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FINAL REPORT

ON

ENERGY CONSULTATIONS WITH THE

MINISTRY OF ENERGY

SOCIALIST REPUBLIC OF THE UNION OF BURMA

BY

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EXECUTIVE SUMMARY

Introduction

Energy consultations with the Ministry of Energy (MOE) and it's agencies were carried out by James A. West, under the sponsorship of the United States Agency for International Development and the Institute of International Education, from April 7 to June 5, 1988.

Purpose and Objectives

The major and most urgent objective was to assist MOE in the planning, development, distribution, and utilization of natural gas to substitute for other fuels and energy sources in Burma. Other major objectives were:

- To observe and assess practices in natural gas exploration, development, production, transmission, distribution, and utilization activities.

- To evaluate in-country technical capabilities and identify possible areas of technical assistance and training.

Findings and Conclusions

Burma's commercial energy demands are supplied almost entirely from it's own domestic resources of crude oil, natural gas, and hydropower. Most commercial energy consumption is in power generation, industrial use, and for transportation. Household and commercial use is largely from non-commercial sources of fuelwood and charcoal.

Burma has a substantial resource base and large remaining proved recoverable reserves of crude oil and natural gas; however, producing rates for both oil and gas are extremely low. Accelerated rates of exploration and development drilling and modern technologies in oil recovery methods are needed to improve producing rates. These, in turn, are needed to fuel the continued industrialization and economic development of the country.

The basic Rangoon natural gas distribution system is a well-designed and equipped, manually-operated flow and pressure regulation system. It distributes up to 30 MMCFD of gas supplied by free flow from the Payagon gas fields to industrial consumers in the Rangoon area. Given local conditions and restraints on resources, it is time-tested in three years of operation as adequate and satisfactory in providing uninterrupted gas deliveries to it's industrial users equivalent to 5,400 BPD of crude oil equivalent energy.

Natural gas utilization in the Rangoon area is expected to continue it's rapid growth rate, increasing from about 24 MMCFD in FY 1987 to as much as 140 MMCFD by FY 1997. Much of this growth will be in the industrial sector; however, MOE has implemented an aggressive program of gas substitution for petroleum products in the large transportation consuming sector. The use of CNG, LPG, and Methanol Blend in motor vehicles is off to a good start with an impressive conversion and testing program.

The Payagon gas fields have supplied all gas to the Rangoon area, beginning in April, 1985. Original estimates of gas reserves determined by volumetric methods indicated a proved reserve of more than 200 BCF in two productive reservoirs. Since production began, reservoir performance and the loss of several wells to water encroachment indicate that the proved recoverable reserve may be only about 92 BCF, giving a current reserve: production ratio of only about 10:1. Thus, the availability and long-term deliverability of this critical gas supply is a major concern.

A development and appraisal well drilling program and a reevaluation of recoverable gas reserves at Payagon is now in progress. This is the first step of the World Bank IDA Gas Development and Utilization Project, Phase I, planned for the expansion of Payagon gas supply by an additional 35 MMCFD, the construction of an 18-inch diameter pipeline transmission system parallel to the existing 10-inch pipeline to Ywama, and modernization of the Rangoon gas distribution system. These elements of the project depend on a continuous and reliable gas supply. Thus, it is concluded that this critical Rayagon development and appraisal study by urgently carried out and completed without delay.

Since it's establishment in 1985, the MOE, through the Energy Planning Department and MOC, the operating oil and gas company, has planned, directed, and implemented a key energy policy of natural gas development and utilization to substitute for liquid fuels. It has established an impressive record of accomplishment in gas fields development, pipeline transmission and distribution system construction and operation, and gas utilization. As a result, Burma has firmly established the "gas age" in the Rangoon area, despite severe investment capital constraints and other problems due to local operating conditions. Nevertheless, it is concluded that an even greater rate of gas utilization is necessary to make up for shortfalls in liquid fuels.

Technical assistance and training in natural gas engineering and technologies in the design, construction, and operation of modern natural gas transmission and distribution systems are needed to assist and accelerate gas utilization. There is a need for training in the use of modern computer programs in gas engineering technologies and in energy and economic planning and analytical techniques.

The UNDP has agreed to fund a Gas Utilization Study to assist the MOE Energy Planning Department in planning for the most efficient use of new gas supply. It is concluded that this study should provide MOE with a valuable quantitative model and the necessary computer capability and programs for operational use in energy planning and policy analysis.

Recommendations and Suggestions

A summary of major recommendations and suggestions follow:

1. It is recommended that the Payagon gas fields appraisal and development well program be completed as soon as possible in order to establish long-term gas supply and deliverability rates.

2. It is recommended that MOE continue it's accelerated gas utilization program, consistent with available gas supply and it's ability to construct necessary pipeline transmission and distribution systems. This should be done in accordance with the objectives of the World Bank IDA Gas Development and Utilization Project, which should be implemented without delay.

3. It is recommended that appropriate electrical current surveys be carried out as soon as possible for the design and installation of effective cathodic protection systems on the existing transmission and distribution pipelines.

4. It is suggested that the basic Rangoon gas distribution continue to be operated as a simple, manually-operated flow and pressure regulation system, until the IDA Phase I project is implemented. Then, convert it to a modern supervisory controlled system, equipped with telecommunications, telemetry, and related systems.

5. It is recommended that MOC develop and implement and emergency load shedding or service curtailment plan, in the event that gas flow is partially interrupted.

6. It is suggested that MOE continue it's aggressive program of substituting CNG, LPG, and Methanol Blend for liquid fuels in the transportation sector, but should firmly establish the relative economic feasibility of using these fuels to guide future efforts.

7. It is recommended that an office of Education and Training be established within MOE to receive, abstract, and disseminate technical, economic, management, financial, and other useful information. It should advise and assist operating companies in developing codes and standards, instructional manuals, and training courses.

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8. It is suggested that MOE develop a priority list of technical assistance and training subjects required to design, install, operate, and maintain the planned new technologies for modernizing the natural gas systems.

9. It is suggested that MOC begin now to select and qualify personnel for specialized academic, on-the-job or intern training in natural gas engineering and the technical skills required today and in the future for planned modern technologies and systems.

10. It is suggested that MOE Energy Planning personnel carefully monitor and participate in the UNDP Gas Utilization Study in order to develop expertise in the operational use of the planning models and computer programs developed therein.

11. It is recommended that MOE adopt a gas pricing policy having "take-or-pay" provisions, requiring a minumum payment by each industrial customer of at least 50 percent of normal monthly consumption or estimated demand. This would assure fair recovery by MOC of sunk investment in providing the gas service.

I. INTRODUCTION

Energy consultations with the Ministry of Energy of the Socialist Republic of the Union of Burma were carried out by James A. West, Energy Consultant, under the sponsorship of the United States Agency for International Development, Office of Energy, through the Institute of International Education, Department of Science and Technology, during the period from April 7 to June 5, 1988.

Purpose and Objectives

The main purpose of this professional engineering consulting assignment was to assist the Ministry of Energy (MOE) 1/ and its energy companies in the further development and utilization of the Nation's energy resources.

The major and most urgent objective was to assist MOE in the development, distribution, and utilization of natural gas. A key energy policy of the Government of Burma (GOB) is the rapid development of Burma's large but underdeveloped natural gas resources and the utilization of natural gas to substitute for declining oil production. Since its commencement three years ago, this policy has resulted in the substitution of up to 30 MMCFD of natural gas (5,400 BPD in the crude oil equivalent) within the Rangoon area, where it is utilized for electric power generation, industrial plant fuel, and a very small amount in the transportation sector. Other major objectives were:

To observe the practices of the various organizations involved in the executive direction, management, supervision, and conduct of natural gas exploration, development, production, transmission, distribution, and utilization activities.

To evaluate the technical capabilities in-country and identify the needs for technological assistance and services required for more efficient planning, development, operations, and maintenance of natural gas systems.

To identify areas of technical and management training that would be of most benefit to the program effort.

Work Program

The work program was carried out on the basis of the following planned weekly schedules, beginning on April 7, 1988:

Week No. 1 - Orientation and Initiation of Program
Weeks No. 2 & 3 - Basic Rangoon Natural Gas Distribution System

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1/ A description of abbreviations and acronyms, weights and measures, and related information used herein is presented in Appendix I.

Weeks No. 4 & 5 - Natural Gas Utilization in the Rangoon Area
Week No. 6 - Natural Gas Fields Exploration and Development
Week No. 7 - Natural Gas Transmission Systems
Week No. 8 - Natural Gas Supply Planning, Policy, and Project Development
Week No. 9 - Report Preparation, Discussions, and Departure

Work program details are shown in Appendix II, Detailed Program Plan for Energy consultations.

II..BACKGROUND

Burma is endowed with relatively abundant and varied sources and resources of energy. These include large forests as a source of fuelwood and charcoal, a large hydropower potential, sizeable and important crude oil and natural gas resources, and small sub-bituminous coal deposits.

Burma's Energy Sector

Total Energy Consumption - Most of Burma's total energy needs are met by traditional non-commercial sources. In recent years, approximately 75 percent of total energy consumption has come from fuelwood, charcoal, and biomass residues. Table 1. - Burma Total Energy Consumption by Source, presents total energy consumption data for selected recent Fiscal Years.

Table 1. - Burma Energy Consumption by Source, Percent

Source	FY 1974	FY 1979	FY 1984	FY 1986
Oil	16.5	20.3	16.4	11.3
Natural Gas	2.3	3.7	5.9	8.3
Coal	0.1	0.1	0.3	0.3
Hydropower	2.3	2.3	2.6	2.5
Biomass	78.8	73.6	74.8	77.6
Total	100.0	100.0	100.0	100.0
Consumption:				
In MBOE	41,142	54,354	68,433	73,167
In MBPDOE	113	149	186	201
Per Capita, BOE	1.38	1.65	1.88	1.93

As shown above, Burma's energy consumption per capita is quite low at less than 2 barrels of oil equivalent. The economy is largely agrarian and industrialization amounts to only 16 percent of gross domestic product (GDP). Energy intensity is a very low 21,000 Btu/GDP.

Commercial Energy Supply/Demand - Burma's commercial energy demand is supplied almost entirely from it's own domestic resources of crude oil, natural gas, hydropower, and a little coal. At times, some small quantities of coal and petroleum lubricants were imported to meet specific needs. Until April, 1988, the GOB followed a strict policy of self-reliance in crude oil production and refining, and prohibited trade in crude oil and petroleum products, but recently began limited crude oil imports to supply the Syriam refinery. This action was taken because of the steady decline in domestic crude oil production during recent years and to meet growing demands for liquid fuels.

Traditionally, petroleum products were the major supply source of commercial energy to the economy, but decreased supplies have reduced oil's share from 78 percent in FY 1974 to about 40 percent in FY 1987. The share of natural gas has grown rapidly from about 11 percent of commercial energy in FY 1974 to more than 42 percent in FY 1987. Utilization of natural gas in FY 1987 was as follows: Power generation, 50 percent; Petrochemical feedstocks, 33 percent; and Direct fuel, 17 percent.

The large river systems of Burma which drain the Irrawaddy, Chindwin, Salween, and Sittang basins provides a total hydropower potential of more than 100,000 MW. Currently, there is only about 700 MW of installed capacity. A number of mini-hydropower plant sites have been identified and several small stations with about 10 MW capacity are in operation. Long-term plans call for substantial development of hydropower where economically justified. Coal is mined in remote northern areas where it is consumed locally, accounting for only 0.3 percent of energy supply. Table 2. - Commercial Energy Consumption by Source, presents data for selected Fiscal Years.

Table 2. - Commercial Energy Consumption by Source, MMBOE

Source	FY 1974	FY 1979	FY 1984	FY 1986	FY 1987
Oil	6.79	11.03	11.22	8.27	6.20
Natural Gas	0.95	2.01	4.04	6.07	6.80
Coal	0.04	0.05	0.20	0.22	0.20
Hydropower	0.95	1.25	1.78	1.83	1.90
Totals:	8.73	14.34	17.24	16.39	16.10
Consumption: In MBPDOE	23.92	39.29	47.23	44.90	44.10

Most commercial energy consumption is in the transportation and industrial sectors. Currently, it is estimated that transportation accounts for about 40 percent of total use. Industrial use (including electric power generation) amounts to about 55 percent. Household and commercial use is a small 5 percent of the total.

Table 3. - Burma Electricity Consumption by Source, shows recent trends in electricity consumption by energy sources. Since FY 1979, the share of natural gas utilized in power generation has more than doubled and now accounts for 52 percent of total generation.

Table 3. - Burma Electricity Consumption by Source, Percent

Source	FY 1979	FY 1984	FY 1986	FY 1987
Hydropower	67.1	53.5	48.4	44.2
Thermal (steam)	3.4	2.6	2.8	2.6
Diesel	5.2	3.4	2.9	1.1
Natural Gas	24.3	40.5	45.9	52.1
Totals:	100.0	100.0	100.0	100.0
Consumption:				
In MMKwh	1,081	1,890	2,217	2,320
Per Capita, Kwh	33	52	59	63

Resources and Reserves

Burma has a substantial resource base in indigenous energy sources. As indicated above, it's undeveloped hydropower potential is quite large. Coal resources are quite limited. Original oil-in-place in oilfields discovered in Burma are estimated to exceed 2 billion barrels. Cumulative oil produced to date amounts to nearly 500 million barrels. Remaining proved recoverable crude oil reserves are estimated to be about 200 million barrels, based on current technologies and economic conditions. Proved natural gas reserves are believed to be in the range of 5 to 7 TCF, with about 85 percent in the offshore Martaban field.

Production rates for both oil and gas are extremely low in terms of depletion of the proved reserves. These depletion rates are about 3.5 percent for oil and less than 1.0 percent for natural gas. New technologies in enhanced oil recovery and increases in the rate of development drilling are needed to improve these depletion rates. The development of offshore natural gas reserves requires large capital investments in offshore drilling, production, processing, and transmission systems, especially if large Liquefied Natural Gas (LNG) plants are built for export markets. Currently, the international LNG market is saturated and large new plants are now being constructed elsewhere in the Far East. A recent Canadian study of Martaban gas fields development indicated that a large LNG venture now would be extremely risky, with capital costs in the order of US $3.00 per MMCFD capacity. Of course, there is the possibility that a small-scale plant (30 to 50 MMCFD) to serve the domestic market in Rangoon could prove to be economically feasible.

The accelerated development of these oil and gas resources is urgently needed for the continued industrialization and economic development of Burma. The offshore areas of Burma have always been open to exploration by international oil companies, but onshore areas have not been. So far, the international oil companies have thought the offshore areas to be gas-prone and therefore not sufficiently attractive, given the high costs of offshore development and the uncertainty of international gas markets. It is believed that some form of onshore-offshore participation agreement, based on a principal of production sharing related to performance (such as those recently negotiated by China and other area countries) could prove to be highly beneficial to Burma by attracting the capital and technological expertise of international oil companies to accelerate oil and gas development.

III. BASIC RANGOON NATURAL GAS DISTRIBUTION SYSTEM

The Rangoon area natural gas distribution system receives up to 30 MMCFD, supplied by free flow from the payagon gas fields via a 64-mile long, 10-inch dieameter pipelone. Delivery pressure to the Ywama city gate station ranges from 450 to 550 psig. Owing to the extremely favourable chemical composition of the natural gas (very dry with 93 percent methane content, no hydrogen sulfide or carbon dioxide, and low water vapor and gas liquids content) the Ywama city gate station operates only as a pressure regulation and gas measurement station. It is well designed and equipped with U.S. standard pressure recorders. Also, it has a pig trap, filteration system, and scrubbers, but they are not needed and are not used for regular operation. The pressure is regulated down to 100 psig fordelivery to the main 6-inch diameter gas distribution line of the basic Rangoon distribution system. This system is comprised largely of 6 and 4-inch diameter spurs to major industrial plants, and lateral pipelines provide further distribution via 2 to 4-inch diameter service lines from sub-stations at operating pressures of 25 to 50 psig. The communications system consists of a VHF radio network providing coverage to Payagon from Ywama and to all sub-stations. There are no vehicles equipped with this radio equipment. It is adequate for current use.

Findings and Conclusions

A summary of major findings and conclusions follow:

It is concluded that this basic manually-operated distribution system is adequate and satisfactory for current operation in consideration of local conditions and restraints on resources. In three years of operation, it is time-tested as satisfactory in providing uninterrupted gas service to it's industrial users. However, the start-up of service to Sittang via the just completed 56-mile long 10-inch and 9-mile long 8-inch diameter pipeline extension will limit the operational flexibility of the basic Rangoon distribution system once it commences deliveries of up to 7 MMCFD to the paper mill there.

As contemplated by the World Bank International Development Association (IDA) Gas Development and Utilization Project, Phase I for the expansion of Payagon gas supply by an additional 35 MMCFD by 1992, the existing gas distribution system would be up-graded and modernized. Ywama would be expanded and serve as a control and dispatch center for the transmission and distribution system. This would require the design and installation of a modern telecommunications, telemetry, and supervisory control and data acquisition system (SCADA), odorization, and filter system. Also, included is provision for cathodic protection for the existing pipelines and distribution system and for the new pipelines constructed for the project.

The lack of any cathodic protection system for the existing transmission and distribution system is concluded to be the most serious present deficiency of the system and poses a real threat of partial or total service interruptions due to pipeline leakage or failure.

The current distribution system grew in response to industrial conversions to gas service and the most direct and expedient pipeline spurs were constructed to serve the plants, and are operated at various pressures from 25 to 100 psig. A steady or uniform pressure distribution system operating at medium pressure (about 60 psig) would provide a more simple network design, operational flexibility, greater line pack or storage, and cost savings for future expansions.

The MOC has no formal training office or program. It carries out training on an ad hoc basis as required to meet the need for engineers and technicians. About twenty MOC management and engineering personnel have received training in the U.S. under the USAID/IIE CETP training program. The planned expansion of the gas system will require much more such training.

Recommendations and Suggestions:

Major recommendations and suggestions are as summarized below:

1. Carry out appropriate electrical current surveys for the design and installation of an effective cathodic protection system on existing transmission and distribution pipelines. A "smart pig" sonic survey could be used to determine the location and extent of existing pipeline corrosion by measuring the internal and external pitting and wall thickness of the pipe. The World Bank IDA project proposal provides consulting services for such measures.

2. Continue to operate the basic distribution system as a simple, manually-operated pressure regulation and measurement system. Defer modernization of the system until the IDA Phase I project is implemented. Then, convert it to a modern uniform pressure and flow monitoring and control system, equipped with telemetry, telecommunications, etc.

3. Develop and implement an emergency load shedding or service curtailment plan in the event gas flow is partially interrupted. Based on established priorities for the various classes of consumers, establish shut-offs or flow reduction sequences. Designate key personnel and instruct them in correct procedures to be followed.

4. Begin selection and training of MOC personnel now for academic or on-the-job or intern training in natural gas engineering and technical skills required today and in the design, operation, and maintenance of the planned new technologies.

5. Establish an Office of Education and Training within MOE as a central point for receiving technical, economic, financial, management, and other useful information. Such information could then be systematically reviewed, abstracted, and disseminated to appropriate officials or departments of the operating companies. Thereafter, it would be filed in a central technical library for future reference. Also, this office, with the advice and assistance of the operating companies, could develop Operating and Instructional Manuals, establish training courses, and develop requirements and criteria for educational programs. For example, in the natural gas distribution and utilization area, it could establish a handbook of gas industry codes and standards for design, operation, and maintenance.

IV. NATURAL GAS UTILIZATION IN THE RANGOON AREA

Total natural gas consumption in Burma has grown rapidly from 1.06 BCF in FY 1974/75, to 4.08 BCF in 1979/80, 18.01 BCF in 1986/87, and to 35.97 BCF in 1987/88. Gas utilization by major consuming sector was as follows: electric power generation, 50%; petrochemical feedstocks, 33%; industrial use as direct fuel, 17%; with a small use as transportation fuel. Natural gas accounted for 52% of Burma's total electrical power generation in FY 1987/88.

Total natural gas production in FY 1987/88 was 40.45 BCF. Of this, internal field use by MOC was 3.53 BCF and 0.95 BCF was flared.

Findings and Conclusions

Major findings and conclusions are as summarized below:

Natural Gas Utilization and Future Demand in the Rangoon Area -

Currently, all gas supply to the Rangoon area is from the Payagon gas fields. Gas utilization of up to 30 MMCFD is as follows: Electric power generation, 15 - 17 MMCFD; Refinery fuel, 5 - 7 MMCFD; and Industrial plants, 4 - 5 MMCFD.

Future gas demand is expected to increase by up to 75 MMCFD by 1992 upon completion of the 35 MMCFD IDA Gas Development and Utilization Project, Phase I. This project is for the further development of the Payagon gas fields and completion of a new 18-inch diameter pipeline to Ywama, parallel to the existing 10-inch pipeline.

In a move to accelerate the substitution of natural gas for liquid fuels, the MOE on it's own initiative has just completed the construction of a 64-mile long 10-inch and 8-inch diameter pipeline spur from Rangoon to Sittang to supply a paper mill with up to 7 MMCFD. Gas deliveries were started on April 20, 1988. This extension is consistent with projected plans under the IDA Gas Development and Utilization Project, Phase II. Also, MOE is in the process and nearing completion of converting the existing 10-inch diameter crude oil pipeline from Central Burma to Syriam to a natural gas pipeline to supply 3 to 5 MMCFD of natural gas from the Prome area oil and gas fields to industrial plants north of Rangoon. A 3-mile long tie-in pipeline from the converted crude oil line to the 6-inch gas pipeline sub-station as Hmawbi on the Rangoon distribution system is now being constructed for this purpose. The converted crude oil pipeline could ultimately supply up to 30 MMCFD of associated gas from Central Burma oil fields to the Rangoon area.

The generalized locations of these pipelines are as shown in Appendix III, Figure 1. - Natural Gas Transmission and Distribution Systems in the Rangoon Area, Burma, April, 1988.

MOE is already planning additional pipeline extensions to industrial areas East and South of Sittang and North of Pegu to Nyaunglebin and Toungoo. Long-term projected natural gas demand for power generation, industrial use, and expanded CNG stations for vehicles in this overall Rangoon area amounts to a grand total of 140 MMCFD by 1997. Thus, gas utilization is expected to quadruple and dominate commercial energy consumption in these areas. Details are shown in Table 4. - Payagon Natural Gas Demand Projections for Fiscal Years 1987 through 1997.

Table 4. - Payagon Natural Gas Demand Projections, MMCFD

Location	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Rangoon	16	18	20	35	40	42	44	47			
Syriam	7	7	7	11	12	14	16	18			
Pegu					2	4	4	5			
Twante				3	3	3	4	4			
Sittang		7	10	10	10	10	11	11			
Thaton/Myaingale							15	25			
Kyaiklat	1	2	3	4	5	5	5	5			
Nyaunglebin									11	11	11
Toungoo										14	14
Totals	24	34	40	63	72	78	99	115	126	140	140

To assist in planning for the efficient use of new gas supply, the UNDP has agreed to fund a Gas Utilization Study. Its objectives are to firm gas supply estimates and deliverabilities, develop gas demand forecasting capabilities, identify gas infrastructure requirements, and recommend optimal allocation among alternative uses, and suggest measures to accelerate gas demand and utilization.

It is concluded that the UNDP Gas Utilization Study should provide the MOE Energy Planning Directorate with a quantitative model and well-defined methodologies for supply/demand assessments, technical and economic feasibility evaluations, and policy analysis. MOE should closely monitor this study and end up with a valuable planning and policy analysis model for immediate operational use.

Natural Gas Utilization in the Transportation Sector - Burma's transportation sector accounts for about 50 percent of total commercial energy consumption in the na on. Further, it is the fastest growing consuming sector and one in which there is a high level of suppressed or unmet demand. The severe decline in domestic oil production and a long-time policy not to import crude oil or petroleum products reduced the available supply from slightly more than 21,000 BPD in FY 1980/81 to only 17,200 BPD in FY 1987/88, a drop of nearly 19 percent. In April, 1988, crude oil imports were begun in an effort to make up for some of the shortfalls in domestic crude oil supply to the Syriam refinery and to supplement petroleum products supply.

In response to a policy of developing and substitution of natural gas for liquid fuels whenever possible, significant steps have been initiated to utilize natural gas in the transportation sector. The potential for use of compressed natural gas (CNG), liquefied petroleum gases (LPG), and methanol-gasoline mixed fuels in motor vehicles, tractors, and boats has been under test for the past two years. To date, the following total number of gasoline and diesel-fueled vehicles and combustion engines have been converted by MOC to use CNG, LPG, and Methonal Blend (a mixture of 80 percent methanol and 20 percent gasoline).

CNG:		
	Motor Vehicles	185
	Tractors	2
	Total	187
LPG:		
	Motor Vehicles	879
	Tractors	99
	Pump Engines	59
	Total	1,037
METHANOL BLEND:		
	Motor Vehicles	6,985
	Boats	10
	Total	6,995

All conversions have been accomplished by MOC personnel. Tanks, vaporizers, pressure regulators, air mixers, and other equipment is manufactured and assemblied in Burma.

Performance testing of these converted vehicles is in progress. Costs are reported to be about US$ 200 to 240 per vehicle plus tankage for the CNG and LPG conversions. The high methanol to gasoline ratio (80:20) of the blended fuel used is an important technology application. In the United States, normally used methanol to gasoline ratios are 15:85. It is reported that vehicle conversion to methanol blend requires only a larger fuel jet in the carburetor and minor engine adjustments costing only a few dollars. This is a significant technical achievement in substitution of a natural gas derived fuel.

The potential for gas substitution is great because there are an estimated 110,000 to 120,000 motor vehicles in operation in Burma. CNG service stations have been built in Rangoon, Chauk, and at Yenangyaung. LPG and methanol blend is widely available at the major population centers in Burma.

It is concluded that gas utilization in the transportation sector is off to a good start with a very active conversion and testing program; however, its technical and economic feasibility has not yet been fully established.

Recommendations and Suggestions:

Major recommendations and suggestions are as follows:

1. It is recommended that MOE continue it's accelerated gas utilization program, consistent with available gas supply and it's ability to construct the necessary pipeline delivery systems. The recent system expansions are in accordance with the World Bank IDA Gas Development and Utilization Project objectives. Major industrial consumers are receiving urgently needed natural gas fuel to replace liquid fuels, which are then put to economic use elsewhere.

2. The long-term gas development and utilization plan of IDA should be implemented as soon as possible in order to firm up gas supply deliverability and provide the transmission and distribution systems required to expand and sustain gas utilization to desired levels.

3. It is suggested that MOE Energy Planning personnel be assigned to work closely with the UNDP Gas Utilization Study team and develop expertise in the development and operational use of the planning models. This could provide valuable on-the-job training and establish additional training needs.

4. It is recommended that MOE continue it's aggressive program of substituting CNG, LPG, and Methanol Blend for liquid fuels in the large transportation consuming sector. However, the comparative costs of producing these fuels, vehicle conversion costs, and the costs of distributing and marketing should be firmly established. This is necessary to determine the relative economic feasibility of these fuels and guide future efforts.

5. As gas utilization grows and new service connections are added to the distribution system, it is necessary to design gas connections to optimize network gas flow and minimize pressure drops. Its was suggested that mathematical network modelling techniques be used for such design planning. The Hardy-Cross method and it's possible application to the Rangoon system was explained to MOC engineers.

6. It was suggested that group discussions or seminars on new technologies and natural gas engineering practices used in the United States that may have specific application in Burma be conducted during my stay. Examples are the use of polypropylene plastic pipe, cathodic protection surveys and equipment, telemetry, and control systems.

V. PAYAGON NATURAL GAS FIELDS DEVELOPMENT

The Payagon Gas Fields, located about 65 miles southwest of Rangoon in the lower Delta Basin, consists of two commercial fields at the present time. Geologically, the productive gas sands occur in Tertiary (Miocene) age sediments of sands and alternating strata of shales and sands. The gas sands are found at depths from about 4,600 to 9,000 feet. Stratigraphic traps are formed by strata overlying deep basement highs. Commercial production is from the 4,600' sand of the "D" structure and the 7,700' to 8,300' sands of the "A" structure. The original discovery well flowed 6.5 MMCFD with 200 barrels of 60 degree API condensate.

The Payagon fields were developed and began limited production in 1981-82 and began supplying gas to Rangoon in April, 1985. Some 20 wells have been drilled on these two structures and drilling is now in progress there. Currently, 8 producing wells are supplying about 24 MMCFD to the pipeline to Ywama. Ten formerly productive gas wells have been watered out and are shut in.

Findings and Conclusions

A summary of major findings and conclusions follow:

The geology of the area is extremely complex. The gas reservoirs of the shallow "D" structure are found in random stratigraphic traps near or along fault lines, with the gas zones probably formed by upward migration along fault planes from hydrocarbon source formations in the strata above the igneous basement rocks. Many structural traps found updip of the 4,600 gas zones have tested only water. The deeper sands of the "A" structure are also quite complex, with gas reservoirs found in stratigraphic traps that are defined by depositional features, including igneous intrusives, dikes, non-conformities, pinch-outs, and faulting.

Owing to the great complexity of these geological features, the normal exploration practice of drilling on structural highs defined by geophysical seismic surveys results often in dry holes. Therefore, the exploratory drilling of many more appraisal wells than would normally be required are necessary to delineate these gas reservoirs or to discover others. The use of detailed seismic and gravity surveys to locate "bright spots" has proved to be more effective in finding these elusive gas reservoirs.

Currently, there are 5 rigs set up on locations in the area to drill appraisal and development wells. The drilling of one well has been completed and final electric logs are being run before abandonment. The remaining rigs are shut down waiting on casing and other drilling consumables. The drilling rigs must be moved in and set up on locations during a 4 to 5-month long dry season, because the fields are situated in low-lying marshes and rice fields which are impassable to heavy equipment during the long monsoon wet season. During this current season, a total of 6 wells are planned to be drilled, including 4 appraisal wells and 2 new producing wells.

The drilling rigs are standard light to medium depth (up to 15,000') and are of United States manufacture. They are quite adequate for drilling these wells and the MOC drilling crews are well-trained and experienced in the well drilling techniques required. The drilling has been greatly hampered by the lack of tubular goods and other drilling consumables. Likewise, last year there were many fewer wells drilled and completed because of the lack of these materials.

The IDA Payagon gas field appraisal and development program is designed to provide the funding to remedy these problems and provide the drilling information for a more accurate determination of proved recoverable natural gas reserves and the long-term deliverability rates required for the IDA Payagon Gas Development and Utilization Project, Phase I. Under this IDA program, 5 appraisal wells and 12 development wells are to be drilled. Funding is provided for imports of tubular goods, drilling tools, consumables, and parts for MOC rigs. About four years will be needed to complete this 17-well drilling program, with completion expected in 1992. It is concluded that this well drilling program should be given highest priority and completed as quickly as possible, given the short drilling season and related problems.

The well completion practices appear to be in accordance with U.S. practices and standards. Production casing is set and cemented through the producing zones and jet perforated in the upper part of the pay zone. Standard tubing is hung open-ended above the top of the producing interval. Wellheads are U.S. manufactured and conform to industry codes and pressure ratings. All surface equipment, seperators, pressure regulators, and gas flow measurement equipment is well designed and installed in conformance with industry standards. It is all manually operated and well maintained and is considered to be quite satisfactory for these gas fields, given the local conditions.

Recommendations and Suggestions

1. It is recommended that the Payagon appraisal and development well drilling program be given top priority and accelerated to assure completion as quickly as supplies and drilling conditions permit.

2. Depending on the progress and outcome of this IDA drilling program, it is suggested that MOC plan a more extensive appraisal and exploratory well drilling program. The extremely complex geological conditions will require more extensive drilling to find and delineate the gas-bearing stratigraphic traps in this region.

3. It is suggested that all current and past producing well records and logs be carefully reviewed to determine if poor well cementing and completion practices may have been responsible for water production problems and early watering out of some of these wells. If so, a workover program may be effective in restoring gas production in those wells through remedial measures and recompletion techniques. A light rig could be used for this purpose. Some of the low water-cut wells may be equipped with gas lift equipment to extend their producing life.

4. It is suggested that consideration be given to the use of directional drilling techniques to drill producing wells from appropriate existing well drilling sites. This would permit several well completions from one drilling location and obviate the delays caused by the time required to move rigs to newly prepared drilling locations. Time and cost savings could be substantial.

VI. NATURAL GAS PLANNING, POLICY, AND PROJECT DEVELOPMENT

The Ministry of Energy (MOE) was established in April, 1985 to plan, direct, and execute all energy policies of the Government of Burma. It is comprised of four national energy corporations: Myanma Oil Corporation, Petrochemical Industries Corporation, Petroleum Products Supply Corporation, and Electric Power Corporation, plus a new Energy Planning Department (EPD). EPD monitors all activities in the energy supply and demand sectors; performs energy supply/demand studies and forecasts; develops and recommends energy policy in fuels substitution and balancing of supply and demand; assists MOE in coordinating the activities of the corporations and monitors progress in the implementation of policies, programs, and specific projects; and initiates or conducts econometric studies and energy research and development projects.

Findings and Conclusions

A summary of major findings and conclusions follow:

The EPD conducts on-going natural gas supply/demand analyses and forecasts and monitors and recommends gas substitution and alternate uses to ease the supply shortages of liquid fuels. This requires the estimation of firm gas supplies and optimal gas allocations to the consuming sectors and regions. It does not have sophisticated modern quantitative models or computer programs to conduct these analytical studies; however, it is expected to acquire such computer equipment this year under an Asian Development Bank project.

The EPD is expected to grow from it's current small staff of 45 people to up to 200 in the next few years. It is now able to handle only the most urgent and important planning activities. It is concluded that this staff should be expanded as rapidly as qualified personnel can be trained and placed as resources will permit.

The success of natural gas substitution for liquid fuels in electric power generation and industrial use in the Rangoon area during the three years and the start of natural gas penetration of the transportation sector attest to the effectiveness of this planning and coordinating activity. Therefore, it is concluded that EPD has played and will continue to play a vital role in policy analysis and development, program initiation, and monitoring of activities.

Recommendations and Suggestions

Major recommendations and suggestions are as follows:

1. It is recommended that the EPD participate fully in the UNDP Gas Utilization Study and it's development and operational use of a modern computer program model for planning purposes. It is suggested that this capability could be used for detailed energy supply/demand balancies by region and sector; forcasting of gas allocation, substitution, cost-benefit analysis, and investment alternatives; and project planning for gas supply, development, production, transmission, and utilization.

2. It is suggested that the EPD develop a list, by priority of subject matter, of technical and economic training needs. This should include training in the use of modern computer programs and software selection, natural gas economics, cost accounting, pricing, and financial planning and forecasting.

3. It is recommended that the selection and qualification of candidates for training be started now and coordinated with the implementation of the IDA Payagon Gas Development and Utilization project.

4. It is suggested that expansion of the overall staff of EPD be given priority so that it may develop the capabilities to assume more of the important planning, coordinating, and monitoring responsibilities of MOE.

VII. TECHNICAL ASSISTANCE AND TRAINING NEEDS

Technical assistance and training needs within MOC and the MOE Energy Planning Department (EPD) are discussed in each of the preceding sections of this report. This section presents a summary of findings and suggestions for consideration of training, in order of priority.

Findings and Conclusions

Based upon observations and consultations with MOC and MOE EPD officials, I have concluded that there is an equally important or priority need for technical assistance and training in both of these organizations. This conclusion pertains only to the specialized natural gas engineering technologies and the energy planning subjects which were the specific areas of my consultations.

In MOC, top priority should be given to on-the-job or intern training in specialized natural gas technologies in the fields of natural gas transmission and distribution systems design, installation, operations, and maintenance. Of secondary priority, but of high importance, is academic training in basic Natural Gas Engineering subjects and in Petroleum Engineering training in Enhanced Oil Recovery (EOR) technologies.

In EPD, the top priority is for technical assistance and training in energy and economic planning technologies at academic institutions offering specialized courses in modern computer modelling in energy and economics, and in energy policy analysis and management.

Recommendations and Suggestions

Recommendations and suggestions for technical assistance and training are as summarized below:

These recommendations and suggestions are not intended to supercede or supplant the currently established and approved training programs of MOE; rather, they are offered for consideration in formulating future training or in revising or modifying the present program to include these important subjects.

The following list, by type of training and subject, is recommended for MOC and MOE EPD technical training, respectively. The suggested order of priority of technical training subjects is as listed in numerical order.

MOC

Specialized on-the-job or intern training at selected gas utilities and/or gas technology institutes in the design, installation, operation, and maintenance of natural gas transmission and distribution systems. Specific subjects for such technical training are:

1. Pipeline cathodic protection surveys and systems.
2. Modern supervisory flow and pressure control and data acquisition systems (SCADA).
3. Telecommunications and telemetry.
4. Natural gas filterization and odorization.
5. Pipeline and compressor station design and construction.
6. Natural gas system survielance, security, and maintenance.

Basic Natural Gas Engineering training at academic institutions specializing in natural gas, such as Texas A & I, Texas A & M, University of Oklahoma, and others. Specific subjects should include:

1. Natural gas well drilling and completion practices.
2. Well testing and production rates.
3. Reserve estimation and gas deliverability.
4. Gas testing and data collection.
5. Production, gathering, and treatment facilities.
6. Transmission pipeline design and operation.
7. Compressor station design and operation.

MOE - Energy Planning Department

Specialized academic training at selected institutes in energy and economic planning, including analytical techniques, modelling, and methodologies. Specific subjects should include:

1. Natural gas economics.
2. Natural gas cost accounting and pricing.
3. Supply/demand planning and forecasting.
4. Use of modern computer programs and selection of software.
5. Cost-benefit analysis and rate of return.

ABBREVIATIONS AND ACRONYMS:

CNG	Compressed Natural Gas
EPC	Electric Power Corporation
GOB	Government of Burma
IDA	International Development Association
LPG	Liquefied Petroleum Gas
MOC	Myanma Oil Corporation
MOE	Ministry of Energy
PGDP	Payagon Gas Development Project
PIC	Petrochemical Industries Corp.
PPSC	Petroleum Products Supply Corp.
SCADA	Supervisory Control and Data Acquisition
UNDP	United Nations Development Program

CURRENCY:

As of April, 1988

Currency unit = Kyat (K)
K 1.00 = 100 Pyas
K 6.162 = US $ 1.00

FISCAL YEAR:

Government of Burma Fiscal Year (FY) is from April 1 - March 31.

WEIGHTS AND MEASURES:

1 Barrel (Bbl)	=	42 US gallons, 0.159 cubic meters
1 British Thermal Unit (BTU)	=	0.252 kilo calories (kcal)
1 Metric ton (MT)	=	7.5 Bbl of oil (0.85 sp. gr.)
1 Toe	=	Tons oil equivalent in heating value
BPD	=	Barrels per day
BOE	=	Barrels oil equivalent in heating value
BCF	=	Billion (1,000 million) cubic feet
MMBbl	=	Million barrels
MCF	=	Thousand standard cubic feet
MCFD	=	1,000 standard cu. ft. per day
MMCF	=	Million standard cubic feet
MMCFD	=	1,000,000 standard cu. ft. per day
MW	=	Megawatt (1,000 kilowatts)
TCF	=	Trillion (1,000 billion) standard cubic feet

Appendix II

DETAILED PROGRAM PLAN FOR ENERGY CONSULTATIONS BY JAMES A. WEST WITH MINISTRY OF ENERGY (MOE) OF THE SOCIALIST REPUBLIC OF THE UNION OF BURMA

PURPOSE:

To provide professional engineering consulting services to assist the appropriate Burmese energy agencies in the further development of the Nation's natural energy resources.

OBJECTIVES:

The major and most urgent objective is to assist the MOE in the development and utilization of natural gas resources. This involves performing all relevant natural gas engineering consultations relative to: wells and gathering systems, gas treatment and liquids recovery facilities, gas pipeline transmission systems, and most especially the Rangoon natural gas distribution and utilization systems that are now supplied by the Payagon gas fields.

Other major objectives are: an observation of the practices of the various organizations involved in the executive direction, management, and conduct of natural gas exploration, development, production, transmission, distribution, and utilization activities.

To evaluate the technological capabilities in-country and identify the needs for technical assistance and services for more efficient development and operations.

To identify areas of technical and management training that could assist the project effort.

PROGRAM PLAN:

April 4 - Depart Daytona Beach. Overnight in San Francisco.
April 5 - Enroute to Hong Kong.
April 6 - Time change. Overnight in Hong Kong.

Week No. 1 - Orientation and initiation of program.

April 7 - Arrival in Rangoon via Bangkok.

April 8 - Meetings with USAID/Rangoon and MOE officials. Discussed preliminary work requirements and initiated detailed program plan preparation with U Tin Tun.

April 9 - Assigned office. Established initial contacts and began to schedule appointments with MOE officials. Prepared suggested program and set up initial meeting schedule.

April 10 - Day off.

April 11 - Meeting with Minister U Sein Tun, Deputy Minister U Than Nyunt, U Tin Tun and other officials of the Energy Planning Department. Discussed assignment and major interests of natural gas distribution and utilization. Senior gas engineers of Myanma Oil Company (MOC) assigned as assistants.

Met with Mr. Christopher Szymanski, DCM US Embassy and Mrs. Jean Szymanski at lunch to discuss Burma energy situation and US Department of Energy Secretary John Herrington visit on April 21 and 22.

April 12 - Meetings with MINISTRY and MOC officials to discuss plan and schedule visits to natural gas distribution system. Observed and discussed organization, management, and operating conditions of existing system.

April 13 - National holiday for water festival. Will visit and inspect natural gas facilities in and around Rangoon, including city gate station, pipeline, industrial distribution system, and plant utilization services.

WEEKS NO. 2 and 3 - Basic Rangoon natural gas distribution system.

April 14 - Examine the existing industrial gas distribution system design, operating characteristics, load factors, peak demands, and other service conditions.

April 15 - Inspect natural gas facilities and installations, including transmission line, main lines, laterals, and service connections.

April 16 - Inspect design and operation of pressure regulation, scrubbing, and metering facilities.

April 17 - Day off.

April 18 - Examine operation and maintenance installations, equipment and crews. Determine practices and problems.

April 19 - Review natural gas delivery metering, billing, and pricing activities.

April 20 - Discuss local or in-country availability of gas distribution equipment and supplies, such as meters, regulators, steel and plastic pipe, fittings, etc.

April 21 - Determine in-country availability of construction equipment, materials, and supplies.

April 22 Discuss and examine safety and security of gas distribution lines and installations.

April 23 Develop recommendations and suggestions for improving the gas distribution system, technical assistance, and training needs.

April 24 - Day off.

April 25 - Discuss findings and conclusions with MOE and operating company officials.

April 26 - Review plans and programs necessary to implement short-term recommendations.

April 27 - Review long-term plans and programs suggested for the gas distribution system.

WEEKS NO. 4 and 5 - Natural Gas Utilization and Future Damands

April 28 - Review current industrial gas demand for power generation, plant fuel, and other large burner use.

April 29 - Examine petrochemical feedstock demand including that for methanol, ammonia, and fertilizers.

April 30 - Review current transportation sector demand for CNG (compressed natural gas), LPG (liquefied petroleum gases), and methanol for blending with gasoline as motor fuel.

May 1 - Day off.

May 2 - Develop technical assessment of facilities and current project needs.

May 3 - Discuss and examine facilities, equipment, and procedures used in operation and maintenance of gas supplies to users.

May 4 Discuss feasibility studies, plans, and financial analysis of gas utilization prospects.

May 5 Review status of gas utilization pilot plants now in operation or in planning stage.

May 6 - Discuss possible gas utilization prospects, such as LNG exports.

May 7 - Develop suggestions and recommendations for gas utilization studies, technical assistance, and training needs.

May 8 - Day off.

May 9		Discuss findings and conclusions with MOE and operating company officials.
May 10		Review plans and programs to implement short-term recommendations.
May 11	-	Review long-term plans and programs.
WEEK NO. 6	-	Natural Gas Field Exploration and Development
May 12	-	Discussion of natural gas reservoir characteristics, reserves, performance, and state of depletion.
May 13	-	Establishment of well and field production capacities and sustained deliverability.
May 14	-	Determination of MEP (most efficient and economical producing rates.)
May 15	-	Day off.
May 16	-	Inspect and evaluate gas gathering, separation, treatment, and other surface facilities required.
May 17	-	Discuss operation and maintenance problems and needs.
May 18	-	Develop recommendations for gas field development studies, including costs and probable returns from gas deliveries, timing, pricing, cash flows, and producing life expectations.
WEEK NO. 7	-	Gas Transmission Systems and projected requirements.
May 19	-	Inspect and discuss existing pipelines, gas mains, and delivery systems.
May 20	-	Determine design, construction practices, and state of technology.
May 21	-	Inspect natural gas liquids recovery, field gas use, and intermediate deliveries.
May 22		Day off.
May 23		Observe operation and maintenance facilities, practices, and equipment.
May 24	-	Observe operations control, communications, telemetry, and cathodic protection practices.
May 25	-	Develop recommendations and suggestions for current transmission system and projected future requirements.

WEEK NO. 8 — Natural Gas Supply Planning, Policy, and Project Development

May 26 - Discussion of plans for Payagon II or offshore supplies and required technical assessments and development options.

May 27 - Program selection and economic evaluations, with financial requirements and risk analysis.

May 28 - Project decision and approval of policy process, initiation of project, organization, and assignment of tasks.

May 29 - Day off.

May 30 - Implementation of project and scheduling of work elements to completion.

May 31 - Development of recommendations and suggestions for planning and policy analysis.

June 1 - Begin write up of final report.

WORK COMPLETION AND DEPARTURE

June 2 - Report preparation.

June 3 - Report preparation.

June 4 - Presentation and discussion of report.

June 5 - Departure.

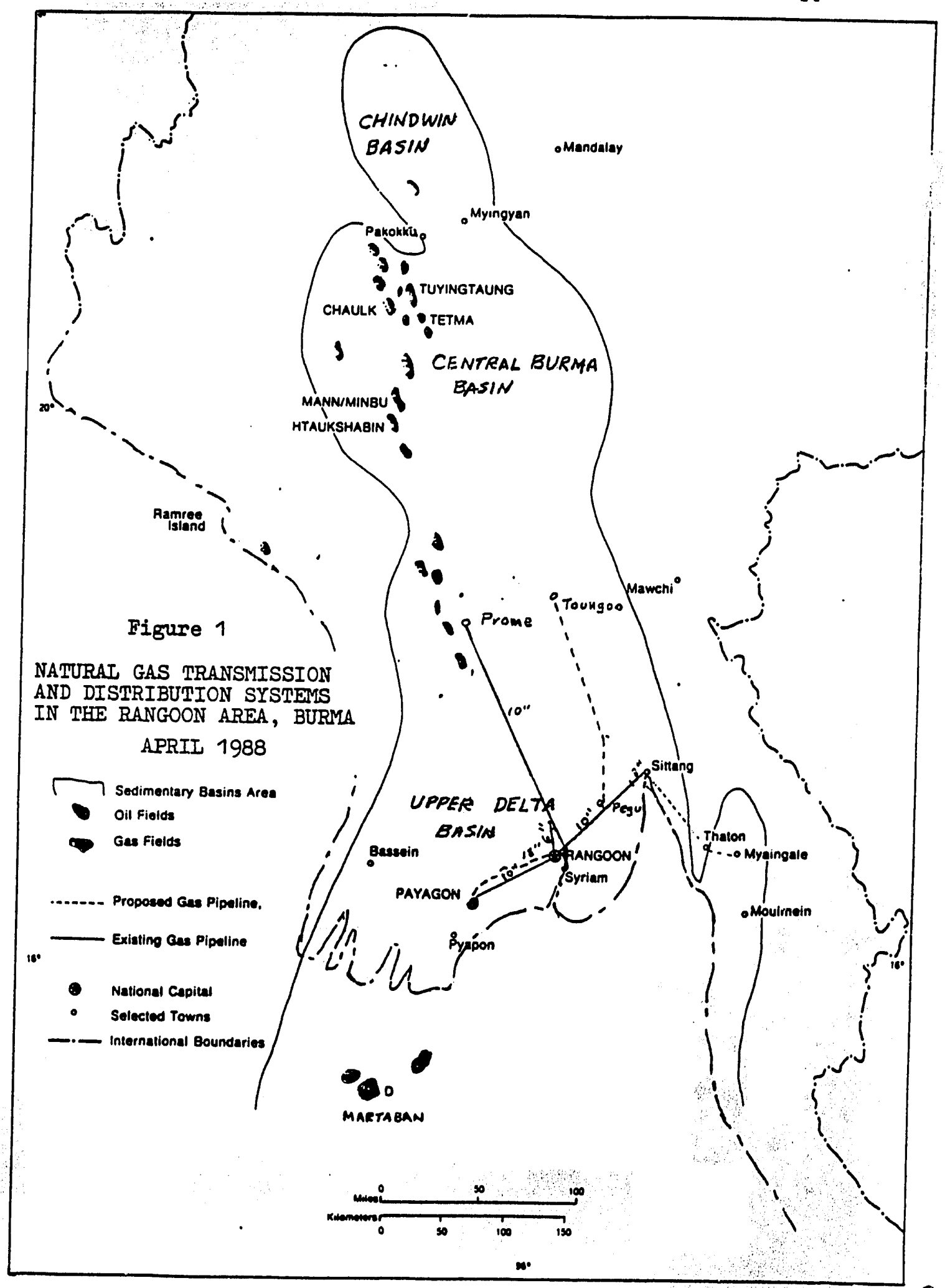

Figure 1

NATURAL GAS TRANSMISSION AND DISTRIBUTION SYSTEMS IN THE RANGOON AREA, BURMA

APRIL 1988