of the initial deep exploration wells.

Phase I efforts in Honduras will therefore have the primary objective of performing a limited reconnaissance-scale geothermal energy development investigation throughout the country and making specific recommendations for future exploration activities to establish the commercial geothermal potential. Emphasis will be directed at geothermal reservoirs that exhibit the greatest potential for electric power generation based on estimates of flow permeability, fluid temperature, and reservoir magnitude. Although a limited country-wide reconnaissance effort is planned, field activities will be concentrated in the volcanic rock sequences located in the west-central region of the country.

Following the OLADE methodology, initial investigations will include an in-depth evaluation of prior work in Honduras, geology and

volcanology field reconnaissance, stratigraphic mapping and analysis, fault mapping, construction of three-dimensional reservoir cross-sections of selected resources, geothermal fluid sampling, spring sampling, gas sampling, major and trace element analyses, stable isotope analyses, gas compositions, rock age dating, reservoir temperature analyses, and construction of hydrologic models to distinguish between significant areas of geothermal fluid upwelling as opposed to lateral distribution of cooler fluids. In accord with the OLADE methodology, significant geophysical field investigations will not be attempted before the analysis of the reconnaissance scale geology, volcanology, hydrology, and geochemistry results.

b) Task Statement.

(1) Evaluation of Prior Work. Immediately after contract initiation, an extensive evaluation of prior work in Honduras will be performed. Emphasis will be directed at the geology, volcanology, fault structures, rock age data, surface manifestations, geochemistry, geothermometer temperatures, hydrology, roving dipole surveys, dipole-dipole profiles, electrical resistivity soundings, and telluric data that are available in the literature. Much of the available information is limited to specific regions of the country that have been previously identified for their geothermal potential. San Ignacio, Platanares, Azacualpa, and Pavana fall in this category. Detailed geophysical surveys were performed around Pavana by Geonomics, Inc. during 1977. However, on the basis of geothermometer temperatures, Pavana has been classified as a region of secondary interest because of its lower projected temperatures. The higher temperature (based on geothermometry) regions of San Ignacio, Platanares, and Azacualpa apparently have not been subjected to this level of geophysical investigation. Early in the program, a visit will be arranged with ENEE officials to obtain the results from any additional geophysical investigations that were performed in Honduras. During this visit, the logistics for the initial field operations will be established.

The work by Geonomics, Inc., GeothermEx, Inc., and the various United Nations' geothermal missions will form the backbone of this evaluation. A literature search will be conducted to locate other appropriate technical references of importance to this evaluation. If satellite images of Honduras are available, the appropriate digitized data will be analyzed. These efforts will be completed before the major field investigations and will be used to determine the initial site priority.

(2) Acquire Existing Oil Well Data. As reported in a recent publication by Caceres, Avila, et al., a total evaluation of the historical petroleum exploration data base has been undertaken by the Direccion General de Minas y Hidrocarburos (DGMH) of the Republic of Honduras. This project has utilized DGMH's extensive geological, geophysical, and petroleum engineering data base obtained from previous exploration operations in Honduras. DGMH also commissioned additional studies in remote sensing, geochemistry, radiometrics, and field surveys. Data from these studies have been collected and analyzed and will be made available to industry through DGMH in the near future. During the initial visit with ENEE officials, a visit will be planned with DGMH officials to obtain pertinent data from the exploratory oil wells and associated geophysical prospecting investigations. A total of twenty-nine wells have been drilled in Honduras with sixteen wells penetrating depths greater than 1500 m. Data from these wells could provide valuable lithologic and temperature information for the geothermal exploration program. Efforts will also be made to obtain the results from seismic investigations that have been conducted by various oil companies for petroleum exploration and have not been made available to geothermal investigators.

(3) Field Investigations. The country has been mapped, on a reconnaissance basis, with the end product being a 1:500,000 scale geologic map. When combined with a volcanological study of the country published in 1969, the above referenced oil well data provide an excellent guide for selecting areas for detailed geothermal exploration investigations. Unfortunately the geologic mapping and geochemical spring surveys were conducted independently and an urgent need exists

for linking these studies. Existing geochemical data therefore suffer from a lack of descriptive information on the geology, structure, and surface manifestations at the sampling sites.

There are five areas considered by GeothermEx to have possible subsurface temperatures above 150°C:

Platanares	(210°C)
San Ignacio	(205°C)
Azacualpa	(185°C)
Agua Caliente	(170°C)
Sambo Creek	(155°C)

Agua Caliente is on the border with Nicaragua and could present a difficult working environment. Sambo Creek is on the north coast, a considerable distance from the axis of volcanism. The other three areas are higher in temperature and in the west-central part of the country near more recent volcanism.

Although a limited country-wide reconnaissance effort is planned, field activities by Los Alamos geologists, volcanologists, geochemists, hydrologists, and geophysicists are expected to be concentrated in specific areas of interest that have been identified in earlier studies or from additional information provided by local or other Central American sources. These will be mostly within a broad N-W trending belt from the Golfo de Fonseca to Lake Yojoa, where there is extensional faulting and Quaternary basaltic volcanism. The following approach will be used in this phase of the study:

(1) Careful synthesis of diverse surveys, such as the geologic mapping and spring surveys.

(2) Analysis of satellite imagery and photography to better understand the structural framework and identify volcanic structures to be visited in the field.

(3) Visit each of the sites listed below for the purpose of geologic mapping, studies of the lavas and pyroclastic rocks (type, composition, nature of vents, volume of deposit--all for the purpose of identifying the nature of the heat source), collecting samples for radiometric dating, and evaluation of aquifers within the hydrothermal area.

(4) Perform a comprehensive sampling program of the hot and cold springs (major/trace element chemistry, stable isotopes, and tritium) and the active fumaroles (chemical composition and isotopes of CO_2). Compile localized structure/ alteration maps of these areas to define permeable faults, fractures, and fluid conduits. The objectives of this sampling program will be to better characterize differences in chemistry related to spacial distribution over the geothermal system, to verify subsurface geothermometry estimates, and to infer the age and recharge characteristics of the geothermal system.

(5) Conduct temperature surveys in shallow wells in the most promising geothermal areas (Los Alamos, working with ENEE representatives, would drill the required shallow temperature gradient wells).

(6) Based on an integrated analysis of available data, design and perform a geophysical testing program in the most promising geothermal areas. Emphasis is expected to be on deep dc resistivity measurements and audiomagnetotelluric (AMT) soundings.

(7) Evaluate the needs of ENEE with regard to training of personnel in geothermal surveys and mapping. Recommend a training program, as appropriate, and implement this program. Whenever possible work with ENEE representatives during the field investigations and hire local Hondurans for field support activities.

Once detailed geologic, geophysical and hydrogeochemical evaluations are completed at the targeted Honduras geothermal sites, two to three sites will be chosen for thermal gradient drilling. The purpose of these wells is to establish what the subsurface thermal gradients at the chosen sites are and to estimate what depths are necessary before possible production drilling commences. These shallow wells will also provide the following information: 1) a stratigraphic test; 2) a preliminary reservoir model based on stacking of cold and hot aquifers and possible temperature reversals; and 3) an introduction to potential drilling problems for deeper production wells.

Experience in the US geothermal industry has shown that one well 300 to 600m deep provides much more information on subsurface gradients and reservoir dynamics than several very shallow wells (100m deep). This is particularly true in areas of very high rainfall because near surface cold aquifers in porous volcanic strata can mask deeper temperature gradients down to several hundred meters. Drilling of 300 to 600m deep wells in two to three of the Honduras geothermal sites is proposed to substantiate subsurface temperatures.

The following areas are recommended for intensive field investigations (Fig. 1):

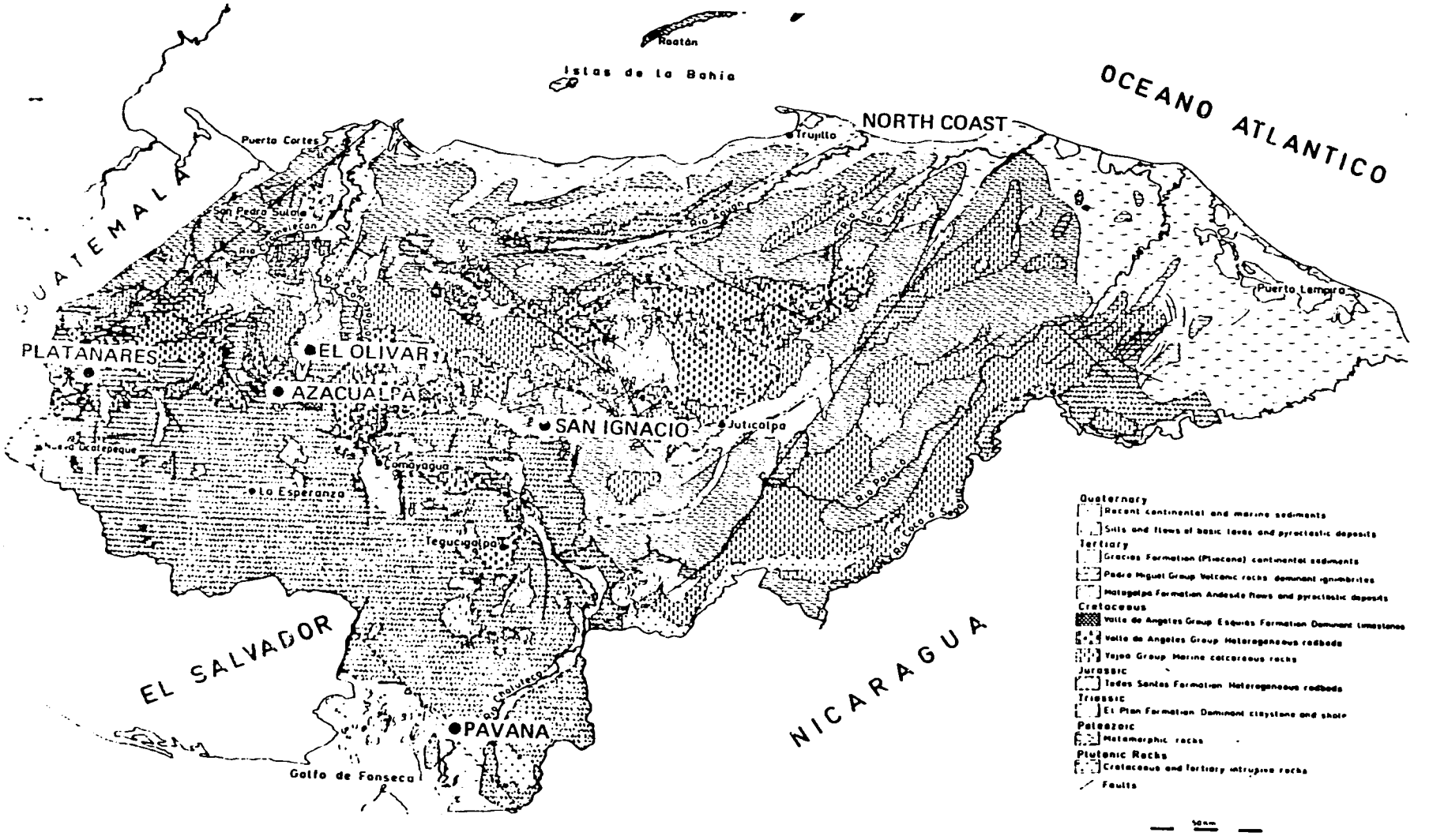


Fig. 1. Geologic map of Honduras.

Pavana-Naocome area. This region, along the Golfo de Fonseca, has been the subject of investigations since 1976, when it was studied by the UN Mission. The area has been mapped to identify the stratigraphy and main faults. There have been electrical resistivity and water sampling surveys. Further attention should be given to this area with regard to the hydrologic framework and evaluation of thermal sources.

Platanares, Copan. The area has been mapped, on reconnaissance scale, and the springs studied during the UNDP program. Further work should include some radiometric dating of rock units and hydrologic analysis of the hydrothermal system.

San Ignacio. A review of the structural framework and its relation to the hydrology is most needed here.

El Olivar - Aguacate (Lago de Yojoa). This region requires detailed study of the volcanic areas, including radiometric dating, relation to structure, volume and nature of the eruption products, and estimates of the thermal source. This region has considerable potential, even if very high temperatures are not reached. There is industrial need for hot water, as mentioned in the UNDP report.

Azacualpa. There is a geological reconnaissance map of the area and spring sampling. This part of the study should be expanded to involve a geological reconnaissance of the entire Santa Barbara graben. According to the UNDP report, there are surface manifestations within the graben that have not been described or sampled.

Northern coastal sites. A visit to these sites is necessary for understanding the reasons for such high water temperatures in a region with no recent volcanism.

The overall success of this field investigation program could be significantly enhanced through collaboration with geologists and civil engineers from the Honduran government and a representative from OLADE. Los Alamos will make every effort to establish this arrangement before

initiating the field investigations. On the basis of this work, Los Alamos and ENEE counterpart personnel will provide an estimate of the magnitude and quality of the hydrothermal resources of Honduras.

(4) Sample Analyses. The following analyses will be performed on samples obtained from Honduras:

- Chemical analyses (major and trace element) to permit geothermometer temperature calculations and to serve as a "benchmark" for comparison with existing data.
- Stable isotope analyses (^{2}H and ^{18}O) to look for oxygen shifts indicative of high-temperature conditions.
- Gas analyses to look for high-temperature gas equilibria.
- ^{13}C analyses on CO_2 in water samples to investigate magmatic or sedimentary origin.
- ^{3}H analyses (tritium) of water to investigate age and, therefore, possible depth of circulation of water.
- K-Ar dating of rock samples.
- Petrographic descriptions of lava and tephra.

(5) Coordination with Proposed Italian Study. With joint funding from the United Nations Development Program, the Government of Italy, and the Government of Honduras, the Italians have proposed a geothermal study for the central region of Honduras. Although an agreement has been signed, work on the project has not been initiated.

Los Alamos is currently investigating the technical details of the proposed Italian effort. The region of coverage is limited to the central part of the country and does not include identified geothermal

manifestations in the northern, western, and southern regions of Honduras. Los Alamos will coordinate its activities with the appropriate Italian organizations when they are identified. Los Alamos has been an active participant in the US/Italy bilateral agreement on "Cooperative Research in Geothermal Energy" since the agreement was signed in 1976. Italian scientists and engineers have participated in Los Alamos geothermal projects in the US along with US personnel that worked in Italy.

Based on previous geothermal exploration activities conducted by Italian organizations, the emphasis in their investigations tends to be different from the normal Los Alamos approach. This is frequently reflected in their reliance on mercury, radon, and gravity data with little emphasis being devoted to deep electrical geophysical techniques. The combination of these techniques and the Los Alamos proposed methodology will result in an enhanced reconnaissance effort, particularly in the central area of Honduras. Los Alamos will make every effort to work with the identified Italian organizations to eliminate unnecessary duplication and to maximize the benefits to Honduras through well integrated and coordinated field and laboratory investigations.

3) Coordination and Implementation Plan. The Nonconventional Energy Section of the IDB has identified the need for a national geothermal reconnaissance study in Honduras but no funds have been allocated for this project. At the OLADE sponsored "Latin American Seminar on Geothermal Exploration," the need for a geothermal prefeasibility study in Honduras was identified and a brief technical plan was outlined.

The work proposed by Los Alamos conforms to the guidelines established by OLADE for an effective reconnaissance methodology and would satisfy the need already identified by the IDB. Reconnaissance investigations in Honduras would complement the IDB geoscientific exploratory studies in the Zunil and Amatitlan geothermal fields in Guatemala, a project that has received loan approval from the IDB. With Honduran government approval and participation, Los Alamos would periodically review its technical findings in Honduras with the appropriate government and private sector organizations in Guatemala.

We will request assistance from AID mission personnel for visiting Los Alamos personnel in the establishment of contacts with appropriate Hondurans to support the necessary data collection efforts. It is assumed that AID introductions will give Los Alamos the authority to collect the necessary data and to discuss the geothermal reconnaissance effort with the appropriate government and private sector individuals. This assistance will be particularly significant during the initial visit with ENEE, the counterpart organization, and DGMH officials to obtain pertinent data from the exploratory oil wells and associated geophysical prospecting investigations. Los Alamos will seek the participation and cooperation of trained professionals from both ENEE and DGMH in the geothermal field reconnaissance and analysis and interpretation efforts. Los Alamos will work with AID, ENEE and DGMH to hire local Honduran guides, field assistants, and trained geologists to support the field geothermal reconnaissance efforts.

The geothermal reconnaissance of Honduras will be performed under the direction of Dr. R. J. Hanold. Project leaders will include Dr. G. H. Heiken (geology), Dr. F. E. Goff (geochemistry), and Dr M. E. Ander (geophysics). The project leaders will spend approximately half of their time on Central American field reconnaissance activities. The individuals named above were all principal participants in the St. Lucia geothermal resource evaluation.

Additional field and laboratory support will be provided by Dr. M. J. Aldrich (structural geologist), D. E. Broxton (geologist), Dr. C. L. Edwards (geophysicist), C. O. Grigsby (chemical engineer), Dr. A. W. Laughlin (geochemist/geologist), Dr. M. A. Mathews (geophysicist-well logging), P. E. Trujillo (chemist), Dr. D. T. Vaniman (petrologist), Dr. T. A. Weaver (geophysicist), and Dr. K. H. Wohletz (volcanologist). The above named scientists and engineers will dedicate their time as needed on Central American initiatives.

Chemical technician services will be directed by Dale A. Counce. Additional field support will be provided by visiting scientists and graduate students from both the United States and Central America. Candidates for these positions are currently being reviewed by the Los Alamos technical staff.

The project leader will establish a working relationship with the appropriate Honduran counterparts and will coordinate all data collection and field reconnaissance efforts. After the initial geological and geochemical reconnaissance efforts are completed, Los Alamos will request the participation of other national laboratories with established records of performance in geophysical surveys and geophysical data interpretation.

4) Status at End of Phase I. Upon termination of the Phase I efforts, the significant accomplishments listed below will be completed:

- A detailed compilation and evaluation of prior work in Honduras will be completed and published as a technical report. Pertinent data from existing oil wells will be included, as appropriate, for comparison with prior geological findings.

- A reconnaissance scale field investigation will be completed with emphasis concentrated in identified areas of potential geothermal interest. A technical report will be published that includes updated geologic maps, details of the lavas and pyroclastic rocks for identifying the nature of the heat sources, radiometric rock age dating results, and geologic cross-sections for the most promising geothermal areas.

- A comprehensive field sampling effort of the hot and cold springs and active fumaroles will be completed. A technical report will be published that includes major/trace element

chemistry, stable isotope data, tritium concentrations, gas compositions, CO_2 isotope data, geothermometer temperature data, localized structure/alteration maps, and hydrologic models of potential geothermal systems including estimated age and recharge characteristics of the systems.

- Based on detailed interpretations of the field and laboratory data, two or three areas in Honduras will be identified as the most promising sites for future geothermal developments.

- Shallow temperature gradient wells will be drilled at the most promising sites to obtain lithologic and geothermal gradient data.

- A geophysical testing program including audiomagnetotelluric (AMT) soundings and deep dc resistivity measurements will be initiated at the most promising geothermal development sites. A preliminary technical report will be published on initial geophysical results.

- Trained professionals from ENEE and DGMH will have participated in all field investigations and data interpretation activities. Periodic seminars will be presented at both organizations to describe the techniques, equipment, and evaluation procedures being implemented by the Los Alamos-Honduran team.

- Los Alamos will work with ENEE to ensure that Hondurans are hired for field support activities throughout the duration of this project component.

- A report will be published that includes specific recommendations for completing the prefeasibility study of geothermal resources in Honduras.

- Professionals from ENEE and DGMH will have received intensive field training in the latest volcanology, geology, geochemical and geophysical exploration techniques.

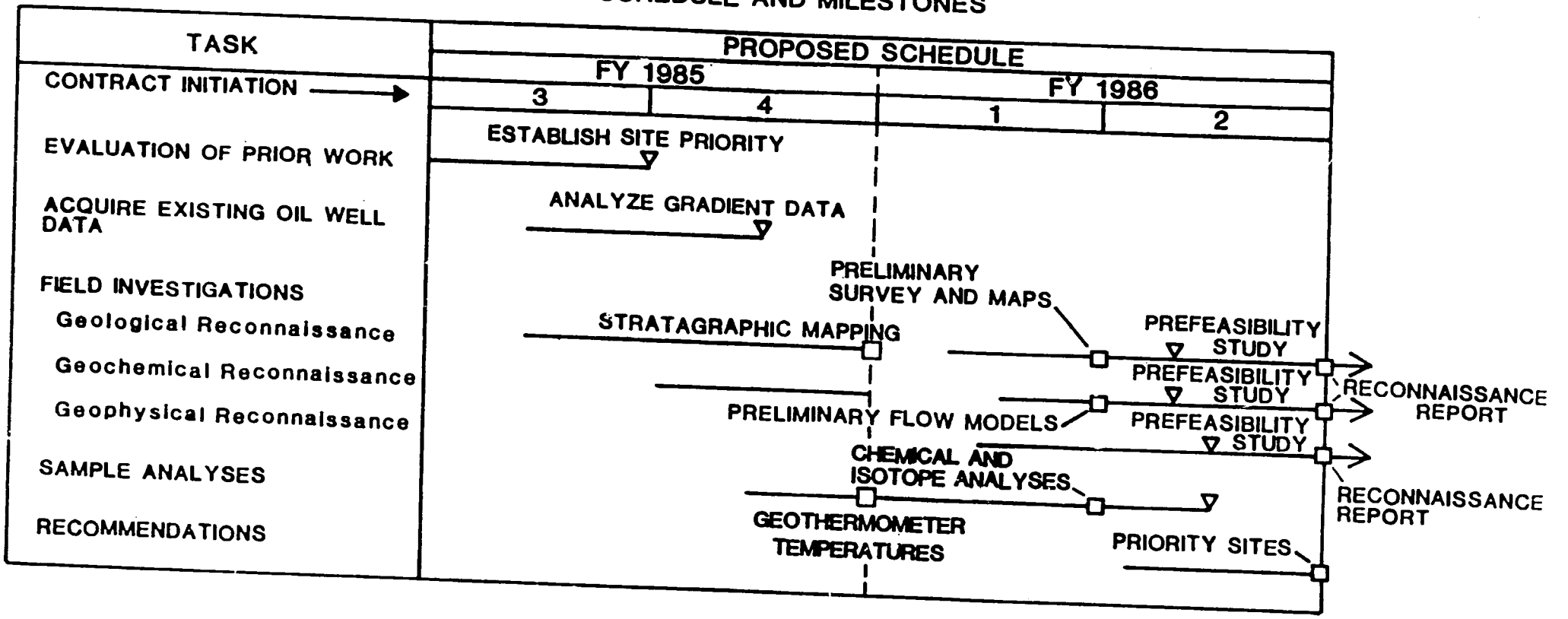
5. Estimated Honduras Geothermal Reconnaissance Project Component Budget

		$K
Projected Budget for Evaluation of Prior Work		
Geologist Base Salary (52K/FTE/Yr) 0.4 FTE	21	
Fringe @ 25% of base salary	5	
Burden @ 77% of base salary plus fringe	20	46
Travel		
Air fare (Albuquerque to Tegucigalpa for 2 people @ $1,000/trip)	2	
Per diem ($96/day for 11 person-days)	1.0	3
Satellite data image enhancement studies		15
Sample analyses		200
Projected Budget to Acquire Existing Oil Well Data and Analyse		
Geologist base salary (52K/FTE/Yr) .1 FTE	5.2	
Fringe @ 25% of base salary	1.3	
Burden @ 77% of base salary plus fringe	5.0	11.5
Projected Budget for Field Investigations		
Base salary for geologists, volcanologists, geochemists, hydrologists, geophysists and engineers (52K/FTE/Yr) 4.1 FTE	213.2	
Fringe @ 25% of base salary	53.3	
Burden @ 77% of base salary plus fringe	205.2	471.7
Base salary for chemical and electrical technicians (28K/FTE/Yr) 1.0 FTE	28	
Fringe @ 25% of base Salary	7	
Burden @ 77% of base salary plus fringe	27	62.0
Equipment rental and supplies for thermal gradient drilling		150.0
Travel		
Air fare (20 round trips Los Alamos to Tegucigalpa @ $1,000/trip)	20.0	
Per diem (357 person-days in field @ $45/night)	16.1	
(63 person-days in Tegucigalpa @ $96/night)	6.1	
Local supplies and miscellaneous	5.6	
Rentals	8.2	56.0
Shipping costs for samples and equipment		20.0
Support Equipment		700.0
Subtotal		1,735.2

6. Activity Schedule and Milestones. The activity schedule and project output milestones are graphically displayed on the following page.

HONDURAS GEOTHERMAL RECONNAISSANCE

ACTIVITY SCHEDULE AND MILESTONES



b. Miravalles Geothermal Development

1) Problem Statement. At the present time almost no high-temperature well logging capabilities exist in Central America. The magnitude of the downhole measurements problem was apparent during a visit by Los Alamos engineers to the Miravalles field. ICE has a very limited well logging system comprised primarily of a Kuster type temperature tool that is quite difficult to use. There is no surface readout and a short downhole lifetime requires many trips in the borehole to obtain one marginal log. A small logging rig equipped with a single conductor armored cable rated at 220° C temperature (temperature in the wells reach 240° C) was purchased in 1979. There are no downhole tools available to operate on this wireline. ICE needs additional instrumentation to properly evaluate the reservoir or the existing production wells.

Downhole logging tools can be effectively used to identify the horizons that are capable of producing geothermal brines, locate damaged zones in production wells, identify chemical scale formations in wellbores, improve the well designs and casing schedules, allow repairs to be made in marginal wells rather than drilling new replacement wells, and improve the well completion techniques to maximize the fluid production.

The work proposed by Los Alamos would allow each production well at Miravalles to be accurately logged to determine its production potential and the existence of any wellbore problems that could lead to future production declines. This information could have a profound impact on the overall economics of the power plant and could lead to improvements in the drilling strategy for the remainder of the production wells.

2) Project Description

a) Activities. A total of six wells have been drilled to date in the Miravalles geothermal field in Costa Rica. Most of these have been ranked as good production wells, with one producing well tested at 7 MW (thermal output). The first phase of this project included drilling six wells in the Miravalles field followed by a reservoir and well testing sequence to determine the potential for electric power generation from the produced hot brine. One of the major obstacles in evaluating this geothermal resource is the very limited capability to make the downhole measurements required to determine the reservoir and individual well characteristics.

The objective of this effort is to provide ICE with the capability for performing downhole diagnostic measurements in the geothermal wells at Miravalles. As addressed in section B1d) of this document, the long term solution to this instrumentation deficiency will be provided by the fully equipped logging truck that will be constructed and shipped to Costa Rica for dedicated use in Central America. During the time period when the logging truck is being constructed, however, ICE has a desperate need for downhole diagnostic information. This immediate need will be filled by equipment that Los Alamos will loan to ICE until the new logging truck is available for use.

b) Task Statement.

(1) Well Logging Rig and High-Temperature Cable. Los Alamos engineers and technicians will overhaul a surplus well logging rig that has recently become available. After overhaul and checkout, the unit will be shipped to Costa Rica for use at Miravalles. Los Alamos will equip the logging rig with at least 1500m of high-temperature armored 7-conductor geothermal logging cable suitable for use in the Miravalles wells. A Los Alamos designed high-temperature cablehead assembly for interfacing with the downhole tools will also be provided. This equipment will be made available to ICE until the completion of the new logging truck.

(2) High-Temperature Downhole Logging Tools. Consistent with the requirements imposed by other programmatic geothermal activities, Los Alamos will provide a selection of available high-temperature instrumentation packages for use in the Miravalles wells. These logging tools, developed by Los Alamos in cooperation with private sector organizations, represent a unique capability that cannot be supplied by commercial logging service companies. Los Alamos engineers will work with ICE representatives to define a Miravalles logging program. The following downhole logging tools could be made available to support this program:

- Temperature
- Pressure
- Casing Collar Locator
- Fluid Velocity Spinner
- Natural Gamma
- Multi-Arm Caliper
- Well Directional Survey Tool
- Fluid Sampler
- Spectral Gamma
- Density Neutron
- Sonic

This equipment will be made available to ICE until the new logging tools for Central America are completed.

(3) Training of Costa Rica Personnel. Los Alamos will provide on-site training to appropriate ICE personnel on the operation of the well logging rig, the operation of the downhole logging tools, and the interpretation of the data from the tools. Los Alamos engineers will be on-site during the initial logging runs into the Miravalles wells. Los Alamos engineers will also assist ICE in setting up a data acquisition system at Miravalles that can be used until the arrival of the new logging truck.

3) Coordination and Implementation Plan. ICE has been identified as the counterpart organization for the Miravalles well logging effort. During the initial logging of the Miravalles wells with the surplus Los Alamos logging rig, ICE engineers and technicians will be expected to operate the equipment under the supervision of on-site Los Alamos staff. Some peripheral equipment, such as a small well site crane or "A" frame structure will be required to support the logging cable sheave. Access to a small laboratory with basic mechanical tools and electrical test equipment will be desirable for assembling and testing the various downhole instrumentation packages before emplacement in the wells.

Assistance from ICE electrical engineers and technicians will be required to set up the data acquisition systems at Miravalles that can be used until the arrival of the new logging truck. ICE or the University of Costa Rica will also be expected to provide some of the equipment required for these temporary systems.

The IDB has been providing technical cooperation and loans to help Costa Rica determine the feasibility of constructing a geothermal power plant at Miravalles since 1975. The IDB expects to process a new loan to Costa Rica during 1985 to help finance the construction of a geothermal power plant at Miravalles plus the additional wells needed for its full power production. At the present time, these wells cannot be adequately logged because of the lack of high-temperature logging equipment in Central America.

The same scenario can be applied to the IDB supported efforts in Guatemala to develop the Zunil I and Zunil II geothermal fields and the proposed 15 MW power plant at Zunil I. Los Alamos would periodically review its technical findings in Costa Rica with the appropriate government and private sector organizations in Guatemala.

The provisions for a temporary well logging rig and high-temperature cable, provisions for temporary high-temperature downhole logging tools, and training of Costa Rican personnel in well logging operations will be performed under the direction of Dr. R. J. Hanold. He will dedicate ninety percent of his time to planning, training, participating in field activities, and meeting reporting requirements for the Central American initiatives.

Project leader for the logging, instrumentation, and training activities will be B. R. Dennis, electrical engineer and group leader of the earth sciences instrumentation group. Additional support will be provided by S. P. Koczan (mechanical engineer), G. A. Bennett (mechanical engineer), P. J. Chavez (mechanical technicial), L. D. Maes (electronics technician), P. R. Gutierrez (logging equipment operator), and Dr. M. A. Mathews (geophysicist-well logging). Detailed technical biographical data for these personnel are enclosed. Activities under this project will be performed entirely by Los Alamos staff.

4) Status at End of Phase I. Upon termination of the Phase I efforts, the significant accomplishments listed below will be completed:

- A surplus well logging rig will be overhauled, equipped with high-temperature armored 7-conductor geothermal logging cable suitable for use in the Miravalles wells, tested in a local geothermal well, and shipped to the Miravalles field in Costa Rica.

- Working with ICE scientists and engineers, a Miravalles well logging program will be developed.

- A selection of high-temperature geothermal well logging tools, consistent with the requirements of the Miravalles well logging program, will be tested and shipped to the Miravalles field in Costa Rica.

- Working with ICE and University of Costa Rica scientists and engineers, a data acquisition system will be fabricated and installed in a facility at the Miravalles geothermal field.

- A well logging program will be conducted in the Miravalles geothermal wells. It is anticipated that 3-4 wells will be logged and that a minimum of 6-8 different logs will be obtained for each well.

- ICE personnel will be trained in the operation of the logging rig, the operation of the downhole logging tools, and the interpretation of the data from the tools.

- The proposed well designs, casing schedules, completion techniques, and drilling fluid programs for future wells at Miravalles will be evaluated on the basis of the logging data obtained from the existing production wells.

5. Estimated Miravalles Geothermal Project Component Budget

Projected Budget for Well Logging Rig and High-Temperature Cable		$K
Base Salary for mechanical and electrical technicians (28K/FTE/Yr) 0.3 FTE	8.4	
Base salary for mechanical and electrical engineers (52K/FTE/Yr) 0.2 FTE	10.4	
Fringe @ 25% of base salary	4.7	
Burden @ 77% of base salary plus fringe	18.1	41.6
Shipping Cost to Costa Rica		5.0

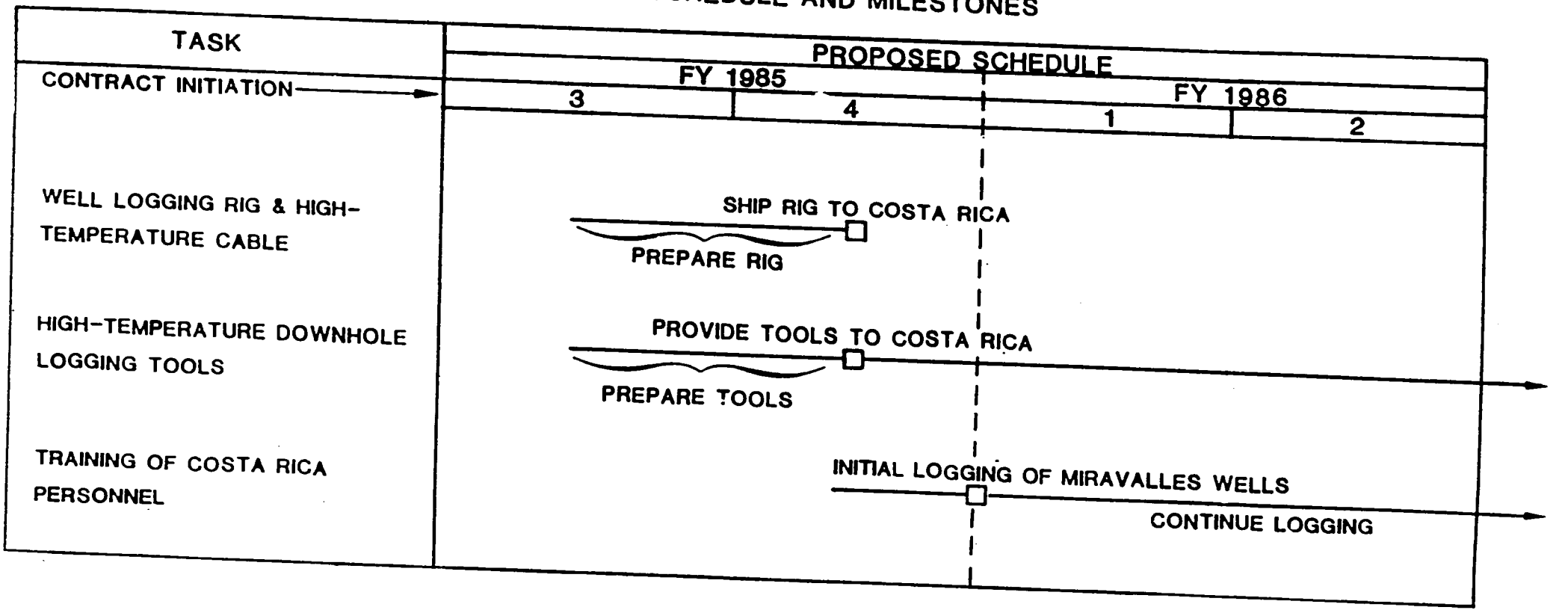
Projected Budget for High Temperature Downhole Logging Tools		
Base salary for mechanical and electrical technicians (28K/FTE/Yr) 0.4 FTE	11.2	
Base salary for mechanical and electrical engineers (52K/FTE/Yr) 0.2 FTE	10.4	
Fringe @ 25% of base salary	5.4	
Burden @ 77% of base salary plus fringe	20.8	47.8
Replacement electrical and mechanical components		30.0

Projected Budget for Training of Costa Rica Personnel		
Base salary for mechanical and electrical technicians (28K/FTE/Yr) 0.8 FTE	22.4	
Base salary for mechanical and electrical engineers (52K/FTE/Yr) 0.5 FTE	26.0	
Fringe @ 25% of base salary	12.1	
Burden @ 77% of base salary plus fringe	46.6	107.1
Laboratory analyses of well samples		12.0
Travel		
Air fare (12 round-trips, Los Alamos to San Jose @ 1150/trip)	13.8	
Per diem (168 person nights @ $70/night)	11.8	
Rental cars and local expense	4.4	30.0
Subtotal		273.5

6. Activity Schedule and Milestone. The activity schedule and project output milestones are graphically displayed on the following page.

MIRAVALLES GEOTHERMAL DEVELOPMENT

ACTIVITY SCHEDULE AND MILESTONES



c. Costa Rica Geothermal Reconnaissance

1) Problem Statement. A total of six geothermal production wells have been drilled in the Miravalles field in Costa Rica as part of a $100,000,000 project to develop a 55 MW power plant. The initial drilling success ratio has been very good, thereby supporting the premise that Miravalles has excellent potential for geothermal energy development. The selection of the Miravalles location for initial drilling operations in Costa Rica was based on a limited reconnaissance effort concentrated along the southwest flank of volcanic activity in the Province of Guanacaste.

With the exception of this region, available data on the geothermal resource potential of Costa Rica is very sparse. The proposed geothermal reconnaissance would provide the scientific data necessary to quantify the resource potential of Costa Rica and allow additional power plant developments to start paralleling the efforts at Miravalles. The work proposed by Los Alamos builds on previus work but provides a more integrated approach involving a broader area than has been conducted in the past. If Costa Rica is to maintain a role as an energy exporter, the country requires a knowledge of the extent of their geothermal resources that could be developed in the near future.

2) Project Component Description

a) Activities. The line of active and dormant volcanoes that form the Central Cordillera of Costa Rica is an obvious expression of the geothermal potential. The United Nations sent in a team of experts during 1963 who confirmed the presence of hydrothermal systems to be developed, but recommended concentrating on the large hydropower resources of the country. During the early 1970's, the Instituto Costarricense de Electricidad, (ICE), with financing from the Interamerican Development Bank, began development of the geothermal resource.

The principal exploration target was the Cordillera de Guanacaste, a line of volcanoes in the northwestern part of the country. Surface manifestations, such as hot springs and fumeroles are visible for 30 km along the flanks of the volcanic chain. Geological mapping, spring sampling and electrical surveys were used to identify several areas within this large field for thermal gradient drilling. A total of 35 boreholes, with an average depth of 70 m, were drilled. Within the Las Hornillas field an area of 10 km^2 was identified with gradients of more than $400^oC/km$. The deepest borehole, with a depth of 200 m, had a bottomhole temperature of 200^oC. Other areas of interest within the Cordillera de Guanacaste are Rincon de la Vieja, Las Pailas, and Borinquen. The work proposed by Los Alamos builds on previous work but provides a more integrated approach involving a broader area than has been conducted in the past. If Costa Rica is to maintain a role as an energy exporter, the country requires a knowledge of the extent of their geothermal resources that could be developed in the near future.

The primary objective is to perform a reconnaissance-scale geothermal energy exploration and to make specific recommendations for follow-up exploration activities to establish the commercial geothermal potential of Costa Rica. This effort would evaluate the hydrothermal system where drilling and development are currently in progress and, in addition, make a limited reconnaissance survey of high-grade volcanic geothermal systems in areas outside of the Cordillera de Guanacaste. Emphasis will be directed at geothermal reservoirs that exhibit the greatest potential for electric power generation based on estimates of flow permeability, fluid temperature, and reservoir magnitude.

Following the OLADE methodology, initial investigations will include an evaluation of prior work in Costa Rica, geology and volcanology field reconnaissance, stratigraphic mapping and analysis, fault mapping, geothermal fluid sampling, spring sampling, gas sampling, major and trace element analyses, stable isotope analyses, gas compositions, ^{13}C and ^{3}H analyses, K-Ar age dating, and reservoir temperature analysis from chemical geothermometers. In accord with the OLADE methodology,

geophysical field investigations will not be attempted before the analysis of the reconnaissance scale geology, volcanology, and geochemistry results.

b) Task Statement.

(1) Evaluation of Prior Work. After contract initiation, an evaluation of prior work in Costa Rica will be performed. Emphasis will be directed at the geology, volcanology, fault structures, rock age data, surface manifestations, geochemistry, geothermometer temperatures, hydrology, and electrical resistivity sounding data that are available in the literature. Much of the available information is limited to the specific region of Las Hornillas de Miravalles within the Cordillera de Guanacaste. Early in the program, a visit will be arranged with ICE officials to obtain the results from any additional geological, hydrogeochemical, and geophysical investigations that were performed in Costa Rica. Data from the gravity survey conducted in 1976 will also be obtained along with the temperature gradient data from the 35 shallow boreholes that were drilled. The earlier work by Rogers Engineering Company, Inc., Geotherm Ex, Inc., ICE, and the various United Nation's geothermal missions will form the backbone of this evaluation. A literature search will be conducted, however, to locate other appropriate technical references of importance to this evaluation. If satellite images of Costa Rica are available, the appropriate digitized data will be analyzed. These efforts will be completed before the field investigations.

(2) Field Investigations. The following approach will be used in this phase of the study:

Las Hornillas de Miravalles. Within the Las Hornillas geothermal area, emphasis will be directed at collecting data from the six production geothermal wells that have been drilled by ICE. Data from available well logs will be analyzed. The possibility of conducting additional high-temperature wellbore logging suites will be investigated with ICE officials. If cuttings and cores have been preserved from the

drilling operations, a petrologic investigation will be made and the results compared with the logs and stratigraphy of the area based on existing (or new) geologic maps.

Downhole logging data, surface data, and the results from geophysical surveys used for the identification of structural settings will be synthesized. A volcanological approach will be adopted to better identify the volcanic framework of the system and the extent of the subsurface aquifers. This approach is founded on the premise that the characteristics of pyroclastic rocks (volcanic ash deposits) associated with young volcanic fields can be used as indicators of the location and nature of geothermal resources. Initial investigations will be conducted that evaluate which of these characteristics can be used effectively by geologists from developing countries to evaluate geothermal fields and to identify potential drilling sites. Water and gas samples will be collected and analyzed for the purpose of establishing water movements, recharge characteristics, and geothermal temperatures. Collected data from all of the above sources will be used for initial reservoir modeling of the system.

Other Areas with Geothermal Potential Within the Cordillera de Guanacaste. Within each identified area, surveys will be performed that will include studies of tephra (as a means of evaluating reservoir rock units and identifying aquifers), volcanological mapping, and sampling of springs and fumeroles. The purpose of the work is to develop concepts concerning the volcanic framework for the hydrothermal systems and reservoir temperatures and compositions. Determining the extent of geothermal systems within calderas that have been mapped will be one of the primary goals of these surveys.

Geothermal Areas Outside the Cordillera de Guanacaste. Previous work on the volcanology and volcanic hazards of areas in Central and Southeastern Costa Rica will form an excellent baseline to work from on the potential geothermal resources. Published data will be evaluated and synthesized and the existence of additional information will be

investigated with sources in the Costa Rican geological community. A reconnaissance evaluation will be made at Arenal, Viejo, Barba, Irazu, Turrialba, and Poas volcanoes. (Fig. 2).

Within each identified area, surveys will be performed that will include studies of tephra, volcanological mapping, and sampling of springs and fumeroles. The purpose of the work will be to develop concepts concerning the volcanic framework for the hydrothermal systems and reservoir temperatures and compositions. Preliminary evaluations of the extent of geothermal systems will be made.

The overall success of this field investigation program could be significantly enhanced through collaboration with geologists and engineers associated with government agencies and the University of Costa Rica. Los Alamos can expose such personnel to new volcanological approaches to geothermal resource evaluation, geothermal well logging techniques, and state-of-the-art methods for analysis of fluids and gases from hydrothermal systems. In addition to field training and work experience, Los Alamos could provide specialized training sessions to local scientists and engineers in these new technology areas.

(3) Sample Analyses. The following analyses will be performed on samples obtained from Costa Rica:

- Chemical analyses (major and trace element) to permit geothermometer temperature calculations and to serve as a "benchmark" for comparison with existing data.

- Stable isotope analyses (^{2}H and ^{18}O) to look for oxygen shifts indicative of high-temperature conditions.

- Gas analyses to look for high-temperature gas equilibria.

- ^{13}C analyses on CO_2 in water samples to investigate magmatic or sedimentary origin.

ad p. 112

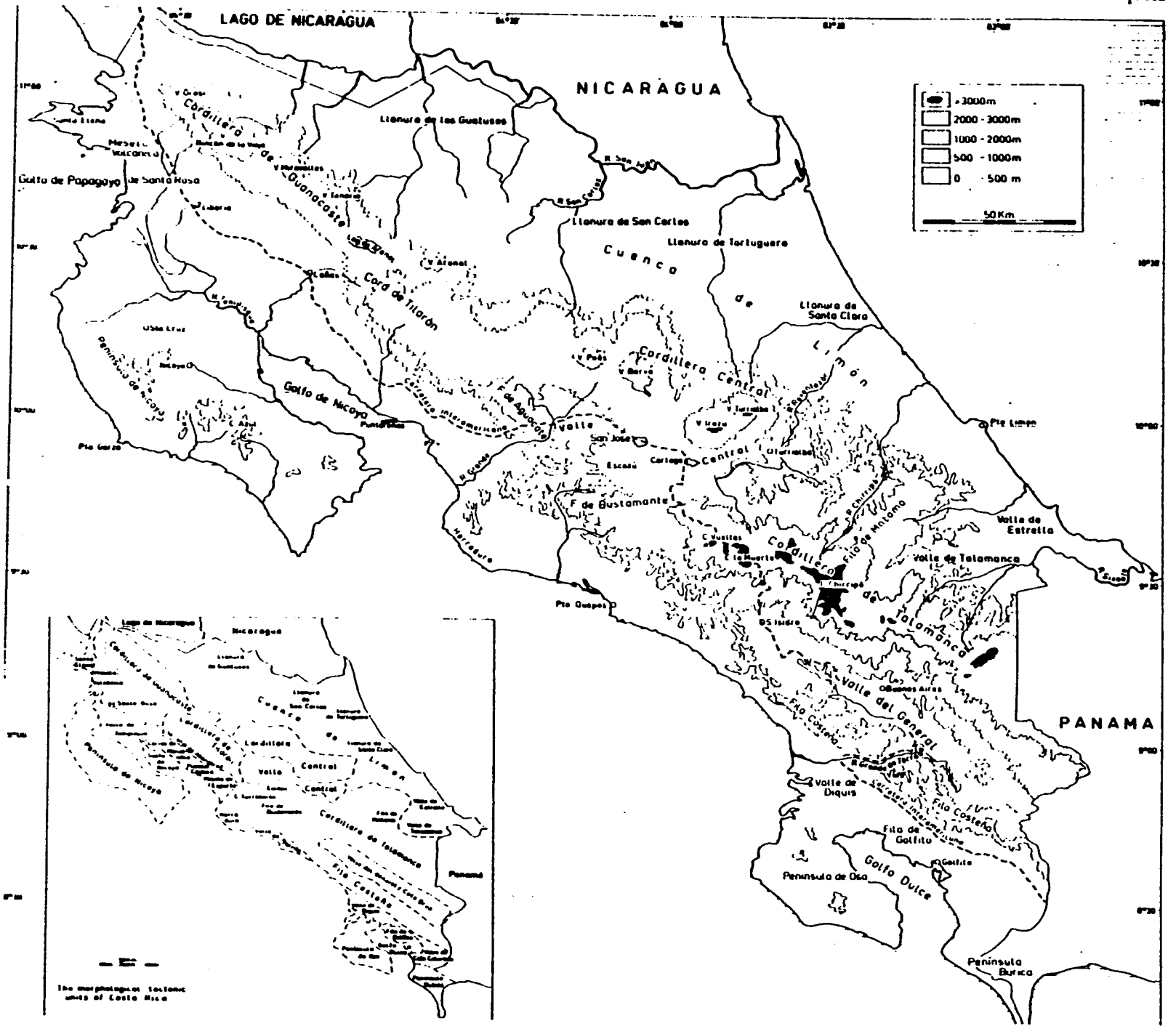


Fig.2 : Morphological map of Costa Rica.

- ^{3}H analyses (tritium) of water to investigate age and, therefore, possible depth of circulation of water.

- K-Ar dating of rock samples.

- Petrographic descriptions of lava and tephra.

3) Coordination and Implementation Plan

Los Alamos personnel will request the assistance of AID mission personnel to establish contacts with appropriate Costa Ricans for supporting the necessary data collection efforts. It is assumed that AID introductions will give Los Alamos the authority to collect the necessary data and to discuss the geothermal reconnaissance effort with the appropriate government and private sector individuals. This assistance will be particularly significant during the initial visits with ICE and University of Costa Rica officials to obtain pertinent data from the deep geothermal production wells, the shallow thermal gradient boreholes, the gravity survey, and any additional geological, hydrogeochemical and geophysical investigations that were performed in Costa Rica.

ICE has been identified as the counterpart organization. Los Alamos will seek the full participation and cooperation of trained professionals from ICE and other Costa Rican organizations. ICE and Los Alamos will work together to ensure that Costa Rican guides, field assistants, and trained geologists are hired to support the field geothermal reconnaissance efforts.

The IDB has been providing technical cooperation and loans to help Costa Rica determine the feasibility of constructing a geothermal power plant at Miravalles since 1975. The IDB expects to process a new loan to Costa Rica during 1985 to help finance the construction of a geothermal power plant at Miravalles plus the additional wells needed for its full power production.

The work proposed by Los Alamos conforms to the guidelines established by OLADE for an effective reconnaisance and prefeasibility methodology and would expand the IDB sponsored initiatives at Miravalles into a more country-wide reconnaissance effort. IDB has indicated to Los Alamos that they support such a reconnaissance project to determine the geothermal energy potential of other areas within Costa Rica. The proposed investigation in Costa Rica would complement the IDB studies by providing additional structural, volcanological, hydrogeochemical, and geophysical interpretations of the geothermal systems within the country. This additional data should help in the modeling and interpretation of the Miravalles reservoir.

With funding from the United Nations' Development Program, the Government of Italy, and the Govenment of Costa Rica, the Italians have proposed a geothermal study of Costa Rica although work on the project has not been initiated. If this effort materializes, Los Alamos will make every effort to work with the identified Italian organizations to eliminate unnecessary duplication and to maximize the benefits to Costa Rica through well integrated and coordinated field and laboratory investigations.

The geothermal reconnaissance of Costa Rica will be performed under the direction of Dr. R. J. Hanold. He will dedicate ninety percent of his time to planning, training, participating in field activities, and meeting reporting requirements for the Central American initiatives. Project leaders will include Dr. G. H. Heiken (geology), Dr. F. E. Goff (geochemistry), and Dr. M. E. Ander (geophysics). The project leaders will spend approximately half of their time on Central American field reconnaissance activities. The individuals named above were all principle participants in the St. Lucia geothermal resource evaluation study.

Additional field and laboratory support will be provided by Dr. M. J. Aldrich (structural geologist), D. E. Broxton (geologist), Dr. C. L. Edwards (geophisicist), C. O. Grigsby (chemical engineer), Dr. A. W. Laughlin (geochemist/geologist), Dr. M. A. Mathews (geophisicist-well

logging), P. E. Trujillo (chemist), Dr. D. T. Vaniman (petrologist), Dr. T. A. Weaver (geophysicist), and Dr. K. H. Wohletz (volcanologist). The above named scientists and engineers will dedicate their time as needed on Central American initiatives.

Chemical technician services will be directed by Dale A. Counce. Additional field support will be provided by visiting scientists and graduate students from both the United States and Costa Rica. Candidates for these positions are currently being reviewed by the Los Alamos technical staff.

The project leader will establish a working relationship with the appropriate Costa Rican counterparts and will coordinate all data collection and field reconnaissance efforts. After the initial geological and geochemical reconnaissance efforts are completed, other national laboratories will be asked to participate in the geophysical reconnaissance and Miravalles geothermal reservoir modeling investigations.

4) Status at End of Phase I

Upon termination of the Phase I efforts, the significant accomplishments listed below will be completed:

- A compilation and evaluation of prior work in Costa Rica will be completed and published as a technical report.

- A limited reconnaissance scale field investigation will be completed with emphasis concentrated within the Cordillera de Guanacaste. A technical report will be published that includes map improvements based on stratigraphic analysis,

characteristics of pyroclastic rocks associated with young volcanic fields, radiometric rock age dating results, and preliminary geologic cross-sections for the most promising geothermal areas.

- A limited field sampling effort of the hot and cold springs and active fumaroles will be completed. A technical report will be published that includes major/trace element chemistry, stable isotope data, tritium concentrations, gas compositions, CO_2 isotope data, geothermometer temperature data, and preliminary hydrologic models of potential geothermal systems including estimated age and recharge characteristics of the systems. Results will be primarily limited to areas within the Cordillera de Guanacaste.

- Trained professionals from ICE will have participated in joint Los Alamos/ICE field investigations and in the data interpretation activities. Periodic seminars will be presented by professionals of both organizations at ICE to describe the techniques and evaluation procedures being implemented.

- As a training vehicle, Costa Ricans will be involved in field support activities throughout the duration of this project component.

- An informal report will be drafted that includes recommendations for completing the reconnaissance and initiating the prefeasibility study of geothermal resources in Costa Rica.

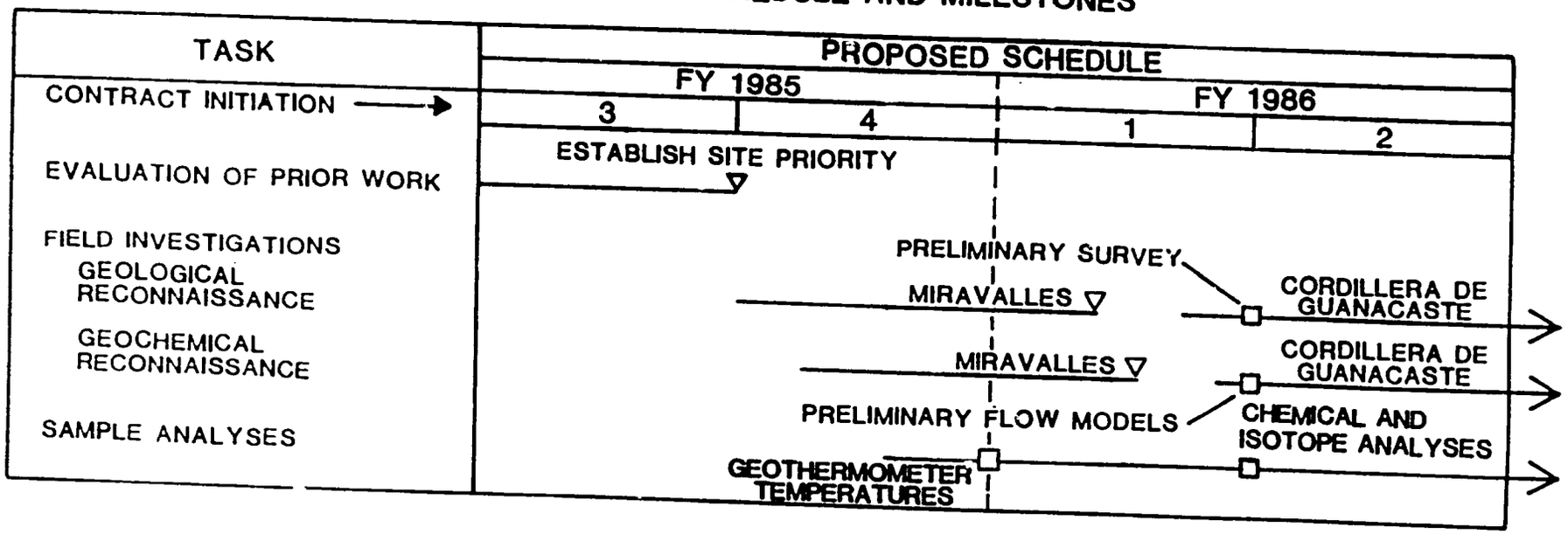
5. Estimated Costa Rica Geothermal Reconnaissance Project Component

		$K
Projected Budget for Evaluation of Prior Work		
Base salary for geologists, volcanologists, geochemists and geophysicists (52K/FTE/Yr) .2 FTE	10.4	
Fringe @ 25% of base salary	2.6	
Burden @ 77% of base salary plus fringe	10.0	23.0
Travel		
Air fare from Albuquerque to San Jose, CR (2 round trips @ $1150/trip)	2.3	
Per diem (10 person-nights @ $70/night)	.7	3.0
Satellite date, image enhancement studies		5.0
Projected Budget for Field Investigations		
Base salary for geologists, volcanologists, and geochemists ($52K/FTE/Yr) .4 FTE	20.8	
Base salary for chemical technicians (28K/FTE/Yr) .1	2.8	
Fringe @ 25% of base salary	5.9	
Burden @ 77% of fringe plus base salary	22.7	52.2
Local labor (guides and field assistants)		7.0
Travel		
Air fare (5 round trips, Los Alamos to San Jose, CR @ $1150/trip)	5.7	
Per diem (105 person-day @ $70/night)	7.3	
Rental cars	2.2	15.0
Expendable field supplies and shipping costs for samples and equipment		5.0
Projected Budget for Sample Analyses		
Base salary for geochemist (52K/FTE/Yr) .1 FTE	5.2	
Base salary for chemical technician (28K/FTE/Yr) .1 FTE	2.8	
Fringe @ 25% of base salary	2.0	
Burden @ 77% of base salary and fringe	7.7	17.7
Radiometric analyses of rocks		8
Petrologic analyses		5
Major/minor chemical analyses		5
Gas analyses		2
Tritium analyses		3
Stable isotope analyses		2
^{13}C analyses		2
X-ray diffraction analyses		2
Subtotal		156.9

6) Activity Schedule and Milestones. The activity schedule and project output milestones are graphically displayed on the following page.

COSTA RICA GEOTHERMAL RECONNAISSANCE

ACTIVITY SCHEDULE AND MILESTONES



d. Support Equipment for Central America

1) Problem Statement. Geothermal exploration and production activities are escalating at a rapid rate in Central America with: operating geothermal power plants in El Salvador and Nicaragua; production well drilling activities in Costa Rica, El Salvador and Guatemala; and reconnaissance exploration investigations in Costa Rica, El Salvador, Guatemala. Honduras, and Panama. An urgent need currently exists for scientific equipment and instrumentation to support these efforts. Since the early days of petroleum production it is a proven fact that the use of modern geophysical exploration equipment and sophisticated downhole logging tools can substantially reduce the cost and increase the production from oil fields. This lesson is being proven again for the development of geothermal fields.

Very little geophysical equipment and almost no high-temperature logging capabilities currently exist in Central America. This equipment can be effectively used to locate geothermal reservoirs, identify the horizons that are capable of producing geothermal brines, locate damaged zones in production wells, identify chemical scale formations in wellbores, improve the well designs and casing schedules, allow repairs to be made in marginal wells rather than drilling new replacement wells, and improve the well completion techniques to maximize the fluid production. With projected geothermal expenditures of tens of millions of dollars per year in Central America, use of such equipment on a routine basis could have an enormous impact on the development and production costs associated with geothermal energy. Lack of access to this sophisticated equipment in Central America is the problem being addressed.

2) Project Component Description

a) Activities. In order to support the geothermal development activities in Central America, specialized technical equipment is required that is not available within the region. Although such equipment does exist in the United States, its availability is extremely limited because of dedicated programmatic commitments. To ensure the suc-

cess of the proposed geothermal development activities, it is essential that certain equipment items be available on demand for use in Central America. Based on numerous visits and contacts with Central American geothermal experts, Los Alamos has identified the most urgent equipment needs of the region. The following items are the highest priority needs:

(1) Self-contained modern logging truck equipped with a high-temperature 7-conductor geothermal logging cable.

(2) High-temperature downhole logging tools capable of operating at 275°C in a geothermal well.

(3) High-current, high-voltage dc resistivity transmitter and power supply for conducting deep resistivity profile experiments.

(4) A portable audiomagnetotelluric (AMT) system for conducting deep geophysical soundings.

The objective of this activity is to provide the above referenced equipment items for dedicated use in the geothermal fields of Central America.

b) Task Statement

(1) Self-Contained Logging Truck. To support high-temperature logging operations in geothermal wells in the United States, Los Alamos acquired two unique logging trucks. These diesel powered units are equipped with hydraulically controlled winches, high-temperature geothermal service instrument cables, automatic data acquisition systems, and self-contained electrical power plants. Although patterned after conventional logging trucks, these units were specifically designed for geothermal well service.

Los Alamos engineers and scientists will develop the technical specifications, prepare the bid packages, oversee the vendor procurement

and construction activities, and take delivery of a similar logging truck for use in Central America. Los Alamos will complete the post-delivery checkout of all systems and ship the completed unit to Costa Rica for operational testing in a well at Miravalles. The logging truck will be fabricated by private sector vendors and installed electronics and data acquisition systems will be purchased from private sector suppliers.

Although the logging truck will be initially stationed at Miravalles, a need currently exists for such a unit in both El Salvador and Guatemala. Based on a recent visit to El Salvador by R. J. Hanold, CEL is interested in logging existing wells in Ahuachapan to investigate the declining reservoir pressure and well production and to assist in the development of a brine reinjection program. Additional logging will also be desired to support the proposed drilling program in the Chipilapa geothermal field located adjacent to Ahuachapan. Extensive logging operations would also be very desirable in Guatemala to support the development of Zunil I and Zunil II for electric power production. This applies to both the existing wells and the new wells to be drilled for the 15 MW power plant.

As geothermal developments continue to expand in Central America, it is anticipated that additional logging operations will be required in both Honduras and Panama along with the continuing existing needs in Costa Rica. The magnitude of these operations will justify the need for a dedicated Central American geothermal logging truck.

One of the most important singular advantages of the proposed logging truck is that it is a totally self-contained unit including its own logging cable, winch, power supply, and data acquisition systems. This allows the unit to operate at essentially any geothermal field without the need for appreciable supporting equipment to be provided by the host country. In addition to assuring the uniformity of data and its rapid computer processing, the logging truck eliminates the need of each host country having to purchase the support equipment that would be required at the well site if a more primitive logging rig were provided. With an

anticipated test program that will involve up to five countries, these support equipment savings alone will justify the purchase of the logging truck.

It is the recommendation of Los Alamos that ownership of the logging truck be retained by AID but assigned to Central America with legal responsibilities residing with an organization such as ICAITI. Under specific project financing, such as Miravalles geothermal development in the current proposal, Los Alamos engineers and technicians will train their host-country counterparts in both the operation and maintenance of the logging truck. Los Alamos will also conduct a centralized training session in Central America on the operation and maintenance of the logging truck, with representatives from all interested countries being invited. Past experience by Los Alamos indicates that the majority of required maintenance and service on the vehicle is routine and can be performed by the host country without difficulty. Los Alamos staff will be available to respond to problems with either the truck or the data acquisition systems that may require specific technicians or parts from the United States. In addition, Los Alamos will provide the truck with an assortment of the most frequently required spare parts, a detailed operating handbook and maintenance manual, and the operating and service instructions for the onboard equipment.

(2) High-Temperature Downhole Logging Tools. Los Alamos has been actively involved in the development and field testing of high-temperature downhole tools for over a decade. In cooperation with industry, this effort has resulted in a suite of downhole logging tools that have been successfully tested at temperatures in the range of 275 - 300°C in geothermal wells. These tools are not available commercially and they represent a unique capability that cannot be duplicated by any well service company.

Los Alamos engineers will develop the technical specifications, based on the existing successful designs, for five different downhole instrument sondes for geothermal well logging. Competitive bids will be solicited from industrial organizations for the fabrication of these

specialized instrument sondes. Based on past experience, it is anticipated that the most competitive bid package will result from a combination of private sector procurements and some unique Los Alamos fabrication activities.

(3) DC Resistivity System. Electrical resistivity testing is a geophysical technique permitting the determination of the distribution of earth resistivities as a function of depth. Direct current (dc) electrical resistivity methods have been employed for geothermal exploration in many countries and have proved to be an invaluable adjunct to the drilling of shallow or deep holes. Numerous case studies indicate that high-quality (200°C) liquid-dominated geothermal reservoirs are characterized by a resistivity of less than 10 ohm-m. This fact prevails regardless of the resistivity of the host rock, which may be many orders of magnitude higher in resistivity than that of the high-quality reservoir. Field data from drilled geothermal fields show remarkable correlations between the resistivity anomaly and the occurrence of an economically viable hydrothermal reservoir.

This transmitting system will be built to handle high current output, up to 70 amps peak-to-peak, over a single dipole or to automatically alternate high-current output over two separate dipoles. This capability permits the transmitter to be easily used in a wide variety of dc resistivity methods requiring both single and multiple current electrodes. The dc transmitter is powered by a trailer-mounted 60-kW diesel generator. The generator output is 480 V, 60 Hz, three phase.

Each of the four portable voltage measuring units consists of a voltage strip chart recorder and a dc voltage bucking box. The strip chart recorder and bucking box are shock mounted in a small portable aluminum transportainer. They are designed to apply a dc offset voltage to the incoming signal before it is plotted on the strip chart recorder. This is necessary to keep the measurements on scale because the currents produced by the dc transmitter (signal) are superimposed on natural earth currents (noise) known as telluric currents, which rapidly fluctuate in magnitude. The receiver system is powered by an internal

rechargeable Ni-Cd battery, which gives approximately ten hours of continuous use on a single charge.

Los Alamos scientists and engineers will develop the technical specifications, based on the existing successful design, for the fabrication of a high-current, high-voltage dc resistivity transmitter, power supply, portable voltage measuring units, and associated cables and accessories. Subcontractors will be selected to fabricate the necessary hardware items with delivery to Los Alamos. Los Alamos will complete the checkout of all systems and components and ship the completed unit to Honduras for operational testing as a part of the geothermal reconnaissance investigation of Honduras.

(4) Audiomagnetotelluric (AMT) System. Developed in the 1950s, AMT is an extension of magnetotellurics (MT) that measures the variations in local electric and magnetic fields in the frequency range 10 to 10,000 Hz. AMT data can be used to make near-surface (1 to 2000-m depth) resistivity measurements that can in turn be used to infer local structure and geologic layering. This technique has proven to be very useful in the exploration of geothermal reservoirs, particularly where rapid coverage of numerous potentially interesting areas is required. Unlike the dc resistivity system, an AMT system is relatively portable and does not require either a high-capacity power source or the emplacement of very long cable arrays.

The backpack-portable, full-tensor, audiomagnetotelluric (AMT) system developed by Los Alamos consists of two 20-kg backpacks that contain power, microprocessors, printer, keyboard, and all sensors (for both electric and magnetic field measurements). These backpack units are used to acquire several stations per day of AMT data on magnetic tape cartridges. The system also includes a separate micro VAX computer and software for data processing at a base station. Under ideal conditions, data can be collected from three to five ground stations per hour.

After successful testing of this existing prototype unit is completed, Los Alamos would fabricate a second unit dedicated to field

operations in Central America. This unit would be initially deployed to Honduras for operational testing as a part of the geothermal reconnaissance investigation of Honduras.

3) Coordination and Implementation Plan

The fabrication of well logging tools and geophysical prospecting equipment for dedicated use in Central America is designed to assist all reconnaissance, prefeasibility, and feasibility geothermal studies in the region irrespective of their sponsor. This equipment could advantageously be used in Costa Rica, Honduras, Guatemala, El Salvador, and Panama to obtain desperately needed well data and/or enhanced geophysical exploration studies.

Use of this equipment could provide valuable information to IDB projects in Costa Rica, Guatemala, and Panama along with possible future IDB projects in El Salvador, and Honduras. OLADE officials have expressed a desire to have this equipment available to support their geothermal projects in the region, particularly in Costa Rica and El Salvador. The importance of the data that could be provided will steadily increase as electric power generation from geothermal plants comes closer to reality in Costa Rica and Guatemala.

ICAITI is proposed as the counterpart organization for this effort. Under contract to Los Alamos, ICAITI will assume the responsibility for transporting the subject equipment to the appropriate geothermal fields. Prior to forwarding any of this equipment to Central America, Los Alamos and ICAITI will develop management plans for utilization of the equipment in the region. This plan will address questions of scheduling intercountry shipment, repair and maintenance and final ownership. Working with Los Alamos and representatives from the involved countries, ICAITI will also determine the scheduling of the equipment to the various geothermal areas and will assist in coordinating the particpants for the Los Alamos-conducted training and maintenance seminars.

The design and construction of the support equipment for Central America will be performed under the direction of Dr. R. J. Hanold. Project leaders will include B. R. Dennis (logging equipment fabrication) and Dr. M. E. Ander (geophysical equipment fabrication). Because most of the required equipment will be fabricated by private sector suppliers, only a small portion of the project leaders' time will be dedicated to this effort. The selection of private sector suppliers will be based on previous procurement experience and solicited cost proposals for the required equipment.

Additional design and fabrication support will be provided by S. P. Koczan (mechanical engineer) and G. A. Bennett (mechanical engineer). Electronics technician services will be directed by L. D. Maes and mechanical technician services will be directed by P. J. Chavez. The above named engineers and technicians will dedicate approximately twenty percent of their time to this effort. Detailed technical biographical data for these personnel are enclosed.

4) Status at End of Phase I

Upon termination of the Phase I efforts, the significant accomplishments listed below will be completed:

- Technical specifications for a state-of-the-art geothermal logging truck will be developed, procurement contracts will be awarded, and the basic logging truck will be fabricated and delivered to Los Alamos.

- Required data acquisition equipment will be ordered, delivered to Los Alamos, and installed in the logging truck.

- The high-temperature 7-conductor logging cable will be ordered, delivered to Los Alamos, fitted with a high-temperature cable head, and installed on the logging truck cable drum.

- Los Alamos engineers will perform a thorough check-out of all logging truck systems, electronic components, and the high-temperature cable using a local geothermal well. Any noted deficiencies will be corrected and the required logging accessories, miscellaneous equipment, and spare parts will be packed in the logging truck.

- A detailed operating handbook will be prepared for the operation and scheduled maintenance of the logging truck.

- The logging truck and associated equipment will be shipped to Central America.

- Technical specifications for the downhole logging tools will be developed, procurement contracts will be awarded, and the tools will be fabricated and delivered to Los Alamos.

- Los Alamos engineers will perform a thorough check-out of all downhole tools, correct any noted deficiencies, prepare operating instructions for their use, and ship the tools and spare components to Central America.

- Technical specifications for the dc resistivity system will be developed, procurement contracts will be awarded, and the system will be fabricated and delivered to Los Alamos.

- Los Alamos geophysicists and engineers will perform a thorough check-out of system performance, correct any noted deficiencies, prepare an operating handbook for its use, and ship the system to Central America.

- Technical specifications for the audiomagnetotelluric (AMT) system will be developed, procurement contracts will be awarded, and the system will be fabricated and delivered to Los Alamos.

- Los Alamos geophysicists and engineers will perform a thorough check-out of system performance, correct any noted deficiencies, prepare an operating handbook for its use, and ship the system to Central America.

5) Project Component Budget

	$K
(1) Self-Contained Logging Truck	135
Diesel-powered logging truck including hydraulic draw works, insulated operators compartment, heavy duty air conditioner with dehumidifier, dual diesel 4 kW electric generator sets, hydraulic cable weight indicator, footage counter, cable oiler, draw works lubrication system, spare tires and tool storage areas	
Data acquisition equipment including 640 k RAM memory computer, dual disc drives, frequency counter, digital voltmeter, printer/plotter, data acquisition controller, dc power supply, oscilloscope, dc differential ammeter, signal conditioner, ac power regulator, patch panels, racks, cabling, and calibration equipment	75
Logging accessories including scheeves for cable, cable wipers, cable packoff, load cell, slings, make-up tools, and portable tool assembly bench	30
Miscellaneous equipment and spares including krytox oil, motor oil, hydraulic fluid, oil filters, air filters, O rings, thermistors, high-temperature connectors, dc motors, hydraulic pump, etc.	27
High-temperature armored 7-conductor logging cable with TFE insulation and galvanized steel armor package - 10,000 feet	50
High-temperature cable heads for interfacing logging tools with 7-conductor cable (3 heads of current Los Alamos design)	18

Operating handbook and service instructions for logging truck	5
Shipping cost to Central America	10
	350

(2) High-Temperature Downhole Logging Tools:

Temperature Probe/Casing Collar Locator (2 each)	9
Fluid Velocity/Temperature Probe (2 each)	22
Natural Gamma Detector (1 with spare electronics)	32
Multi-Arm Caliper Tool (1 each)	47
Pressure and Temperature Probe (2 each)	36
Spare Components	4
	150

(3) dc Resistivity System 100

Cost estimate is based on fabrication of a similar system for Los Alamos and includes shipping cost to Central America

(4) Audiomagnetotelluric (AMT) System 100

Cost estimate is based on fabrication of a similar system for Los Alamos and includes shipping cost to Central America

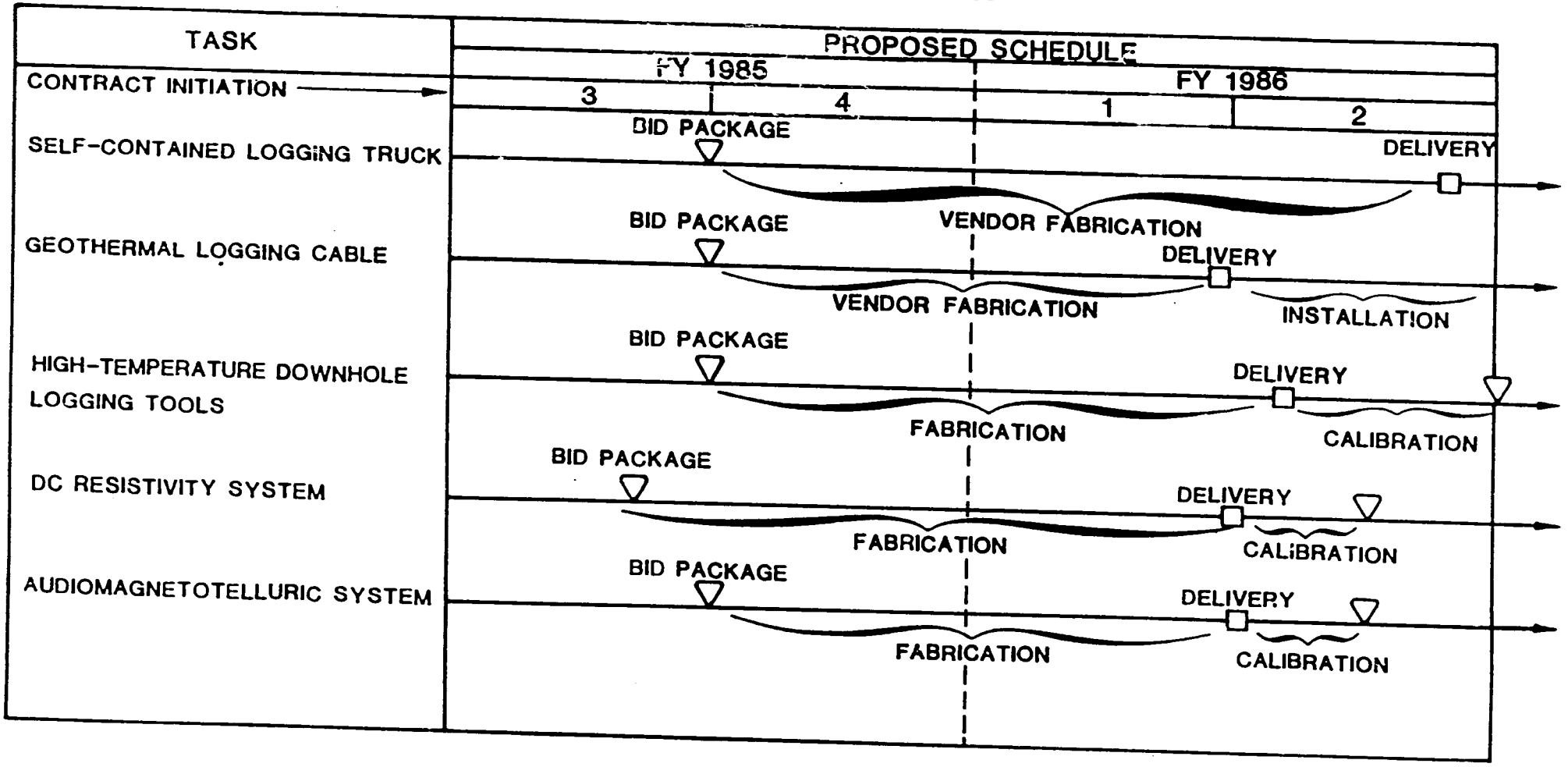
TOTAL	700

6) Activity Schedule and Milestones

The activity schedule and project output milestones are graphically displayed on the following page.

SUPPORT EQUIPMENT FOR CENTRAL AMERICA

ACTIVITY SCHEDULE AND MILESTONES



e. Direct Heat Applications In Central America

1) Problem Statement. Central America has a balance of payment and deforestation problem that could be partially alleviated if some direct heat requirements are met by geothermal energy rather than imported oil and fuelwood.

By 1980, more than 7000 MWt of heat from geothermal sources were in use worldwide. Of this total, 17% was used for space heating and cooling, 80% was used in agriculture and aquaculture, and the remainder in industrial applications (Geothermal Resources Council, 1979). Many possible applications of process heat and steam from geothermal reservoirs exist for Central America. They include: small electric generating facilities, space cooling and water heating for residential and commercial use around more developed areas such as cities and tourist areas; low- and medium-temperature refrigeration; the drying of crops, fish, lumber, and other products such as concrete; food canning; and evaporation in sugar refining. These and other possible uses will be examined in more detail and matched with existing resources and markets for Central America to determine the role that direct heat applications can play in the region.

2) Project Component Description

a) Activities. The first objective of this effort is to identify, assess, and recommend agricultural (particularly isolated rural agricultural), industrial, or commercial applications for low- or medium-temperature process heat or steam from known geothermal reservoirs in Central America. The applications will be selected to further development and/or decrease dependence on imported fuel. The second objective is to promote the development of the most promising applications. This effort is designed to complement other activities being conducted in the region, especially the geothermal resource assessments being conducted in Costa Rica and Honduras, but also the energy situation analysis that requires data on energy use. The energy situation analysis will, in turn, aid in assessing the role of direct heat from geothermal.

b) Task Statement.

(1) Survey of Existing Process Heat Requirements. A senior engineer affiliated with Los Alamos will collaborate with a consulting firm or university to conduct a survey of process heat use in existing industries in Guatemala and Costa Rica. The location, amount of heat, temperature requirements, and power-to-heat ratios will be collected for the major operations. Data on the location and characteristics of the geothermal resources will also be compiled. The two countries have been chosen because: (1) the demonstration of the most promising application chosen in Subtask (3) is expected to take place in Guatemala, but a survey of the more developed country of Costa Rica will aid in identifying uses that are appropriate throughout the region; and (2) both countries contain known geothermal reservoirs that have been drilled, and should be able to benefit from the use of geothermal process heat without incurring additional substantial drilling costs. A study on energy conservation in industry currently funded by AID may provide useful results for our survey. When the data from the survey have been assimilated, we will identify existing industries, based on their heat requirements and proximity to geothermal resources, that could benefit from near-term conversion to a geothermal heat source, with special attention to possible applications to benefit the agroindustry. The schedule is also designed to provide data for the energy situation analysis. The report summarizing the results of the survey should be completed within four months of receipt of funding.

(2) Identification of the Most Promising Applications Of Geothermal Heat Use. In addition to our consideration of existing industries, we will identify the potential of direct heat use and/or cogeneration from geothermal resources in new industries in Central America. For example, a potentially feasible application that could benefit the region is dry ice production using carbon dioxide recovered from the noncondensible geothermal gases. In the production process the carbon dioxide could be pressurized by compressors driven by geothermal steam. The dry ice could be used for freezing food for export or domestic marketing. After several applications of direct heat use and/or

cogeneration have been identified for existing and new industries, we will hold a technical exchange meeting in Guatemala for participants from all countries of the region to ascertain which applications are most favored for the region in general. Based upon the input from this meeting, we will recommend a few that are deemed most promising for demonstration in Guatemala. Consideration of the resource base, technologic capability, and market for new products in the Central American countries will be considered in our recommendations. It is expected that geothermal process heat applications to agroindustry will have high priority.

(3) Feasibility Studies of Selected Applications and Regional Workshops. With AID's concurrence, we will select a few applications for detailed prefeasibility studies. For these applications, a more site-specific study of the engineering and economic feasibility will be performed for Guatemala and two will be selected for detailed feasibility study, plant design and demonstration. It may be possible to implement the demonstration project at Amatitlan, a geothermal area to the southwest of Guatemala City, to take advantage of existing wells.

Concurrent with the feasibility studies, we will organize a workshop to be held in Central America on the application of geothermal resources to supply process heat with or without electricity in Central America. The purpose of the workshop is to present the results of the feasibility studies and to generate more interest among governments and industries in Central America in the economic potential of geothermal heat use. International authorities on the subject will be invited to present papers and paper submission by scientists and engineers from the region will be especially encouraged. The workshop will be held in the second year of our reseach effort and it could be timed to coincide with the conference described under the energy situation analysis.

3) Coordination and Implementation Plan. This work will be closely coordinated qrne TOWz who is funding geothermal resource development in Costa Rica and Guatemala, but the demonstration will be planned for an area where it would not interfere with development of electricity generating facilities.

This project will be managed by a senior engineer at Los Alamos with knowledge of process heat applications from geothermal energy, either John Altseimer or Frederick Edeskuty. It will be the main task for John Altseimer and Frederick Edeskuty or equivalently trained personnel, as well as another Los Alamos engineer assisted by members of the private sector and universities. We plan to conduct our analysis jointly with the Guatemalan Ministry of Energy and Mines and ICAITI. Our primary contact at the Ministry will be Leonel Lopez Rodas, Director General of New and Renewable Resources, and, at ICAITI, Ludwig Ingram, Deputy Director. Engineers from the Ministry of Energy and Mines will be trained to evaluate projects and make technology comparisons. Members of the private sector and universities will be acquainted with direct heat applications through technical exchange meetings and workshops.

4) Status at End of Phase 1

- o Survey of direct heat requirements completed.
- o Counterparts established and trained in the appropriate methodologies.
- o Direct heat applications surveyed and most promising selected.
- o Technical exchange meeting held to disseminate information about direct heat applications and to solicit comments from the private sector.
- o Two most promising applications selected and feasibility studies completed.

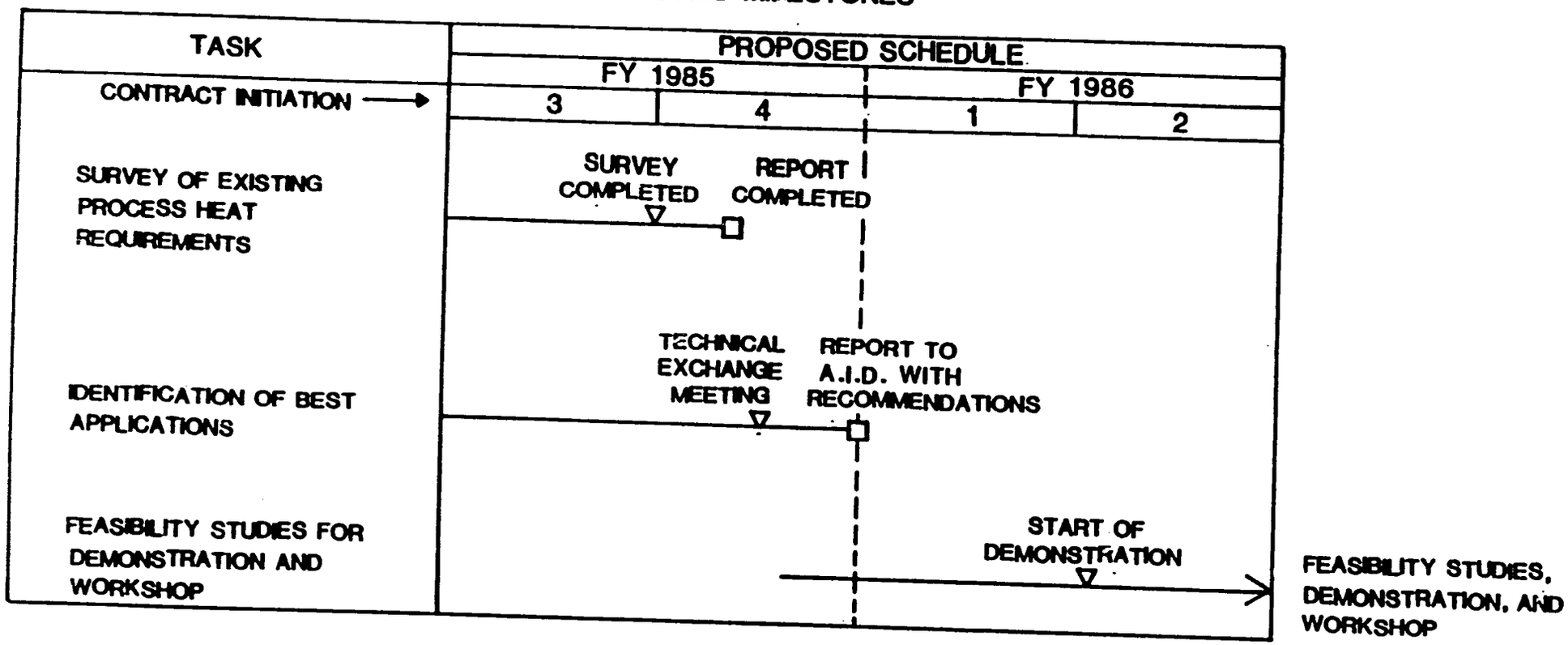
5. Estimated Direct Heat Applications in Central America Project Component Budget

			$K
Projected Budget for Survey of Direct Heat Requirements			
Base salary for engineer (52K/FTE/Yr)	0.5 FTE	26	
Fringe @ 25% of base Salary		6.5	
Burden at 77% of base salary plus fringe		25.0	57.5
Travel			
Air fare (Los Alamos to Guatemala City) 6 trips at $1200 each round trip		7.2	
Per diem (3 trips of 14 days and 3 trips of 7 days at $58/day x 63 person days)		3.7	
Local expense and transportation		1.1	12.0
Projected Budget for Identification of Most Promising Applications			
Base salary for engineer (52K/FTE/Yr)	0.4 FTE	20.8	
Fringe @ 25% of base salary		5.2	
Burden @ 77% of fringe plus base salary		20.0	46.0
Travel			
Air fare (Los Alamos to Guatemala City) 6 round trips @ $1,200/trip		7.2	
Per diem (3 trips of 14 days and 3 trips of 7 days @ $58/day x 63 person days)		3.7	
Local miscellaneous and transportation		1.1	12.0
Technical exchange meeting			10.0
Projected Budget for Feasibility Studies			
Base salary for engineer (52K/FTE/Yr)	0.6 FTE	31.2	
Fringe @ 25% of base salary		7.8	
Burden @ 77% of base salary plus fringe		30.0	69.0
Travel			
Air fare (4 round trips Los Alamos to Guatemala City @ $1200 per trip)		4.8	
Per diem (2 trips of 14 days plus 2 trips of 7 days @ $58/day x 42 person days)		2.4	
Local expense and transportation		.8	8.0
	Subtotal		214.5

6. Activity Schedule and Milestones. The schedule for the described tasks is shown on the accompanying chart.

DIRECT HEAT APPLICATIONS

ACTIVITY SCHEDULE AND MILESTONES



2. Costa Rican Peat End Use Assessment

a. Problem Statement. The Central American countries have a severe deforestation problem and scarce foreign exchange with which to pay for imported oil. Unemployment among the rural and urban poor must be decreased in order to achieve social and political stability. Development of indigenous peat resources can address these problems by: 1) substituting for fuelwood and imported oil; 2) providing useful end-products for agricultural and industrial use; and 3) increasing rural employment through labor-intensive peat harvesting.

Peat is an organic-rich sediment produced in swamps and marshes from partially decayed plant material. If found in suitable quality and thickness, peat can be converted to gaseous or liquid fuels for either industrial or vehicular uses. Peat can also be burned directly as fuel, as in Northern Europe and the Soviet Union, where it is used extensively for electric power generation. In addition to its well-known agricultural and horticultural uses, peat is also a source of many valuable organic chemicals such as waxes and resins and even of medicinals. A vast literature exists documenting the wide and growing uses for peat. While specific markets and uses for peat in Costa Rica must await the appropriate analyses, we indicate below some uses which appear to be of immediate interest to Costa Rica:

- Milled peat, sod peat or peat pellets can be substituted for fuel wood or charcoal in domestic cooking and heating and possibly in industrial processes. For countries in Central America and the Caribbean such as Costa Rica which suffer from high rates of deforestation, use of peat in this fashion could immediately relieve pressure on the forests. The AID Alternative Energy peat development program has funded the design and development of a peat burning stove made from waste metal. This stove is in use in Burundi.

- Costa Rica's substantial livestock industry could benefit from use of biologically active additives obtained from chemical processing of peat. These additives used as livestock feed supplements have resulted in 20 to 30 percent increases in reported animal weight gains. The problem of lengthy fattening times reported by Costa Rican hog farmers could be alleviated by such additives.

- Peat coke has been demonstrated to be a good raw material from which homogeneous granular or powdered activated carbon can be obtained. Activated carbon is widely used in the sugar and starch refining industries to remove colored organic impurities. It is used for the same purposes in pharmaceutical, water purification, rum production and sewage treatment processes.

- Methanol produced from peat could be added in small percentages (say 4 to 10 percent) to reduce the quantity of gasoline consumed and therefore of petroleum imported. Studies indicate that such mixtures of methanol and gasoline in unconverted internal combustion vehicle engines also result in fuel economy increases, increases in octane ratings, reductions in operating costs and reductions in exhaust emissions.

- Peat can be burned directly in electric power generation facilities. Finland, which in 1981 produced approximately equal proportions of electricity from hydro, nuclear and thermal sources, finds peat an economical fuel source for its thermal plants. According to the State Fuel Centre, peat is approximately half the price of heavy fuel oil and approximately equal in price to imported coal at the dock. Most analyses of the economics of peat in all uses, including the recent World Bank report, indicate that the economics of peat use are very site specific, requiring analyses of the size and location of the

deposits and chemistry of the peat as well as its economic characteristics.

- The Electric Power Research Institute (EPRI) studied the costs of using peat as a feedstock for electric power generation and compared the cost to coal. Their results indicate that a peat-fired power plant is cheaper than its coal-fired counterpart. Two, 150 MW peat-fired units with and without flue gas desulphurization (FGD) have costs of 87.6 and 80.4 mills/Kwh respectively, while a 300 MW coal-fired plant has costs of 91.9 mills/Kwh. ("Evaluation of Peat as a Utility Boiler Fuel," EPRI Report Number CS-2913, March 1983, prepared by Burns and Roe).

- The Irish Peat authority, Bord Na Mona, reported the following costs in a recent telephone conversation. The "national average value" for briquettes of peat is $US 4.01/$10^6$ BTU. This compares to an industrial coal cost of $US 4.50-4.75/$10^6$ BTU. Bord Na Mona confirmed the observations made in the EPRI report that the capital cost for a peat-fired electric facility is higher than for a coal-fired facility but that when the lower peat fuel cost is considered, the busbar cost per Kwh is lower for peat.

Other potential uses for peat will result from examination of Costa Rica's current and potential industrial structure, manufacturing product mix, import mix and other industrial and economic variables.

Soil, geomorphologic, and vegetational maps of Costa Rica have suggested the presence of peat deposits in several regions of Costa Rica, but detailed field investigations have never been undertaken to verify this or to establish the quality or thickness of these deposits. Under the IDB sponsorship, Los Alamos peat specialists, accompanied by personnel from RECOPE and ICE, visited Costa Rica in February 1984 to field check potential areas and to take samples for preliminary quality determinations. The results of this short-term mission were very encouraging. Peats with as little as 10% ash and up to four meters thick were identified during this brief visit. These results strongly

suggest the desirability of a systematic investigation of end uses to determine whether peat development is warranted.

b Project Component Description

1) Activities. The objective of the end use assessment is to identify uses of peat that are economically and environmentally feasible and that will benefit the economies of Costa Rica as well as neighboring republics. Accomplishing this objective requires four related tasks. First, we will work with Costa Ricans to examine the present industrial mix of manufacturing in Costa Rica in order to identify potential for import substitutes or export products that can be economically provided by peat. Next since end uses are very specific to the chemical and physical quality of the peat resource, a limited amount of sampling and analysis of previously identified peat resources will be required to determine feasible end uses. Third, with the results of the previous two tasks and input on the regional characteristics, the most promising end uses will be identified in consultation with the Costa Ricans, and fourth, detailed feasibility studies will be performed on a selected few end uses for a specific region that will lead to pilot demonstrations of one or more of these end uses in FY'86. This component will begin with a search and review of the literature which documents the uses to which peat is applied elsewhere in the world, including costs where available. At the same time, limited sample collection of Costa Rican peats will begin to provide material for lab analysis and other experimentation. Two-week reconnaissance trips to Panama, Honduras and Guatemala will also be initiated during this time frame. These reconnaissance trips will be funded from Phase II funds. Finally, after completion of the economic parameters study, a detailed resource assessment of Costa Rican peats will begin.

2) Task Statement

a) Parametric Study of Economically Feasible End Uses. Immediately after receipt of funding, Los Alamos will perform an extensive literature review of world-wide peat use, obtaining cost estimates per

standard unit of measure wherever available. After reviewing this literature, a team consisting of a Los Alamos staff engineer, an economist, a peat specialist and an authority on peat end uses from the private sector or a university, and a Costa Rican engineer will collaborate to compose a list of peat end uses that appear potentially feasible for Costa Rica. A short list of three to five potential end uses will be drawn from the larger list based upon consideration of Costa Rica's industrial mix by major industrial sector.

This process will establish that there exist (or do not exist) end uses for peat that can potentially compete in existing markets in Costa Rica. It will not purport to indicate conclusively that peat is economically competitive in a particular use nor will it be inclusive as to all potentially feasible end uses. Deliverables for this phase will be a report containing the results of analysis of the economic parameters of the short list of end uses including a bibliography of the peat literature and costs. Assuming receipt of funding in mid-March 1985, these deliverables will be available by the middle of July 1985. A favorable conclusion regarding the potential for peat use in Costa Rica will permit the Costa Rican Peat Resource Assessment to begin. This project component will be funded out of Phase II funds.

b) Peat End Use Experimentation. In order to establish the most probable end uses for Costa Rican peats, we will need to collect a limited amount of representative peat samples from 1-2 of the areas that we had previously tentatively identified as containing the best peats. This will involve collecting samples from sites selected for ease of access and because they represent particular depositional types. Collection will be accomplished in a time frame compatible with the activities outlined in Task a). Between five to ten cubic yards of samples will be collected at each site. Samples will be split in the field and half will be kept by RECOPE for their analyses (see below) and half will be packaged for transport to Los Alamos.

Standard laboratory analyses will be performed. These will include: 1) "proximate" analysis (ash, moisture, fixed carbon, and

volatile matter); 2) combustion heating value (BTU); 3) bulk density, fiber, and pH; 4) petrographic-botanical analysis; 5) combustion products analysis; and 6) trace element analysis. Proximate analysis, BTU, bulk density fiber and pH will be done by RECOPE in their coal analysis laboratory. Petrographic-botanical analysis, trace element analysis, and combustion products analysis will be done at Los Alamos. At the same time that the above analyses are being performed, samples of the peat will be transmitted to technologists to proceed with end-use experimentation. These will include tests for briquetting, gasification, use as a chemical feedstock, animal feed, soil conditioner and construction material.

c) Selection of the Most Promising End Uses. A more complete study of potential end uses will be conducted in light of the analyses of Costa Rican peat and regional characteristics to ascertain the end uses that are best, given the quality of the peat and the region's characteristics. Regional characteristics are important in the determiation of which region is best suited for locating a facility for a particular end use. The research team will collect more detailed information on the selected end uses, regions, regional peat characteristics, and benefits for the remaining end uses. This information will be applied to the decision on which end uses, and regions are to be selected for a detailed cost/benefit analysis. The report describing the end uses will be modified to specify which end uses are technically feasible and desirable. We will then distribute it to appropriate private and public sector members of Costa Rica and will hold a technical exchange meeting to determine which end uses would be most favored by the Costa Ricans. A few (≈3) of the most promising end uses and corresponding regions will be chosen for more detailed cost/benefit analysis. The choice of the most promising end uses will be documented using a Los Alamos decision-analysis code. The various inputs to the code for the decision process will be requested from the Costa Ricans.

d) Feasibility Studies of Selected End Uses. The research team described in Task a. will perform detailed feasibility studies of the most promising end uses identified in Task c. This will entail

modification of engineering designs that have been used elsewhere to suit Costa Rican conditions, selection of a peat deposit at which to site the project and determination of an environmentally sound method of harvesting the peat, a preliminary environmental impact analysis of the effect of peat development, regional infrastructure requirements and a detailed cost/benefit analysis of the end use. As indicated by the activity schedule, feasibility studies will not be initiated prior to the completion of the parametric studies of economically feasible end use. Results of this phase will lead to a pilot demonstration of one or more of the end uses in late FY'86.

c. Coordination and Implementation Plan. The Interamerican Development Bank is very interested in cooperating in the peat resource assessment of Costa Rica to be performed by Los Alamos National Laboratory peat specialists and Costa Rican geologists. RECOPE is sufficiently commited to the resource assessment to contribute financially as well. It is anticipated that the resource assessment will begin after the parametric study of end uses. However, preliminary results should be available in FY'86 to aid in the selection of a pilot demonstration location.

The project will be managed by Dr. Kenneth Williamson or his equivalent, a chemical engineer with several years of technical and managerial experience. Dr. Arthur Cohen, a Los Alamos National Laboratory peat specialist, will conduct field sampling and analysis in cooperation with RECOPE and will advise regarding end uses. The engineering and economic study of end uses will be jointly conducted with members of RECOPE, chosen by Mr. Oldemer Ramiraz, Director of Carboniferous Studies. Engineers or economists from RECOPE will be trained in technology comparisons and assessments. In addition, an international authority on end uses of peat will be sought to participate in the study. The schedule of implementation is shown on the accompanying milestone chart.

d. Status at End of Phase 1

- o Potential end uses analyzed with regard to Costa Rican market conditions and regional characteristics including literature review of world-wide peat use and associated costs.
- o Technical exchange meeting held to educate private sector members in peat end uses and to solicit their input.
- o Physical characterization of peat completed and results incorporated in selection of most promising end uses.
- o Costa Rican engineers or economists trained in technology comparisons and feasibility methodology. Geologists trained in peat sampling and analysis.
- o Report completed with cost/benefit analysis of up to three of the most promising end uses, including preliminary design, site selection, and environmental analysis.

e. Estimated Costa Rican Peat End Use Assessment Project Component Budget

Projected Budget for Identification of End Uses		$K	
Base salary for engineer (52K/FTE/Yr)	0.3 FTE	15.6	
Fringe @ 25% of base salary		3.9	
Burden @ 77% of base salary plus fringe		15.6	34.5
Costa Rican engineer and economist (2people for 3.3 months @ $1500/mo)			1.0
Travel			
Air fare (3 round trips Los Alamos to San Jose CR @ $1500/ea)		3.5	
Per diem (32 person-days @ $70/day)		2.3	
Local and Field expenses		.2	6.0
Projected Budget for Peat Characterization			
Base salary for engineers (52K/FTE/Yr)	.5 FTE	26.0	
Fringe @ 25% of base salary		13.0	
Burden @ 77% of base salary plus fringe		30.0	69.0
Travel			
Air fare (6 round trips, Los Alamos to San Jose, CR @ $1150/ea)		6.9	
Per diem (12 person-days @ $70/day)		.8	
Local Expenses		.3	
Field expenses for 20 days for 3 US people @ $45/day and 5 ROCOPE people @ $27.50/day		6.0	14
Laboratory Analyses			
RECOPE (ash, volatile matter, fixed carbon, BTU, moisture, sulfur)			10
Los Alamos (petrographic and botanical composition and combustion products)			26
Projected Budget for Selection of Most Promising End Uses			
Base salary for engineer (52K/FTE/Yr)	.4 FTE	20.8	
Fringe @ 25% of base salary		5.2	
Burden @ 77% of base salary plus fringe		20.0	46.0
Consulting engineer (1 person @ $55/day for 10 days)			5.0
ROCOPE counterparts (2 people @ $35/day $1500/mo)			5.0
Travel			
Air fare (7 round trips Los Alamos to San Jose, CR @ $1500/ea)		8.0	
Per diem (74 person-days @ $70/day x 45%)		5.2	
Local and field Expenses		.8	14
Technical exchange meeting			10.0

Projected Budget for Feasibility Studies

Base Salary for engineer (52K/FTE/Yr)	.7 FTE	36.4	
Fringe at 25% of base salary		9.1	
Burden at 77% of base salary and fringe		35.0	80.5
		Subtotal for Year 1	321.0
7. Unprogrammed Contingency		Subtotal	400.0
8. Management and Evaluation		Subtotal	100.0
		TOTAL	$3,732.4

f. Activity Schedule and Milestone. The schedule for the described tasks is shown on the accompanying milestone chart.

V. TRAINING

A. Training Activities

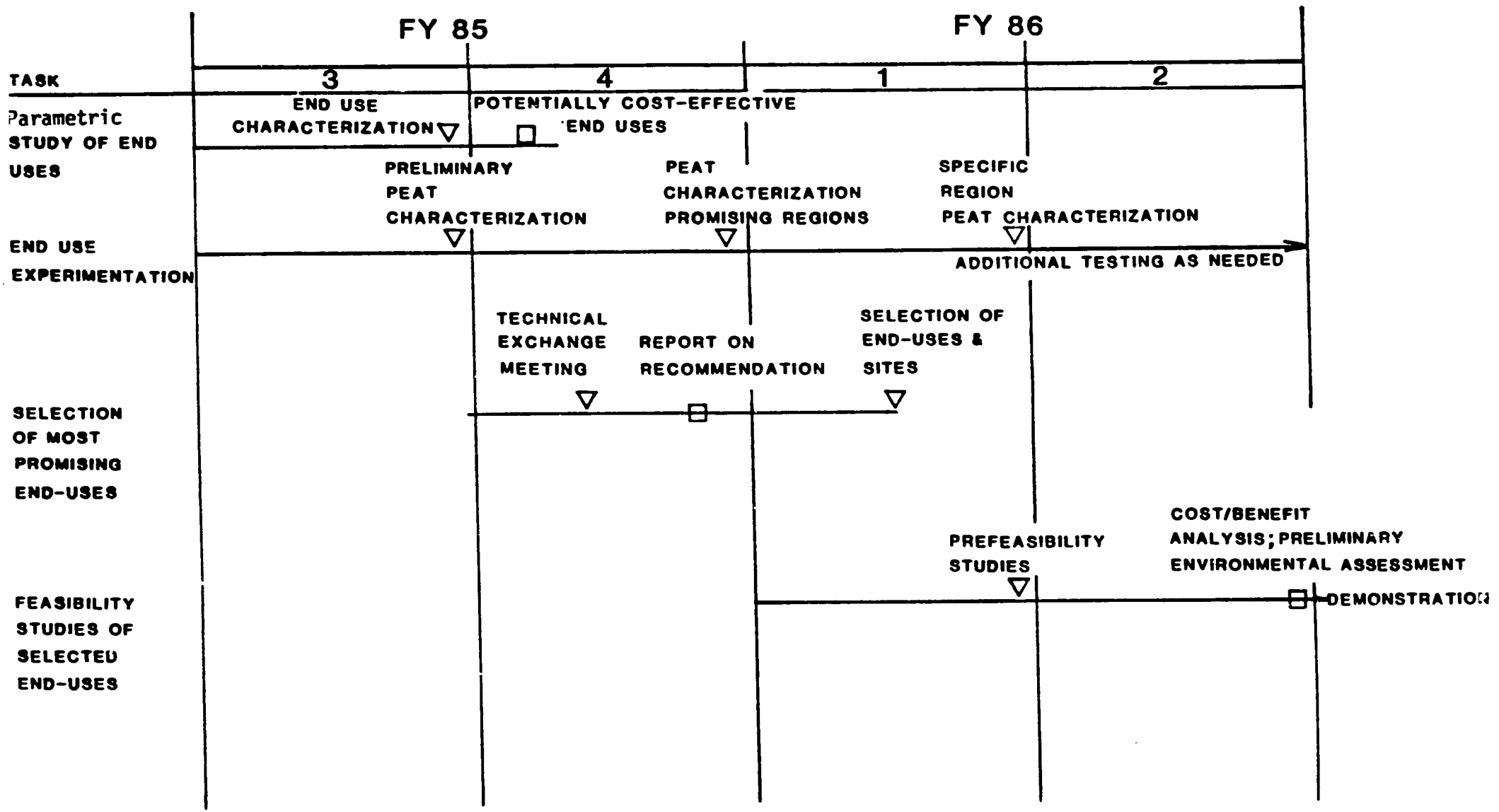
Specific areas of training have been identified through consultations with counterpart organizations and through the Laboratory's desire to train counterparts in all methodologies used to achieve the Project's objectives, where possible. A description of the areas of training are described below by project component.

1. Energy Situation Analysis. In the course of discussions with energy planners in the region, a need for the following training was identified: energy data collection, computerization, analysis and dissemination; design and implementation of surveys to collect basic energy data; energy demand forecasting; and energy supply optimization. Since training needs of the countries vary with their level of institutional development, we will respond to the needs of each country with individualized programs. Personal computers will be purchased with project funds and transferred to counterparts along with appropriate software and a regional database on energy.

2. Honduras Geothermal Reconnaissance. Trained geologists from ENEE and DGMH will be invited to participate in all activities. Through their participation, they will receive training in the following areas: the latest concepts and techniques in volcanological mapping; structural mapping to determine permeable zones; rock sampling for radiometric dating; gas and fluid sampling; the siting, drilling and geophysical logging of shallow temperature gradient holes; modern goephysical techniques; and interpretation of data from all of the above activities to characterize the heat source.

3. Support Equipment for Central America. This project component is primarily a hardware fabrication effort. Formal training and field instruction will take place when the equipment is put into service in the geothermal fields of Central America. Activities that contribute to training in Phase I include preparation of detailed operator's handbooks and maintainance instructions.

COSTA RICAN PEAT END USES
ACTIVITY SCHEDULE AND MILESTONES



▽ MILESTONES OR DECISION POINTS

□ REPORTS

4. Miravalles. Working with ICE scientists and engineers, a geophysical data acquisition system will be designed, fabricated and installed at the Miravalles geothermal field. After arrival of the equipment in Costa Rica, ICE personnel will be intensively trained in the operation of the rig, well logging, and data recording and interpretation. This training will be conducted in the field by engineers, geophysicists and well log interpretation specialists from Los Alamos.

5. Costa Rica Geothermal Reconnaissance. Professionals from ICE will be trained in all aspects of geothermal reconnaissance at a level commensurate with the scale of the effort in Costa Rica in Phase I. Training activities will intensify during the second year of the project. The specific areas of training are described in the above section on the Honduras Geothermal Reconnaissance.

6. Direct Heat Applications. A Guatemalan counterpart from the Ministry of Energy and Mines will be trained in the following activities and will be supported with project funds to participate in and learn from our activities. The areas of training are: evaluation of energy requirements for industry; evaluation of direct heat uses suitable for Guatemala; technology comparisons; prefeasibility and feasibility methodology.

7. Costa Rican Peat End Uses. A Costa Rican economist and/or an engineer will be selected by RECOPE to participate in all aspects of the project and will be trained in the following areas: familiarization with worldwide peat uses; technology comparisons to evaluate which end uses are best for Costa Rica; and training in prefeasibility and feasibility methodology. In addition, RECOPE geologists will be given the opportunity to work in the field with world peat experts and receive training in peat mapping, sampling, analysis, and data interpretation.

B. Implementation of Training Program

Training will be accomplished by several different methods that are appropriate to the specific area of training. Interactions with Los

Alamos personnel while they are in the field will train counterparts in geologic mapping, sampling, data collection and survey techniques. Engineers and economists will also work with counterparts to train them in use of selected methodologies. Workshops conducted by experts from Los Alamos, other national laboratories, universities, and/or the private sector on specific topics will be held periodically to train counterparts in areas such as operation of the logging truck, use of personal computers, and energy planning methodology. Workshops and technical exchange meetings will also be used to disseminate information to the private sector and to acquaint them with the applications of peat end uses or direct heat uses. For several of the components, project funds are budgeted to support counterparts to participate in and to learn from all component activities through their direct involvement. In some components, trips to Los Alamos and elsewhere in the US will be provided for counterparts for training on specific methodologies.

C. Estimated Budget for Training Activities

The budget was estimated individually for each project component and it includes the following: counterpart salaries where shown in the detailed budgets for the project components, counterpart field expenses, travel for counterparts to the US or within Central America to attend workshops or to receive special training, and the cost of workshops and technical exchange meetings. In addition, approximately 20 per cent of travel costs and personnel time spent in Central America is considered as directly related to training. The training budget is shown below for Phase I.

Project Component	$K
Energy Situation Analysis	130
Honduras Geothermal Reconnaissance	175
Support Equipment	25
Miravalles Geothermal	75
Costa Rican Geothermal Reconnaissance	30
Direct Heat Applications	55
Costa Rican Peat End Uses	60
Total for Phase I:	550

VI. UNPROGRAMMED CONTINGENCY

Recognizing that the program outlined in this document will generate large quantities of new information about the energy options and opportunities of the Central American countries, we propose allocating a small percentage of the budget to permit examination of issues, ideas or options which arise during the course of execution. We encourage particularly the AID missions to make suggestions for the expenditure of these funds on specific projects. Before embarking on studies, discussions will be held between concerned individuals and institutions to ensure that all are in agreement on the merits of the idea.

Based partly on discussions with host country personnal as well as representatives of donor institutions, Los Alamos makes the following suggestions for additional projects. This list is not a rank ordering:

- o Assistance to the Guatemala government in development, adaptation and application of frontier oilfield planning techniques.
- o High temperature well-logging in the production wells at Ahuachapan, El Salvador.
- o Geophysical measurements, including deep resistivity, in the Chipilapa area adjacent to Ahuachapan.
- o An assessment of the role of geothermal energy development in Honduras.
- o High temperature well-logging in Zunil I geothermal wells in Guatemala.
- o Evaluation of low permeability Zunil wells for future well stimulation treatments.
- o National energy situation analysis for Belize.

- Assistance to Panama in purchasing chemical equipment for evaluation of geothermal fluids.

- Assistance to El Salvador in purchasing chemical equipment for evaluation of geothermal fluids.

- A conference on energy technology to be held in Central America.

CENTRAL AMERICA ENERGY RESOURCES PROJECT
(596-0134)
Estimated Project Component Budget
For the First Two Years
($000)

		TOTAL
1.	Energy Situation Analysis	1100.0
2.	Honduras Geothermal Reconnaissance	2100.0
3.	Miravalles Geothermal	400.0
4.	Costa Rica Geothermal Reconnaissance	200.0
5.	Direct Heat Applications in Central America	400.0
6.	Costa Rican Peat End-Use Assessment	500.0
7.	Unprogrammed Contingency	400.0
8.	Management and Evaluaion	100.0
	T O T A L	5200.0

93a

VII Phase I Budget Summary

Project Description	Project Leader	FY85 $Millions
Geothermal		
Honduras Reconnaissance	Dr. R.J. Handal	1.7
Costa Rica	Dr. Robert J. Handal	
Miravalles Geothermal Development		.273
Reconnaissance		.157
Regionwide Equipment Purchase		.7
Direct Heat Application	Dr. F. Edeskuty	.215
Total		3.045
Peat		
Costa Rica Peat End Uses	Dr. K. Williamson	.41
Regionwide Energy Situation Analysis	Linda K. Trochi	.531
Unprogrammed Contingency AID	Dr. V.W. Loose	.4
Management and Evaluation	Dr. V.M. Loose	.1
Total		4.486

VIII. PHASE II: EXTENDED FIRST-YEAR PROJECT COMPONENTS

Additional FY '85 no-year funds in the amount of $5.0 million dollars have been appropriated for the extension of the Central America Energy and other Natural Resources Project. The disposition of these funds has been discussed with AID representatives in very general terms but no commitments as to approved activities have been made either by AID or by Los Alamos personnel. However, the discussion developed below identifies the areas in which both organizations have reached tentative agreement on expenditures to be covered by the additional funds. Before these funds are committed to any activity, Los Alamos and AID must reach agreement that a specific activity is approved and Los Alamos must submit an approved addendum to this Project Paper covering the details of the approved activity.

A. Costa Rica Mineral Reconnaissance Component

In June 1983, a Los Alamos representative was a member of an OAS Employment Generation Mission to Costa Rica. The designated sector responsibilities of this individual were the energy and mineral sectors. Through participation in this Mission, Los Alamos gained a great deal of knowledge of the current status and future needs of the Costa Rican energy and minerals industries as well as extensive contacts in these sectors. Costa Ricans also gained information about the capabilities of Los Alamos to address issues in these sectors. One of the contacts made was with Dr. Rolando Castillo, Director of the School of Geology at the University of Costa Rica who expressed great interest in geochemical reconnaissance in Costa Rica. Dr. Castillo was very impressed with Los Alamos capability in this area and indicated his interest in working with Los Alamos to develop a proposal for a country-wide mineral reconnaissance for Costa Rica. Two meetings followed, one in Costa Rica and one in Los Alamos, during which a detailed proposal was developed by Dr. Castillo and Los Alamos technical staff. The proposal anticipates extensive involvement of faculty and students of the UCR School of Geology in both field activities and data interpretation and analysis. The immediate results of this study will be the compilation of a Geochemical Atlas for Costa Rica, establishment of a permanent geochemical data base for Costa Rica, a preliminary resource

assessment identifying potential resource target areas, purchase of new laboratory equipment for UCR, construction of a laboratory-library facility for the UCR, establishment of a Masters program in mining geology at UCR, training of UCR staff and students in geochemical sampling techniques, and establishment of communications and cooperative research between Los Alamos National Laboratory and the Escuela Centroamericana de Geologia. Since this proposal was developed, discussions with the USGS have been undertaken. The Costa Rican Mineral Assessment will now be a joint effort between Los Alamos, the UCR and the USGS with the Ministerio de Industria, Energia y Minas (MIEM) acting as the counterpart organization. We expect that a Costa Rica mineral reconnaissance will be responsive to the results of the AID funded/USGS organized conference to be held in Antigua, Guatemala next month as well as by the sector profiles work described below.

B. Mineral Sector Profiles Component

Generally there is significantly less publicly available, widely disseminated information on the mineral sector in Central America than there is on the energy sector. In order to begin to fill this information void, Los Alamos and other organizations will develop mineral sector profiles for each of the countries in the region. These profiles will review worldwide supply and demand, price, the reserve situation and other economic parameters for all the economic minerals.

C. Coal, Lignite and Peat Component

The parametric study of economically feasible peat end uses for Costa Rica will be conducted as rapidly as possible so as to obtain results in the near term. Results from this portion of the study will help to guide the resource assessment by identifying the types of peat or peat constituents that will serve existing markets in Costa Rica. Funds from Phase II will be used to initiate the peat resource assessment in Costa Rica. More or less simultaneously with the economic parameter study, prefeasibility reconnaissance efforts could be conducted in Panama, Honduras and Guatemala. Market and end use studies may also be scheduled for each of these countries.

D. Equipment Maintenance Expenditures Component

A portion of the Phase II funds might be used to provide for regular maintenance of the logging truck, logging instruments and deep resistivity equipment. However, the portion of funds required for this would likely be small inasmuch as most of this equipment will be available no sooner than the close of the first year of the program.

E. Database Maintenance Component

As indicated in the Energy Situation Analysis Component of Phase I of the Project, we expect to establish a mechanism for regularly scheduled updates of the databases that are developed. This will be established as the responsibility of a regional organization such as ICAITI or SIECA or some combination of the two organizations. In order to provide the resources for this activity, some of the funds from Phase II of the project may be committed to this task. However, because most of the databases will not be developed until late in the first and the second year of the Project, we do not anticipate the need for updating until future years of the Project.

F. Geothermal Support to El Salvador, Panama and Guatemala Component

Additional funds will permit the expansion of the geothermal support to the region. This could involve a number of activities among which are: 1) High temperature well-logging in the production wells at Ahuachapan, El Salvador; 2) Geophysical measurements, including deep resistivity, in the Chipilapa area adjacent to Ahuachapan; 3) High temperature well logging in the Zunil I geothermal wells in Guatemala; 4) Evaluation of low permeability Zunil wells for future well stimulation treatments.

G. Application of Oil Field Planning Techniques in Guatemala Component

The Guatemalan Ministry of Energy and Mines, Directorate of Hydrocarbons is planning a study of a pipeline from the oilfields in the Peten region to the consuming centers in the environs of Guatemala City. Techniques exist for the analysis and planning of oilfield development taking

into consideration the location or probable location of production wells as the field develops, gathering of petroleum at a central location, refining close to production or consumption and route alignment for long distance transport of product. Los Alamos staff have experience in application of such tools to the National Petroleum Reserve in Alaska and could apply this to frontier oil regions such as the Peten field in Guatemala.

H. Conservation and Fuel Substitution in the Transport Sector Component

A major focus of the existing AID energy program in Central America has been conservation and fuel substitution in the industrial sector. Very little attention has been given to conservation in the transport sector. Significant quantities, often forty to fifty percent of a countrys' petroleum consumption is in the transport sector. For petroleum conservation, the transport sector is a significant target of opportunity. Yet this sector has been the one sector in which conservation appears the most difficult to attain. However, there may be some opportunities for fuel substitution and conservation in this sector and these opportunities should be explored in more depth.

I. Wind Energy Component

The possibility that wind energy could play a role in Central American energy futures received high level Reagan Administration attention. From available wind data, Los Alamos could examine the potential for wind energy applications, particularly in remote locations.

J. Bi Phase Energy Systems Geothermal Well Prover in Guatemala

Bi Phase Energy Systems has approached Los Alamos with an unsolicited proposal to provide an existing geothermal well prover to Guatemala for pilot operation at Zunil. The assistance required of the project would be for training of Guatemalan technicians and for surface transport of the unit to Houston from Utah.

IX. OVERALL PROJECT IMPLEMENTATION

A. Introduction

The intent of development assistance is to produce positive results that benefit the recipients and advance the interests of the US in the region. Los Alamos National Laboratory is committed to effective and efficient management and execution of the program. The Laboratory will establish information systems so that objective and quantifiable measures of project success can be developed. A part of this activity will be to provide external peer review for the activities and results of each project componet.

B. Project Management

The existing management structure at Los Alamos National Laboratory was designed for the management of large scale, multidisciplinary programs in energy and defense R and D. The management structure is a matrix system with Program Offices serving as the primary interface to funding sources in Washington and to ensure that goals and objectives of the project are accomplished. The technical divisions at Los Alamos National Laboratory house the technical staff and discipline managers who ensure the technical quality of the work.

The Central American energy programs proposed in this document will be managed and coordinated by the Assistant Director for Industrial and International Initiatives (ADIII), Dr. Ronald Lohrding. This office was organized expressly to conduct programs such as that proposed herein. This Office is responsible directly to the Laboratory Director.

The International Initiatives and Energy Policy Officer, Dr. Verne Loose, will be primarily responsible for the day-to-day development and management of the program activities. Reporting to the Officer will be Project Managers who will be designated as such by the technical divisions who contribute to the program. The Project Manager for the geosciences technical activity will be Dr. Robert Hanold and the Project

Manager for analysis and assessment activities will be Ph. D. candidate Linda Trocki. The subcomponents will be managed by the previously named project leaders. The line or discipline managers will be Dr. John Whetten, Division Leader of the Earth and Space Sciences Division and his Deputy, Dr. Doyle Evans, and Dr. Larry Booth, Analysis and Assessment Division Leader and his Deputy, Dr. Ray Waller. This structure is used on all of the multiple discipline programs at the Laboratory and assures responsive program management with quality control by the line managers.

Existing standardized Laboratory cost control procedures will be used to assure the fiscal integrity of the project. This standardized system complies with the Budget and Accounting Procedures Act of 1950 and fulfills the requirements of other Federal statutes and government regulations. This system is designed as a management tool for the allocation, forecasting, and monitoring of financial resources to determine progress towards project objectives.

Upon receipt of funding at Los Alamos National Laboratory, the Program Manager will allocate to each Project Manager the funds required to meet their specific tasks in FY'85. The projected costing schedule for the allocation will be forecast, by monthly increments, by each Project Manager. This information resides in a computerized data base that is the core of the Los Alamos National Laboratory cost control system. The system is based on a unique digital code that identifies the project, the organizational unit charging to the project and the particular type of expenditure. All costs associated with the project can be traced by these identifiers back to their original source document, i.e. purchase order, travel expense, time report. Costs are posted to the accounts at the end of every month. Following the month-end update, the Project Managers and Program Manager may access the computerized accounting system for a variety of reports. The information can be presented in summary form to review the status of the project or in desired levels of detail to determine progress of various tasks. Anomalies in costing can quickly be traced to specific researchers and action instituted if necessary to ensure the project progresses to its established goals.

Data on the status of all purchase requests and purchase orders is available via computer reports. Project Managers can quickly evaluate manpower and material expenditures against forecasted performance to identify potential concerns. In addition to the fiscal review conducted by the Project Leaders and the Program Manager, each Laboratory Division has an individual who reviews costs for that Division to assure accuracy and appropriateness. An internal audit staff is attached to the Los Alamos National Laboratory Controller's Office and conducts random audits to verify the integrity of the existing cost control system. The University of California, funded by the DOE to operate Los Alamos National Laboratory, also maintains an audit staff at the Laboratory to inspect procedures. Los Alamos National Laboratory is also scrutinized periodically by independent auditors representing the DOE, GAO, IG, or other entities. Such continuous and intense review assure Los Alamos National Laboratory of a cost control and reporting system that meets the concern for precision, dependability and integrity.

At the outset of the program this structure will be employed to manage and coordinate program activities. However, it is envisioned that as the program expands and more activities are initiated, Los Alamos representatives in the region will be required. Therefore, it is likely that before the end of the first year of activities, Los Alamos will employ US or Central American personnel to coordinate field activities and logistics and maintain contact with AID and country government personnel.

To achieve the goals of this project will require an effective blend of the expertise at Los Alamos with the assistance of experts from other national laboratories, educational institutions and the private sector. Contracts must be negotiated by Los Alamos National Laboratory with the appropriate entities for their servic

Procedures for contracting with private firms, other national labs and educational institutions are in place at Los Alamos National Laboratory. These procedures are based on the University of California Purchasing Policy, Prime Contract No. W-7405-ENG-36 and DOE

Subcontracting Policies and Procedures for Operating and On-Site Service Contracts. A specialized contracts staff at Los Alamos is available to assist in resolving any unique difficulties which might be encountered. However, Los Alamos regularly contracts with other national laboratories for support to its programs. Such contracts are handled as routine purchase orders and do not require going out on a public bid or providing sole source justification. Los Alamos also uses the services of educational institution staff through its affiliates program or as employees of the institution under contract. These contracts also do not have to be bid publicly or justified as to sole source. Contracts with private firms usually require full and free public competition. However, a sole source contract can be justified if the circumstances warrant, i.e., when the minimum needs can be satisfied only by services unique to one source.

The routine competitive contract with a private firm is initiated by the Project Leader via a Purchase Request Form 838. This request is reviewed by Los Alamos purchasing specialists for completeness, correctness, clarity, reasonableness of specified schedule and economical-buy quantities.

The request is then submitted by the purchasing specialists for public bid and the contract is awarded to the firm which most closely meets the requested criteria. Precautions are taken to award contracts only to responsible quoters who can reasonably be expected to comply with procurement requirements. The details of the contract are negotiated by the purchasing specialist with the successful bidder. DOE review and approval is required for contracts with private firms which exceed $500,000.

While Los Alamos conducts its procurements in compliance with the Buy American Act, contracts can be negotiated for foreign purchases when such action is determined to be appropriate. Los Alamos policies define the criteria for such determinations.

All Los Alamos policies and procedures for contracting with other national laboratories, educational institutions and the private sector are well-established and routinely used by Laboratory staff. The system provides for the efficient and effective procurement of services and materials necessary to achieve project goals. Due to the unique research conducted at Los Alamos, the contracts staff is experienced in negotiating a diversity of contracts with a variety of sources.

Relationships between Los Alamos National Laboratory and international funding and development organizations can be established with the appropriate authorities. To date, Los Alamos has worked effectively with the Interamerican Development Bank (IDB), the Caribbean Development Bank (CDB), the United Nations Development Program (UNDP) and the World Bank (IBRD). Discussions concerning program activities can be undertaken directly with these organizations. These organizations funded Los Alamos National Laboratory through formal contractual arrangements developed with the US Department of Energy (DOE).

Through the several projects in Mexico, the Caribbean and Central America, Los Alamos National Laboratory has established good contacts at a variety of levels with the Governments of Costa Rica, Honduras, and El Salvador. In many cases these contacts include representatives of the electric utilities which are often quasi-public corporations. Finally, Los Alamos has established relationships with the Organisacion Latino America de Energia (OLADE), particularly the Geothermal Division, Instituto Centroamericano de Investigacion y Tecnologia Industrial (ICAITI). These relationships will be formalized by memoranda of understanding or other similar documents as prescribed by the LAC Bureau and will be signed by all of the major participating Central American agencies and organizations with the Bureau, the appropriate bilateral mission and Los Alamos as signatories.

We strongly support the concept of peer review to ensure that the program activities are carried out in the best possible way. We suggest that Los Alamos and AID work together to appoint a peer review panel(s) for each of the major areas of project activity. These panels would

meet on a semi-annual basis and would receive a detailed briefing on the past progress, current status and future plans for each activity. If peer review panels have been established by other donor organizations, we believe they should be used. For example the IDB panel reviewing the Costa Rica work could also include Los Alamos work in its review process.

C. Post Project Evaluation and Monitoring

1. Review Evaluation Procedures. Los Alamos will work with AID personnel to establish data and information requirements that must be met by a post-project monitoring and evaluation system.

2. Development of a System. Los Alamos will combine its own expertise in program management with that of collaborators who have experience in post-project evaluation in developing countries to develop a system that meets AID requirements. This system will be reviewed in detail with AID representatives before it is implemented.

3. Budget

	FTE	$K
Staff Members	.5	65K
Collaborators		35K
	TOTAL	100K

4. Staffing

Verne Loose will lead this effort and draw upon systems analysis and assessment division personnel as required. Outside consultants with experience in project evaluation in developing countries will be retained.

Socio Economic Systems (SES) Corporation has worked with AID in the Philippines to develop and apply measurement techniques for evaluating project impacts and effectiveness. Los Alamos will review with AID the capabilities of this and other firms that will be identified soon after program initiation.

D. Clarifications

Los Alamos and AID representatives have reached several understandings regarding certain Project implementation and management issues.

1. Workplans containing goals, personnel, counterpart assistance and so forth will, as appropriate, precede visits to the region. AID will be given reasonable advance notice of such visits.

2. Los Alamos field teams will endeavor to ensure that they are accompanied by country agency counterparts at all times. These teams will include at least one fluent Spanish speaker.

3. Los Alamos will undertake language training for individuals involved in the Project who are not currently bilingual.

4. Quarterly status reports will be provided to AID with copies to the bilateral AID missions and ROCAP.

5. When appropriate, publications will be jointly authored by Los Alamos and members of the cooperating host country.

6. Los Alamos will procede with the existing management structure for the management of the Project but is preparing to provide for regional logistical assistance if it is necessary.

7. The establishment of an advisory committee comprised of US and regional members has been suggested. This committee would provide policy guidance and project priorities and would have the ability to blend the interests of the US and the countries of the region. This committee would meet perhaps three times each year, once in the region, once in Los Alamos and once in Washington. The final determination regarding the function and membership of this committee will be determined in discussions between AID and Los Alamos.

X. ENVIRONMENTAL IMPACT

The potential environmental impact of the activities proposed in this document is expected to be minimal. Permission from the appropriate government and/or private officials will be obtained before conducting any shallow-gradient drilling to support geothermal reconnaissance exploration and before removal of large peat samples for laboratory testing. The environmental impact of demonstration projects for geothermal process heat applications or peat end uses will be addressed in FY'86 when the most promising applications have been selected in consultation with Guatemalan, Costa Rican and AID officials.

REQUESTS FOR ASSISTANCE

INSTITUTO COSTARRICENSE DE ELECTRICIDAD

25611

4 de octubre de 1984

Dr. R. J. Hanold
Los Alamos National Laboratory
Los Alamos, New México, 87545
U.S.A.

Dear Dr. Hanold:

Thanks for your letter ESS-DO 84594 of August 27, 1984, by which you sent me the trip report prepared by Bert Dennis and Leo Maes about their visit to our Mirvalles Geothermal Proyect, regarding downhole looging equipment.

I think that in general, that report reflects the situation regarding looging tools in our geothermal field.

I agree with you, that the first step for improving our looging facilities should be to obtain a 7-conductor cable and the drum for it. Now, in order to implement this action, we should know what could be the cost of cable and the drum, undertanting that we could use the rest of the G. O. equipment that we have available, and if there is any possibility of having both cable and drum as a cooperation from any US Institution. Second, we should know for how long time could you lend us some of the special downhole tools (fluid sampler, pressure gage, spinner, etc). What kind of agreement should we get in order to use both personnel and equipment from "Los Alamos"?

Finally, what could be the cost of these tools if were built by you, or if they can be purchased commercially, can you supply us specifications, name of factories and/or distribuitors; in any case, cost and time of delivery is a very important information.

Do you see any possibility of taking any actions in order to implement first and second steps during the rest of this year?

I reallly would appreciate your coments.

Truly yours,

Ing. Manuel Fco. Corrales
JEFE DIRECCION PLANIFICACION ELECTRICA

MCV/mvc
#1171

108

MR. JOHN WTTHEN
LOS ALAMOS NATIONAL LABORATORY
MS-D 446, LOS ALAMOS
NUEVO MEXICO, ESTADOS UNIDOS

DISTRIBUTION

John Whetten D446
Ron Lohrding F685

T/1560/84.-
JUNE 20/84 WE SENT YOU FOLLOWING TELEX
''AS RESULT OF LECTURES DR ROBERT HANOL GEOTHERMAL SEMINAR EL SALVADOR LAST APRIL, AND TALKS HELD BETWEEN DR. HANOL AND CEL, WE HAVE

COL 446, T/1560/84.- 20/84 ''

Aug 14 / 11 AM '84

QOB509 P058 MR. JOHN PAGE/2

RECEIVED REQUEST FROM SALVADOREAN OFFICIALS FOR ASSISTANCE IN POSSIBLE LOGGING HIGH-TEMPERATURE WELLS (ELECTRICAL, CALIPER, CBL, LOGS, ETC.) PURPOSE ASSESSMENT STATE OF CASINGS, CEMENTATION, OTHER WELL CHARACTERISTICS.
OF INTEREST TO CEL THESE BE DONE BY LOS ALAMOS WITH POSSIBLE FINANCIAL SUPPORT U.S. GOVERNMENT, KENDLY REQUEST YOU INFORM US FEASIBILITY YR ARRANGING

COL (ELECTRICAL, CALIPER, CBL, LOGS, ETCML

QOB509 P058 MR. JOHN PAGE3

SAID ASSISTANCE''.
- CEL IS THINKING TO SET-UP A RESEARCH CENTER FOR AHUACHAPAN GEOTHERMAL FIELD. REGARDS,
GUSTAVO CUELLAR
HEAD OF REGIONAL GEOTHERMAL PROGRAM

COL NIL

109

WU INFOMASTER 1-010207A339 12/04/84
ICS IPMMVIU MVN
03891 12-04 1216P CST MVIR
TWX 9109881773 LOS ALAMOS LAB
1-1383710339 12/04/84
ICS IPMIIHA IISS
IISS F M TRT 04 1303
PMS D LOS ALAMOS NM
TNA065 LCC1625 MPA738 IRHE043 TLX2158 339430123105
UTNX CV PAPA 178
PANAMARP 356/336 4 0941 VIATRT SEC1/2

T-019

DEC 4 11 58 AM '84

FROM PANAMA

LOS ALAMOS NATIONAL LABORATORY
OFFICE LOCATION SM-215, ROOM 211
MAIL STOP D446
LOS ALAMOS, NEW MEXICO 87545
USA
ATTENTION: JOHN T. WHETTEN

We need asap a quotation of the following chemical determination:

NECESITAMOS MAYOR BREVEDAD, COTIZACION DETERMINACIONES QUIMICAS SIGUIENTES:
AGUAS: WATERS
CA2", MG2", NA", K", LI "(HCO3-"CO3-2),
SO4-2, CL-, ;'892, B, F-, NO-3
Y FE2" and FE 2

The analysis of FE2 - only in the samples where it is visibly present

EL ANALISIS DE FE2" SOLAMENTE EN LAS MUESTRAS DONDE ES VISIBLEMENTE PRESENTE.
GASES:
O2, N2, CO2, CH4, H2, CO Y C2H6

The analytical det. limits give attention to the following area + limits of det.

LAS DETERMINACIONES ANALITICAS DEBERAN RESPETAR LAS SIGUIENTES SENSIBILIDADES Y LIMITES DE LA DTECCION.

A. ESPECTRAFOTOMETRO DE LLAMA Sensitivity for 1% of
SENSIBILIDAD PARA 1 POR CIENTO DE DETECCCION.

ABSORCION	(MG/1) ABSORCION	LIMITE (MH/1)	(" 0 - PROCIENTO)
NA	0.015	0.02	3
K	0.04	0.08	3
CA	0.1	0.1	3
MG	0.008	0.01	3
LI	0.04	0.02	3

B. METODO COLORIMETRICOS Y TURBIDIMETRICOS
SENSIBILIDAD 1 POR CIENTO DE DTECCCION.

ELEMENTO	ABSORCION (MG/1)	LIMITE (MG/1) (BAJO)	(" 0 - PORCIENTO) ALTO
ELEMENT	ABSORPTION	LOWER	HIGHER

PERCENTAGE

COL FOLLOWS SECTION TWO
NNN
1307 EST

1327 EST

LOS ALAMOS LAB

12/5

04/12/84 18:29 10

DOC 1 . 55PFC673678--B4[illegible] LOS ALAMO NATION

110

PHILLIPS PETROLEUM COMPANY
BARTLESVILLE, OKLAHOMA 74004 918 661-6600

April 23, 1984
O'Br-04-84

Bert R. Dennis
ESS-6, MSJ980
Los Alamos National Laboratory
Los Alamos, New Mexico 87545

Dear Bert:

I had intended to write this letter immediately after completion of the VSP experiments that we ran in the Imperial Valley of California in August of 1983. Please accept this belated letter with my apologies.

As you know, the VSP experiments were finally completed after two full years of planning, negotiating, scheduling, and failures in all of these areas. We at Phillips were pleased with the final results and we understood the reasons for the difficulties. We would have been unable to complete the VSP in the high temperature environment without your special tool and cable.

In all cases, your scientists and technicians demonstrated a depth of professionalism and knowledge of the problems involved. I want to include in this a commendation for the chemists who caught the pH problem in 1982 which delayed the test for a year but saved the experiment from total failure. Also I would like to single out your field engineer, Larry Parker, and your chief technician, Everett Horton, who ran your field operation in adverse heat problems. The work would have failed without their input. I also want to emphasize the effort you yourself put into the project. It was invaluable. This is the sort of cooperative work that should occur between industry and government laboratories. If an occasion should arise in the future, I would encourage it.

If James Albright's work at Dessert Peak ever comes to fruition, please notify me as I would like to monitor it.

Sincerely,

John T. O'Brien

John T. O'Brien
Supervisor, Seismic Interp. Section

JTO:dt

cc: J. Whetler
ESS-DO, MS D446
Los Alamos National Laboratory

J. Albright
ESS-4, MS J979
Los Alamos National Laboratory

(1 of 3

MINISTERIO DE ENERGIA Y MINAS
GUATEMALA, C.A

SOLICITUD DE ASISTENCIA TECNICA REQUERIDA POR EL MINISTERIO DE ENERGIA Y MINAS EN EL AREA DE LA PLANIFICACION -- ENERGETICA

Preparado por el Departamento
de Planificación Energética y
Minera

GUATEMALA, FEBRERO DE 1985

112

AREA DE LA PLANIFICACION ENERGETICA Y MINERA

PROYECTO	DESCRIPCION DEL PROYECTO	OBJETIVO	ASISTENCIA SOLICITADA	PERIODO ASIST. PREVISTO
1. PLAN NACIONAL DE ENERGIA	Revisión diagnóstico sector energético series históricas de balances energéticos, elaboración de plan equipamiento e inversiones del sector energético, formulación de escenarios energéticos, formulación de políticas a seguir el estado en el sector energético.	Elaborar un Plan Nac. de Energía, que le permita a las más altas autoridades del país, dictar políticas de acción en el sector energético del país.	Asistencia de expertos en las áreas de la planificación energética. Ingeniería de sistemas, con énfasis en modelaje, y en el área económica financiera en sector energético.	
2. SISTEMA NAC. DE INFORMACION ENERGETICO/MINERO	Crear las bases necesarias para la creación del Centro Nac. de Información Energético/Minero, así como los lineamientos y base legal de funcionamiento, metodologías de recopilación y tratamiento de información documental y numérica.	Crear un centro nacional de información energético y minero en las áreas documental y numérico.	Asesoría de expertos en informática y documental.	
3. PLAN NACIONAL DE LA MINERIA	Formulación y programación a seguirse para el desarrollo del Plan Nacional Minero, Diagnóstico del Sector, Plan de Inversiones en el Sector, Evaluación de los Recursos Minerales del País, etc.	Elaborar un Plan Nacional Minero que le permita a las autoridades del país implantar las medidas necesarias que tiendan al desarrollo de la minería en el país.	Asistencia de expertos en planificación minera.	

113

(2) 8 3

PROYECTO	DESCRIPCION DEL PROYECTO	OBJETIVO	ASISTENCIA SOLICITADA	PERIODO ASIST. PREVISTO
4. MODELO DE DEMANDA, BAJO METODOLOGIA OLADE	Desarrollar una metodología de adaptación al país, del modelo de demanda de energía, desarrollado por OLADE e impulsado en sus países miembros.	Implantar en el país un Modelo de Pronóstico Económico-Energético, como herramienta de Planificación Energética, en la formulación de escenarios energéticos, tomando en consideración crecimiento económico, uso final de la energía e inversiones del sector.	Asistencia de experto en modelos matemáticos y sistemas.	

114

(38) 3

UNITED STATES INTERNATIONAL DEVELOPMENT COOPERATION AGENCY
AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D.C. 20523

LAC/DR-IEE-85-31

ENVIRONMENTAL THRESHOLD DECISION

Project Location	:	Central America Regional
Project Title and Number	:	Central America Energy Resources 596-0134
Funding	:	$10,200,000 (G)
Life of Project	:	Two years
IEE Prepared by	:	Reynold J. Bloom, Jr. LAC/DR/CEN
Recommended Threshold Decision	:	Negative Determination
Bureau Threshold Decision	:	Concur with Recommendation
Comments	:	None
Copy to	:	Dwight B. Johnson, Director LAC/DR
Copy to	:	Lars Klassen, LAC/DR/CEN
Copy to	:	Reynold J. Bloom, LAC/DR/CEN
Copy to	:	IEE File

James S. Hester Date MAR 22 1985

James S. Hester
Chief Environmental Officer
Bureau for Latin America
and the Caribbean

ANNEX A

INITIAL ENVIRONMENTAL EXAMINATION

I. Basic Project Date

Project Location:	Central America and Panama
Project Title:	Central America Energy Resources
Project Number:	596-0134
Funding:	$10,200,000 (G)
Life of Project:	2 Years
IEE Prepared by:	Reynold J. Bloom, Jr. LAC/DR/CEN
Date:	March, 18, 1985
Action Recommended:	Negative Determination

II. Description of Project

The Central America Energy Resources project is a new LAC Bureau initiative designed to address the problems in Central America related to energy and mineral resource exploitation and utilization. The goal of the project is to improve economic conditions in Central America and to help create employment through increased and more efficient utilization of the region's energy and natural resource endowment. The purpose of the project is to introduce new research methodologies into the region that will allow each of the participating countries to better analyze and assess their current and future energy needs, to develop non-traditional sources of energy such as geothermal and low-grade fossil fuel resources, and to more efficiently utilize their energy resources.

The project is composed of two major components:

1) A Regional Energy Situation Analysis/Data Base which will involve the collection and analysis of regional energy and resource data to be used to develop long term planning models and to assist in the formulation of energy and resource policy.

2) An Alternative Energy Resource Development component which will:

A. Provide assistance in the use of geothermal resources to generate electricity.

B. Assess potential industrial and domestic uses for peat and low grade coal.

C. Demonstrate the use of low temperature geothermal heat for commercial and agroindustrial uses.

Life-of-Project funding for the project is $10.2 million.

III. Impact and Evaluation

The project is primarily research and training oriented. There will be some small scale sampling of peat and other mineral resources but nothing on a scale to cause environmental concern. If initial research should lead to subsequent recommendations that a particular resource be exploited, such a recommendation would include a full analysis of the potential environmental impact of such exploitation. This will also be true of the geothermal component.

The Peat end use study proposed for the project will include an analysis of non-extractive uses for peat, i.e., the long term economic, environmental, and social benefits of leaving the peat in site and using it for agriculture, forestry, watershed management, and parks.

IV. Environmental Determination

The proposed project is not one which will have a significant environmental effect in and of itself. In view of the nature of the project and of the recommendations outlined in part III of this IEE, a negative threshold determination is recommended.

Dwight B Johnson
Director
LAC/DR

LAC/DR/CEN:RBloom:3/18/85/#05680:2-3402

VII Phase I Budget Summary

Project Description	Project Leader	FY85 $Millions
Geothermal		
Honduras Reconnaissance	Dr. R.J. Handal	1.7
Costa Rica	Dr. Robert J. Handal	
Miravalles Geothermal Development		.273
Reconnaissance		.157
Regionwide Equipment Purchase		.7
Direct Heat Application	Dr. F. Edeskuty	.215
Total		3.045
Peat		
Costa Rica Peat End Uses	Dr. K. Williamson	.41
Regionwide Energy Situation Analysis	Linda K. Trochi	.531
Unprogrammed Contingency AID	Dr. V.W. Loose	.4
Management and Evaluation	Dr. V.M. Loose	.1
Total		4.486

VII. PHASE I BUDGET SUMMARY

Project Description	Project Leader	FY '85 Millions
Geothermal		
Honduras Reconnaissance	Dr. Robert J. Hanold	$1.4
Costa Rica		
- Miravalles Geothermal Development	Dr. Robert J. Hanold	0.4
- Reconnaissance	Dr. Robert J. Hanold	0.2
Regionwide - Equipment Purchases	Dr. Robert J. Hanold	0.7
Direct Heat Applications	Dr. Frederick Edeskuty	0.4
Total Geothermal		$3.2
Peat		
Costa Rica Peat End Uses	Dr. Kenneth Williamson	0.5
Regionwide Energy Situation Analysis	Linda K. Trocki	1.1
Unprogrammed Contingency per AID	Dr. Verne W. Loose	0.4
Management and Evaluation	Dr. Verne W. Loose	0.1
		$5.2

5C(2) PROJECT CHECKLIST

Listed below are statutory criteria applicable to projects. This section is divided into two parts. Part A. includes criteria applicable to all projects. Part B. applies to projects funded from specific sources only: B.1. applies to all projects funded with Development Assistance loans, and B.3. applies to projects funded from ESF.

CROSS REFERENCES: IS COUNTRY CHECKLIST UP TO DATE? HAS STANDARD ITEM CHECKLIST BEEN REVIEWED FOR THIS PROJECT?

A. GENERAL CRITERIA FOR PROJECT

1. FY 1985 Continuing Resolution Sec. 525; FAA Sec. 634A; Sec. 653(b).

   (a) Describe how authorizing and appropriations committees of Senate and House have been or will be notified concerning the project; (b) is assistance within (Operational Year Budget) country or international organization allocation reported to Congress (or nor more than $1 million over that amount)?

   (a) Congress will be notified according to standard procedures.

   (b) YES.

2. FAA Sec. 611(a)(1). Prior to obligation in excess of $100,000, will there be (a) engineering, financial or other plans necessary to carry out the assistance and (b) a reasonably firm estimte of the cost to the U.S. of the assistance?

   (a) YES.

   (b) YES.

3.	FAA Sec. 611(a)(2). If further legislative action is required within recipient country, what is basis for reasonable expectation that such action will be completed in time to permit orderly accomplishment of purpose of the assistance?	None is required.
4.	FAA Sec. 611(b); FY 1985 Continuing Resolution Sec. 501. If for water or water-related land resource construction, has project met the standards and criteria as set forth in the Principles and Standards for Planning Water and Related Land Resources, dated October 25, 1973, or the Water Resources Planning Act (42 U.S.C. 1962, et seq.)? (See AID Handbook 3 for new guidelines.)	N/A
5.	FAA Sec. 611(e). If project is capital assistance (e.g., construction), and all U.S. assistance for it will exceed $1 million, has Mission Director certified and Regional Assistant Administrator taken into consideration the country's capability effectively to maintain and utilize the project?	N/A
6.	FAA Sec. 209. Is project susceptible to execution as part of regional or multilateral project? If so, why is project not so executed? Information and conclusion whether assistance will encourage regional development programs.	This is a regional project which will pursue similar activities in the several countries of Central America. A standardized data collection and policy formulation format will be emplo which will give the project wider, regional significance.

170

7. FAA Sec. 601(a). Information and conclusions whether projects will encourage efforts of the country to: (a) increase the flow of international trade; (b) foster private initiative and competition; and (c) encourage development and use of cooperatives, and credit unions, and savings and loan associations; (d) discourage monopolistic practices; (e) improve technical efficiency of industry, agriculture and commerce; and (f) strengthen free labor unions.	Resources discovered owing to the activities of this project will depend upon private initiative and competition if they are going to be exploited. The private sector will be actively involved in the actural exploitation of the resources. A major purpose of the project is to introduce new and modern research/ exploration methodologies into the region which will improve the technical efficiency of the energy/mineral resource sector.
8. FAA Sec. 601(b). Information and conclusions on how project will encourage U.S. private trade and investment abroad and encourage private U.S. participation in foreign assistance programs (including use of private trade channels and the services of U.S. private enterprise).	By enhancing the strength and independence of the judiciary and, as a result thereof, of the democratic institutions, the project will improve the climate for private trade and investment by U.S. enterprises.
9. FAA Sec. 612(b), 636(h); FY 1985 Continuing Resolution Sec. 507. Describe steps taken to assure that, to the maximum extent possible, the country is contributing local currencies to meet the cost of contractual and other services, and foreign currencies owned by the U.S. are utilized in lieu of dollars.	Participating Countries will be requested to share costs of country specific activities.
10. FAA Sec. 612(d). Does the U.S. own excess foreign currency of the country and, if so, what arrangements have been made for its release?	No.

11.	FAA Sec. 601(e). Will the project utilize competitive selection procedures for the awarding of contracts, except where applicable procurement rules allow otherwise?	YES.
12.	FY 1985 Continuing Resolution Sec. 522. If assistance is for the production of any commodity for export, is the commodity likely to be in surplus on world markets at the time the resulting productive capacity becomes operative, and is such assistance likely to cause substantial injury to U.S. producers of the same, similar or competing commodity?	N/A.
13.	FAA 118(c) and (d). Does the project comply with the environomental procedures set forth in AID Regulation 16. Does the project or prograam taken into consideration the problem of the destruction of tropical forests?	YES.
14.	FAA 121(d). If a Sahel project, has a determination been made that the host government has an adequate sysem for accounting for and controlling receipt and expenditure of project funds (dollars or local currency generated therefrom)?	N/A.

15. FY 1985 Continuing Resolution Sec. 536. Is disbursement of the assistance conditioned solely on the basis of the policies of any multilateral institution? NO.

B. FUNDING CRITERIA FOR PROJECT

1. Development Assistance Project Criteria N/A.

a. FAA Sec. 102(b), 111, 113, 281(a). Extent to which activity will (a) effectively involve the poor in development, by extending access to economy at local level, increasing labor-intensive production and the use of appropriate technology, spreading investment out from cities to small towns and rural areas, and insuring wide participation of the poor in the benefits of development on a sustained basis, using the appropriate U.S. institutions; (b) help develop cooperatives, especially by technical assistance, to assist rural and urban poor to help themselves toward better life, and otherwise encourage democratic private and local governmental institutions; (c) support the self-help efforts of developing countries; (d) promote

the participation of women in the national economies of developing countries and the improvement of women's status, (e) utilize and encourage regional cooperation by developing countries?

b. FAA Sec. 103, 103A, 104, 105, 106. Does the project fit the criteria for the type of funds (functional account) being used?

c. FAA Sec. 107. Is emphasis on use of appropriate technology (relatively smaller, cost-saving, labor-using technologies that are generally most appropriate for the small farms, small businesses, and small incomes of the poor)?

d. FAA Sec. 110(a). Will the recipient country provide at least 25% of the costs of the program, project, or activity with respect to whch the assistance is to be furnished (or is the latter cost-sharing requirement being waived for a "relatively least developed country)?

e. FAA Sec. 110(b). Will grant capital assistance be disbursed for project for more than 3 years? If so, has justification satisfactory to Congress been made, and efforts for other financing, or is the recipient country

"relatively least developed"? (M.O. 1232.1 defined a capital project as "the construction, expansion, equipping or alteration of a physical facility or facilities financed by AID dollar assistance of not less than $100,000, including related advisory, managerial and training services, and not undertaken as part of a project of a predominantly technical assistance character."

f. FAA Sec. 122(b). Does the activity give reasonable promise of contributing to the development of economic resources, or to the increase of productive capacities and self-sustaining economic growth?

g. FAA Sec. 281(b). Describe extent to which program recognizes the particular needs, desires, and capacities of the people of the country; utilizes the country's intellectual resources to encourage institutional development; and supports civil education and training in skills required for effective participation in governmental processes essential to self-government.

2. Development Assistance Project Criteria (Loans Only)

a. FAA Sec. 122(b). Information an conclusion on capacity of the country to repay the loan, at a reasonable rate of interest.

b. FAA Sec. 620(d). If assistance is for any productive enterprise which will compete with U.S. enterprises, is there an agreement by the recipient country to prevent export to the U.S. of more than 20% of the enterprise's annual production during the life of the loan?

3. Economic Support Fund Project Criteria

a. FAA Sec. 531(a). Will this assistance promote economic and political stability? To the extent possible, does it reflect the policy directions of FAA Section 102?

Yes. By making the region more self-sufficient in energy and other resources the project will improve the overall economic situation in the region.

b. FAA Sec. 531(c). Will assistance under this chapter be used for military, or paramilitary activities?

NO

c. FAA Sec. 534. Will ESF funds be used to finance the construction of, or the operation or maintenance of, or the supplying of fuel for, a nuclear facility? If so, has the President certified that such use of funds is indispensable to nonproliferation objectives?

NO

126

d.	FAA Sec. 609. If commodities are to be granted so that sale proceeds will accrue to the recipient country, have Special Account (counterpart) arrangements been made?	N/A.