THE FEASIBILITY STUDY REPORT
ON
THE INTEGRATED LPG PROJECT (PHASE III)
IN
THE SOCIALIST REPUBLIC
OF THE UNION OF BURMA

OCTOBER 1985

JAPAN INTERNATIONAL COOPERATION AGENCY

THE FEASIBILITY STUDY REPORT
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PREFACE

In response to the request of the Government of the Socialist Republic of the Union of Burma, the Government of Japan decided to conduct a feasibility study on the Project for the Integrated Liquefied Petroleum Gas (Phase III) and entrusted the study to the Japan International Cooperation Agency (JICA). The JICA sent to Burma a survey team headed by Mr. Tetsuhiko Tsunoda from 26 April to 17 May, 1985.

The team exchanged views on the project with the officials concerned of the Government of Burma and conducted a field survey in the Kyangin areas with cooperation of the Burmese officials concerned. After the team returned to Japan, further studies were made and the present report has been prepared.

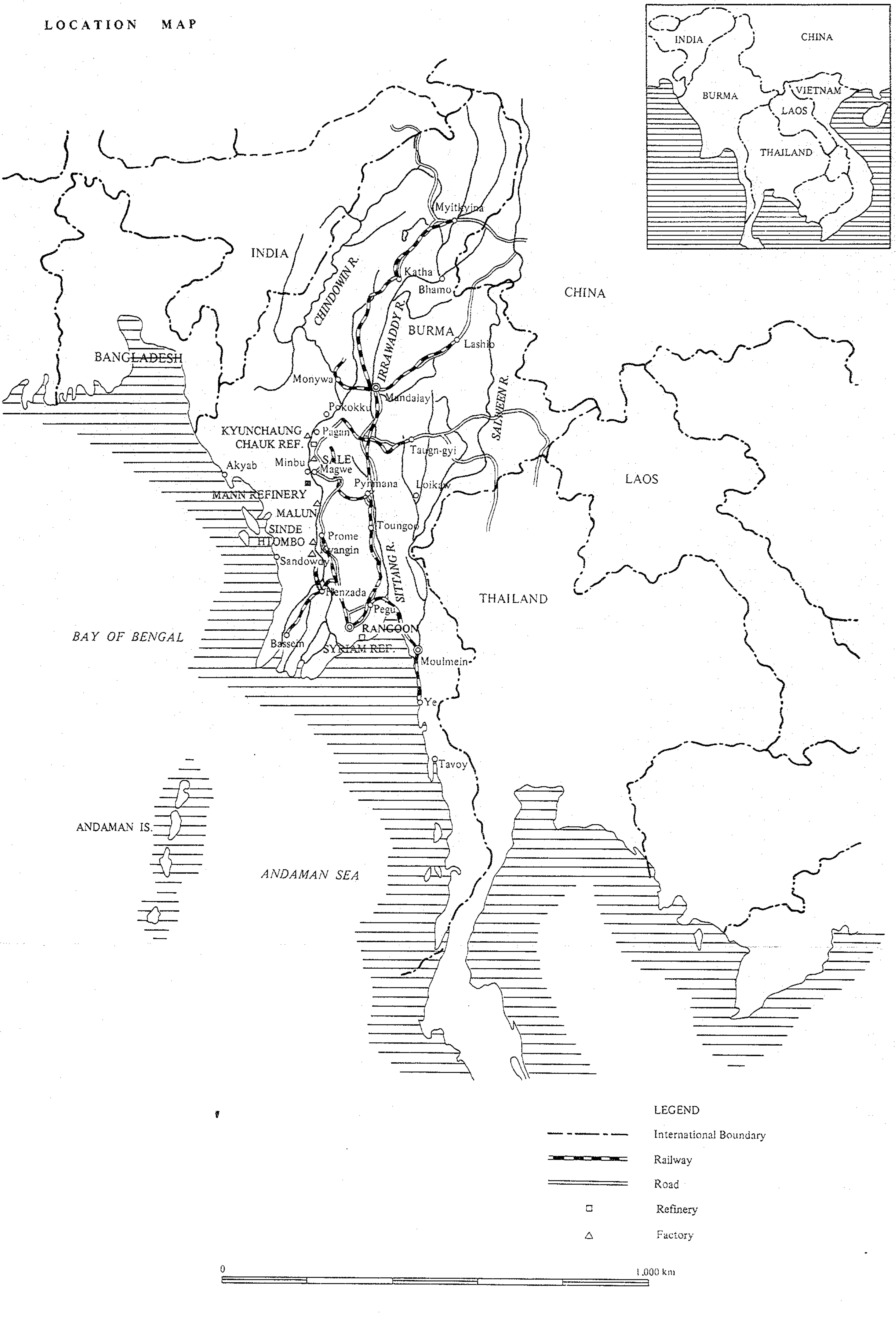
I wish to express my deep appreciation to the officials concerned of the Government of the Socialist Republic of the Union of Burma for their close cooperation extended to the team.

October, 1985

Keisuke Arita

Keisuke Arita
President
JAPAN INTERNATIONAL COOPERATION AGENCY

LOCATION MAP



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ABBREVIATIONS

General

C & F	Cost & Freight
CIF	Cost Insurance and Freight
FOB	Free On Board
G.D.P.	Gross Domestic Product
JIS	Japanese Industrial Standard
K	Kyat(s)
Lakh	1.0 Lakh = 100,000
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
R/P	Reserves/Production
US$	United States Dollar(s)
¥	Japanese Yen
FS	Feasibility Study
CTS	Contribution to the State
ID	Import Duty

Organization and Others

CIC	Ceramic Industries Corporation
EPC	Electric Power Corporation
GOCS	Gas & Oil Collecting Station
HIC	Heavy Industry Corporation
JICA	Japan International Cooperation Agency
MOC	Myanma Oil Corporation
PCS	Petrochemical/Corporation of Singapore
PIC	Petrochemical Industries Corporation
PPSC	Petroleum Products Supply Corporation
PTC	Post and Telecommunication Corporation
TG	Thai International Air Ways
TSC	Technical Service Corporation

Units

Time

Y	Year
M	Month
D	Day
H, h	Hour
Min, min	Minute
Sec, sec	Second

Length

m	Meter
Km	Kilometer

Area

cm^2	Square Centimeter
m^2	Square Meter
Km^2	*Square Kilometer*
ha	Hectar (= 10,000 m^2)

Volume

l	Liter
Kl	Kilo Liter
m^3	Cubic Meter
SCF	Standard Cubic Feet (= 0.0268 Nm^3)
SCFD	Standard Cubic Feet per Day
G	Gallon (= 3.785 l)
I.G.	Imperial Gallon (= 4.546 l)
B	Barrel (= 0.1589 Kl)
BBL	Barrel
BPCD	Barrel per Calendar Day
BPSD	Barrel per Stream Day

Weight

g	Gram
Kg	Kilo Gram
T, Ton	Ton
DWT	Dead Weight Ton

Pressure

Kg/cm^2	Kilogram per Square Centi Meter
Kg/cm^2g	Kilogram per Square Centi Meter Gauge
psi	Pound per Square Inch (= 0.07031 Kg/cm^2)
psig	Pound per Square Inch Gauge

Electrical Units and Others

V	Volt
kV	Kilo volt
kVA	Kilo volt Ampere
W	Watt
kW	Kilo watt
kWh	Kilo watt Hour (= 860 Kcal = 3,413 BTU)
Hz	Hertz (Frequency)
ACSR	Aluminium Conductors Steel Reinforced
CT	Current Transformer
DS	Disconnecting Switch
HTr	House Service Transformer
MCM	Mega Circular Mil
MTr	Main Transformer
NGR	Natural Grounding Resistor
PCB	Porcelain-clad Oil Circuit Breaker
SSB	Single Side Band

Chapter 1

INTRODUCTION

Chapter 1. INTRODUCTION

1.1 Background and Survey

In the Socialist Republic of the Union of Burma (hereinafter referred to as Burma), the oil output has increased year by year since the Mann Oil Field along the midstream of the Irrawaddy River was found in 1970. It came up to 11,020,000 B/Y in 1979 and the amount of 1,000,000 B was exported to Japan at the same year. However, since then the oil output had not been increasing substantially. (Refer to Table 1-1)

As for natural gas (or associated gas), the Prome Oil Field, Shwepyitha Oil Field, Myanaung Oil Field and Htantabin Oil Field, along the midstream of the Irrawaddy River were developed one after another beside the Mann Oil Field. The gas is in active utilization. It is used as a fuel in the gas turbine power generation plants, and factories such as cement mills. It is also used as material gas in petrochemical plants like fertilizer plants (in future methanol plants). (Refer to Table 1-1)

Table 1-1 Production of Crude Oil and Natural Gas in Burma

	1980/81	1981/82	1982/83	1983/84 (Provisional actual)	1984/85 (Provisional)	1985/86 (Target)
Crude oil (10^3 B/Y)	10,100	10,447	9,789	10,168	11,761	12,504
Natural gas (10^6 SCF/Y)	14,837	14,878	17,400	18,190	24,796	44,902

Source: REPORT TO THE PYITHU HLUTTAW on the Financial, Economic and Social Conditions of the Socialist Republic of the Union of Burma for 1985/86 by MINISTRY OF PLANNING AND FINANCE (1985).

On the other hand, Burmese Government has planned more effective utilization of the natural gas and off gas from Mann Refinery which has been operating since 1982. According to its plan propane (C_3) and butane (C_4) in the off gas and in associated gas of the oil fields previously mentioned will be recovered as LPG and most of it will be exported. In materialization of the above planning, it has been requested by the Burmese Government to the Japanese Government to perform survey for the feasibility study to be designated as Phase III of the "Integrated LPG Project in Burma". The Project will consist of Phase I-part 1, Phase I-part 2 and Phase II which are under implementation, and this Phase III which is currently on planning stage. Based on the above request, the Japanese Government entrusted the undertaking of the said feasibility study to the Japan International Cooperation Agency.

The outline and the progress of the Integrated LPG Project in Burma is as shown in Table 1-2.

Table 1-2 Progress of "Integrated LPG Project in Burma"

Phase	Outline of plan	LPG output (T/Y)	Shipment for export (T/Y)	Completion	Remarks
–	Construction of Mann Refinery (25,000 B/D) (topper, reformer, coker, etc.) and jetty	13,500 (18,000 including domestic use 3,000)	–	1982	
Phase I -part 1	Construction of coker (5,200 B/D) at Syriam Refinery	6,900 (8,000)	5,900 (8,000)	Estimate 1985	
Phase I -part 2	Construction of terminal for LPG transportation at Mann and Syriam Shipbuilding of four barges	–	30,000 (45,000)	Estimate 1985 A part of them enter service	
Phase II	Construction of LPG extraction plant (24 x 10^6 SCFD) at Mann GOCS.	30,000 (30,000)	–	Estimate 1986	
Phase III	Construction of LPG extraction plant (50 x 10^6 SCFD) and terminal and jetty at Kyangin Shipbuilding of three big barges	61,000 (25,000)	61,000 (25,000)		
Total		111,400 (81,000)	96,900 (78,000)		

Figure in parentheses is the amount of output and shipment at planning of Phase I - part 2 and Phase II (1981).

1.2 Outline of the Project

The contents of the "Integrated LPG Project" (Phase III) are as follows.

LPG extraction plant, terminal and jetty will be constructed around Kyangin which is located about 200 km up from the mouth of Irrawaddy River. Most of (50×10^6 SCFD) associated gas (rich gas) produced from each oil field of Shwepyitha, Myanaung and Htantabin will be processed, and propane and butane will be recovered as LPG. Then all of the amount (61,000 T/Y) is planned to be exported. By-product gas (lean gas) will be supplied instead of rich gas to the current consumers (cement mill, power station and in future methanol plant).

The project also includes piping construction for sending associated gas to the extraction plant, as well as the construction of power transmission line from the power station.

Product LPG will be sent from Kyangin to Syriam Terminal nearby Rangoon by 600 T capacity river barges (three days for down stream sailing, five days for upstream sailing). After storage for a while in LPG tanks in the Syriam Terminal, it will be charged to pressurized LPG ocean tankers (1,000 T to 1,500 T capacity) and exported to neighboring countries such as Singapore. The total exporting amount of LPG will be 96,900 T/Y including the output of Phase I and Phase II.

1.3 Purpose and Scope of Survey

The survey is based on the official request by the Burmese Government. The purpose of survey is to examine the feasibility of the "Integrated LPG Project" (Phase III) (hereinafter referred to as Phase III), as well as to review the current situation of Phase I-part 1, Phase I-part 2 and Phase II.

The scope of survey is based on the following document in April 1985;

"Scope of Work for the Feasibility Study on the Integrated Liquified Petroleum Gas Project (Phase III) in the Socialist Republic of the Union of Burma agreed upon between the Japan International Cooperation Agency and the Petrochemical Industries Corporation".

The concrete scope of survey are as follows:

1) Discussion on possible supply of associated gas (rich gas).

2) Demand of LPG.
3) Discussion on size and constitution of LPG extraction plant, terminal and jetty.
4) Discussion on construction site of LPG extraction plant.
5) Discussion on method, size and constitution for transportation of associated-gas (rich gas), by-product gas (lean gas) and product LPG.
6) Discussion on transportation of equipment and materials for plant construction.
7) Dispatch of supervisors in charge of construction and construction and trial operation.
8) Discussion on schedule of construction.
9) Discussion on related infrastructures.
10) Discussion on power transmission lines.
11) Discussion on communication installations.
12) Estimation of amount of investments.
13) Financial and economic evaluation.
14) Recommendation

1.4 Constitution of Survey Team

The members of the survey team are as follows:

Team Leader : Mr. Tetsuhiko Tsunoda
Process Engineer : Mr. Muneteru Yoshizawa
Mechanical Engineer : Mr. Masatoshi Harada
Civil Engineer : Mr. Akira Nagumo
Marketing Engineer : Mr. Shinji Izume
Electric Engineer : Mr. Saburo Mizuno
Economist : Mr. Masaaki Awamoto
Coordinator : Mr. Yuusuke Kitamura

1.5 Field Survey

During the term of field survey, the survey team made an effort to obtain necessary data. The team also collected much data by inspections of the Plant site, the terminal and the jetties for the project. The details of the survey team's schedule in field are as follows:

1st: Apr. 26 (Fri.) : Leave Tokyo at 17:20 p.m. by TG741
: Arrive at Bangkok at 21:30 p.m.

2nd: Apr. 27 (Sat.) : Leave Bangkok at 14:50 p.m. by TG305
: Arrive at Rangoon at 15:30 p.m.

3rd: Apr. 28 (Sun.) : Discussion within the Team

4th: Apr. 29 (Mon.) : (PM) Meeting at PIC

5th: Apr. 30 (Tue.) : (AM) Visit the Japanese Embassy and Japan International Cooperation Agency
: (PM) Discussion at PIC

6th: May 1 (Wed.) : Discussion within the Team

7th May 2 (Thu.) : (AM) Discussion at MOC
: (PM) Joint Discussion with TSC/PIC

8th: May 3 (Fri.) : (AM) Discussion at PIC
: (PM) Jont Discussion with PIC/EPC

9th: May 4 (Sat.) : (AM) Visit Syriam Refinery, Syrima LPG Terminal and Jetties

10th: May 5 (Sun.) : Go to Seiktha from Rangoon

11th: May 6 (Mon.) : Survey Kyangin the North Site and the South Site
: Survey Kyangin LPG Jetty site

12th: May 7 (Tue.) : Survey Myanaung Power Station
: Survey Myanaung Gas Field
: Survey Myanaung Gas Control Station
: Survey Transmission-line route from Myanaung Power Station to Plant site

13th: May 8 (Wed.) : Survey Kyangin Cement Mill
: Survey Kyangin Cement Jetty

		: Survey Seiktha Methanol Plant : Survey Seiktha Methanol Jetty
14th:	May 9 (Thu.)	: Survey Shwepyitha Oil Field : Survey Htantabin Oil Field : Survey Methanol Temporary Jetty
15th:	May 10 (Fri.)	: Return to Rangoon from Seiktha
16th:	May 11 (Sat.)	: (AM) Discussion within the Team : (PM) Discussion of questionnaire content at PIC
17th:	May 12 (Sun.)	: Discussion within the Team
18th:	May 13 (Mon.)	: (AM) Joint Discussion with PIC/TSC/EPC : (PM) Joint Discussion with PIC/TSC/EPC
19th:	May 14 (Tue.)	: Joint Discussion with PIC/TSC/EPC
20th:	May 15 (Wed.)	: (AM) SUBMIT THE PROGRESS REPORTS to the Burmese Side : (PM) RECEIVE BURMESE REPLY for the questionnaire prepared by the Team : Joint final Discussion with PIC/TSC/EPC
21st:	May 16 (Thu.)	: (AM) Visit the Japanese Embassy and Japan International Cooperation Agency : Leave Rangoon at 16:30 p.m. by TG306 : Arrive at Bangkok at 18:10 p.m.
22nd:	May 17 (Fri.)	: Leave Bangkok at 10:30 a.m. by TG740 : Arrive at Tokyo at 18:25 p.m.

(Notes) Mr. Izume left Japan on April 28. After market research of LPG in Singapore, he joined the team on May 2.

Mr. Mizuno left Japan on May 1 and joined the team on May 2.

Mr. Kitamura came back to Japan from Rangoon on May 4.

Fig. 1-1 Location Map of Integrated LPG Project in Burma

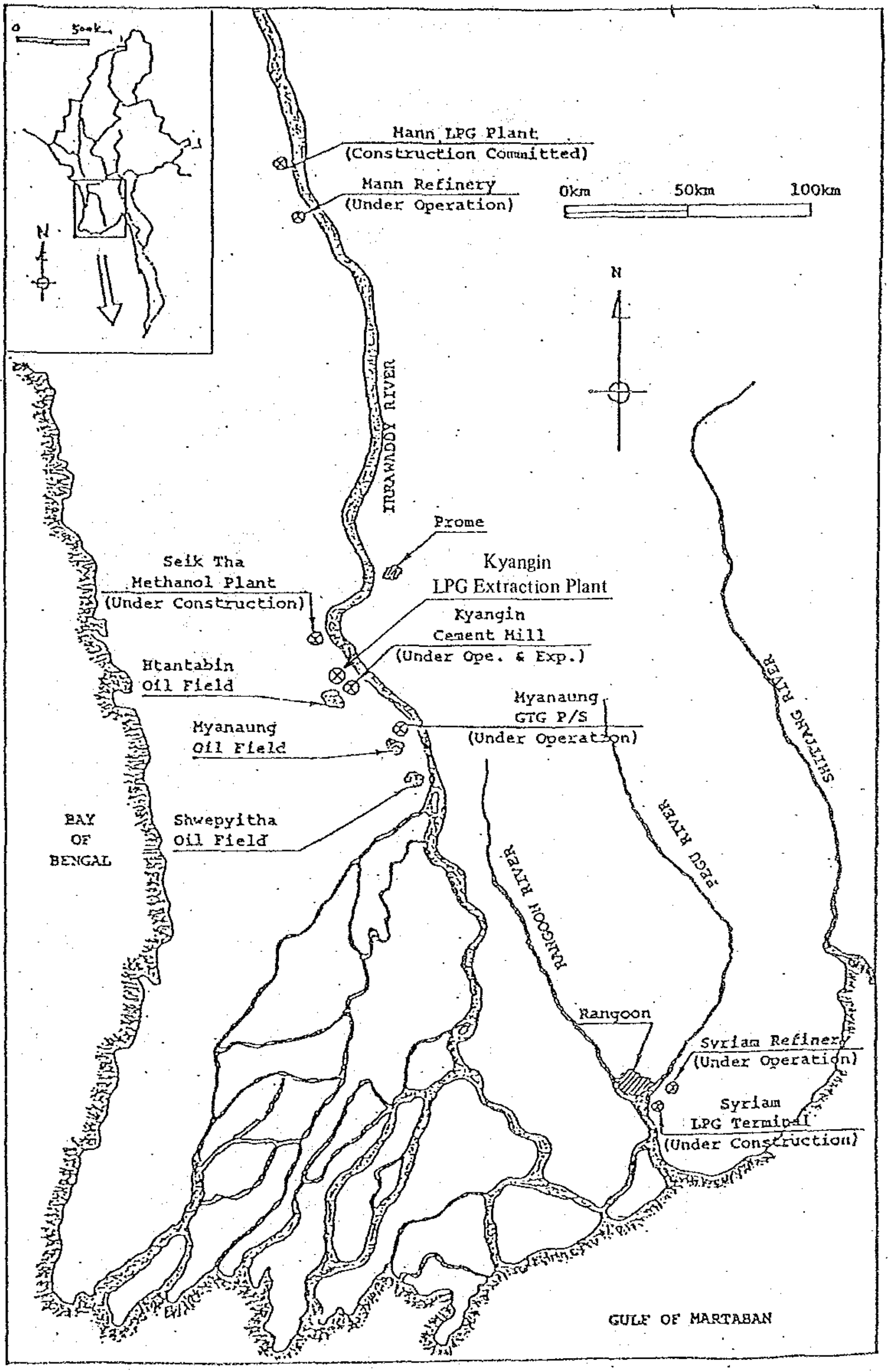


Fig. 1-2 Plant Sites Observed by JICA Survey Team

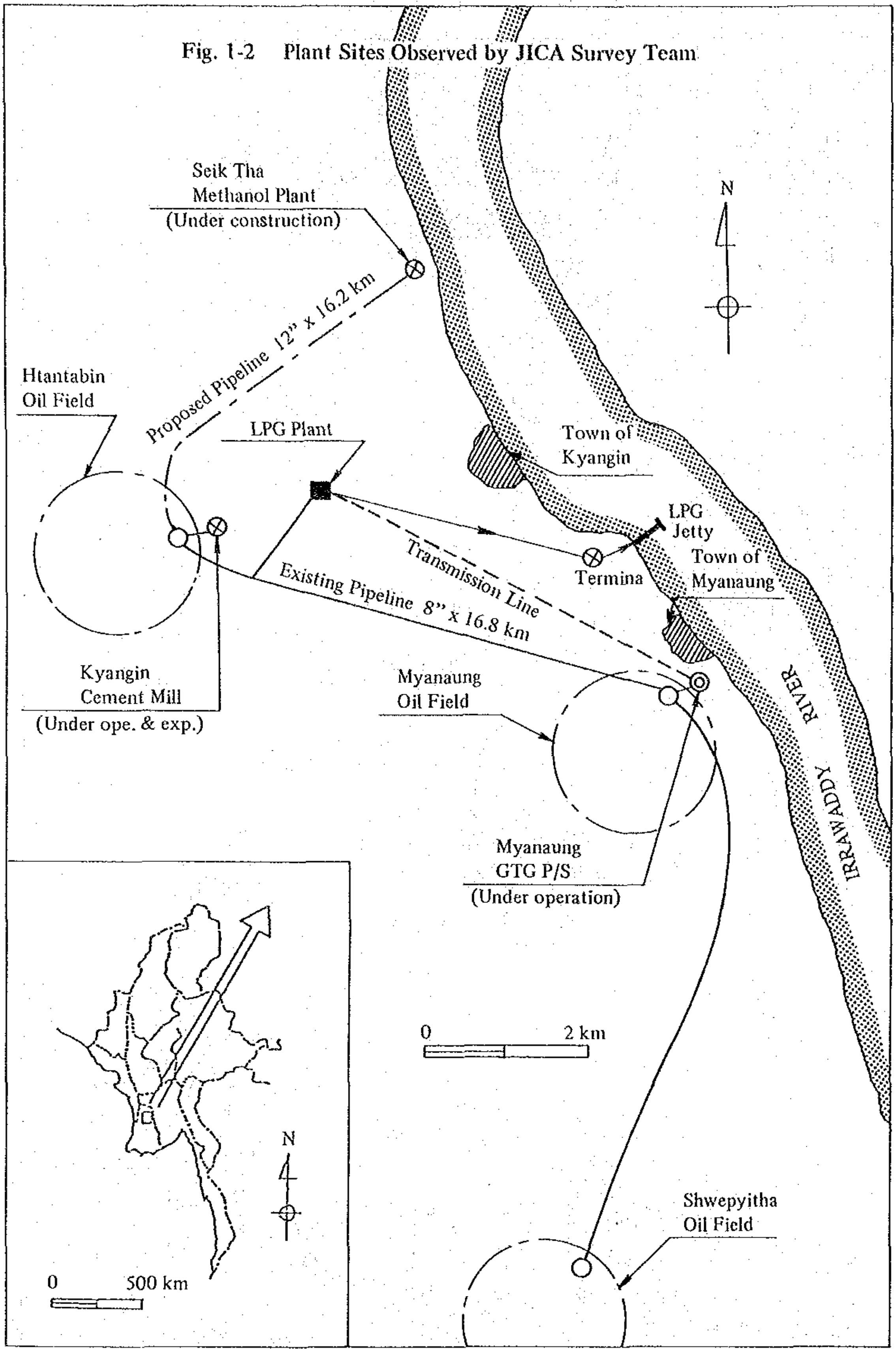


Fig. 1-3 Rangoon Port

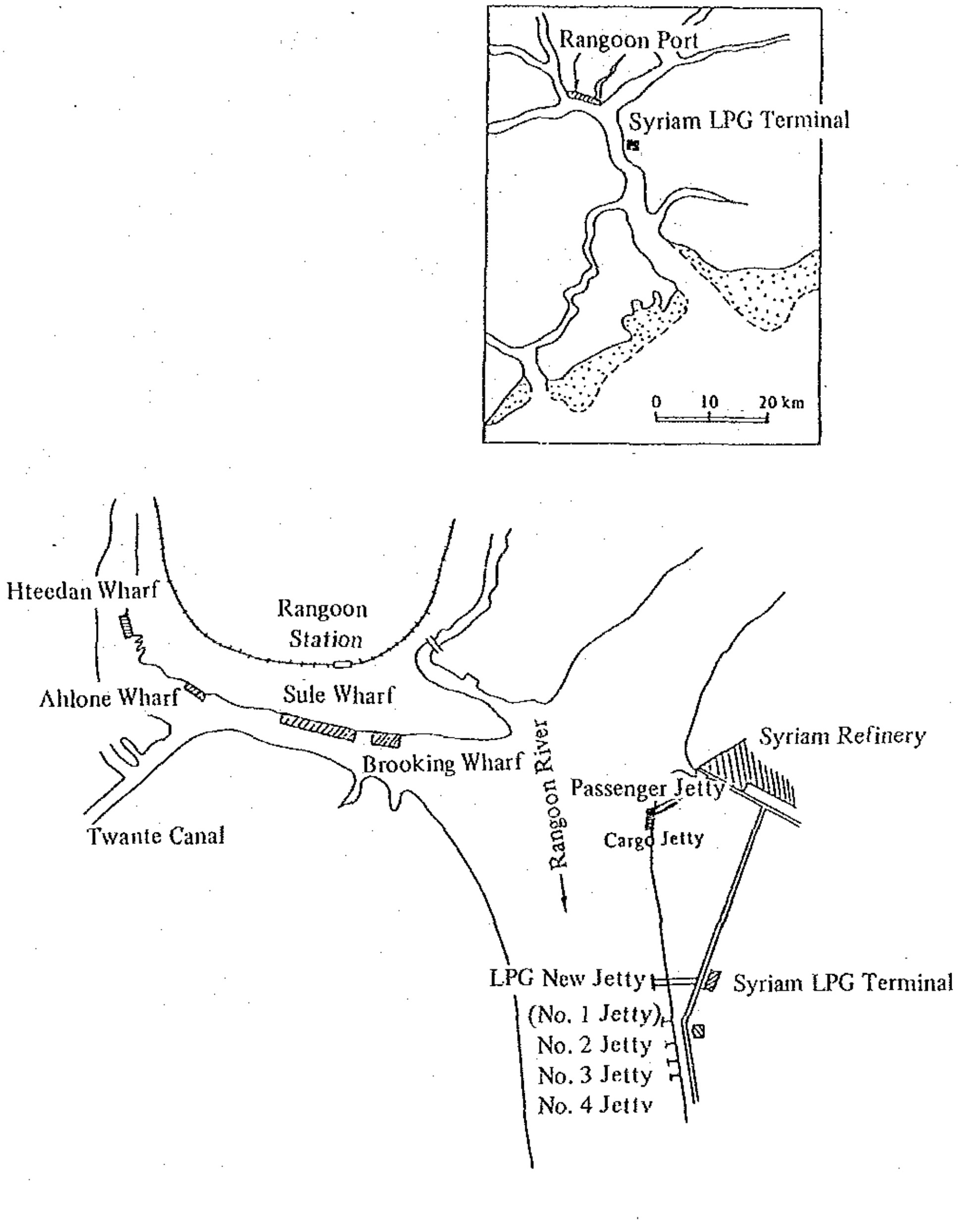
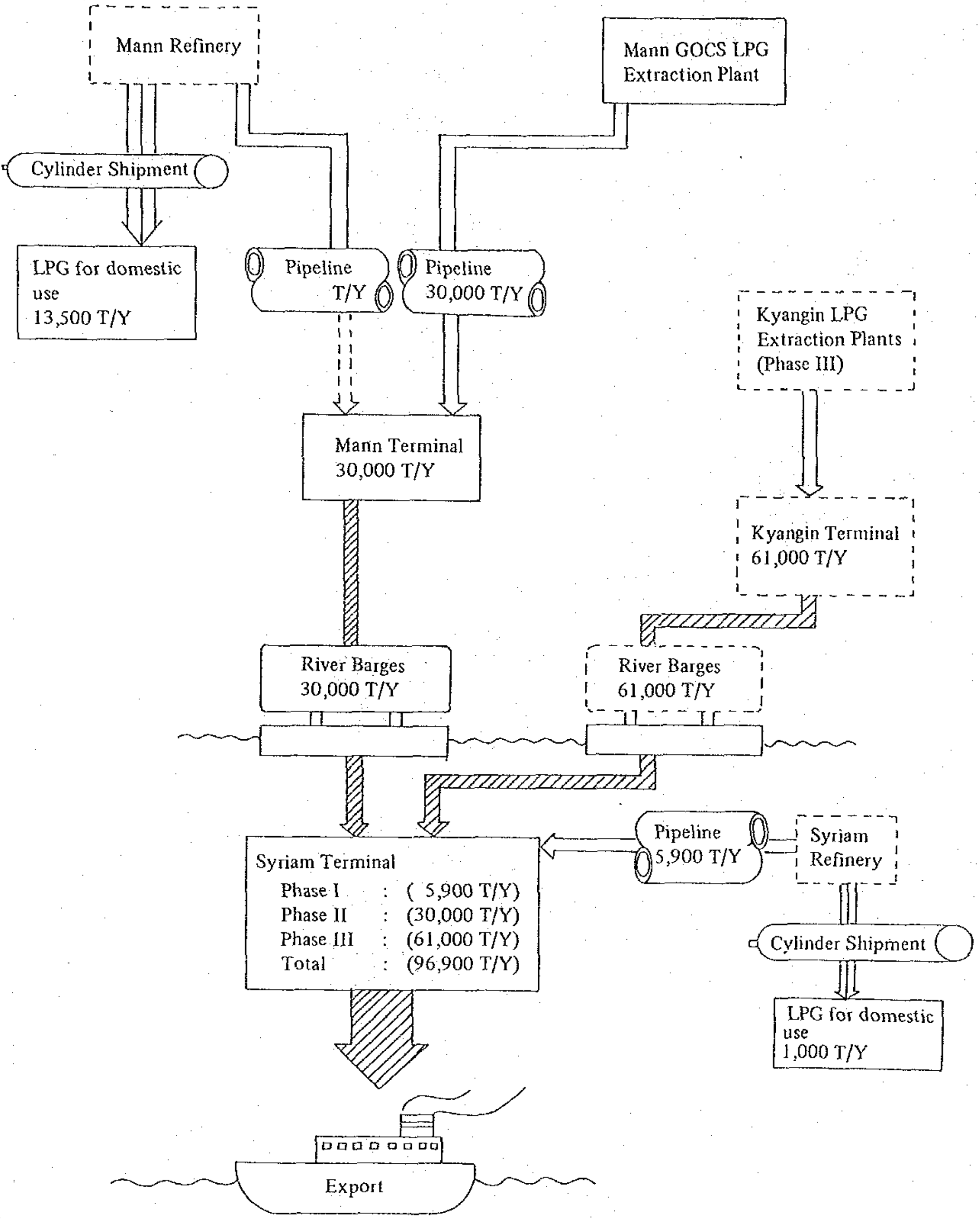


Fig. 1-4 LPG Transportation System



Chapter 2

SUMMARY, CONCLUSION AND RECOMMENDATION

Chapter 2. SUMMARY, CONCLUSION AND RECOMMENDATION

2.1 Main Facilities

o Kyangin LPG Extraction Plant (located about 10 kilometers away from Irrawaddy riverside)

This is the main equipment of the project, which will treat the raw gas (50 x 10^6 SCFD) sent from Shwepyitha Myanaung, Htantabin, through the refrigerated absorption process in which Naphtha is used as a solvent, and recover about 90 percent of propane (C_3) and butane (C_4) which are contained in the gas at the rate of approximately 8%, and produce 61,000 T/Y of LPG.

Area: approx. 75,000 m^2 (250 m x 300 m)
Personnel required (for extraction plant, terminal and jetty): 475 in total
Main equipment:

- a) Raw gas and by-product gas compression system
- b) Raw gas preliminary treatment process system
- c) Cooling system
- d) Propane and butane absorption system
- e) Propane and butane distillation system
- f) Utility facilities
- g) Propane spherical tanks (for one day)
- h) Butane spherical tanks (for one day)

o Kyangin LPG Terminal

The terminal will be located near the Kyangin LPG shipping jetty and equipped with the spherical tanks for safe keeping the LPG product sent from the spherical tanks in the extraction plant. The terminal is designed to ensure stable supply of LPG to river barges which come to load LPG at intervals of 2 – 5 days.

Area: approx. 20,000 m^2 (100 m x 200 m)
Main equipment:

- a) Propane spherical tanks (for 15 days)
- b) Butane spherical tanks (for 15 days)

o Kyangin LPG Jetty

The jetty will be situated on the riverbank near the above-mentioned terminal and the river is needed to be deep and wide enough for a 600-T capacity barge to have free access to the jetty even during the dry season.

Main equipment:

a) Main body of jetty
b) Pontoon
c) Loading arms for shipment of LPG

o Pipelines for Raw Gas, Lean Gas, LPG, etc.

Associated gas must be carried to the extraction plant as raw material by means of pipelines. For that purpose the pipes of 8 – 14 inch diameter must be laid from both Shwepyitha oil fields (by way of Myanaung) and Htantabin oil fields. Lean gas must be supplied to the consumers like methanol factories by means of pipelines.

In addition, LPG pipeline, naphtha pipeline and water pipeline must be laid on among the extraction plant, the terminal and the jetty.

Main equipment:

a) Raw gas pipeline
   Shwepyitha – Kyangin approx. 45 km
   Htantabin – Kyangin approx. 3 km
b) Lean gas pipeline
   Kyangin – Lean gas consumer network junction approx. 5 km
c) LPG pipeline
   Extraction plant – Terminal – Jetty approx. 15 km
d) Water pipeline
   Extraction plant – Terminal – Jetty approx. 15 km
e) Naphtha pipeline
   Extraction plant – Terminal – Jetty approx. 15 km

o Power Transmission Lines

The capacity of Myanaung power station is 67,650 kW and the present demand for electricity is 32,400 kW which is far below the capacity. Although there exist power transmission line leading to the Kyangin cement mill, the transmission line has no extra capacity and a new transmission line needs to be constructed for the project.

Main equipment:

Transmission line for Myanaung power station – Kyangin (66 kV): approx. 14 km

o Communication Installation

The LPG extraction plant must constantly receive raw gas from the respective oil fields 3 – 45 km away and at the same time supply the lean gas for the consumers far way. Mutual communication relating to the transportation of LPG from the extraction plant to the terminal, and power transmission from the power station to the plant are very important for a steady and continuous operation of this plant.

However, in this district public communication network is not available, it is necessary to install an exclusive line as communication facilities for the project.

Main equipment:

Telecommunication facilities

o Auxiliary Facilities

As Kyangin and its vicinity are scarcely populated areas on the west bank of the Irrawaddy River, the workers for the plant are difficult to recruit.

Therefore, it is needed to build living quarters for the employee. As infrastructure is incomplete in this area, some facilities, such as electricity and water supply, are necessary to be prepared before the completion of plant construction.

o LPG River-Barges

Barges with a shallow draught should be used for transportation of LPG products to Syriam Terminal nearby Rangoon.

The pusher boats for the river barges built in Phase I-part 2 are insufficient in number, thus being unavailable in the Phase III. Self-propelled river barges should be provided for the Phase III.

Main equipment:

Self-propelled LPG river-barge (a 600T capacity barge) x 3

- Construction Machinery, etc.

Although the construction machineries purchased under the previous project should be used as much as possible, the most of them are worn considerably requiring a large amount of repair costs.

What is characteristic of this area is to carry all the construction materials acorss the Irrawaddy River and it takes a few more days to make a detour up the stream using a ferry.

In order to carry out the construction smoothly, it is necessary for a Z-craft to wait for by the riverbank near the construction site and carry construction materials by the river transportation whenever necessary.

Main equipment:

a) One lot of construction machinery
b) One lot of spare part for existing machinery
c) One unit of Z-craft

- Syriam Terminal (nearby Rangoon)

According to the project up to Phase II, the export quantity was 53,000 T/Y, but is revised to 96,900 T/Y by Phase III.

As a matter of course, it is necessary to expand receiving tanks and expand or increase the jetty at the terminal. However, as for the jetty, the number of navigation of barges is decreased by increasing the capacity of the LPG barges to 600 T and the expansion or increase of the jetty will be avoided by adopting night shift of stevedoring.

Main equipment:

a) Propane spherical tanks (for 20 days as a target)
b) Butane spherical tanks (for 20 days as a target)

2.2 Construction Schedule

Commencement of construction work : July, 1987
Completion of construction work : June, 1989

The schedule may be accelerated if procurement work can be done in shorter time.

2.3 Export Market for LPG

Under the project, the total quantity of LPG is to be appropriated for export and accordingly attention should always be paid to the trends of demand and prices at the destinations.

In the world market of LPG, the quantity of Middle East produced LPG is overwhelmingly large. Hence their prices are becoming leading ones in the world, and the prices of LPG in the Asian or European markets are determined by CIF prices of the LPG from the Middle East.

The LPG is carried from the Middle East or Indonesia into the Japanese market in a large quantity by using the large-capacity refrigerated type tankers for the exclusive use of LPG (30,000 – 50,000 T capacity) at a very cheap freight rate.

However, under the project, the export quantity is 96,900 T/Y which is rather small an as there is no utilizing the above-mentioned refrigerated type tankers, therefore it is applied to small capacity pressurized tankers (1,000 – 1,500 T capacity) in order to carry out LPG. As a result, a tanker rate becomes rather costly, which means that the transportation for a long distance will be disadvantage and available market would be Singapore or at most Hongkong.

Particularly, Singapore, since the commencement of operation of Petrochemical Corporation of Singapore, has come up on the stage as a consumer of LPG which is their raw material and increased importance as the export destination of Burma.

When the FOB Rangoon price of LPG is estimated from the LPG price of US$210 – 220 per ton at Singapore, it will be US$130 – 150 per ton.

Under the project, the FOB Rangoon price is assumed to be US$140 per ton.

2.4 The Fund Required (Total Capital Requirement)

	Foreign Currency (¥1,000)	Local Currency (K1,000)
Kyangin LPG plant	6,516,000	26,600
Kyangin terminal, jetty	1,492,000	4,500
Syriam terminal expansion	747,000	900
LPG barge (3 barges)	1,890,000	
Construction machinery and tools	600,000	21,000 *
Transportation	755,000	6,500 **
Sub-total	12,000,000	59,500
Physical contingency	300,000	3,500
Price contingency	200,000	0
Construction cost Sub-total	12,500,000	63,000
Commissioning fee	100,000	–
Sub-total	12,600,000	63,000
Pre-operation cost	–	3,246
Initial working capital	–	250
Interest during construction	260,870	–
Total	12,860,870	66,490
Grand total	US$60,073,000	

* Rental fee

** Including insurance expense

2.5 Financial & Economic Analysis

2.5.1 Premises

o Project life	20 years	
o Foreign exchange rates	US$1 = 8.6 Kyat	¥100 = 3.5 Kyat

o Conditions for long-term loan

		Annual interest rate	Term of repayment
a)	Base Case	2.75%	30 years (including the greace period of 10 years)
b)	Case A	5.0 %	10 years
c)	Case B	7.8 %	10 years

o Depreciation

"Straight-line method" is adopted for depreciation. The term of depreciation is 20 years for equipment and machinery, and the estimated salvage value is 12%. The term of depreciation is 50 years for civil and buildings and the estimated salvage value is 10%. As for pre-operation costs, commissioning fee and interest incurred during construction, the term of depreciation is 5 years with no salvage value.

o Contribution to state (CTS)

The rate of contribution is 30% on net income, however, in case it is over Kyat 50 million, the rate will be 40%.

o Import duty

It is 15% on a CIF Rangoon price of the equipment & machinery and accrued payments will be made in annual equal installments for 5 years starting from the second year of operation.

2.5.2 Financial Analysis

1) Base Case

	IRROI (%)	IRROE (%)
Before tax/CTS	7.90	45.69
After tax/CTS (import duty, CTS)	5.11	34.32
Payback period	13.1 (years)	2.6 (years)

2) Import duty exempted

After tax (CTS)	5.78	40.09
Payback period	12.1 (years)	2.2 (years)

3) CTS exempted

After tax (import duty)	6.93	37.81
Payback period	11.1 (years)	2.4 (years)

4) Change of financing conditions

	Case A IRROE (%)	Case B IRROE (%)
Before tax/CTS	14.84	11.96
After tax/CTS (import duty, CTS)	8.08	4.22
Payback period	17.1 (years)	–

(a) The IRROI after tax/CTS of the Project is 5.11%. This indicates that the profitability of the Project itself may not be so high, but not so desperately low. However, the IRROE after tax/CTS is 34.32%, if capital procurement under the soft financing conditions of long term loan presumed in this report is affirmative.

(b) The position of funds and financial situation of the Project are sound and hence the Project is financially viable.

2.5.3 Economic Analysis

The EIRR is 7.20% which is better than 5.11% of the IRROI after tax/CTS but is slightly lower than 7.90% of the IRROI before tax/CTS in the financial analysis. The implementation of the Project will contribute immensely to the Burmese Economy, by earning foreign exchange amounting to US$90,532,000 as direct economic benefits over the entire project life. Furthermore, a number of indirect economic benefits are also concieved. As results of the above benefits, the project will make a high overall economic effect, and therefore the implementation of the Project is suggested itself to proceed positively.

2.6 Evaluation and Conclusion

As a result of the financial and economic analyses, the followings are set forth:

1) IRROI after tax/CTS of the Base Case is 5.11%, which proves the Project to be feasible. In IRROI before tax/CTS of the Base Case, the CTS and the import duty is assumed to be exempted and IRROI is 7.90%. This may be available if the Project is considered as the national project with the highest priority.

2) The import duty exempted case in the Base Case is the case where the import duty on the imported equipment and machinery is exempted, though the CTS is not exempted. The IRROI is then improved favorably to 5.78%.

3) In the CTS exempted case in the Base Case, the import duty on the imported equipment and machinery will be paid irrespective of exemption of the CTS.

   The basic industries like Phase III Project can contribute much for the development of the regional society, at the same time having spread effects on the other industries, so such project may enjoy special treatment like CTS exemption. Then, the IRROI will rise favorably to 6.93%.

4) For both of Case A and Case B, long term loans on higher interest rates (5.0% p.a., 7.8% p.a.) are introduced respectively, together with a shorter repayment period (10 years). Both cases make the shortage of money from the first year of operation, so that short-term loans have to be borrowed. As a result, compared with the Base Case, the IRROE of both cases are very low. In Case A, it will take 17 years to recover the investment, and in Case B it is not possible to recover it. Since both cases show that the operation and management of the Project are very difficult in fact, the project plans under such strict conditions are infeasible.

5) In the Base Case, the EIRR for the Project is 7.20% which exceeds the financial IRROI after tax/CTS of 5.11%. With the implementation of the Project, a direct benefit like foreign exchange earnings and many indirect benefits will be incurred,

indicating high economic impact on the country.

2.7 Recommendation

The attention should be directed to the following in execution of the Integrated LPG Project (Phase III).

2.7.1 Improvement of the Plant Operations Rate

The treatment volume of rich gas in the Kyangin LPG extraction plant is dependent on the gas consumption of the Myanaung power station, Kyangin cement mill and in the future, Seik Tha methanol plant which are now supplied with rich gas from Shwepyitha, Myanaung and Htantabin oil fields.

Therefore, to improve this plant's operations, close contacts with the consuming factories and the power station must be made. Furthermore, coordination should be made to carry out the plant's maintenance during the times when the consumers do not operate – such efforts must be made throughout the year to improve the plant operations.

2.7.2 Preparation for Construction

Soon after the execution of the project is decided, an ortanization should be formed with reference to the experience in the previous project, and its members must start action and make preparations such as listing of construction machinery used for the previous project, their repair, the procurement of construction materials to be purchased in Burma, etc.

2.7.3 Execution of Preliminary Work

The roads, bridges, etc. in the vicinity of the site for the plant are defective and incomplete and their improvement is of course needed, but as the land preparation of the plant site and especially, the terminal site is accompanied with the transport of a large quantity of soil which takes a long time and this can be a bottleneck in the whole construction schedule. Therefore, the preparation work must be started beforehand immediately after the execution of the project is decided.

2.7.4 Planning and Execution of the Expansion Program of Domestic Market

If LPG proves to be an economical energy source for enterprises, corporations and the public from the point of handling as well as economy, it will not be difficult to increase the domestic consumption.

As it is clearly of benefit to the nation to substitute LPG for the other petroleum products, electricity, etc., it is advisable to lessen price discrepancies between LPG and gasoline, kerosene, electricity for domestic use, and, for example, give a subsidy for promotion of domestic consumption as one of the concrete policies.

In any case, for the expansion of domestic market for LPG, the problems close at hand are necessary to be solved.

2.7.5 Cultivation of Export Market

Since under the project, the whole LPG product is to be directed toward the export due attention should be paid to the export market.

In the world petroleum market in which LNG takes part as well, a price system among crude oil, LPG and LNG seems to be steady now, but yet there can sometimes be a case where LPG alone starts a different movement from the others. Foreseeing the above circumstances, Burmese Government should strengthen its investigating faculty of the world market, for LPG so that it can export the LPG product on the most favorable conditions possible.

2.7.6 Application of the Experiences from the Preceding Projects

In order to expect the favorable performance of the project, best effort should be made to make a good use of experience in the previous projects (Mann Oil Refinery, Phase I, Phase II).

Chapter 3

RAW MATERIALS FOR LPG RECOVERY AND PRODUCTION PLANS

Chapter 3. RAW MATERIALS FOR LPG RECOVERY AND PRODUCTION PLANS

3.1 Summary

There are two kinds of LPG which are dealt with in Burma's Integrated LPG project; LPG which is produced at Mann and Syriam Refineries (Phase I); LPG which is produced at Mann GOCS and Kyangin LPG Extraction Plant, using associated gas from oil fields as a raw material (Phase II, Phase III).

In this chapter a study will be made on the securing of raw materials which are necessary for LPG production and on the LPG production plan at Phase III. Furhtermore, a review will be made on the securing of raw materials and on the LPG production plan at Phase I and Phase II.

The crude oil reserves in MANN/Htaukshabin area is 500 x 10^6 barrel according to the data which was shown by Burmese side in the present survey, which is available for more than 20 years from the aspect of processing plan of crude oil at Mann and Syriam Refineries. On the one hand, the reserves of associated gas in MANN/Htaukshabin area is 775 x 10^9 SCF which is enoughly available for more than 20 years from the aspect of consumption of feed gas at Mann GOCS. On the other hand, the feed gas in Phase III is associated gas from the oil fields around Kyangin which are Htantabin Oil Field, Myanaung Oil Field and Shwepyitha Oil Field. The total reserves of associated gas in these three oil fields is 859 x 10^9 SCF. From the aspect of consumption of feed gas at Kyangin LPG Extraction Plant, it is available for 48 years (R/P). Though the reserves of associated gas in Htantabin Oil Field includes much estimable amount beside proved amount.

Burmese side has a plan to perform gradual exploration work of proving from now on. In performing the project of Phase III, if the project life is decided for 20 years, the securing of raw materials is judged to be enough.

When the LPG output in Phase I, II and III is estimated according to the present crude oil processing plan and the associated gas production plan, it becomes as Table 3-1.

Table 3-1 LPG Production Plan

(Unit: T/Y)

	Phase I		Phase II	Phase III	Total
	Mann REF.	Syriam REF.	Mann GOCS	Kyangin LPG E.P.	
1982	2,550				2,550
1983					
1984					
1985	6,700				6,700
1986	10,500	4,500			15,000
1987	12,000	5,800	30,000		47,800
1988	13,500	6,200	30,000		49,700
1989	13,500	6,500	30,000	30,000	80,000
1990	13,500	6,900	30,000	61,000	111,400

3.2 Distribution and Reserves of Oil Fields and Gas Fields, and Present Production of Oil and Gas

Of the natural gas fields and oil fields (associated gas producing centers) so far discovered in Burma, the following are major ones.

Area	Kind
Mann/Htaukshabin	A.G., N.G
Peppi	N.G.
Yenangyaung	A.G.
Chauk	N.G.
Yenangyat	N.G.
Letpando	N.G.
Myanaung	A.G., N.G.
Shwepyitha	A.G., N.G.
Htantabin	A.G.
Tegyigon	A.G.
Prome	A.G., N.G.

Pyalo	N.G.
Payagon	A.G., N.G.
Pagan/Tuyintaung/Tetma	A.G.

(A.G.: Associated Gas, N.G.: Natural Gas)

The geographical locations of these oil and gas fields are shown in Fig. 3-1. And the gas reserves and gas composition in representative areas are shown in Tables 3-2. The crude oil reserves and production are shown in Tables 3-3.

3.2.1 Raw Material Plan of Phase III

Of the above oil fields, Htantabin Oil Field, Myanaung Oil Field and Shwepyitha Oil Field are concerned with Phase III project. The feed gas is associated gas which is separated from curde oil produced from wells.

(1) Gas reserves

Myanaung	(proved reserves)	42.2×10^9 SCF
Shwepyitha	(proved reserves)	42.5×10^9 SCF
Htantabin	(proved reserves)	105.6×10^9 SCF
	(unproved reserves)	669.2×10^9 SCF

(2) Compositions of gas

The propane contents is 4.7 ~ 3.7%, the butane contents is 2.8 ~ 4.5%. The propane and butane contents make a total of 7.5 ~ 9.2%.

(3) Output and consumption of associated gas

In Myanaung Oil Field, a total number of wells now in operation is 36, composed of 12 flowing wells, 22 pumping wells and 2 gas lifting wells. In Shwepyitha Oil Field, 6 wells are composed of only flowing wells. In Htantabin Oil Field, 5 wells are composed of only flowing wells.

Fig. 3-1 Geographical Location of Oil and Gas Fields

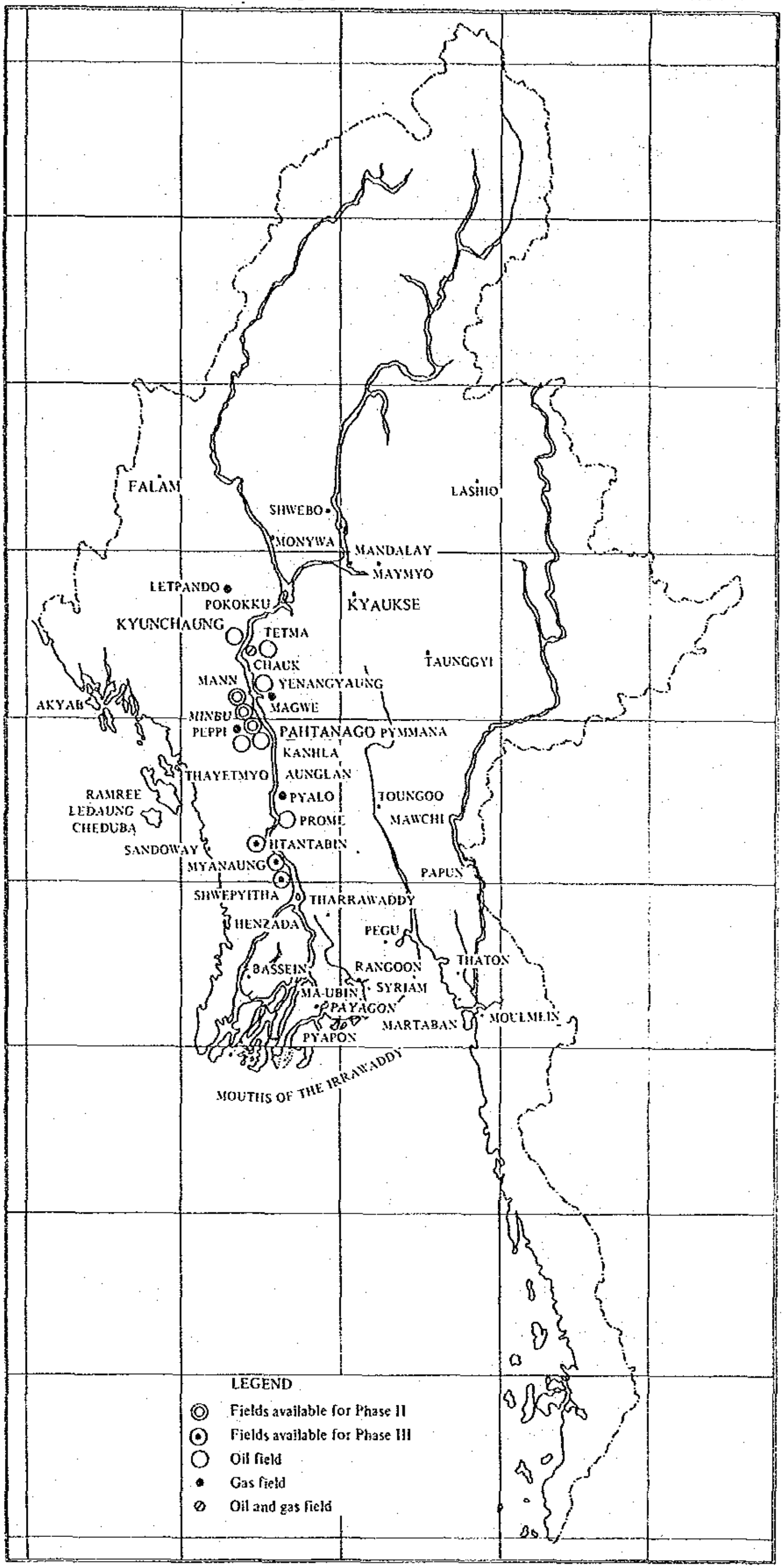


Table 3-2-1 Gas Reserves and Composition

1. Gas and oil fields	Mann/Htaukshabin		Peppi		Mindegyi		Ngahlaingdwin	
2. The proved reserves (10^6 SCF)	at 1. 4. 85		at 1. 4. 85		at 1. 4. 85		at 1. 4. 85	
(a) Associated gas	775,446		–		–		–	
(b) Natural gas	96,645		45,719		* 1,228		2,110	
3. Properties (Vol %)	A.G	N.G	A.G	N.G	A.G	N.G	A.G	N.G
C1	86.34	90.63	–	99.7	–	88.84	–	95.17
C2	5.85	4.29	–	0.1	–	6.56	–	3.78
C3	3.49	2.12	–	0.1	–	1.73	–	0.61
n-C4	1.99	1.41	–	Trace	–	1.10	–	0.06
i-C4	1.59	1.05	–	0.1	–	1.18	–	0.30
$C5^+$	0.74	0.50	–	Trace	–	0.59	–	0.08
CO_2	–	–	–	–	–	–	–	–
H_2S	–	–	–	–	–	–	–	–
Others	–	–	–	–	–	–	–	–
Temperature (°C)	21.1-45.5		–	–	–	–	–	–
Pressure (psig) at B.L. condition	LPS 30-75 HPS 600		–	–	–	–	–	–

LPS = Low pressure system
HPS = High pressure system

Table 3-2-2 Gas Researves and Composition

1. Gas and oil fields	Yenangyaung		Chauk		Yenangyat		Letpando	
2. The proved reserves (10^6 SCF)	at 1. 4. 85		at 1. 4. 85		at 1. 4. 85		at 1. 4. 85	
(a) Associated gas	8,964		–		–		–	
(b) Natural gas	29,352		174,543		133,947		29,817	
3. Properties (Vol %)	A.G	N.G	A.G	N.G	A.G	N.G	A.G	N.G.
C1	93.87	–	–	93.26	–	94.0	–	96.67
C2	3.35	–	–	2.42	–	2.22	–	1.35
C3	1.17	–	–	1.96	–	1.86	–	0.64
n-C4	0.41	–	–	0.63	–	0.45	–	0.53
i-C4	0.92	–	–	1.62	–	1.29	–	0.64
$C5^+$	0.28	–	–	0.11	–	0.18	–	0.17
CO_2	–	–	–	–	–	–	–	–
H_2S	–	–	–	–	–	–	–	–
Others	–	–	–	–	–	–	–	–
Temperature (°C)	21.1-45.5		21.1-45.5		21-45		–	–
Pressure (psig) at B.L. condition	LPS 34-36 HPS 260-300		HPS 560 = 580		HPS 680		–	–

LPS = Low pressure system
HPS = High pressure system

Table 3-2-3 Gas Reserves and Compositioan

1. Gas and oil fields	Myanaung		Shwepyitha		Htantabin		Tegyigon		Prome	
2. The Reserves (10^6 SCF)	at 1.4.85		at 1.4.85		at 1.4.85		at 1.4.85		at 1.4.85	
(a) Associated gas										
Proved	42,208		42,474		105,581		—		23,627	
Probable	—		—		12,913		—			
Possible	—		—		599,682		56,550			
Sub-total	42,208		42,474		718,176		56,550			
(b) Natural gas										
Proved	25,934		45,773		—		—		33,914	
Probable	686		3,366		—		—			
Possible	522		102,282		—		—			
Sub-total	27,142		151,421		—		—			
(c) Total (a) + (b)	69,350		193,895		718,176		56,550			
3. Properties (Vol %)	A.G	N.G	A.G	N.G	A.G	N.G	A.G	N.G	A.G	N.G
C1	81.86	84.47	85.067	93.28	85.98	—			88.86	96.81
C2	7.91	6.92	6.628	2.81	5.76	—			3.79	1.05
C3	4.72	4.54	3.748	1.78	4.72	—			4.32	0.94
n-C4	2.63	1.03	1.320	0.50	1.18	—			1.52	0.79
i-C4	1.83	2.70	2.800	1.37	1.62	—			1.44	0.39
$C5^+$	0.75	0.34	0.437	0.26	0.74	—			0.07	0.02
CO_2	0.30	—	—	—	—	—			—	—
H_2S	—	—	—	—	—	—			—	—
Others	—	—	—	—	—	—			—	—
Temperature (°C)	32.2-43.3		32.2-43.3		32.2-43.3				32.2-43.3	
Pressure (psig) at B.L. condition	LPS 100-120 HPS400-450		HPS 400-450		LPS 85-120 HPS 400-450				LPS 30-50 HPS 790-810	

LPS = Low pressure system
HPS = High pressure system

Table 3-2-4 Gas Reserves and Composition

1. Gas and oil fields	Pyalo		Natmi		Pyaye		Payagon	
2. The proved reserves (10^6 SCF)	at 1. 4. 85		at 1. 4. 85		at 1. 4. 85		at 1. 4. 85	
(a) Associated gas	–		–		–		141,076	
(b) Natural gas	72,158		2,653		815		13,002	
3. Properties (Vol %)	A.G	N.G	A.G	N.G	A.G	N.G *	A.G	N.G
C1	–	97.79	–	95.07	* Composition taken similar to Pyalo since both fields being situated on the same structure.		88.54	99.40
C2	–	0.51	–	3.18			5.22	0.47
C3	–	0.48	–	1.05			2.66	0.07
n-C4	–	0.48	–	0.70			0.25	0.01
i-C4	–	0.38	–	–			0.55	0.02
$C5^+$	–	0.36	–	–			0.50	0.03
CO_2	–	–	–	–			0.24	–
H_2S	–	–	–	–			–	–
Others	–	–	–	–			–	–
Temperature (°C)	32.2-43.3		–		–		29.4-36	
Pressure (psig) at B.L. condition	LPS 120-180						HPS 580-600	

LPS = Low pressure system
HPS = High pressure system

Table 3-2-5 Gas Reserves and Composition

1. Gas and oil fields	Pagan/Tuyintaung/Tetma
2. The proved reserves (10^6 SCF)	at 1. 4. 85
(a) Associated gas	395,891
(b) Natural gas	–
3. Properties (Vol %)	
C1	
C2	
C3	
n-C4	
i-C4	
$C5^+$	
CO_2	
H_2S	
Others	
Temperature (°C)	21.1-45.5
Pressure (psig) at B.L. condition	

Table 3-3-1 Crude Oil Reserves & Productions

1. Oil field	Mann/Htaukshabin Field		Yenangyaung Oil Field		Chauk/Lanywa/ Yenangyat Fields	
2. Proved crude oil reserve	499.504		74.202		6.458	
(Unit x 10^6 BBL)	at 1. 4. 85		at 1. 4. 85		at 1. 4. 85	
3. Production (BPSD)	1980-81	21,271	1980-81	3,229	1980-81	1,037
	1981-82	22,191	1981-82	3,297	1981-82	996
	1982-83	20,083	1982-83	3,453	1982-83	1,052
	1983-84	21,277	1983-84	3,627	1983-84	982
	1984-85	24,555	1984-85	3,515	1984-85	962
	1985-86	26,000	1985-86	3,500	1985-86	950
	1986-87	27,000	1986-87	3,600	1986-87	1,060
	1987-88	28,450	1987-88	3,600	1987-88	1,060
	1988-89	29,100	1988-89	3,700	1988-89	1,060
	1989-90	29,600	1989-90	3,700	1989-90	1,060
	1990-91	31,000	1990-91	3,700	1990-91	1,060

Table 3-3-2 Crude Oil Reserves & Productions

1. Oil field	Myanaung		Shwepyitha		Htantabin	
2. Proved crude oil reserve (Unit x 10^6 BBL)	22.765 at 1. 4. 85		6.853 at 1. 4. 85		67.722 at 1. 4. 85	
3. Production (BPSD)	1980-81	1,097	1980-81	204	1980-81	19
	1981-82	1,013	1981-82	123	1981-82	246
	1982-83	1,012	1982-83	79	1982-83	361
	1983-84	808	1983-84	47	1983-84	102
	1984-85	616	1984-85	46	1984-85	41
	1985-86	700	1985-86	100	1985-86	50
	1986-87	800	1986-87	300	1986-87	50
	1987-88	900	1987-88	400	1987-88	50
	1988-89	1,000	1988-89	500	1988-89	50
	1989-90	1,000	1989-90	500	1989-90	50
	1990-91	1,000	1990-91	500	1990-91	200

Table 3-4 Phase III Raw Material Gas Plan

	Myanaung	Shwepyitha	Htantabin
• Number of wells			
(a) Flowing wells	12	6	5
(b) Pumping wells	22	–	–
(c) Gas lifting wells	2	–	–
[Total]	36	6	5
• Production rate (unit: 10^6 SCFD)			
1980-81	0.018	10.066	0.336
1981-82	–	9.081	4.483
1982-83	—	7.715	8.417
1983-84	–	6.024	5.191
1984-85	1.260	8.008	2.438
1985-86	7.000	8.000	2.500
1986-87	25.000	25.000	2.500
1987-88	25.000	25.000	2.500
1988-89	25.000	25.000	–
1989-90	25.000	25.000	–
1990-91	20.000	20.000	10.000
• Supply capacity to other plants (unit: 10^6 SCFD)			
(a) To phase II project			
1984-85	–	–	–
1985-86	–	–	–
1986-87	–	–	–
1987-88	–	–	–
1988-89	–	–	–
1989-90	–	–	–
1990-91	–	–	–
(b) To phase III project			
1986-87	←	50	→
1987-88		50	
1988-89		50	
1989-90		50	
1990-91		50	
1991-92		50	
1992-93		50	

Supply capacity = (Production rate) – (Consumption in gas fields)

• Consumption for each purpose

Purpose	Consumption (10^6 SCFD)	
	Present	Future
a. Kyangin Cement Mill	6.8	
b. Myanaung EPC	7.9	
c. Seiktha Methanol Plant	–	

The present output of curde oil and associated gas is as follows:

Oil field	Crude oil output (BSPD)	Gas output (10^6 SCF)
Myanaung	700	7.0
Shwepyitha	100	8.0
Htantabin	50	2.5

Of the present consumption of gas, Kyangin Cement Mill which uses 6.8 x 10^6 SFCD and Myanaung Power Station which uses 7.9 x 10^6 SFCD are the major ones.

From now on, the output will be increased according to the usage plan of the consumers. For this purpose, the number of wells are planned to increase gradually. As for the future plan of supply, Myanaung Oil Field and Shwepyitha Oil Field will play a major role at first. Then, after 1990, Htantabin Oil Field will substitute for them because its associated gas output will increase.

The details of output and supply plan are shown in Table 3-4.

(4) Available years of associated gas

Calculating the available years of associated gas from the present reserves and feed gas of Phase III, it is assumed to be R/P - 52.1 years.

When only the proved amount is calculated, it is assumed to be R/P = 11.5 years.

3.2.2 Raw Material Plan of Phase II

Of the above gas fields, Mann/Htaukshabin Oil Field is concerned with Phase II project.

Reviewing the previous FS by the data shown by Burmese side, the available amount of associated gas is increased from 191.8 x 10^9 SCF to 775.4 x 10^9 SCF by a large margin. The number of the wells is doubled from 265 to 566. Therefore, the estimated available year R/P comes to 83 years by calculation, which is enough for securing of raw materials.

The details of output and supply plan are shown in Talbe 3-5.

3.2.3 Raw Material Plan of Phase I

Of the above oil fields, Mann/Htaukshabin Oil Field is concerned with Phase I project. The crude oil produced in this oil field is transported by the pipeline to Mann Refinery and Syriam Refinery to be processed there. Beside the crude oil which is supplied by this pipeline, a small amount of oil which transported from other oil fields by the river barges is also processed at Syriam Refinery. Therefore the crude oil reserves in Mann/Htaukshabin Oil Field is important from the aspect of securing of raw materials at Phase I.

Reviewing the previous FS by the data shown by Burmese side, the available amount of crude oil reserves comes to 500 x 10^6 BBL. When the crude oil processing capacity of the Mann Refinery is estimated to be 25,000 BPSD and that of Syriam Refinery, 26,000 BPSD, then process this crude oil only, the available year comes to 29 years by calculation, and no problem for crude oil reserves. The output of crude oil will be increased gradually according to the crude oil processing plan of oil refineries.

Table 3-5 Phase II Raw Material Gas Plan

	Mann/Htaukshabin Fields
• Number of wells	
(a) Flowing wells	94
(b) Pumping wells	472
(c) Gas lifting wells	–
[Total]	566
• Production rate (Unit: 10^6 SCFD)	
1980-81	2.320
1981-82	3.000
1982-83	4.380
1983-84	6.422
1984-85	18.340
1985-86	26.000
1986-87	32.000
1987-88	32.000
1988-89	32.000
1989-90	32.000
1990-91	32.000
• Supply capacity to other plants (Unit: 10^6 SCFD)	
(a) To phase II Project	
1984-85	12
1985-86	24
1986-87	28
1987-88	28
1988-89	28
1989-90	28
1990-91	28
(b) To phase III project	
1986-87	–
1987-88	–
1988-89	–
1989-90	–
1990-91	–
1991-92	–
1992-93	–

Supply capacity = (Production rate) – (Consumption in gas fields)

- Consumption for each purpose

Purpose	Consumption (10^6 SCFD)	
	Present	Future
a. EPC gas turbine	3.5	10.0
b. Refinery	3.6	7.0
c. MOC industrial use	2.0	4.0
d. Gas Injection for pressure maintenance	3.0	6.0

3.3 Present Status and Future Prospects of Refineries and LPG Extraction Plant

Burma has the following oil refineries now in operation: Chauk Refinery built in 1954, Syriam Refinery built in 1957 which has subsequently been expanded twice, and Mann Refinery which has started in 1982.

(1) Chauk Refinery has a 6,000 BPSD atmospheric distillation plant, 2,400 BPSD vacuum distillation plant and wax manufacturing plant. The refinery is producing gasoline, kerosene, gas oil, fuel oil and wax.

(2) Syriam Refinery has three atmospheric distillation plants called Bench A, Bench B and Bench C. Their respective capacity is 6,000 BPSD, 14,000 BPSD and 6,000 BPSD, totalling 26,000 BPSD. Besides, the refinery has a 2,400 BPSD vacuum distillation plant and a 1,500 BPSD thermal cracking plant. The atmospheric distillation plant, vacuum distillation plant and thermal cracking plant in the Bench A were constructed in 1957. Further, the Bench B was constructed in 1963 and the atmospheric distillation plant in the Bench C was constructed in 1980. They compose the plants existing present. The products of the refinery are gasoline, kerosene, jet fuel, gas oil, fuel oil and coke.

A new 5,200 BPSD delayed coking plant is now under construction in the Syriam Refinery as a project of Phase I-Part 1. It is expected to be completed toward the end of November, 1985. Main equipments have already been installed and the construction is at the final stage. The project involves a coking plant, LPG recovery plant, LPG Merox plant (a system which removes sulfuric compounds out of LPG and improve its quality), de-olefinizer plant (a system which polimerize olefine in LPG to make polymer gasoline; the olefine content of LPG is reduced; and the quality of LPG is improved), and will produce 6,900 T/Y of LPG. When the coking plant is completed, the Syriam Refinery will have a configuration of the plants as shown in Fig. 3-2. Operation plan of crude oil processing and a production capacity of each petroleum product at the Syriam Refinery are shown in Table 3-6.

(3) According to the data shown by Burmese side, Mann Refinery is a modern refinery which has processing capacity of 25,000 BPSD crude oil. The construction has completed in June, 1982 and the refinery has started operation in June, 1982. The plants and their capacities at the refinery are as follows:

Fig. 3-2 Configuration of Syriam Refinery (Phase I – part 1)

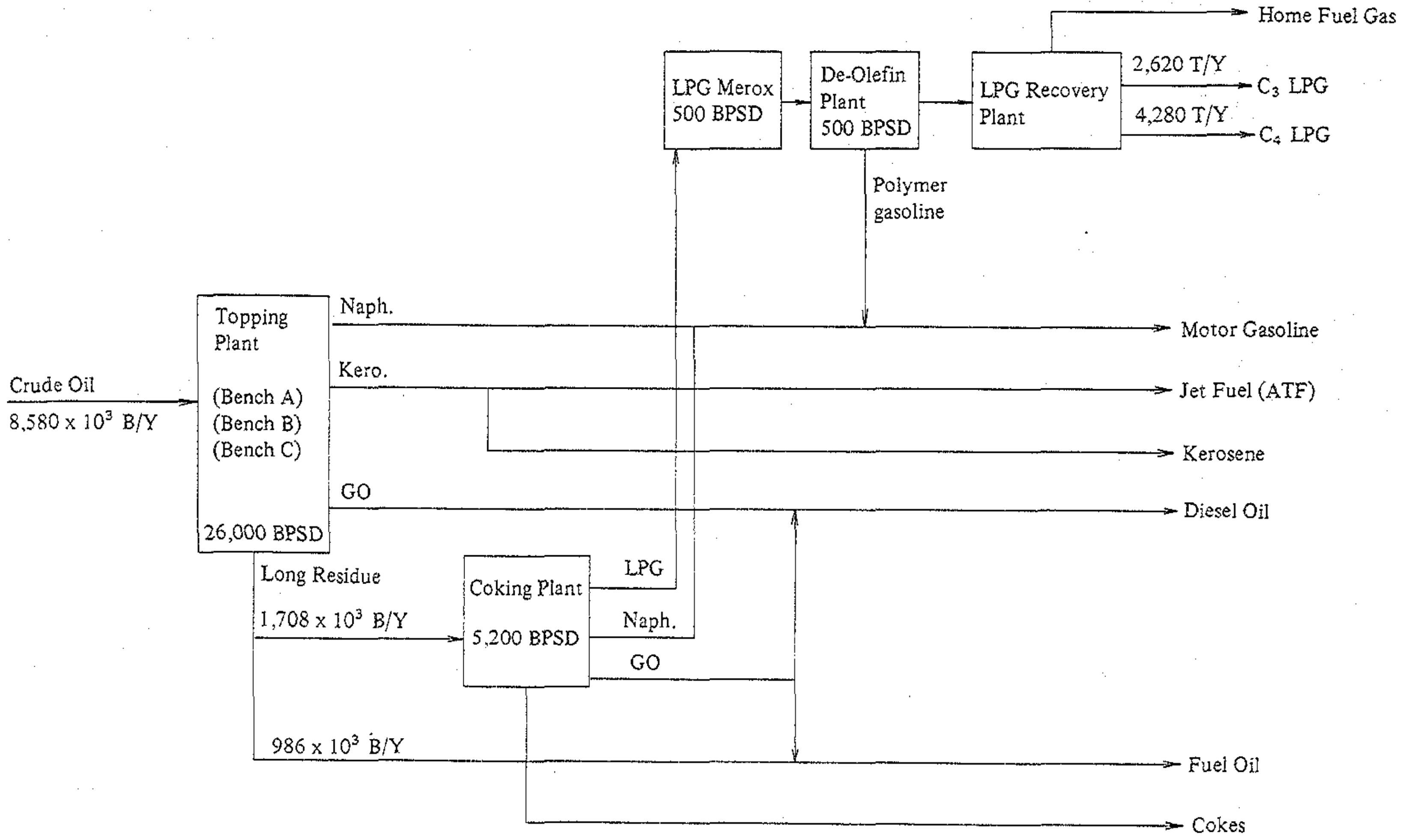


Table 3-6 Existing Refinery & LPG Recovery Plant Capacity & Operation Plan

		Chauk Refinery	Syriam Refinery				Mann Refinery	Mann GOCS LPG Recovery
			BENCH A	BENCH B	BENCH C	COKER		
1. Constructed Year		1954	1957	1963	1980	1985	1982	1986
2. Process Constitution								
Topping Unit	BPSD	6,000	6,000	14,000	6,000	–	25,000	LPG Extraction
Vacuum Flasher	BPSD	2,400	2,400	–	–	–	–	Plant
Catalitic Reformer	BPSD	–	–	–	–	–	2,800	24 x 10^6 SCFD
Naphcha HDS	BPSD	–	–	–	–	–	5,000	
Kerosen SPI	BPSD	–	–	–	–	500	3,000	
LPG Merox & Recovery	BPSD	–	–	–	–	500	800	
Naphcha Merox	BPSD	–	–	–	–	–	1,400	
Delayed Coker	BPSD	–	–	–	–	5,200	5,200	
Thermal Cracker	BPSD	–	1,500	–	–	–	–	
Deolefinizer	BPSD	–	–	–	–	500	–	
3. Products								
C3 LPG	BPSD	–	–	–	–	104	107	C3 = 39 T/SD
C4 LPG	BPSD	–	–	–	–	146	460	C4 = 60 "
Motor Spirit	BPSD	1,383	1,387	3,235	1,387	1,370	5,750	Naph = 11 "
Kerosen	BPSD	782	198	462	198	–	3,128	
Jet Fuel	BPSD	–	226	528	226	–	875	
Diesel Oil	BPSD	1,865	1,775	4,141	1,775	2,511	7,750	
Fuel Oil	BPSD	1,910	2,114	5,494	2,554	139	6,290	
Cokes	Ton/Day	–	45	–	–	104	104	
Waxes	"	25	–	–	–	–	–	
4. Processed Crude (past and future)								
1976 (in Thousand U.S. Barrels)		2,264		5,519	–	–	–	–
1977	"	2,400		5,923	–	–	–	–
1978	"	2,402	A + B	6,100	–	–	–	–
1979	"	2,491		6,267	–	–	–	–
1980	"	2,110		6,047	–	–	–	–
1981	"	2,414		6,633	–	–	–	–
1982	"	1,714		6,053	–	–	2,506	–
1983	"	1,143		4,745	–	–	4,563	–
1984	"	1,143		5,220	–	–	4,334	–
1985	"	1,143		4,745	–	–	5,100	–
1986	"	1,143	A + B + C	5,200	–	1,139	5,322	–
1987	"	1,143		5,500	–	1,425	5,597	24 x 10^6 SCFD
1988	"	1,143		5,500	–	1,520	6,057	24 "
1989	"	1,143		5,800	–	1,615	6,545	24 "
1990	"	1,143		6,400	–	1,710	6,619	24 "
						T.C. feed		of feed A.G.

Topping Plant	25,000	BPSD
Naphtha HDS	5,000	BPSD
Catalytic Reformer	2,800	BPSD
Kerosene SPI	3,000	BPSD
LPG Merox	800	BPSD
Naphtha Merox	1,400	BPSD
Delayed Coker	5,200	BPSD

The refinery produces LPG, gasoline, kerosene, jet fuel, gas oil, fuel oil and coke.

Fig. 3-3 shows the schematic configuration of plants at the refinery.

A production capacity of each petroleum product and a crude oil processing plan at the refinery are shown in Table 3-6.

(4) Mann GOCS LPG Extraction Plant is planned in Phase II. According to the explanation by Burmese side, it is now under construction and is expected to be completed in the end of December, 1986. The plant will produce 30,000 T/Y of LPG from 24 x 10^6 SCFD of associated gas by using the refrigerated absorption process. The outline of the installations is shown in Fig. 3-4.

3.4 LPG Production Plan

3.4.1 Kyangin LPG Extraction Plant

LPG output at the Kyangin LPG extraction plant is 61,000 T/Y. Its feed gas is associated gas coming from the Myanaung Oil Field, Shwepyitha Oil Field and Htantabin Oil Field, and the required quantity is 38 – 50 x 10^6 SCDF. Lean gas being by-producted is 33 – 43 10^6 SCFD. As for the present demand of the gas, Myanaung Power Plant and Kyangin Cement Mill are using approximately 15 x 10^6 SCFD. In the near future, it will come up to 43 x 10^6 SCFD by new demand at Seiktha Methanol Plant which is under construction now, and by increase in the demand because of expansion plan at above mentioned power station and cement mill.

The feed gas will be maintained sufficiently by the production of associated gas which corresponds to the demand of lean gas. The production of LPG will be performed on a scale of 61,000 T/Y from the first year.

Fig. 3-3 Configuration of Mann Refinery

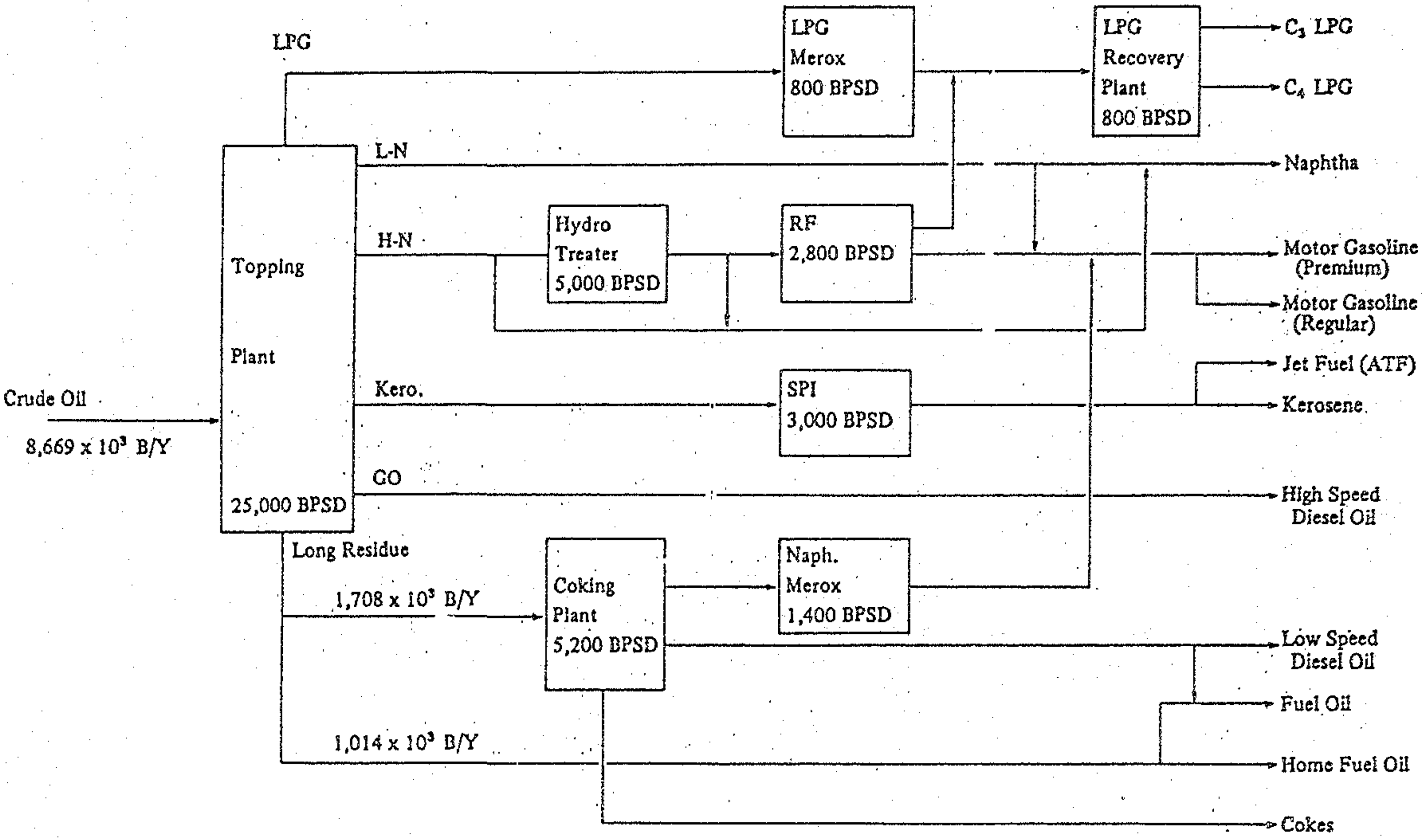


Fig. 3-4 Block Diagram of Process Flow at Mann GOCS

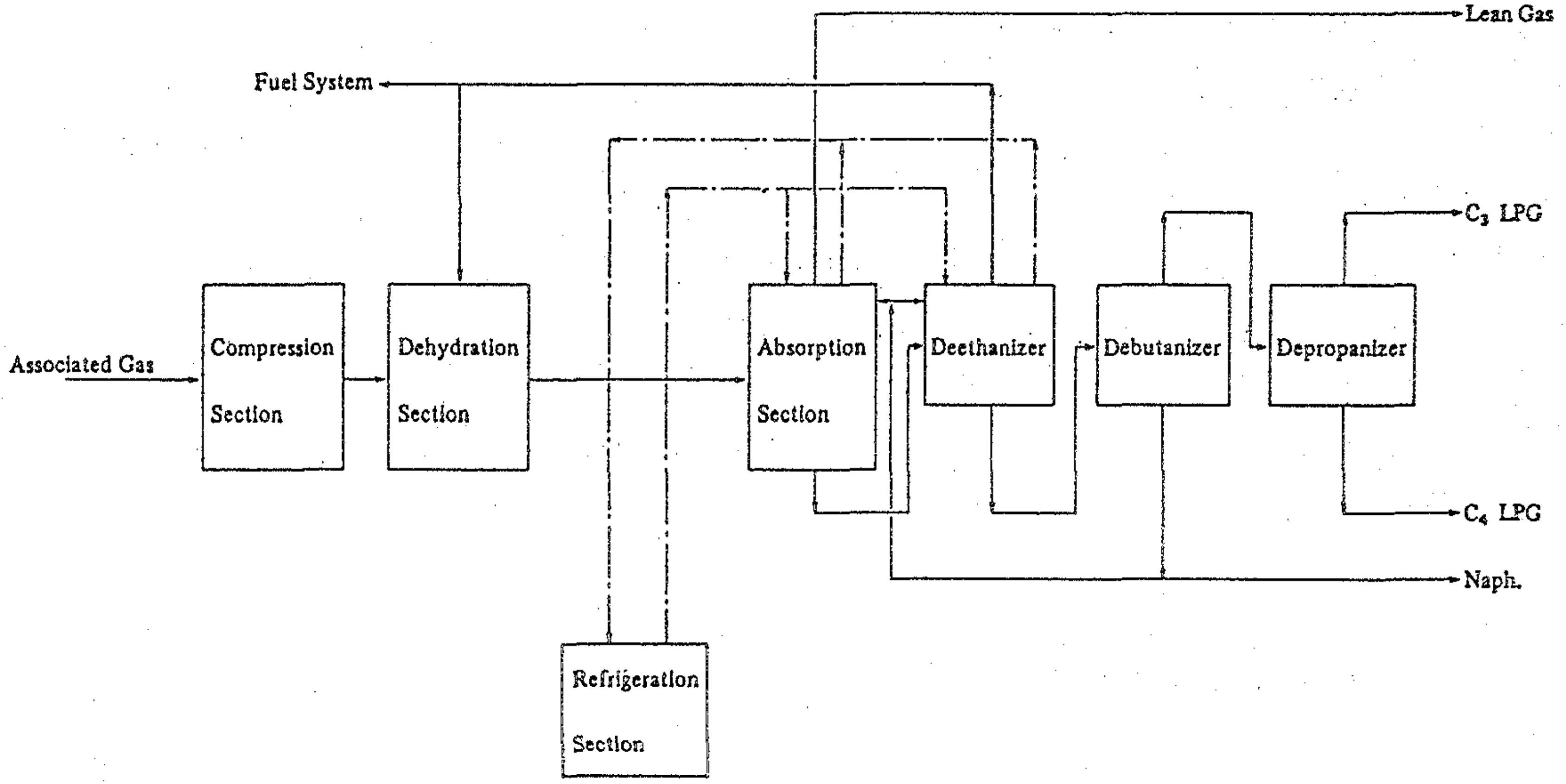


Fig. 3-5 Basic Flow Scheme for Phase III Project

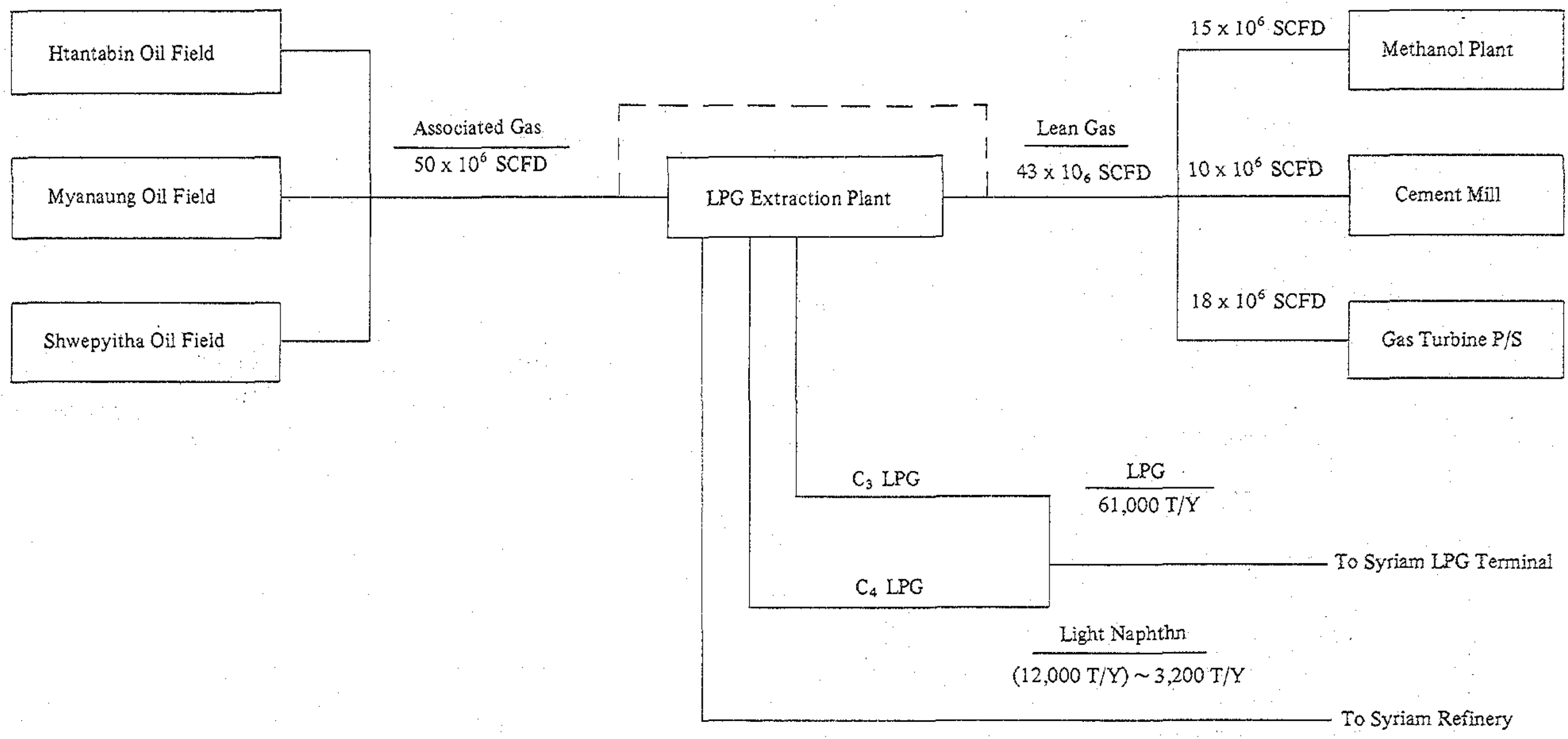


Table 3-7 LPG Production Plan in Refineries & Gas Fields

1. Plant	Mann Refinery									Syriam Refinery									Mann GOCS LPG Recovery Plant				
	Crude Oil Processing Quantity	Long Residue Output	Coking Plant		LPG Generation Quantity			(Note) LPG Output Quantity		Crude oil Processing Quantity	Long Residue Output	Coking Plant		LPG Generation Quantity			(Note) LPG Output Quantity		Associat-ed Gas Processing Quantity	LPG Production Quantity		(Note) LPG Output Quantity	
			Charge	Opera-tion Rate	Top-ping	Re-form-er	Coker	C3	C4			Charge	Opera-tion Rate	Top-ping	Re-form-er	Coker	C3	C4		C3	C4	C3	C4
Unit	10^3 B/Y	10^3 B/Y	10^3 B/Y	%	MT/Y	MT/Y	MT/Y	MT/Y	MT/Y	10^3 B/Y	10^3 B/Y	10^3 B/Y	%	MT/Y	MT/Y	MT/Y	MT/Y	MT/Y	10^6 SCF/Y	MT/Y	MT/Y	MT/Y	MT/Y
2. Production plan																							
1982	2,506									6,053													
1983	4,563									4,745													
1984	4,334							250	2,300	5,220													
1985	5,100		1,139	60			6,700	1,350	5,350	4,745													
1986	5,322		1,330	70	3,500		7,000	2,100	8,400	5,200		1,139	60				1,700	2.800					
1987	5,597		1,520	80	4,000		8,000	2,400	9,600	5,500		1,425	75				2,200	3,600	7,920	11,200	18,800		
1988	6,057		1,710	90	4,500		9,000	2,700	10,800	5,500		1,520	80				2,350	3,850	7,920	11,200	18,800		
1989	6,545		1,710	90	4,500		9,000	2,700	10,800	5,800		1,615	85				2,470	4,030	7,920	11,200	18,800		
1990	6,619		1,710	90	4,500		9,000	2,700	10,800	6,400		1,710	90				2,620	4,280	7,920	11,200	18,800		
	Note: LPG Output - (Production Quantity - Consumption in Refinery)									Note: LPG Output - (Production Quantity - Consumption in Refinery)													

The flow scheme of the materials, products, by-product lean gas at Kyangin LPG Extraction Plant is shown in Fig. 3-5.

3.4.2 Syriam Refinery

The crude oil processing plan at this refinery was shown in Table 3-6. In view of the trend of demand for light fraction, it is planned that the coking plant will maintain as high rate of operation as possible. On the other hand, taking account of sales plan of coke as well as demand of fuel oil, the rate of operation is planned to be increased every year from 60% of the first year. By doing this, the LPG output will increase from 4,500 T/Y in 1986 to 6,900 T/Y in 1990. The LPG production plan is shown in Table 3-7.

3.4.3 Mann Refinery

LPG of this refinery is produced at topping plant and coking plant. Although, the LPG output changes according to the crude oil processing quantity and the rate of operation of the coking plant, it will increase gradually and after 1988 will come up to the full output of 13,500 T/Y. The LPG production plan is shown in Table 3-7.

3.4.4 Mann GOCS LPG Extraction Plant

LPG output at the LPG extraction plant in Mann GOCS is 30,000 T/Y. Its feed gas is associated gas coming from oil fields, and the required quantity is 24 x 10^6 SCFD. According to the data from Burmese side, it is possible to produce feed gas and to accept lean gas being by-produced by the consumption plan of consumers that are power station, oil refinery and oil fields. The LPG output is planned to be in its full output in 1987, the first year. The LPG production plan is shown in Table 3-7.

Chapter 4

LPG DEMAND

Chapter 4. LPG DEMAND

4.1 Trend of LPG Demand and Its Forecast

4.1.1 Present LPG Demand in Burma

In answer to the survey team's questionnaire, they explained that there were the annual productions of 2,110 tons of LPG in 1982, 811 tons in 1983 and 534 tons in 1984, all of which having been domestically consumed. In 1985, it is planned that 6,700 tons of LPG are produced, 1,200 tons of which are directed to the domestic use and the rest 5,500 tons are exported. However, as Syriam Terminal has not yet been completed, the 1st shipment of LPG bound to Petrochemical Corporation of Singapore is scheduled to be transshipped from river barges into an ocean-going tanker in July, 1985.

4.1.2 Forecast of LPG Demand and Supply in Burma

The future forecast of LPG supply and demand in and after 1985 is indicated in the following Table 4-1.

Table 4-1 Future Forecast of LPG Supply and Demand

Unit: T/Y

	1985–86			1986–87			1987–88			1988–89			1989–90		
	C3	C4	Total	C3	C4	Total	C3	C4	Total	C3	C4	Total	C3	C4	Total
(Supply)															
Syriam refinery	–	–	–	1,700	2,800	4,500	2,200	3,600	5,800	2,350	3,850	6,200	2,470	4,030	6,500
Mann refinery	1,350	5,350	6,700	2,100	8,400	10,500	2,400	9,600	12,000	2,700	10,800	13,500	2,700	10,800	13,500
Mann GOCS	–	–	–	–	–	–	11,200	18,800	30,000	11,200	18,800	30,000	11,200	18,800	30,000
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Kyangin GOCS	–	–	–	–	–	–	–	–	–	–	–	–	12,600	17,400	30,000
	–	–	–	–	–	–	–	–	–	–	–	–			
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Total	1,350	5,350	6,700	3,800	11,200	15,000	15,800	32,000	47,800	16,250	33,450	49,700	28,970	51,030	80,000
(Demand)															
Cooking fuel			1,200			3,000			4,000			6,000			8,000
Industrial use															
Power generation															
Export			5,500			12,000			43,800			43,700			72,000
Total			6,700			15,000			47,800			49,700			80,000

In the above table, it is seen that while a supply expansion of 150 times is planned from 534 tons in 1984 to 80,000 tons in 1989, expansion in the domestic demand is planned to be 16 times from 500 tons to 8,000 tons in the corresponding period.

LPG production by plant after the completion of Phase III, domestic consumption and export are as indicated hereunder.

	Production	Domestic consumption	Export
Syriam Refinery	6,900 MT	1,000 MT	5,900 MT
Mann Refinery	13,500 "	13,500 "	–
Mann GOCS	30,000 "	–	30,000 MT
Kyangin GOCS	61,000 "	–	61,000 "
Total	111,400 "	14,500 MT	96,900 "

4.1.3 Present Situation of International LPG Market and Forecast

(1) The United Nation's energy statistics carries the figures as indicated in Table 4-2 as the actual LPG demand and supply in the world during the thirteen years from 1970 to 1982.

The statistics says that the world's LPG output in 1982 registered 117,838,000 tons and consumption 121,608,000 tons, showing that the output increased 22% during the ten years from 1973 and consumption 27%. Comparing these figures with the corresponding figures shown in the report prepared by the previous survey team for the ten yeras from 1970, i.e. production 42% and consumption 47%, it will be said that the increase rates have been considerably blunted.

The actual LPG demand and supply by country in 1982 surveyed by the United Nations are indicated in Table 4-3.

By country (1) USA consumed 55,135,000 tons in 1982; (2) Japan: 15, 854,000 tons; (3) USSR: 9,500,000 tons; (4) Mexico: 3,852,000; and (5) France: 3,175,000 tons. It shows that these five countries occupy 72.0% of the world's consumption.

The imports by country in 1982 are as follows: (1) Japan 11,860,000 tons; (2) USA 7,067,000 tons; (3) Netherlands 1,601,000 tons; (4) Spain 1,322,000 tons; and (5)

Table 4-2 Actual LPG Demand & Supply by United Nations from 1970 to 1982

(Unit: 10^3T)

		North America	Europe	Asia	Oceania	Central and South America	Africa	Middle East	Total
Production	1970	48,692	16,461	4,033	313	4,994	292	3,436	78,221
	1971	50,916	17,341	4,441	721	5,783	331	4,188	83,721
	1972	53,966	18,694	4,869	1,015	6,571	648	4,500	90,263
	1973	55,403	20,323	5,627	1,344	7,539	896	5,558	96,690
	1974	54,542	20,619	5,670	1,503	7,699	907	6,371	97,311
	1975	53,526	20,509	5,786	1,617	7,843	1,195	6,390	96,866
	1976	54,084	22,162	5,840	1,659	8,332	1,300	7,197	100,574
	1977	55,023	23,713	5,903	1,805	9,279	1,416	8,619	105,758
	1978	54,013	24,393	6,067	1,841	9,377	1,860	9,660	107,211
	1979	55,699	25,469	6,299	1,947	9,901	1,935	9,560	110,810
	1980	56,711	24,534	5,569	2,029	11,031	2,064	12,147	114,085
	1981	42,687	23,371	5,703	1,974	10,304	1,889	15,430	101,358
	1982	56,290	25,187	5,706	2,029	10,111	2,248	16,267	117,838
Import	1970	1,650	2,009	2,754	11	1,756	226	141	8,547
	1971	2,209	2,077	3,418	10	2,039	281	140	10,174
	1972	2,786	2,109	4,419	15	1,988	359	82	11,758
	1973	4,141	2,115	5,285	15	1,777	282	56	13,671
	1974	3,866	2,236	5,847	14	1,734	295	98	14,090
	1975	3,499	2,556	5,890	16	1,705	346	201	14,213
	1976	4,077	2,875	6,721	16	1,446	429	272	15,836
	1977	5,061	3,283	7,491	17	1,220	681	291	18,044
	1978	3,857	3,691	8,356	20	866	802	384	17,976
	1979	6,808	4,073	9,790	19	982	831	385	22,888
	1980	5,688	6,188	10,024	22	1,201	428	373	23,924
	1981	4,438	8,131	10,475	19	941	538	510	25,052
	1982	7,071	7,889	12,514	17	1,142	450	609	29,692
Export	1970	2,665	2,250	94	147	723	15	2,786	8,680
	1971	2,746	2,304	120	502	1,221	14	3,131	10,042
	1972	3,565	2,372	126	726	1,507	252	3,227	11,755
	1973	3,960	2,560	263	1,053	1,876	353	4,258	14,323
	1974	3,751	2,358	244	987	1,638	287	5,124	14,389
	1975	3,762	2,415	241	1,089	1,536	411	5,073	14,527
	1976	4,035	2,735	212	1,178	1,197	417	5,914	15,688
	1977	4,511	3,294	279	1,379	1,528	441	7,069	18,501
	1978	3,727	3,145	279	1,389	1,210	487	8,341	18,578
	1979	4,667	3,478	222	1,400	1,275	501	8,232	19,775
	1980	5,872	3,351	168	1,501	1,715	615	10,719	23,941
	1981	6,313	3,328	228	787	857	741	15,835	28,089
	1982	7,309	3,357	282	1,400	770	1,041	14,149	28,308
Change in stock	1970	37	388	226	–	7	2	(-) 22	638
	1971	145	122	82	–	28	(-) 1	172	548
	1972	38	111	155	–	4	(-) 1	291	598
	1973	(-) 5	325	67	–	21	9	89	506
	1974	108	126	238	–	(-) 16	5	(-) 9	452
	1975	201	(-) 17	(-) 29	–	12	16	62	245
	1976	(-) 57	119	15	–	(-) 1	–	79	155
	1977	26	(-) 150	353	1	72	2	249	553
	1978	(-) 1	327	(-) 219	1	33	2	8	151
	1979	(-) 138	258	–	–	–	5	11	136
	1980	1,150	60	41	19	(-) 6	(-) 40	(-) 69	1,155
	1981	3,422	1,664	(-) 246	19	(-) 24	2	(-) 137	4,700
	1982	(-)2,457	9	(-) 48	0	164	0	(-) 54	(-) 2,386

Table 4-3 Actual LPG Demand & Supply by Country by United Nations in 1982

(Unit: 10^3T)

Item Regional Country	Supply			Demand		
	Domestic Production	Import	Total	Export	Domestic Demand	Total
Africa (30 Countries)	2,248	450	2,698	1,041	1,657	2,698
Algeria	1,200	10	1,210	760	450	1,210
Libya	375	–	375	270	105	375
Egypt	260	200	460	–	460	460
Morocco	170	85	255	–	255	255
Others	243	155	398	11	387	398
North America (3 Countries)	56,290	7,071	63,361	7,039	58,509	65,818
U.S.A.	47,865	7,067	54,932	2,026	55,135	57,161
Canada	8,425	–	8,425	5,283	3,370	8,653
Bermuda	–	4	4	–	4	4
Central & South America (38 Countries)	10,111	1,142	11,253	770	10,319	11,089
Mexico	3,776	113	3,889	37	3,852	3,889
Brazil	2,445	575	3,020	20	2,900	2,920
Venezuela	1,455	–	1,455	500	930	1,430
Argentina	900	–	900	28	843	871
Chile	433	88	521	10	511	521
Colombia	263	–	263	–	263	263
Others	839	366	1,205	175	1,020	1,195
Middle East (14 Countries)	16,267	609	16,876	14,149	2,781	16,930
Saudi Arabia	11,355	–	11,355	10,917	486	11,403
Iran	1,090	–	1,090	540	550	1,090
Kuwait	1,035	–	1,035	996	60	1,056
U.A.E.	1,009	–	1,009	994	15	1,009
Others	1,778	609	2,387	702	1,670	2,372
Far East (17 Countries)	5,706	12,514	18,220	282	17,986	18,268
Japan	4,119	11,860	15,979	44	15,854	15,889
India	522	41	563	–	563	563
Korea	373	228	601	1	600	601
Philippines	114	109	223	10	217	227
Singapore	255	–	255	223	32	255
Thailand	138	130	268	–	268	268
Others	185	146	311	4	461	465
West Europe (20 Countries)	14,491	7,837	22,328	3,274	19,045	22,319
France	2,819	1,049	3,866	690	3,175	3,865
W. Germany	2,265	817	3,082	587	2,486	3,073
Italy	1,987	575	2,562	200	2,388	2,588
England	2,450	361	2,811	451	2,232	2,683
Spain	1,084	1,322	2,406	48	2,473	2,521
Netherlands	1,972	1,601	3,573	828	2,735	3,563
Belgium	364	370	734	282	447	729
Portugal	242	233	475	–	477	477
Others	1,308	1,511	2,819	188	2,632	2,820
East Europe (7 Countries)	10,696	52	10,748	83	10,665	10,748
U.S.S.R.	9,500	–	9,500	–	9,500	9,500
E. Germany	244	30	274	–	274	274
Poland	187	–	187	2	185	187
Others	765	22	787	81	706	787
Oceania (7 Countries)	2,029	17	2,046	1,400	646	2,046
Australia	2,000	–	2,000	1,400	600	2,000
Others	29	17	46	–	46	46
Total	117,838	29,692	147,530	28,308	121,608	149,916

Source: World Energy Supplies (UN) Figures on Japan have been modified based on actual record.

France 1,049,000 tons. This indicates that the five countries occupy 77.1% of the world's imports. Especially, Japan and USA dominate other countries in the import volume.

The exporting countries, namely the supply sources, that met the above imports and demand in 1982 are: (1) Saudi Arabia exported 10,917,000 tons; (2) Canada 5,283,000 tons; (3) Australia 1,400,000 tons; (4) Kuwait 996,000 tons; and (5) United Arab Emirates 999,000 tons; which shows that these five countries share 66% of the entire exports.

However, the United Nations' statistics lack the figures on People's Republic of China, Taiwan and other non-member countries, leaving some room of uncertainty about the quantity by country, and moreover, there is a great gap between the imports and exports, with the imports of 1982 exceeding the exports as much as 1,384,000 tons. Nevertheless, the statistics well indicate the trend by region like this:

(a) Asia region embracing Japan, a great importing country, imports 70% of its consumption.

(b) The Middle East and Oceania are exporting regions. In the Middle East, Saudi Arabia exports 96% of its output. At the time of 1982, it was anticipated that along with the completion of various new projects in other oil producing countries in the Middle East, export will further increase. However, due to the subsequent worldwide large reduction in the demand for crude oil, export of LPG from the Middle East in 1984 remains at around 12,500,000 tons.

(2) Forecast of World LPG Demand

1979 was the year when LPG demand in the world increased a great deal. The reason was that the revolution in Iran caused a shortage of oil hydrocarbon throughout the world, forcing it to switch over to the use of LPG having a relatively high availability. Consequently, LPG price rose over that of crude oil, and the average price of propane and butane reached US$319/ton FOB Ras Tanura, Saudi Arabia, in May, 1980. This is 2.68 times the LPG price as of October, 1978. During that time the price of crude oil of Arabian Light increased 2.2 times.

Reacting against that, the users came to lose reliance on LPG and in 1980 the price decreased 1% from that in the foregoing year, such decrease being for the first time since 1970. In 1981, in spite of the cut down in the LPG posted price in the Middle East by US$64/ton as propane/butane average done under the guidance of Saudi Arabia Petromin, the world LPG demand was reduced 17% compared with the previous year.

In 1982, LPG price was further reduced by US$18/ton and under the influence of rise in crude oil by US$2/BBL, LPG demand made a large increase of 30% over that in the previous year.

In 1983, as a result of the worldwide decrease in the demand for crude oil, especially a marked decrease in OPEC crude, the production of LPG which is produced mainly from associated gas was drastically reduced and consequently, in May, 1983, the LPG posted price rose to US$280/ton.

Such price rise was about to bring a decrease in LPG demand, but Saudi Arabia cut down the price six times since then and the average price of propane and butane presently stands at US$206/ton, which is 90% of the price of Arabian Light crude oil on the calorific value basis. The trend of change in the FOB prices of Saudi Arabia LPG and Arabian Light crude oil is indicated in Table 4-4.

Table 4-4　Change in FOB Price of Crude Oil/LPG (Saudi Arabia)

Year	Month	FOB price			FOB Price (US$/BBL)			FOB Price (US$/MM BTU)			Premium value	
		Crude oil (US$/BBL)	Propane (US$/t)	Butane (US$/t)	Crude oil	Propane	Butane	Crude oil (A)	Propane (B)	Butane (C)	(B)/(A)	(C)/(A)
1981	Jan.	32.00	305.0	295.0	32.00	24.62	27.44	5.54	6.44	6.31	1.16	1.14
	Feb.	32.00	305.0	298.0	32.00	24.63	27.72	5.54	6.44	6.38	1.16	1.15
	Apr.	32.00	300.0	298.0	32.00	24.23	27.74	5.54	6.33	6.38	1.14	1.15
	May	32.00	275.0	295.0	32.00	23.83	27.44	5.54	5.80	6.31	1.05	1.14
	May (19)	32.00	255.0	255.0	32.00	20.59	23.72	5.54	5.38	5.46	0.97	0.99
1981	Oct.	34.00	255.0	255.0	34.00	20.59	23.72	5.88	5.38	5.46	0.91	0.93
	Dec.	34.00	255.0	255.0	34.00	18.17	20.93	5.88	4.75	5.46	0.81	0.93
1982	Nov.	34.00	235.0	255.0	34.00	18.98	20.93	5.88	4.96	5.46	0.84	0.93
1983	Jan.	34.00	250.0	250.0	34.00	20.19	23.25	5.88	5.28	5.35	0.90	0.91
	Feb.	30.00	260.0	270.0	30.00	20.99	25.11	5.19	5.49	5.78	1.06	1.11
	Mar.	29.00	260.0	270.0	29.00	20.99	25.11	5.02	5.49	5.78	1.09	1.15
	May	29.00	280.00	280.0	29.00	22.61	26.04	5.02	5.92	5.99	1.18	1.19
	Aug.	29.00	270.00	270.0	29.00	21.80	25.11	5.02	5.70	5.78	1.14	1.15
	Sept.	29.00	260.00	260.0	29.00	20.99	24.18	5.02	5.49	5.56	1.09	1.11
	Oct.	29.00	225.00	250.0	29.00	18.17	23.25	5.02	4.75	5.35	0.95	1.07
1984	Apr.	29.00	225.0	240.0	29.00	18.17	22.32	5.02	4.75	5.13	0.95	1.02
	Aug. (1)	29.00	215.0	215.0	29.00	17.36	20.00	5.02	4.54	4.60	0.90	0.92
	Aug. (7)	29.00	206.0	206.0	29.00	16.63	19.16	5.02	4.35	4.41	0.87	0.88
1985	Feb.	28.00	206.0	206.0	28.00	16.63	19.16	4.84	4.35	4.41	0.90	0.91

Remarks: Propane 12.384 BBL/ton (S.G.O. 508); Butane 10.751 BBL/ton (S.G.O. 585); Crude oil 5.78 MMBTU/BBL;
Propane 47.39 MM BTU/ton; Butane 46.74 MM BTU/ton.

The demand trend should be determined by taking into account all such factors as these:

(a) Economic activity
(b) LPG supply availability, transportation and receiving facilities
(c) Demand and supply of other competing petroleum products
(d) LPG price level against crude oil and other competing petroleum products

The following are the prospects of LPG demand and supply in the world, which Purvin & Gertz Inc. in USA published in November, 1983 on the basis of their field surveys and comprehensive analysis. (Refer to Table 4-5)

This forecast of demand and supply was made on the assumption that the ratio of price by weight between LPG and crude oil is 0.9 in FOB price, Middle East. Owing to the increase in supply around the Middle East and Africa, the 1980's will be the years of surplus supply, which necessitates the development of new demand.

As of May 1, 1985 the ratio between Saudi Arabia Petromin LPG posted price of US$206/ton and Arabian Light crude oil posted price of US$28/barrel is 0.99; which infers rather disadvantage for the new LPG demand development. On the other hand, under the worldwide trend of decrease in the crude oil demand, LPG production has also been largely cut down and consequently the LPG surplus is estimated to have been reduced to the level of 2,000,000 to 3,000,000 tons by the present in 1985.

(3) The world's major supply regions

The world's major LPG supply regions in the 1980's are the Middle East, Africa and Oceania.

Purvin & Gertz Inc., which is worldwidely credited as an authority on LPG survey, predicts the exportabilities of these major supply regions as follows:

(a) The Middle East

After the "oil shock" in the 1970's, there came various projects taken up one after another for the efficient utilization of associated gas that had been flared off in great quantities to recover them in the forms of natural gas, LPG, etc.

Table 4-5 World Total LPG Supply/Base Demand (Likely Level)

Unit: 10^3T

	Historical				Est.	Projected						
	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1990	1995
[Supply]												
North America	42,434	43,236	42,401	43,231	40,195	40,020	41,006	41,853	42,141	42,410	42,409	42,252
Europe	14,641	16,231	14,766	13,888	14,700	15,055	16,590	16,820	17,235	17,205	16,835	16,525
Asia	6,051	6,559	6,768	6,300	6,503	6,710	6,923	7,523	8,062	8,415	9,859	10,920
Oceania	2,395	2,546	2,423	2,467	2,540	2,702	3,120	3,615	3,625	3,465	3,515	4,445
Latin America	8,701	9,367	10,595	11,312	11,752	11,040	12,455	12,870	14,625	14,980	10,170	18,490
Africa	1,210	1,730	1,062	2,244	2,53	2,000	5,265	6,565	7,955	7,990	8,050	12,100
Middle East	9,493	12,072	13,121	15,429	16,246	13,739	15,072	19,023	19,908	21,323	24,971	27,301
Total	84,934	81,047	92,016	94,957	94,560	93,746	101,231	100,269	113,551	115,796	121,009	132,033
[Base Demand]												
North America	42,104	46,106	43,122	43,401	43,071	41,246	41,054	42,443	42,304	42,372	41,070	42,977
Europe	15,506	17,721	17,309	17,463	17,334	17,170	17,390	16,977	17,137	17,137	17,491	18,140
Asia	14,902	16,305	16,908	17,209	18,675	17,205	17,647	18,519	19,232	19,560	21,400	24,005
Oceania	541	539	600	605	760	810	870	1,000	1,225	1,310	1,555	2,045
Latin America	8,215	9,032	10,052	11,161	12,154	12,010	13,305	13,095	15,065	15,610	17,465	21,015
Africa	1,467	1,631	1,055	2,093	2,001	2,236	2,553	2,715	2,922	3,064	3,528	4,501
Middle East	1,406	1,491	1,547	1,457	1,576	1,699	2,045	2,501	2,072	3,264	3,905	5,700
Total	84,301	92,905	91,553	93,469	95,651	93,254	95,762	98,130	100,662	102,317	107,382	110,543
[Surplus (Deficit)]												
North America	250	(2,950)	(641)	(170)	(2,876)	(1,236)	(848)	(590)	(163)	46	539	(725)
Europe	(865)	(1,490)	(2,623)	(3,575)	(2,554)	(1,323)	(808)	(157)	193	50	(656)	(1,615)
Asia	(8,931)	(9,746)	(10,220)	(10,823)	(12,172)	(10,575)	(10,724)	(10,996)	(11,170)	(11,145)	(11,620)	(13,165)
Oceania	1,054	2,107	1,923	1,782	1,786	1,972	2,250	2,535	2,400	2,155	1,960	2,400
Latin America	406	335	543	151	(402)	(970)	(940)	(1,025)	(440)	(630)	(1,295)	(2,525)
Africa	(248)	105	7	151	457	574	2,712	3,050	5,033	4,926	4,522	7,599
Middle East	8,007	10,501	11,574	13,972	14,670	12,040	13,027	16,522	17,036	18,059	20,906	21,521
Total (1)	633	(1,050)	463	1,406	(1,091)	492	5,469	10,139	12,009	13,479	14,427	13,490

Notes (1) Beginning in 1983, these supplies are available for additional market development.

Many of these have come to completion and more importance has come to be attached to the Middle East as LPG export region. Recently, however, due to the reduction in crude oil demand and subsequent production, Saudi Arabia, for instance, can produce LPG only to about half of its production capacity. Under such circumstances, they have vigorously set to the exploitation of non-associated gas fields.

Table 4-6 LPG Exportable Quantities of Middle East

Unit: 10^3 T

	Iran	Iraq	Saudi Arabia	Kuwait	Qatar	U.A.E	Others	Total
1985	300	0	10,645	1,880	742	2,850	105	16,522
1986	450	0	10,920	1,930	751	2,875	110	17,036
1987	600	0	11,420	1,955	959	3,030	95	18,059
1990	1,500	1,900	11,220	1,960	1,186	3,170	50	20,986

This prediction per the above table was published in the autumn of 1983 and reviewing the figures for 1985 at present, it is considered that the quantity of 1985 is ought to be modified down to 11,000,000 tons.

(b) Africa

Algeria, which has completed a project to recover LPG in large quantities from non-associated gas fields, will emerge as a major LPG supply region to export it to Europe, the Mediterrandean district and South America. Table 4-7 shows the exportable quantities of Africa.

Table 4-7 LPG Exportable Quantities of Africa

Unit: 10^3 T

	Libya	Algeria	Nigeria	Others	Total
1985	445	3,420	140	(155)	3,850
1986	440	4,840	138	(185)	5,033
1987	425	4,580	136	(215)	4,826
1990	365	4,380	127	(350)	4,522

(c) Oceania

In Australia, in addition to westernport engaged in LPG export since 1970, Bonython started exporting from the autumn of 1984, covering an annual handling amount of about 400,000 tons.

Indonesia is exporting from Ardjuna propane in the refrigerated type to Japan and butane (containing pentane approx. 35%) in the pressurized type to Singapore, about 400,000 tons/year in total. Also, from Santan, propane in the pressurized type is exported mainly to Japan in the amount of about 100,000 tons/year and LPG produced from refineries, in the pressurized type, to the neighboring countries in the amount of about 200,000 tons/year. Besides, there is a plan under progress whereby, starting in 1988, LPG is extracted from the LNG projects in Bontang and Arun in the amount of 2,100,000 tons/year and the products are to be exported to Japan in the refrigerated type. However, as this plan has not yet been finalized, this amount is excluded from the prediction in the table hereunder.

Table 4-8 LPG Exportable Quantities of Oceania

Unit: 10^3T

	Australia	Indonesia	Total
1985	1,645	890	2,535
1986	1,450	950	2,400
1987	1,185	970	2,155
1990	1,040	920	1,960

4.2 Forecast on Future LPG Selling Price in Burma

4.2.1 Domestic Selling Price

It is so decided that LPG to be produced in Phase III will be entirely exported and therefore this has no direct relation to the LPG selling price in Burma. However, the present domestic selling prices are propane 2,000 Kyat (US$233/ton) and butane 1,550 Kyat (US$180/ton).

4.2.2 Export Price

(1) Scheme for setting FOB price Rangoon

LPG to be produced under the present project can not be exportable unless its C&F price is well competitive with the international price of LPG or its substitute fuels prevailing in the consuming country in question. Therefore, FOB price Rangoon is set as the international price of LPG or its substitute fuels [refer to 4.2.2 (2)] minus the freight of 1,000 or 1,500 ton pressurized tanker from Rangoon to the supposed consuming country [refer to 4.2.2 (6)].

(2) LPG international price in consuming country

(a) LPG international prices in Japan, Korea, Taiwan and the Philippines which possess LPG refrigerated import terminals are to be represented as the total of the following items:

i) LPG posted price in Saudi Arabia
ii) Refrigerated tanker freight between Saudi Arabia and the consuming country.
iii) Refrigerated import terminal cost (estimated at US$30 as standard)

(b) As Hongkong does not possess refrigerated import terminal, transportation by pressurized tanker from the refrigerated import terminal in the neighboring Philippines is necessitated. Therefore, LPG price there will be the amount of the international price in the Philippines per 4.2.2 (2) (a) plus pressurized tanker freight between the Philippines and Hongkong.

(c) Although Singapore lacks the facility of refrigerated storage terminal, it exports LPG produced from the refineries therein to the neighboring countries. So Burmese LPG price is required to be competitive with such export price.

Incidentally, Singapore LPG export price in April, 1985 as quoted in Platt's LPGAS WIRE published weekly in London was US$220/ton.

(3) International price of LPG substitute in consuming countries

As a substitute in the consuming countries with which Burmese LPG will be competable, naphtha for the petrochemical industries in Singapore may be firstly mentioned. LPG price competable with naphtha, though depending on the prices of derivatives, is generally, said to be 85 to 95% of the naphtha price. 90% is adopted in the present feasibility study. Meanwhile, as the Singapore naphtha price, US$243/ton is adopted as the monthly mean value of the prices quoted daily in PLATT'S PRICE REPORT.

(4) FOB price Saudi Arabia

The world's LPG price is influenced by the price of LPG from the Middle East, world biggest export source, especially by LPG of Saudi Arabia, greatest exporting country.

The change in the FOB prices of crude oil and LPG in and after 1981 is as shown in Table 4-4. During this period, LPG price on the calorific value basis sometimes rose above and fell below the price of crude oil. However, it is considered that LPG and crude oil move on in parity on the long term basis, unless a change occurs in the world's energy situation caused by a war or some other politifal reasons.

Because of the difficulty of foreseeing the LPG price of Saudi Arabia, like with its crude, oil, and as a result of discussions with the Brumese side, it is decided to examine the present project on the basis of the current FOB price Arabian Gulf (US$206/ton) as fixed.

(5) Refirgerated tanker freight

The freight rate of a refrigerated tanker from the Middle East (Ras Tanura, Saudi Arabia) to Yokohama, Japan was assumed at the current average rate of US$35/ton (shipment of 70,000 ~ 75,000 cubic meters) and the rates to other destinations were calculated simply applying the ratio between the base rate from Ras Tanura to Yokohama by the World Scale (valid from Jan. 1 to June 30, 1985) and the equivalent from Ras Tanura to each supposed destination. (Refer to Table 4-9) Although there are naturally fluctuating factors with the freight rate according to the type of tanker to be hired, etc., such effects were neglected in the calculations.

Table 4-9 **Refrigerated Tanker Freight Rate**

Voyage	World Scale (US$/LT)	LPG Freight Rate (US$/T)
Ras Tanura – Yokohama	17.02	35
" – Yoesu	15.51	32
" – Kaoshiung	13.44	28
" – Manila	12.95	27
" – Hong Kong	13.15	(27)
" – Singapore	9.67	(20)

Remarks: ( ) = Refrigerated Tanks are not available.

(6) Pressurized tanker freight

The freight rates per Table 4-11 is provided on the basis that Burmese LPG will be exported in pressurized form in anticipation of the completion of a 1,000 T and a 1,500 T pressurized tankers in 1988 for a long-term service and also with the terms and conditions as per Table 4-10 taken into consideration.

Remarks: 1,000 T tanker means a vessel much has loadable capacity of LPG 1,000 T, and does not mean 1,000 dead weight tonner.

(7) FOB price Rangoon

On the above assumptions, FOB Rangoon prices are estimated as indicated in Tables 4-12 and 4-13. Upon studying these tables, Yokohama and Yoesu being inconsiderable, they have been eliminated through discussions with Burmese side. The FOB price Rangoon is set at US$140/ton. In the present feasibility study, facility and operation plans have been prepared on the basis of hiring a 1,500 T tanker. However, in deciding the price, the case of 1,000 T tanker is also taken into consideration to be on the severe side. Further, while the freight rate is on the assumption of a newly built pressurized tanker, by hiring an existing tanker, the operation cost may be relatively reduced. Under such circumstances LPG price is not considered to come under estimated US$140/ton for several years to come and the export price may reasonably be fixed at this value throughout the present feasibility study.

Table 4-10 Assumption of Pressurized Tanker Freight Rate

	1,500 Ton Tanker		1,000 Ton Tanker	
(A) Vessel		Annual Cost (5-year avg.)		Annual Cost (5-year avg.)
· Ship building	(To be completed 1986) 1.5 thousand million yen		(To be completed 1988) 1.0 thousand million yen	
· Depreciation	Salvage value 10% Amount fixed for 11 years	¥103,846,000	Salvage value 10% Amount fixed for 11 years	¥ 81,818,000
· Interest on repayment	Payable in 10 years Annual rate 10%	118,750,000	Payable in 10 years Annual rate 10%	75,000,000
· Insurance	Vessel premium + P.I.	24,000,000	Vessel premium + P.I.	17,000,000
· Fixed property tax	Salvage value x1/2x14/1,000	9,046,000	Salvage value x1/2x14/1,000	5,855,000
· Crew wages	15 men ¥693,772/man/month 5% up every year	124,879,000	15 men ¥693,772/man/month 5% up every year	124,879,000
· Repair & maintenance	Various inspection and repair coits set forth for period from 1st to 4th year. 5% up per annum in and after 5th year.	29,800,000	Various inspection and repair costs set forth for period from 1st to 4th year. 5% up per annum in and after 5th year.	19,600,000
· Administration cost	¥27,000,000 for 1st year 5% up per annum thereafter	29,839,000	¥18,000,000 for 1st year 5% up per annum thereafter	19,892,000
· Ship's stores	¥5,000,000 – ditto –	5,526,000	¥5,000,000 – ditto –	5,526,000
· Lubricant	¥8,000,000 for 1st year Fixed thereafter	8,000,000	¥7,000,000 for 1st year Fixed thereafter	7,000,000
· Misc. expenses	¥4,000,000 for 1st year 5% up per annum thereafter	4,421,000	¥4,000,000 for 1st year 5% up per annum thereafter	4,421,000
Total		458,107,000		360,991,000
(B) Running Cost				
(a) Speed	13.0 knots/hour		12.5 knots/hour	
(b) Fuel	Price MDO US$270/ton CFO US$190/ton Consumption At sea CFO 8.8 m tons/day In port MDO 0.7 ” Loading/Unloading MDO 2.5 ”		Price MDO US$270/ton CFO US$190/ton Consumption At sea CFO 8.0 m tons/day In port MDO 0.6 ” Loading/Unloading MDO 2.0 ”	
(c) Port charges	Rangoon US$6,600 Manila US$5,300 Singapore US$6,600 Yoesu US$4,700 Hong Kong US$5,300 Kaoshsiung US$4,700 Yokohama US$5,300		Rangoon US$6,000 Manila US$4,800 Singapore US$6,000 Yoesu US$4,200 Hong Kong US$4,800 Kaoshsiung US$4,200 Yokohama US$4,800	
(d) Loading/Unloading	Loading 2 days Unloading 1 day		Loading 2 days Unloading 1 day	
(C) Exchange Rate	US$1 = ¥240		US$1 = ¥240	

Table 4-11 Pressurized Tanker Freight Rate from Rangoon

Distination	Distance (miles)	Freight Rate (US$/T)	
		1,500 MT	1,000 MT
Yokohama	4,025	153	192
Yoesu	3,631	140	176
Kaoshiung	2,745	111	140
Manila	2,463	103	128
Hong Kong	2,546	104	132
Singapore	1,120	57	75

Table 4-12 Estimated LPG Price (FOB) Rangoon

Unit: US$/T

		Japan (Yokohama)	Korea (Yoesu)	Taiwan (Kaoshiung)	Philippines (Manila)	Hong Kong (Hong Kong) via Manila
Estimated cost of Middle East LPG	Ras Tanura FOB	206	206	206	206	206
	Refrigerated Tanker freight	35	32	28	27	27
	Estimated Terminal cost	20	30	30	30	30
	Pressurized Tanker freight	–	–	–	–	50
	Total	271	268	264	263	313
1. In case of 1,000T						
Pressurized Tanker freight from Rangoon		192	176	140	128	132
FOB price Rangoon		79	92	124	135	181
2. In case of 1,500T						
Pressurized Tanker freight from Rangoon		153	140	111	103	104
FOB price Rangoon		118	128	153	160	209

Table 4-13 Estimated LPG Price (FOB) Rangoon

Unit: US$/T

	Singapore		
	LPG	LPG (NAPHTHA)	
Market Price	220	219	
1. In case of 1,000T			
Pressurized Tanker freight	75	75	from Rangoon
FOB price Rangoon	145	144	
2. In case of 1,500T			
Pressurized Tanker freight	57	57	from Rangoon
FOB price Rangoon	163	162	

Remarks:
Market Prices of Singapore.
L.P.G. = Experimental Spot Quotes (FOB Singapore) of Platts LPGAS WIRE published weekly.
L.P.G. (Naphtha) = L.P.G. price equivalent to Naphtha price.
Naphtha = Spot market prices of PLATT'S PRICE REPORT published daily.
The LPG prices competitive with Naphtha for petrochemical use is 85–95 percent of these naphtha prices (current naptha prices $243/MT x 0.9 = $219 MT.

4.3 Future Prospects of Burmese LPG

4.3.1 Quality of Burmese LPG

LPG to be produced under Phase III uses associated gas as its feedstock and is free from olefine. Therefore, the products are expected to be of good quality to meet the international standard.

In the present survey, it was learned that Syriam plans to use a de-olefinizer to reduce the olefine contents to the level of several % and therefore the products will involve no problem both for the domestic use and exports. Meanwhile, as to the products of Mann Refinery, unsaturated components (15 ~ 20%) will not be eliminated and accordingly these are planned to be directed mainly to the domestic use. Such policy is considered to be rational as these are usable without problem for the domestic use as far as the quality is concerned.

As discussed hereinafter, while Mann LPG containing olefine is scheduled to be exported to Singapore for the petrochemical use in the middle of July, 1985, and high olefine content in the product, there seems to be no better way than to be exported to Singapore as petrochemical feedstock even with the disadvantage of lower selling price before domestic demand thereon increases within Burma.

4.3.2 Handling of High-pressure Gas

Generally, final consumption of LPG is conducted in the form of high-pressure gas and the major portion of great deal of LPG in transaction through international trade is of the refrigerated type.

Essential point in the trade or transportation of LPG consists in the reduction of transportation cost. Namely, when LPG is transported under high pressure, its quantity is limited and cost rises, being uneconomical for a long-distance trade or transportation. In the meantime, the development in refrigerating technique and improvement in materials and atmospheric liquefaction of gas made it possible to transport large quantities and to reduce the transportation cost. Thus, LPG has come to be handled in large quantities in international trade.

As a result, USA, Japan and West Europe, where they import large quantities of LPG, usually unload refrigerated-type LPG at their import terminals, and after converting it into high-pressure LPG, they transport it to their secondary terminals or deliver it by pipelines. This is a transport pattern they are employing at present. In other words, the import terminal, as a rule, has no high-pressure LPG receiving facilities. In view of this, high-pressure LPG of the present project ought to seek its market in the neighboring areas from the points of transportation and receiving facilities.

Information concerning high-pressure LPG terminals in Singapore, Hongkong and the Philippines and their capacities, etc. are indicated in Table 4-14.

In the present survey, it was found that Syriam LPG jetty is capable of mooring a tanker of up to 1,500 T. Therefore, it is advised that, depending on the export destination, as large tanker as possible be employed to minimize transportation cost and thus to improve the FOB Rangoon price. For instance, as Petrochemical Corporation of Singapore is provided with facilities to receive 1,500 T tanker, a considerable reduction in transportation cost will be anticipated by hiring a large tanker.

Operation of large ocean-going LPG tankers for export involves much risk and requires considerable amount of experience before earning reasonable profit. So it is suggested that PIC will make FOB contracts with the customers so that the tanker operation risks are on their sides.

Table 4-14 Pressurized LPG Terminals

Country	Owner/operator	Location	Storage (m^3)	Max. cargo size (tons)
Singapore	PCS	Pulau Ayer Merbau	12,000*	3,000
	ESSO	Pulau Ayer Chawan	3,000	1,800
	Mobil	Jurong	8,500	1,500
	Shell	Pulau Bukom	8,000	2,000
Hong Kong	Caltex	Tsuen Wan	3,000	1,500
	ESSO	Tsing Yi	2,900	1,500
	HK Oil	"	3,400	1,500
	Mobil	"	3,400	1,500
	Shell	Kwan Tong	5,000	1,800
Philippines	BRC	Limay	8,000	4,000
	Caltex	Bataangas	5,000	3,000
	PSPC	Tabangao	6,000	3,000

* Storage of 9,000 M^3 will be added in Autumn, 1985.
P.C.S. = Petrochemical Corporation of Singapore
B.R.C. = Bataangas Refining Co.
P.S.P.C. = Philippines Shell Petroleum Co.

4.3.3 Future Prospects of Burmese LPG Export

(1) Present LPG demand in Asia and its forecast

Considering that LPG to be produced under the present project is of the high-pressure type, Southeast Asia should be considered as its market in order to secure profits, because this market requires comparatively a little transportation cost.

As was mentioned in 4.1.3 (1) on the present LPG demand and supply in the world, Asia is a region where they import as a whole 70% of their consumption. This is because of Japan, a large-quantity importing country, lies in the region. The following shows the actual demand and supply in 1982, estimated for major LPG consuming countries other than Japan.

Table 4-15 Actual Demand (1982) by Country

Unit: 10^3 T

	Demand	Domestic productions	Import (Export)
Taiwan	700	588	112
Korea	641	404	237
Hong Kong	138	0	138
Thailand	350	131	219
Philippines	255	170	55
Singapore	68	260	(192)
Malaysia	110	85	25
Total	2,232	1,638	594

Based on these data in Table 4-15, future LPG demand and supply in those countries for 1990 is estimated as shown hereunder:

Table 4-16 Future Demand (1990) by Country

Unit: 10^3T

	Demand	Domestic Production	Import (Export)
Taiwan	1,200	1,025	175
Korea	1,563	734	829
Hong Kong	250	0	250
Thailand	840	1,100	(260)
Philippines	320	180	140
Singapore	400	150	250
Malaysia	1,070	1,000	70
Total	5,643	4,189	1,454

(2) Structural change in LPG trade in Asia

Except Japan, it was only Taiwan until 1981 that could receive refrigerated LPG (Kaoshsiung: 17,000 tons). With an increase in LPG import, refrigerated tankage of 55,000 ton capacity has been added after 1981. Also, Korea completed an underground type refrigerated storage with 153,000 ton capacity at Yoesu in 1983. Further, Philippines Shell has constructed a 50,000-ton refrigerated import terminal in Manila.

These equipment investments are intended to obtain large quantities of the Middle East's LPG, which was not imported directly so far except Japan and Taiwan.

As to structural change concerning exports. Thailand, which had been importing about 200,000 tons of the Middle East's LPG every year by transshipment from refrigerated tankers off the shore of Bangkok, completed a LPG recovery facility at Rayong in 1985. While the major portion of its products (approx. 400,000 tons/year) is to be domestically consumed, propane which will still be in small demand for some years in future will inevitably be directed to exports.

Malaysia has been importing a little amount of LPG to cover the deficiency for its domestic demand. However, beginning in 1985, it has come to export refrigerated LPG in the annual amount of about 300,000 tons to Japan, Korea and other countries.

Indonesia, besides exporting LPG from the existing Ardjuna and Santan Projects, it plans to export 450,000 tons of LPG annually from Tanjung Uban starting in 1985, 1,800,000 tons from Arun and 300,000 tons from Bontang, both starting in 1988.

(3) Proposition on Burmese LPG exports

As discussed repeatedly hereabove, profitability of the present project depends on the selection of export destinations which require as little freightage as possible in consideration of the LPG production amount, facility scale and transportation method and the export should be studied concentrating on the matter of freight rate.

In this connection, the present survey team would like to make the following proposals.

(a) In the case of executing the present project, marketing activities should be started as soon as the policy has been decided.

(b) Then, engotiations should be energetically had with potential customers, especially those in the neighboring countries (e.g. Singapore, Hongkong, the Philippines, etc.).

(c) Spot sales should be avoided as far as possible and sales under long-term contracts with terms and conditions based on a rational price formula should be sought for.

(4) Potential markets for Burmese LPG

As potential markets for Burmese LPG, Singapore, Hongkong and the Philippines are to be considered and the conditions of these three markets will be described in the following:

(a) Singapore

In 1983, out of the total LPG production of about 200,000 tons, 70,000 tons were used for the domestic demand (80% for the residential sector's use and 20%, for other industrial uses and town gas service) and the remaining 130,000 tons were exported to Hongkong, the Philippines, Thailand, etc. At the beginning of 1984, a joint venture between Japan and Singapore, Petrochemical Corporation of Singapore (Private) Limited (PCS) started operation and LPG situation has totally changed since then.

This corporation possesses an ethylene production capacity of 300,000 tons/year and in 1985, it is being operated almost to its full capacity. As feedstock, domestically produced naphtha and also LPG of domestic production and of the neighboring countries are being considered, with such facilities provided as to flexibly use feedstock whichever cheaper on occasion.

As to LPG, their facilities were firstly albe to use only up to 40% of the feedstock but these have been modified so as to utilize up to 70% at present. As a result, LPG of about 560,000 tons has come to be physically usable a year.

On the other hand, long-term basis contracts they presently conclude for LPG supply cover solely 200,000 to 250,000 tons/year from Ardjuna, Indonesia and 100,000 tons/year from Singapore Shell (this can be switched to naphtha) and also a little amount under the contract recently concluded with Burma (see Note). So, LPG to be produced under Phase III in the amount of 61,000 tons/year is expected to be safely absorbed into the contract.

Under such circumstances, it is considered that Burma should deem PCS as a main customer on a long-term and stabilized contract basis and negotiate to expand the present contract for increasing their sales to meet the future expanded production under the present project.

Note: Business Times (Singapore) of April 29, 1985 edition carries a report in the following gist:

* PCS purchases LPG from Burma on a 5-year contract basis.

* PCS and Mitsubishi Corporation agree on 5-year contract for Burmese LPG.

* The long-term contract for the first time will insure PCS a stabilized LPG supply.

* The 1st shipment will arrive at PCS in July, 1985.

(b) Hongkong

LPG consumption there is about 160,000 tons/year and almost the whole of the imports has been the products of Singapore Refinery. However, when PCS began to use LPG, import from Singapore became impossible and it is forced to import LPG of the Middle East source via the Philippines and other countries by pressurized tankers. It is predicted that 200,000 tons of LPG will be imported in 1985, 250,000 tons in 1990 and 300,000 tons in 1995.

If FOB Rangoon price for Hongkong market can be anticipated to be higher for a long period than long-term contract price (FOB Rangoon price) with PCS, Burma ought to negotiate with Hongkong for concluding a long-term contract.

LPG demand in Hongkong is almost all for the residential and commercial use.

(c) The Philippines

Consumption was about 200,000 tons in 1983. 85% of the demand is for the use of household kitchen. Such demand is quite sensitive to the trend of LPG price and electricity rate. Many users possess both propane cookers and electric hot plates and use either cheaper ones. Previously, almost all LPG for consumption was supplied from the domestic refineries but as supply does not catch up with demand, import has been increased. On the other hand, although a refrigerated import terminal of Tabangao Shell was completed in 1983, import remained only at 50,000 tons in the same year due to the economic problems and shortage of foreign exchange in the Philippines. Assuming that such economic problems are solved within some years in future, the demand is estimated at 230,000 tons in 1985, 320,000 tons in 1990 and 500,000 tons in 1995.

In the case of exporting LPG from Rangoon to the Philippines, it should be shipped directly to the high-pressure receiving terminal rather than to the above-mentioned refrigerated terminal. Because, FOB price Rangoon can be raised by the amount of LPG transit freight from the refrigerated terminal to the high-pressure terminal.

4.4 Demand and Price of By-products

4.4.1 By-product Naphtha

Naphtha to be produced under Phase III as by-product will be in the amount of about 3,200 tons/year and this amount can be safely absorbed in the use of petrochemical industries in the neighboring countries. Its export price (as FOB Rangoon) is fixed at US$225/ton based on the current Naphtha price FOB Singapore.

4.4.2 Lean Gas

Lean gas to be produced as by-product in the Kyangin LPG extraction plant is scheduled to be sold at the rate of 1.8 kyat/1,000 SCF for the use of fuel in power station and cement mill and also as feedstock for methanol plant.

4.5 Domestic Market Development

Burmese domestic LPG demand as studied by the previous survey team in 1981 was 700 tons/year and the planned amount for 1985 is also 1,200 tons/year without any increase. To drastically increase the same to about 12 times in a short period hereafter, PIC contemplates domestic market development program as follows:

4.5.1 Domestic Market Development Program by PIC

(a) Background

The domestic market for LPG in Burma was started in the 1960's concurrent with the start of domestic production of electric bulbs in a plant under HIC's jurisdiction. At that time, LPG was not produced in Burma and was imported mainly from Japan in the form contained in 2-ton containers. The kind in use was propane and was consumed merely 50 tons a year.

LPG domestic production was started in 1982 at the Mann Refinery and the product LPG was supplied to HIC. Meanwhile, domestic manufacturing of glass bottles and sheet glass was started at Syriam and Bassein respectively by Ceramic Industries Corporation and LPG was supplied thereto from Mann in 1984.

In 1985, the domestic demand will rise to about 1,200 tons. This is because Burmese people are not sufficiently instructed for the safe use of LPG and its usage for cooking has not yet been duly introduced into households. At present a government cooperation concerned is engaged in the preparation of laws and regulations related to LPG utilization. When such have been established, it is expected that LPG will be introduced into certain selected sections, such as large hotels, hostels, military barracks, hospitals, etc. as cooking fuel.

(b) Distribution.

Due introduction of LPG for the use by common people requires the development of retail centers to be engaged in district distribution and presently, Rangoon, Mandalay, Megwe, Moulmein, Bassein and Prome are considered to become the first LPG distribution districts. While the authority to be mainly in charge of such distribution is P.P.S.C., it is supposed to closely collaborate with PIC for safe and efficient operation. It is decided that some districts are selected for tests in this regard.

(c) Details

Details of the plan for domestic market development may be itemized as follows:

i) Selection of industrial customers.
ii) Selection of common customers.
iii) Use for automobiles as alternate fuel to motor gasoline.
iv) Allocation of accepting quantities to the customers according to the type of trade.
v) Setting forth of distribution districts through close discussion with P.P.S.C.
vi) Establishment of distribution centers for such districts.
vii) Control on the storage of LPG containers. Tests of the containers and certificates.
viii) Watch for safety work and compulsory safety procedure.
ix) Feedback of information concerning troubles experienced by users and countermeasures against such.

(d) Schedule

Introduction of LPG for domestic consumption is scheduled as follows:

i) Introduction of propane usage for light industries such as metal cutting work and for minor factories and enterprises.
ii) Introduction of butane for the use in hotels, public cooking kitchens and hospitals for the heating purposes (mainly for cooking).
iii) Introduction of butane for domestic cooking by the dwellers of large cities.

iv) Introduction of butane and propane as alternate fuel to motor gasoline for vehicles.

At present, evaluation of the possibility of LPG utilization in the above four categories is in progress and detailed schedule will be clarified as soon as relative data have been gathered.

(e) Cost and effect

Cost to be incurred concerning LPG introduction to the domestic market will be commonly borne by PIC and P.P.S.C. In the early stage, however, as PIC is to sell it only to government corporations, the cost will not be so much. Meanwhile, when the distribution centers have been established for the consumption by common people, cost at the level of 100,000 Kyat a year will be required for 5 years on a consecutive basis.

The introduction of LPG will bring the following effects:

i) Common people obtain thermally efficient clean fuel.
ii) As the consumption amount of wood and charcoal by people for the fuel use is reduced, this will serve to preserve forestry resources.
iii) If LPG is used as automobile fuel, this will take the place of gasoline presently used for cars.

4.5.2 Proposition for Domestic Market Development

PIC is contemplating a plan for developing the domestic market as described hereabove. However, as to the plan to drastically increase domestic demand, presently 1,200 tons/year, to 14,500 tons/year corresponding to 12 times, there may be various problems. In this regard, the present survey team would like to make the following proposition:

(a) Propagation of knowledge about LPG's fuel characteristics, merits, safe handling method, etc. to the common people is urgently required. In this connection, it is considered to be very effective that any large LPG consuming country, e.g. Japan is requested for despatch of experts to Burma in early period to have them join plan making for the preparation of LPG safe handling regulations and domestic market development. (See Note)

(b) As the present LPG ex-factory prices in Burma (propane 2,000 Kyat/ton, butane 1,550 Kyat/ton) are relatively higher than those of competitive energies (electricity, kerosene, etc.), it will be necessary to reduce the LPG price or to grant subsidy for increasing LPG domestic demand.

Note: As the items of work to be committed to JICA experts, the following are considerable:

i) Collection of demand data, their analysis, demand forecast, plan making for demand development and introduction of LPG equipment.
ii) Distribution system (facilities and operation).
iii) Plan execution (documents control, computerization).
iv) Preparation of safety regulations and instruction manual.
v) Personnel training.

Chapter 5

BASIC PLAN FOR LPG RECOVERY FACILITIES

Chapter 5. BASIC PLAN FOR LPG RECOVERY FACILITIES

5.1 Outline of LPG Recovery Facilities

The facilities plan for Phase I-Part 2, Phase II and Phase III in 'Integrated LPG Project of Burma' is as shown in Table 6-1.

5.2 Determining the Scale of LPG Recovery Facilities

5.2.1 Kyangin LPG Extraction Plant

The scale of the LPG extraction plant is determined by studying the following determinants.

- LPG demand
- Output and availability of feed gas
- Demand and supply of by-product lean gas
- Economy of plant scale

(1) LPG demand

When the demand in Burma only is considered, it is extremely small as described in Section 4.1. Therefore, the LPG extraction plant will have to be designed for export of LPG. Accordingly, the scale of the plant is determined with LPG export in mind.

(2) Output and availability of feed gas

The present output and volume of use of associated gas at Myanaung, Shwepyitha and Htantabin Oil Field are approximately 17 x 10^6 SCFD as pointed out in Section 3.2. It is anticipated, however, to be able to sufficiently secure for a long period of time a volume of 38 ~ 50 x 10^6 SCFD by increasing the output in accordance with the increase of demand expected in the future. The entire volume of these gases can be used as the raw materials for this LPG extraction plant when the plant is completed in the future.

(3) Demand and supply of by-product lean gas

From the standpoints of economy and efficiency, the volume of by-product lean gas should be limited to the output that is matched with the demand, and disposal of surplus gas by combustion should be avoided. Production will be made as matched with the scale and timing of intake of lean gas by the methenol plant in Seiktha, cement mill in Kyangin and power station in Myanaung, all located in the vicinity of the Kyangin LPG extraction plant. If the output of the lean gas is insufficient, it will be supplemented with associated gas and natural gas.

Table 5-1 Outline of LPG Recovery Facilities

Phase	Facilities Plan	
	Facilities	Outline of Facilities
Phase III	Kyangin LPG Extraction Plant	(1) LPG extraction facilities and ancillary equipment are to be provided for extracting LPG from Myanaung, Shwepyitha and Htantabin's associated gas. (2) Electric power transmission line and ancillary equipment are to be installed from Myanaung power station to Kyangin LPG Extraction Plant site. (3) Pipe line of associated gas for receiving feed gas is to be installed from Shwepyitha oil field to Kyangin LPG Extraction Plant site. And a part of pipe line of lean gas is to be installed. (4) Pipe lines are to be provided for pumping LPG to Kyangin LPG Terminal and Naphtha to Kyangin Jetty through Kyangin Terminal, and for supplying utilities.
	Kyangin LPG Terminal	(1) Spherical LPG tanks and ancillary facilities are to be provided as LPG collection facilities for receiving LPG from Kyangin LPG Extraction Plant. (2) Jetty for river barges, shipping pumps, LPG pipe lines and ancillary facilities are to be provided as LPG shipping facilities.
	Syriam LPG Terminal	(1) Newly constructed jetty for river barges and LPG ocean tankers in Phase I-part 2 is to be used new jetty now under constructing at Phase I-part 2. (2) Spherical LPG tanks and ancillary facilities are to be added to the facilities of Phase I-part 2 for receiving LPG from Kyangin LPG Extraction Plant.
	River Barges	(1) River barges are to be provided for transporting LPG from Kyangin LPG Terminal to Syriam Terminal.
Phase I-Part 2	Syriam LPG Terminal	(1) Jetty for river barges and LPG oceantankers is to be provided as LPG unloading and loading facilities. (2) Spherical LPG tanks, unloading compressors, shifting pumps, LPG pipe lines and ancillary facilities are to be provided as LPG collection facilities for receiving LPG from Mann Terminal, Syriam Refinery and Kyangin LPG Terminal. (3) Shipping pumps and LPG pipelines are to be provided as LPG shipping (Export) facilities.
	Mann LPG Terminal	(1) Spherical LPG tanks, LPG pipelines and ancillary facilities are to be provided as LPG collection facilities for receiving LPG from Mann Refinery and Mann GOCS LPG Extraction Plant. (2) Jetties for river barges (existing jetties to be used), shipping pumps and LPG pipelines are to be provided as LPG shipping facilities.
	River Barges	(1) River barges are to be provided for transporting LPG from Mann Terminal to Syriam Terminal.
Phase II	Mann GOCS LPG Extraction Plant	(1) LPG extraction facilities and ancillary equipment are to be provided for extracting LPG from Mann GOCS associated gas. (2) Pipelines are to be provided for pumping LPG to Mann Terminal.

(4) Economy of plant scale

Normally, the construction costs of a plant of this type are known to be proportional to the plant scale raised to the 0.6 ~ 0.8th power. Accordingly, the larger the plant scale, the lower the construction costs per unit product, and therefore the more economical.

Items (1) and (4) above indicate that designing the plant scale as large as possible will be desirable. That is, the plant scale should be made as large as possible within the framework of the stable supply of feed gas available as indicated in Item (2) and within the framework of delivery of the by-product lean gas as indicated in Item (3). Accordingly, the plant scale of 50 x 10^6 SCFD based on feed gas is determined as viewed from the balance of demand and supply of lean gas. When the LPG output is computed based on the composition of the mixed feed gas of the associated gas produced at Myanaung, Shwepyitha and Htantabin Oil Field and also on the LPG recovery ratio of the LPG extraction plant, it will be an annual production level of roughly 61,000 tons or more. Adjustment will be made by the input gas volume if the contents of C_3 and/or C_4 are excessive in the mixed feed gas.

5.2.2 Receiving, Shipping and Storage Facilities at Kyangin

(1) Factors for determining the scale

The following factors should be examined in general for determining the scale of a terminal.

- LPG handling volume
- LPG receiving/shipping schedule

1) LPG handling volume

Decision of the handling volume is an extremely important criterion for determining the scale of a terminal.

The entire volume of the LPG produced at the Kyangin LPG extraction plant will be handled at this terminal. Accordingly, the handling volume is 61,000 tons per year.

2) LPG receiving/shipping schedule

The LPG receiving/shipping schedule is the most important factor that determines the scale of the Kyangin LPG terminal.

The terminal's receiving/shipping schedule is planned based on the following considerations.

- Receiving/shipping should be suitably distributed in time, and concentration to specific time zones should be avoided.
- The storage capacity of tanks should be maintained with appropriate allowance.
- The number of times of use of jetties should not exceed the range that permits operation of jetties.
- Reduction of capacity of the terminal due to maintenance of tank facilities, etc. should be taken into account.
- LPG transportation from the Kyangin Extraction Plant is made once a day to receive the output of the previous day.

(2) Determination of terminal scale

As a result of through examination of the determinants for determining the terminal scale, it is considered to be most suitable to plan the terminal scale as shown in Table 5-2.

(3) LPG receiving/shipping schedule

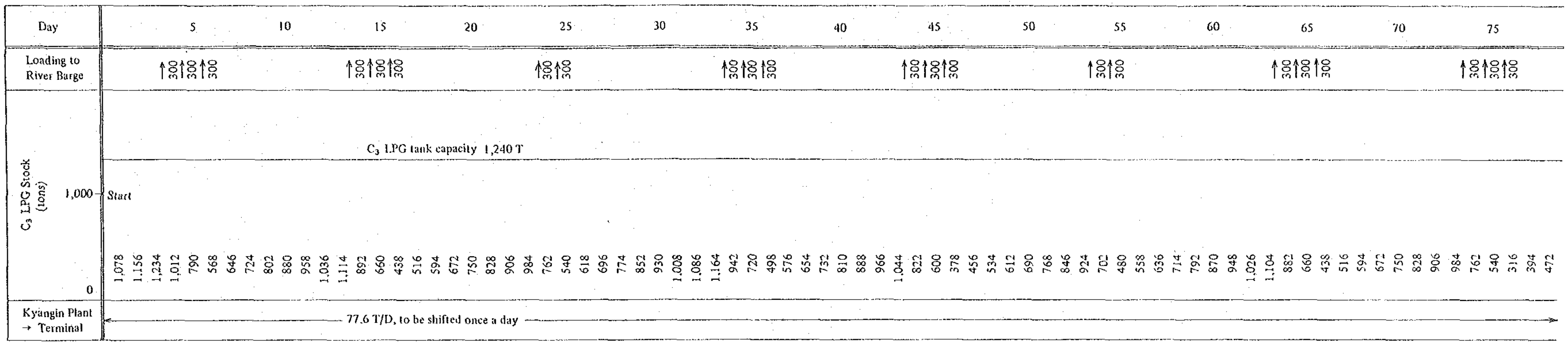
The planned scheduled for LPG receiving/shipping at the Kyangin LPG Terminal is as shown in Table 5-3, Table 5-4 and Table 5-6.

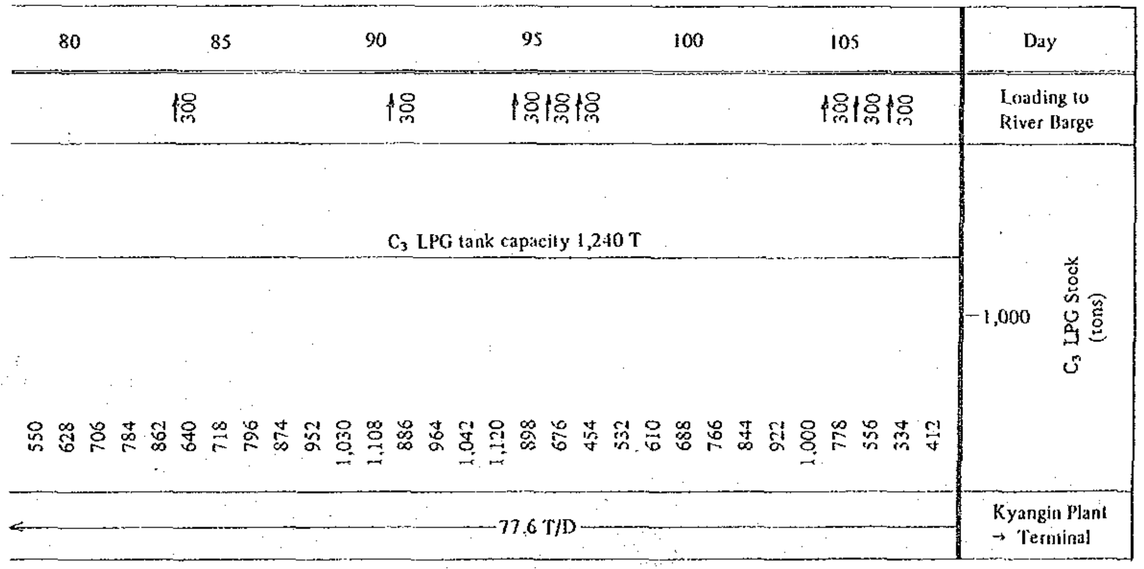
The condition of use of LPG tanks summarized on the basis of these planned schedules is shown in Table 5-6. It is judged the terminal scale indicated Table 5-2 is suitable.

Table 5-2 Scale of Kyangin LPG Terminal

Item	Scale of terminal	Remarks
1. LPG handling volume	C_3 LPG 25,600 T/Y C_4 LPG 35,400 " Total 61,000 "	
2. Tank capacity	C_3 LPG 1,000 m^3 x 3 units C_4 LPG 2,000 m^3 x 2 units	Storage capacity: Equivalent to 15 days.
3. Shipping pump	C_3 LPG 300 m^3/H x 2 units C_4 LPG 300 m^3/H x 2 units	Loading into river barges to be done in the daytime. (within 8 hrs.)

Table 5-3 C_3 LPG Receiving and Shipping Schedule at Kyangin LPG Terminal





Remark: Required time between Kyangin Terminal and Syriam Terminal.
(1) to Syriam Terminal 3 days
(2) to Kyangin Terminal 5 days

Table 5-4 C_4 LPG Receiving and Shipping Schedule at Kyangin Terminal

C_4 LPG tank capacity 1,930 T

Start 1,200 T

Kyangin Plant → Terminal: 107.3 T/D to be shifted once a day

Day	Loading to River Barge	C_4 LPG Stock (tons)
1		1,307
2		1,414
3		1,521
4	300	1,328
5	300	1,135
6	300	942
7		1,049
8		1,156
9		1,263
10	300	1,370
11		1,477
12		1,584
13		1,691
14	300	1,498
15	300	1,305
16		1,112
17		1,219
18		1,326
19	500	933
20		1,040
21		1,147
22		1,254
23		1,361
24	300	1,168
25	300	975
26	600	482
27		589
28		696
29		803
30	300	910
31		1,017
32		1,124
33		1,231
34	300	1,038
35	300	845
36		652
37		759
38		866
39		973
40		1,080
41		1,187
42		1,294
43		1,401
44	300	1,208
45	300	1,015
46	300	822
47		929
48		1,036
49		1,143
50	500	750
51		857
52		964
53		1,071
54	300	878
55	300	685
56	600	192
57		299
58		406
59		513
60		620
61		727
62		834
63		941
64	300	748
65	300	555
66	300	362
67		469
68		576
69		683
70		790
71		897
72		1,004
73		1,025
74	300	918
75	300	725
76	300	532
77		639
78		746
79		853
80	500	460
81		567
82		674
83		781
84	300	588
85		695
86	600	202
87		309
88		416
89		523
90		630
91	300	437
92		544
93		651
94		758
95	300	565
96	300	372
97	300	179
98		286
99		393
100		500
101		607
102		714
103		821
104		928
105	300	735
106	300	542
107	300	349

Kyangin Plant → Terminal: 107.3 T/D

Table 5-5 Syriam Terminal Jetty and River Barges Operation Schedule

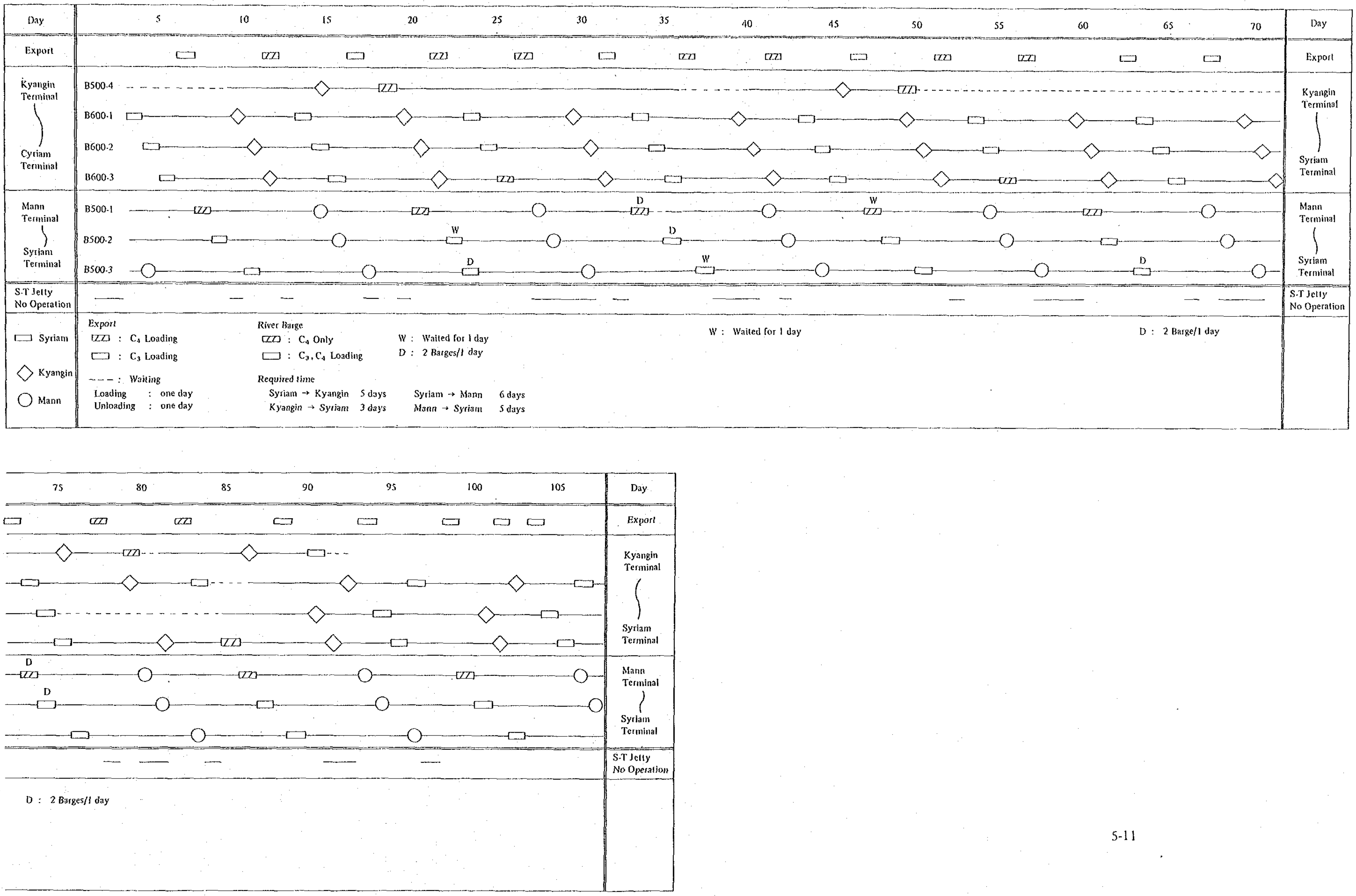


Table 5-6 Condition of Use of Tanks at Kyangin LPG Terminal

Tank	LPG handling volume		Tank capacity	Mean stock (Receiving tolerance)	Maximum stock (Receiving tolerance)
	Annual	Daily mean			
C_3 LPG tank	25,600 T/Y	77.6 T/D	1,240 T	776 T (6 days' equivalent)	1,164 T (1 day's equivalent)
C_4 LPG tank	35,400 T/Y	107.3 T/D	1,930 T	860 T (10 days' equivalent)	1,691 T (2 days' equivalent)

5.2.3 Receiving/Shipping/Storage Facilities at Syriam Terminal

(1) Factors for determining the terminal scale

The following factors should be examined in general for determining the scale of the terminal.

- LPG handling volume
- LPG receiving/shipping schedule

1) LPG handling volume

Determination of the handling volume is an important problem in the determination of the terminal scale. The Integrated LPG Project of Burma has planned to be implemented in three phases, i.e., Phase I through Phase III.

The facilities planning of the Syriam Terminal in Phase I, however, was made in advance to meet the final handling volume after completion of Phase III. This time, however, said planning is totally reviewed based on the Phase I and Phase II execution planning and also on the planning of Phase III as of this date, and facilities planning and operation planning are designed.

The LPG handling volume at the Syriam terminal is shown in Table 5-7.

Table 5-7 Syriam Terminal's LPG Handling Volume (Unit: T/Y)

Project phase	LPG production facility	LPG output	Use	
			For export	For domestic consumption
Phase I-Part 1	Syriam Refinery COKER LPG Plant	6,900	5,900	1,000
Phase I-Part 2	Mann Refinery	13,500	–	13,500
Phase II	Mann GOCS LPG Extraction Plant	30,000	30,000	–
Phase III	Kyangin LPG Extraction Plant	61,000	61,000	–
	Total	111,400	96,900	14,500
Syriam terminal's LPG handling volume			96,900 T/Y	

2) LPG receiving/shipping schedule

The LPG receiving/shipping schedule is the most impportant problem for determining the scale of the Syriam Terminal.

- Receiving/shipping should be properly spread with reasonable intervals, and concentration to specific periods should be avoided.
- The storage capacity of tanks should not be exceeded.
- The number of times of use of jetties should not exceed the range that permits operation of jetties.
- Reduction of effective tank capacity of the terminal due to maintenance of tank facilities, etc. should be taken into account.
- Loading/unloading works shall be enabled for whole day, but berthing/unberthing to/from jetties should be made in the daytime only.

(2) Determination of terminal scale

As a result of thorough examination of the factors for determining the terminal scale, it is considered to be most suitable to plan the terminal scale as shown in

Table 5-8.

(3) LPG receiving/shipping schedule

The planned schedule for LPG collection/shipping at the Syriam Terminal is as shown in Table 5-5, Table 5-9, Table 5-10 and Table 5-11.

Table 5-8 Scale of Syriam Terminal

Item	Scale of Terminal	Remarks
1. LPG handling volume	C_3 LPG 38,770 T/Y C_4 LPG 58,130 ,, Total 96,900 ,,	
2. Tank capacity	C_3 LPG	
	1,000 m^3 x 4 units	Existing
	1,000 m^3 x 3 units	Newly provided.
	C_4 LPG	
	1,000 m^3 x 1 unit	Existing
	2,000 m^3 x 3 units	Existing
	1,000 m^3 x 1 unit	Newly provided.
	2,000 m^3 x 1 unit	Newly provided.
3. Shipping pump	C_3 LPG · C_4 LPG	
	300 m^3/H x 2 units	Existing
	300 m^3/H x 2 units	Existing
4. Unloading compressor	C_3 LPG	
	200 m^3 /H x 2 unit	Existing
5. Transfer pump	C_4 LPG	
	200 m^3/H x 2 unit	Existing
	200 m^3/H x 2 units	Existing

Notes: (1) Storage tank capacity is equivalent to 20 days.
(2) Loading into ocean tanker is to be done whole day.
(3) Unloading from river barges is to be done whole day.
(4) Capacity of unloading compressor is equivalent to LPG liquid base.

Table 5-9 LPG Receiving and Shipping Conditions of Syriam Terminal

LPG transportation method	Receiving and shipping volume			Transportation speed	Volume per shipping	Mean transportation frequency	Longest LPG receiving and shipping interval	Remarks
	C_3 or C_4	T/Y	T/D					
Pipeline transportation Syriam Refinery	C_3 C_4 Sub-total	1,970 3,930 5,900	6.0 11.9 17.9	20 m^3/H C_3 9.6 T/H C_4 11.1 T/H	C_3 50 T C_4 100 T	C_3 once/7 days C_4 once/7 days	7 days (in view of tank stock of Syriam Refinery)	
River Barge transportation								
a) Mann Terminal	C_3 C_4 Sub-total	11,200 18,800 30,000	33.9 57.0 90.9	13 days/voyage	500 & 600 tons/ships	5.5 ships/M.		
b) Kyangin Terminal	C_3 C_4 Sub-total	25,600 35,400 61,000	77.6 107.3 184.9	10 days/voyage		9.4 ship/M		
c) Syriam Terminal total received		96,900				14.9		
	LPG export volume			Navigation schedule		Tanker capacity	Shipping frequency	
Export of LPG Syriam Terminal	C_3 C_4 Sub-total	38,770 T/Y 58,130 96,900		Mean 25 days/voyage		1,500 DWT	Mean 5.4 ship/M	

Table 5-10 C_3 LPG Receiving and Shipping Schedule at Syriam Terminal

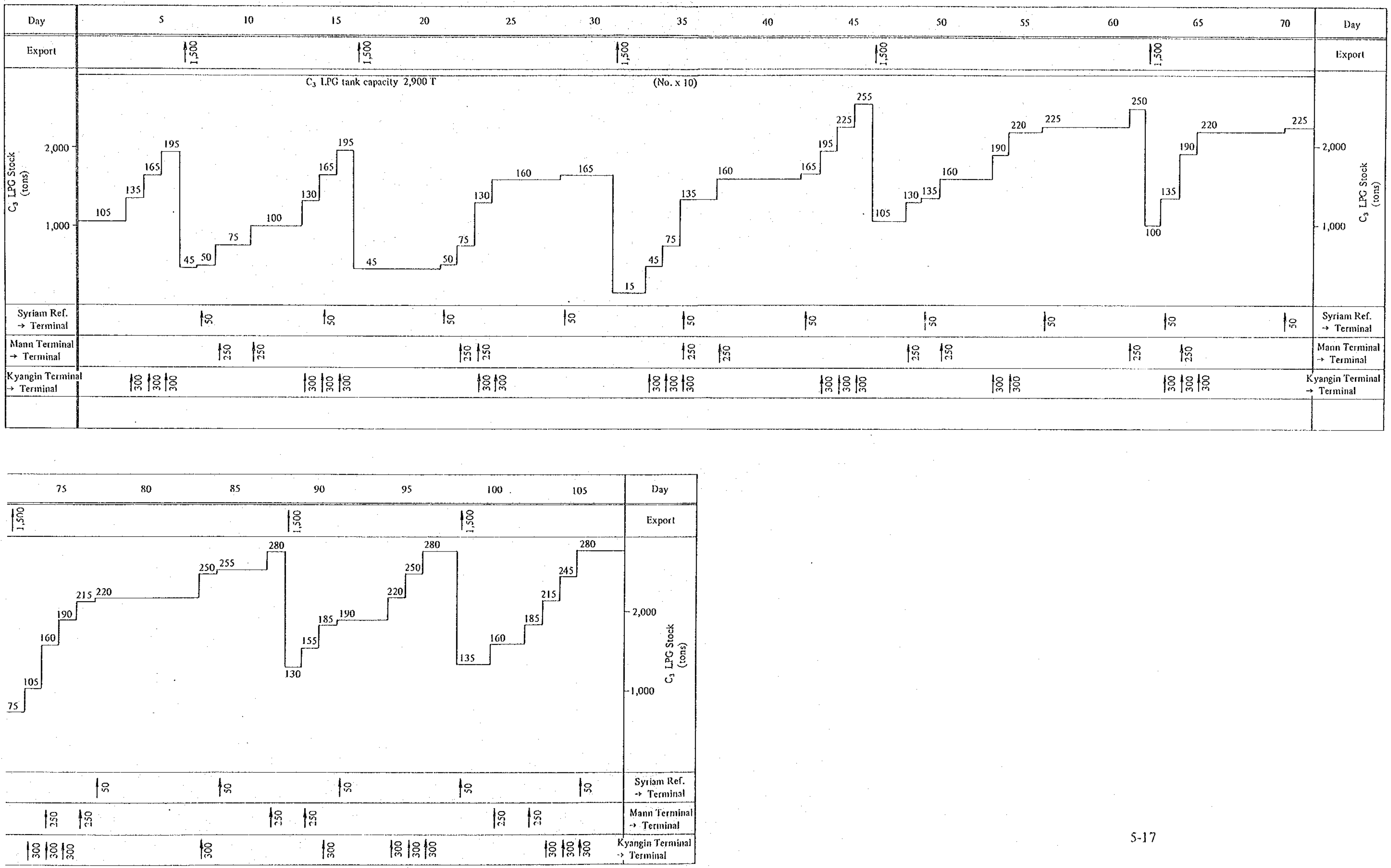
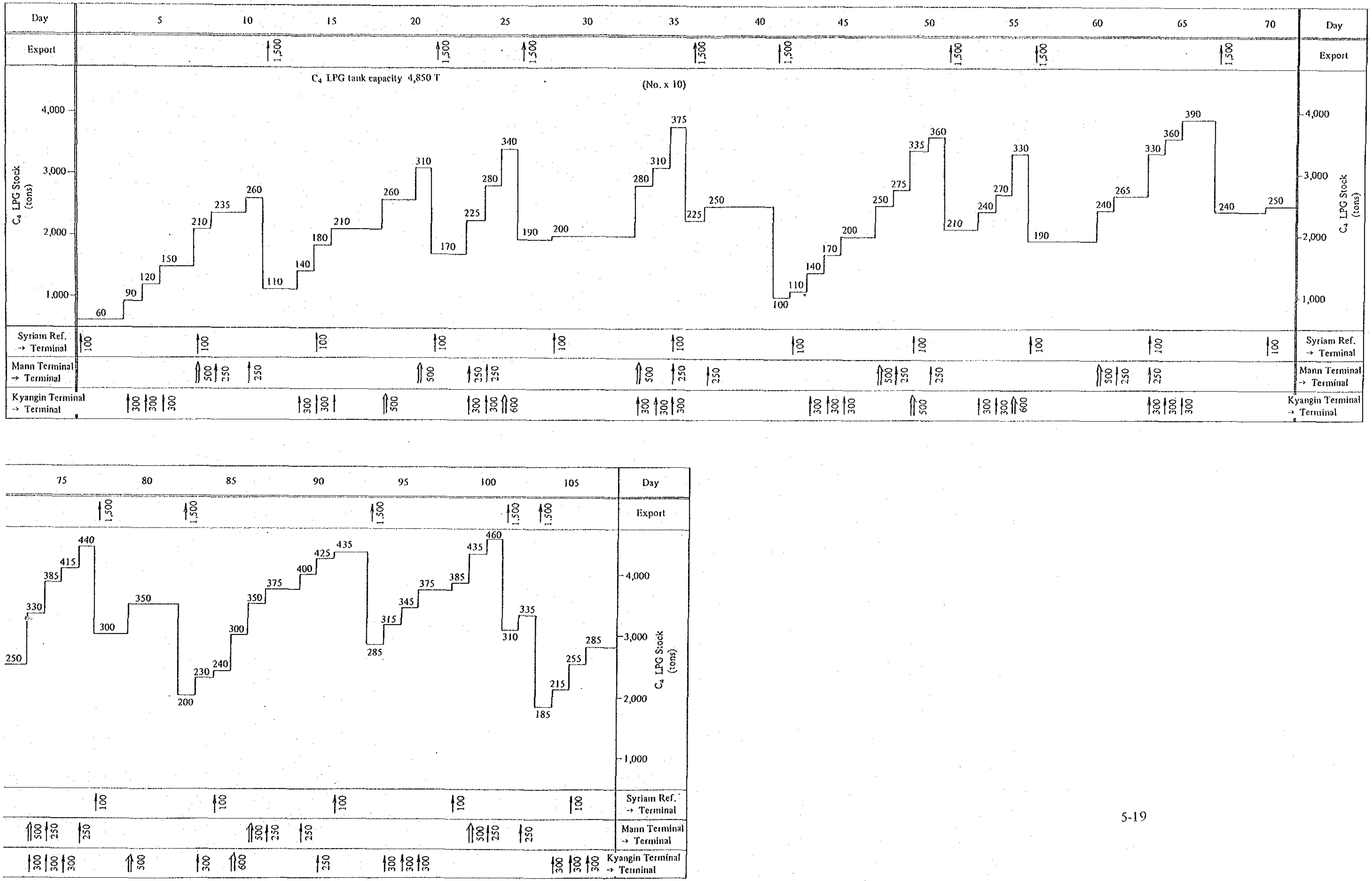


Table 5-11 C$_4$ LPG Receiving and Shipping Schedule at Syriam Terminal



This schedule is planned based on the following conditions.

1) Receiving from a river barge and shipping to an ocean tanker cannot be performed simultaneously; this condition is too critical. The LPG jetties are common for ocean tankers and river barges. No addition will be made in Phase III.

2) The capacity of an ocean tanker is 1,500 tons, and either C_3 or C_4 LPG is shipped individually in each tanker. The jetty occupancy time of an ocean tanker is determined as 24 hours at a time for berthing, loading and unberthing. It is also determined that waiting for tide for entry/exit to/from the port does not exert adverse effects on the operation of river barges on the preceding or the following day.

3) As for the operation of river barges, loading at Mann or Kyangin is the daytime work of one barge per day, and whole day work of two barges per day is permitted for unloading at Syriam.

As a result, the mean stock and margins of C_3 and C_4 LPG tanks are as shown in Table 5-12, and the terminal scale indicated earlier is suitable from the standpoint of terminal management.

Table 5-12 Scheduled Use of Syriam Terminal Tanks

Tank	LPG handling volume		Tank capacity :	Mean stock (Receiving tolerance)	Maximum stock (Receiving tolerance)
	Annual	Daily mean			
C_3 LPG tank	38,770 T/Y	117.5 T/D	2,900 T	1,630 T (11 days' equivalent)	2,800 T (1 day's equivalent)
C_4 LPG tank	58,130 T/Y	176.2 T/D	4,850 T	2,600 T (13 days' equivalent)	4,600 T (1 day's equivalent)

Remark: Tank capacity: Effective capacity based on C_3 Sp. Gr. 0.46 at 45°C
C_4 Sp. Gr. 0.54 at 45°C

5.2.4 Receiving/Shipping/Storage Facilities at Mann Terminal

The C_3 and C_4 LPG handling volume at the Mann Terminal is largely reduced to 30,000 tons per year this time from 45,000 tons per year in Phase I. It is because C_3 and C_4 LPG containing olefin produced at the Mann Refinery is changed from 18,000 tons per year to 13,500 tons per year, and it is filled in cylinders at the Mann Refinery for shipment to the domestic market. Therefore, transport by river barges between Mann Terminal and Syriam Terminal is conducted using three 500 ton barges. The operation schedule is as shown in Table 5-5. One barge out of four barges built in Phase I will be used for transport between Kyangin Terminal and Syriam Terminal, and integrated operation of barges is made. The LPG tanks at the Mann Terminal will be operated with sufficient margins because of reduction of its handling volume.

5.2.5 Transport of Product LPG

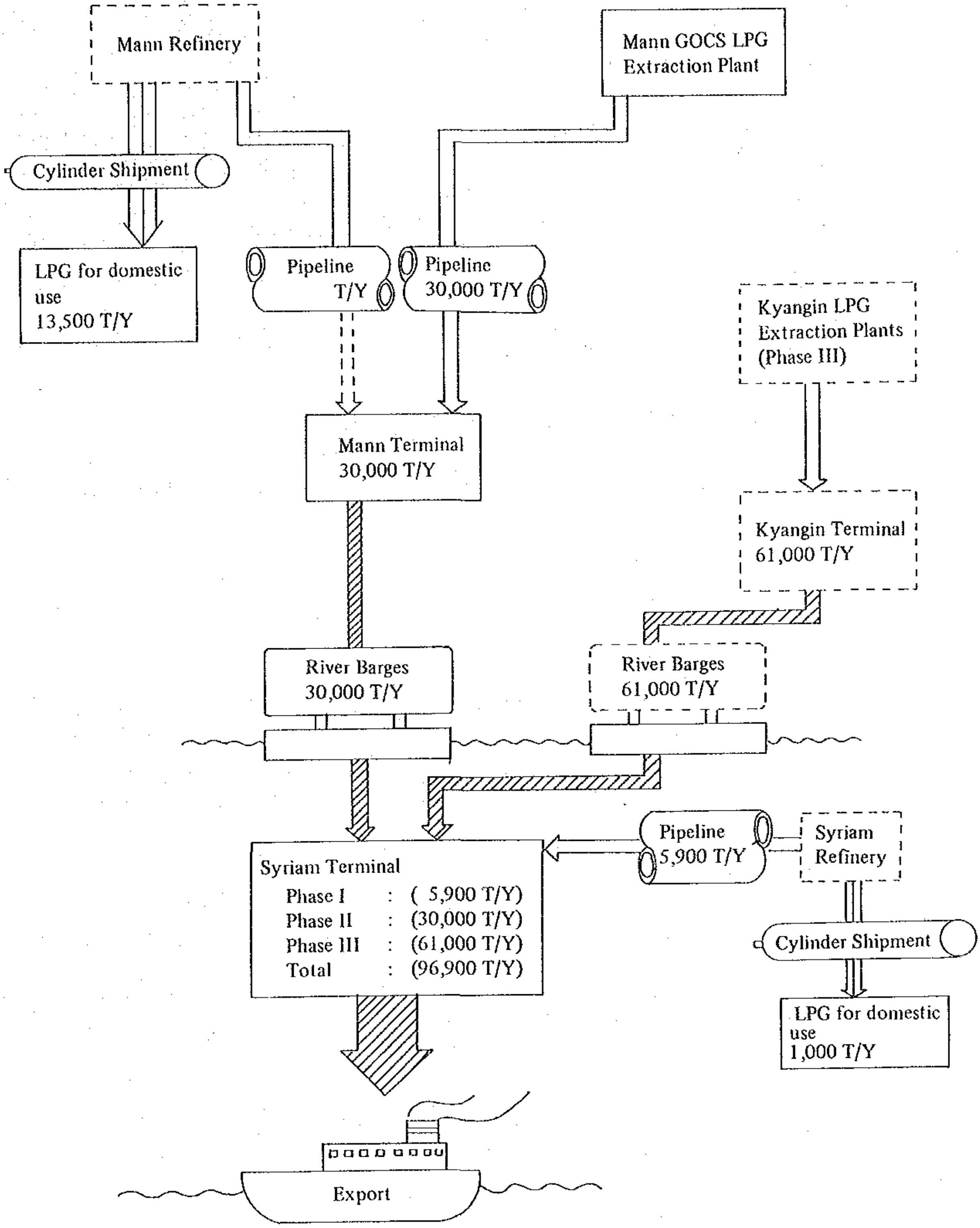
(1) It is planned that the LPG of this project is produced at the following four places, and LPG of 96,900 tons per year excluding 14,500 tons per year for the domestic market will be exported in the stage of completion of Phase III.

1) *Syrima Refinery (6,900 tons per year)*
2) Mann Refinery (13,500 tons per year)
3) Mann GOCS LPG Extraction Plant (30,000 tons per year)
4) Kyangin LPG Extraction Plant (61,000 tons per year)

(2) In connection with LPG transportation, the adoption of the LPG transportation system indicated in Fig. 5-1 is regarded the most suitable when taking various factors into consideration – the safety of handling pressurized LPG, locational relationship between terminals and production facilities, selection of LPG exporting ports, management of terminals and operation of river barges.

(3) The capacity of river barges used for LPG transport from Kyangin and Mann Terminals to Syriam Terminal is considered suitable to plan as follows based on the river barge operation schedule in Section 5.2.3, Item (3) from the standpoint of the transport volume, number of days for voyage, number of days for loading and unloading tank capacity at terminals and so forth.

Fig. 5-1 LPG Transportation System



To be newly built (as planned for Phase III)

Loading capacity per vessel	:	300 tons x 2
Number of vessels	:	3

5.3 Selection of Plant and Terminal Sites

For selection of sites of LPG Terminals and of the LPG Extraction Plant, study is made on the following matters and the plant sites which are judged to be advantageous for this project are selected.

(1) Feed gas transportation conditions

(2) By-product lean gas transportation conditions

(3) LPG producing and transportation conditions

(4) Relation with market and transport of product LPG and with preceding programs

(5) Conditions of Irrawaddy River

(6) Plants, terminals and jetty construction costs

(7) Meteorological conditions and ground conditions of the sites including topography and soil conditions

(8) Construction period

(9) Availability of utilities

(10) Environmental conditions

The results are shown in Table 5-13.

Table 5-13 Selection of Plant Site

Item	Kyangin LPG Extraction Plant	Kyangin Terminal	Syriam Terminal Expansion
1. Proposed plant site	Near existing Kyangin Cement Mill (See Fig. 5-3)	River side at Malakagon for Jetty Paddy field area on land side of new jetty (See Fig. 5-3)	Paddy field area next the Tank yard in Syriam Terminal (See Fig. 5-2)
2. Reason for selection (1) Associated gas and lean gas transportation condition	It will be necessary to construct the Extraction Plant near oil field and lean gas user's factories. Because it has to receive feed stock gas from oil field and supply lean gas to factories after recovery of C_3 and C_4.	–	–
(2) Product LPG marketing and transportation conditions	No particular limitation is observed in aspects of the plant's location for pipeline transfer of product LPG to new Terminal.	Locating the Terminal and Jetty near Kyangin LPG Extraction Plant site will be necessary for loading product LPG on river barges for transport of the Syriam Terminal for LPG exports.	Since all of the LPG output of this Phase III project is to be exported, the Syriam region is optimum in that it permits use of existing the Syriam Terminal's jetty and facilities and is to be handled by existing Syriam members.
(3) Plant construction cost and schedule	It's most suitable place in view of construction cost and construction schedule.	The Terminal will be located at the near place from new jetty in aspects of operation for loading into river barges. Though the proposed site will require additional costs for filling up the existing paddy fields with earth, there aren't other site that appears more advantageous than the proposed site from general observation.	The site is suitable as observed from the aspects of conveyance of construction equipment and materials, supply of utilities for construction purposes and relationship with existing facilities.
(4) Meteorological and geological conditions	There are good soil conditions and comparatively flat place.	The jetty will be located in aspects of Irraddy River's conditions.	No particular limitation is observed.
	No particular problem.	This site is recommended by Burma as the most suitable place for river jetty. There are stable river current and appropriate depth for river barge operation.	It will be necessary to fill up the existing paddy fields with earth as the Syriam Terminal was done.
(5) Utilities condition	A power transmission line for receiving electricity from the Myanaung power station will be necessary, also a pipeline for receiving water from new jetty will be necessary. The other utilities facilities inside the plant site will be necessary.	A power transmission line for receiving electricity from Kyangin Plant site and water pipeline will be necessary.	All of utilities will be received from existing Syriam Terminal.
(6) Environmental	There are a few houses near the plant site. But it is possible to keep a safe distance between Plant site and the houses.	It will be located far away from the railyard for the purpose of safety.	No problem, because this is only expansion of the tank facilities in the Syriam Terminal.

Fig. 5-2 Syriam Terminal Site

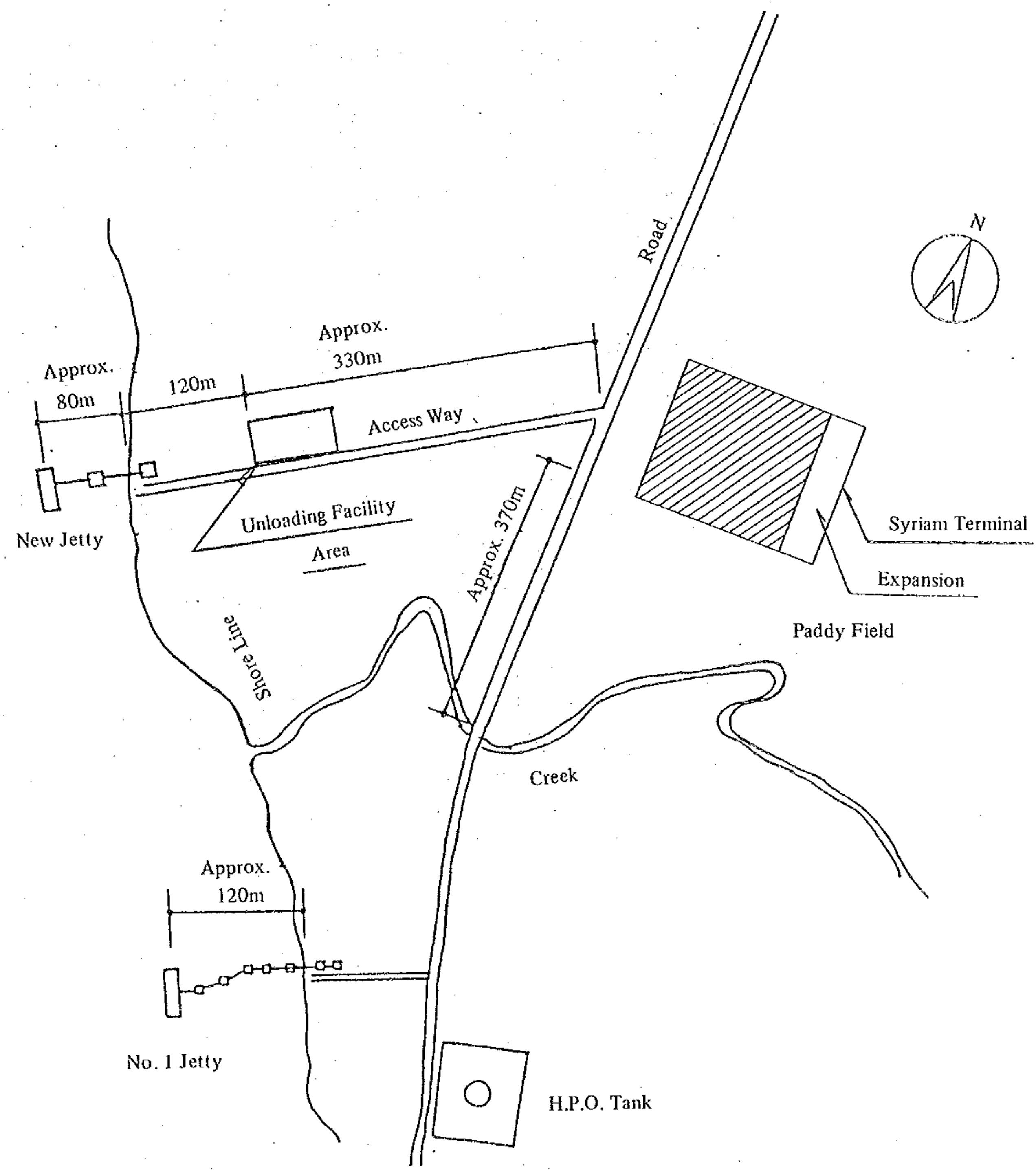
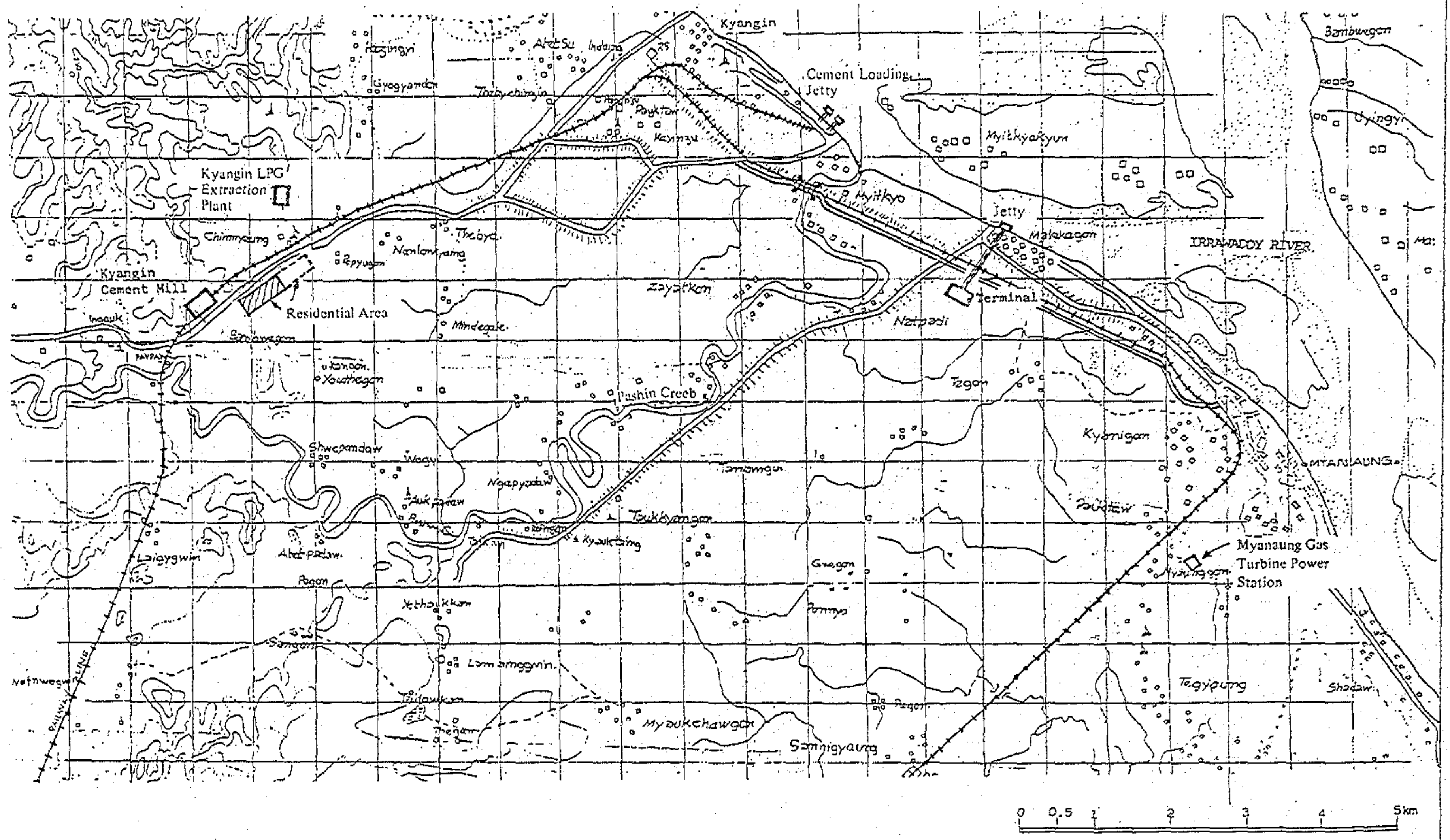


Fig. 5-3 Kyangin LPG Extraction Plant, Terminal and Jetty



5.4 Piping Planning

The piping planning in Phase III is of the following contents.

(1) Piping and system for transporting the associated gas of the feed gas of the LPG extraction facilities from Myanaung, Shwepyitha and Htantabin Oil Field to Kyangin LPG Extraction Plant.

(2) Piping and system for transporting the lean gas by-produced at the LPG extraction plant from the plant side to users, i.e., Myanaung Power Station Kyangin Cement Mill and Seiktha Methanol Plant.

(3) Piping and system for transporting LPG, Naphtha and utilities between Kyangin LPG Extraction Plant, terminals and jetties.

Study is made with the following matters on the pipings mentioned above, and the piping planning which is judged to be most advantageous for this project is designed.

(1) Effective use of existing gas pipelines from Myanaung, Shwepyitha and Htantabin Oil Fields to Myanaung Power Plant, Kyangin Cement Mill and Seiktha Methanol Plant as well as the control station.

(2) Output of associated gas at each well and usable pressure of each well source.

(3) The feed gas inlet pressure and pressure boosting cost at the plant site

(4) Fluctuation of associated gas output at each well

(5) Lean gas consumption rate and inlet pressure at each user

(6) Lean gas output classified by pressure system at the plant site

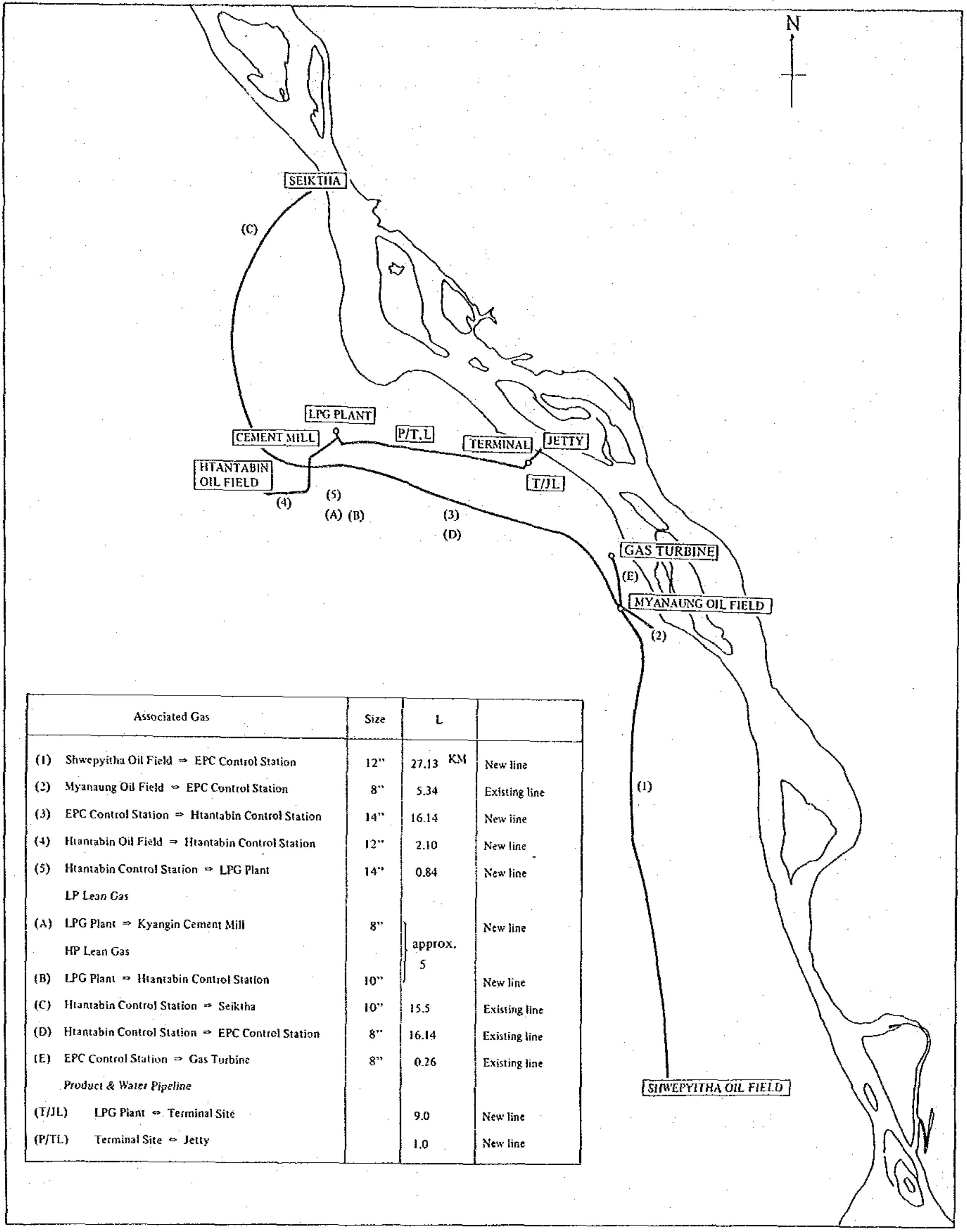
(7) Arrangement planning

(8) Maintenance and safety measures

(9) Construction cost

Fig. 5-4 Myanaung, and Kyangin Industrial Area

[Pipeline Route Map]



Associated Gas	Size	L	
(1) Shwepyitha Oil Field ⇒ EPC Control Station	12"	27.13 KM	New line
(2) Myanaung Oil Field ⇒ EPC Control Station	8"	5.34	Existing line
(3) EPC Control Station ⇒ Htantabin Control Station	14"	16.14	New line
(4) Htantabin Oil Field ⇒ Htantabin Control Station	12"	2.10	New line
(5) Htantabin Control Station ⇒ LPG Plant	14"	0.84	New line
LP Lean Gas			
(A) LPG Plant ⇒ Kyangin Cement Mill	8"	approx. 5	New line
HP Lean Gas			
(B) LPG Plant ⇒ Htantabin Control Station	10"		New line
(C) Htantabin Control Station ⇒ Seiktha	10"	15.5	Existing line
(D) Htantabin Control Station ⇒ EPC Control Station	8"	16.14	Existing line
(E) EPC Control Station ⇒ Gas Turbine	8"	0.26	Existing line
Product & Water Pipeline			
(T/JL) LPG Plant ⇔ Terminal Site		9.0	New line
(P/TL) Terminal Site ⇔ Jetty		1.0	New line

The piping planning completed based on the above is as shown in Fig. 5-4. The pipelines for associated gas and lean gas and so also pipelines for product LPG and Naphtha are buried as a rule.

5.5 Power Supply Plan

5.5.1 Power Transmission/Supply System in Burma

The power transmission/supply system in Burma is currently composed of the following two main systems.

(1) Lawpita power transmission system mainly using hydroelectric power.

(2) Prome · Myanaung power transmission system

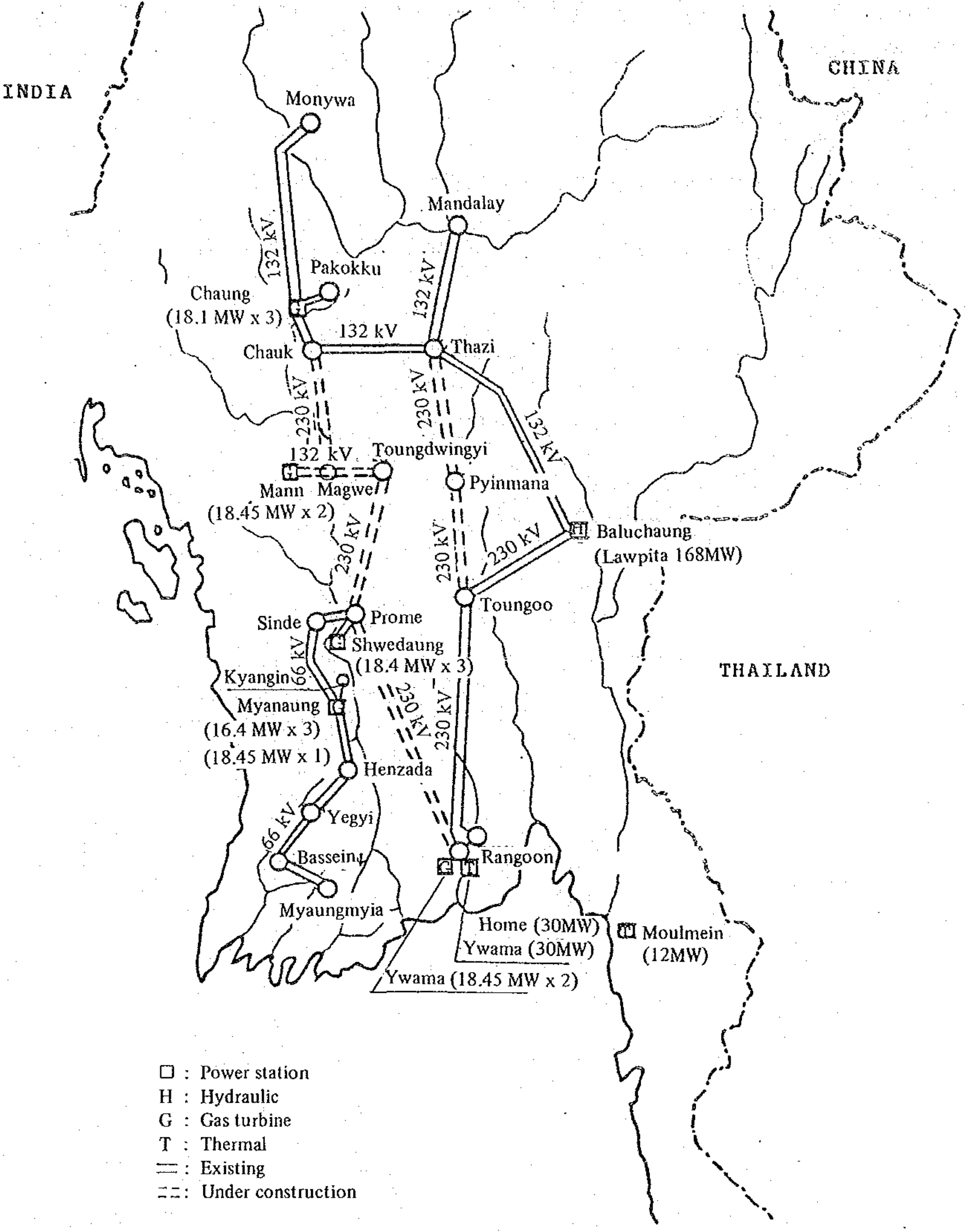
As for system (1) above, the power of 168 MW generated at Lawpita Power Station is supplied through 230 kV transmission lines by way of Toungoo to Rangoon and is linked to a thermal power station located in the outskirts of Rangoon. Furthermore, the power from the Lawpita Power Station is also supplied through 132 kV and 66 kV transmission lines by way of Thazi to Mandalay and Chauk areas, and linkage is also made with Kyungchaung Power Station. The power from Prome and Myanaung Power Stations is supplied to Prome, Myanaung, Henzada, Yegyi, Bassein and Myaungmya through 66 kV transmission lines. Even when the Myanaung Power Station is completely shut down, it is possible to supply power from Prome to these areas.

Kyangin Cement Mill is located in the vicinity of the LPG recovery facilities. The expansion of this cement mill is under construction.

This mill receives power from the Myanaung Gas Turbine Power Station through a 3-phase, 66 kV transmission line.

The power grid system in Burma is shown in Fig. 5-5.

Fig. 5-5 Power Grid System



5.5.2 Power Supply Plan to LPG Recovery Facilities

(1) Power supply capacity

The power supply capacity to the LPG recovery facilities is 3-phase 5,000 kVA, as described in the outline of facilities in Section 6.1.3.

(2) Power supply system

The following two methods can be considered for supply of power to the LPG recovery facilities.

1) To construct a transmission line branching from existing transmission lines.

2) To construct a new transmission line from Myanaung Gas Turbine Power Station.

As for branching from existing transmission lines, the current load of the Kyangin Cement Mill is 10.5 MW (3.5 MW x 3 units) and one more unit is being added at the present time. When this addition is taken into account the capacity is 14 MW (3.5 MW x 4). Therefore, it is hard from the standpoint of capacity that power is supplied from existing lines along a private branch to the LPG recovery facilities. Under these circumstances it is considered best to supply power with a private transmission line constructed from Myanaung Gas Turbine Power Station directly to the LPG recovery facilities. As for the number of circuits of the power transmission line, it is determined to construct a single circuit, with a diesel driven generator installed at the LPG Extraction Plant as an emergency back-up measure when supply of power is interrupted.

5.5.3 Outline of Myanaung Gas Turbine Power Station

(1) Outline of facilities

The maximum allowable power supply capacity of the Myanaung Gas Turbine Power Station is 67.65 MW. Three generators of 24.875 MVA each and one generator of 25 MVA are installed. The principal transformers are three units of 24 MVA each and one unit of 25 MVA.

The outline of the facilities is shown in Table 5-14.

Table 5-14 Outline for Myanaung Power Station

1. Generator		for 16.4 MW	for 18.45 MW
Quantity	(Set)	3	1
Rated capacity	(MVA)	24.875	25.0
Rated voltage	(kV)	11.5	11.5
Frequency	(Hz)	50	50
Phase	(ϕ)	3	3

2. Transformer		for 16.4 MW	for 18.45 MW
Quantity	(Set)	3	1
Rated capacity	(MVA)	24	25
Primary voltage	(kV)	11.5 (delta)	11.5 (delta)
Secondary voltage	(kV)	66 (star)	66 (star)
% Z		8.5	10.0

(2) Current load conditions

The load for the Myanaung Gas Turbine Power Station is currently 32.4 MW which is about one half of the maximum allowable capacity, 67.65 MW. Therefore, there is no problem at all in the capacity of the power station even if the load for the LPG recovery facilities, 5 MVA, is added to the load for the Myanaung Gas Turbine Power Station.

The load capacity is as shown in Table 5-15.

(2) Load dispatch destinations and loaded energy

The load dispatch destinations and transmitted energy from the Myanaung Gas Turbine Power Station are as shown in Table 5-16.

Table 5-15 Present Load at Myanaung Power Station

Time	Load	(MW)
Daily	Maximum	32.4
	Minimum	14.0
	Average	20.0
Monthly	Maximum	32.4
	Minimum	10.8
	Average	19.6
	Maximum month	January-85
Annual	Maximum	32.4
	Minimum	1.7
	Average	16.2

Table 5-16 Composition of Load

Location	Voltage (kV)	Number of circuits	Type	*Transmitted energy (x 10^9 Wh)
Kyangin Cement Mill	66	1	Overhead transmission	20.12
Prome-Sinde	66	2	Overhead transmission	73.50
Henzada-Bassein	66	2	Overhead transmission	52.84
Myanaung	11	1	Overhead distribution	3.56
M.O.C.	11	1	Overhead distribution	2.84

* From April 1, 1984 to March 31, 1985.

5.6 Communication Equipment Plan

5.6.1 Determinants for Equipment Planning

Planning of the communication equipment for the LPG recovery facilities should be examined according to the following determinants:

- Means for secure communications should be ensured for safety running the LPG recovery facilities.

- It should be possible to easily perform maintenance of the LPG recovery facilities as well as general operational communications.

- Equipment should provide superior operatability, economy and maintainability and shall conform to legal regulations.

5.6.2 Places Requiring Communication Equipment

The following places are selected as places requiring communication equipment, upon deliberation with Burma.

- Kyangin Plant, Terminal and Jetty
- Residential area
- MOC Myanaung, Kyangin Cement Mill
- Seiktha Methanol Plant, Myanaung Gas Turbine Power Station, PTC Kyangin
- Head office in Rangoon

5.6.3 Types of Communication Equipment

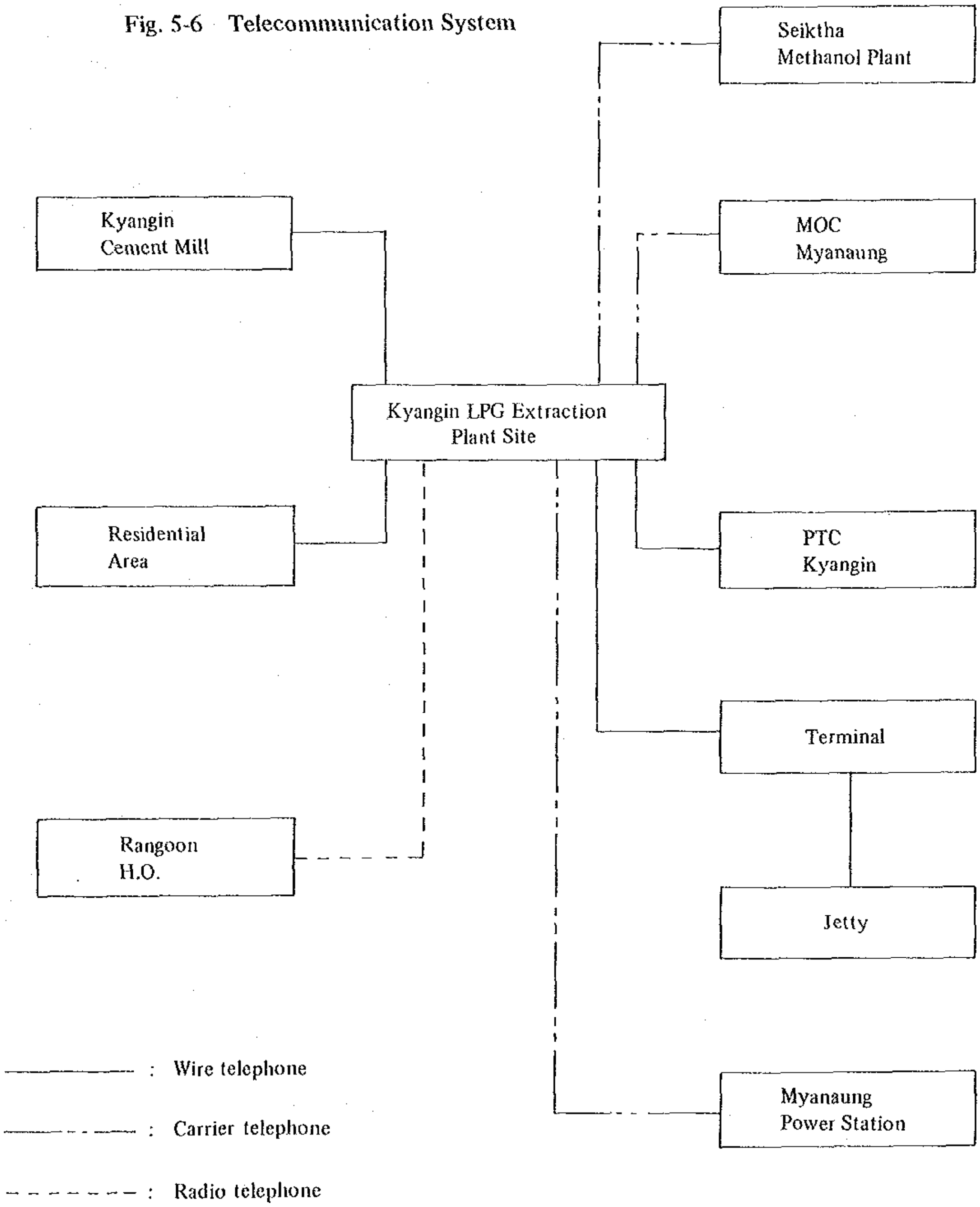
Communication equipment of the following types can be considered for the Phase III.

- Wire telephone
- Power-line-carrier telephone
- Radio telephone
- Paging
- General on-site broadcasting

5.6.4 Planning of Communication Equipment

With the master station located at the Kyangin Plant, the means for communication among the necessary sites will be secured. The telecommunication system is as shown in Fig. 5-6.

Fig. 5-6 Telecommunication System



Chapter 6

CONCEPTUAL DESIGNS OF LPG RECOVERY FACILITIES

Chapter 6. CONCEPTUAL DESIGNS OF LPG RECOVERY FACILITIES

This chapter deals with the conceptual designs of the following facilities scheduled for construction in Phase III of Burma's "Integrated LPG Project".

(1) Kyangin LPG Extraction Plant
(2) Kyangin LPG Terminal
(3) Expansion of Syriam Terminal
(4) River barges for LPG transportation
(5) Piping facilities
(6) Power supply facilities
(7) Telecommunication facilities

Data and information necessary for the conceptual designs are based on the supply from the Burmese side, or otherwise set by the Survey Team.

In preparing plans and designs for the respective facilities, the greatest emphasis is placed on operational ease, maintenance ease, system economy and flexibility.

6.1 Kyangin LPG Extraction Plant

6.1.1 Design Conditions

(1) Feed gas

Feed gas used in this LPG Extraction Plant is the composite gas of associated gas produced in Shwepyitha, Myanaung and Htantabin Oil Fields. Design base of feedstock gas is determined as given in Table 6-1 by mutual consent with the Burmese side. However, production rate of LPG varies due to the difference in composition of associated gas of Shwepyitha, Myanaung and Htantabin Oil Fields as described in Chapter 3, then LPG Extraction Plant is designed to enable production of LPG of 61,000 tons per year even if associated gas of Htantabin Oil Field which has less content of LPG only is obtained as feed gas.

(2) Products

Products obtained from Kyangin LPG Extraction Plant are C_3 LPG, C_4 LPG, and such by-products as naphtha and lean gas. C_3 LPG and C_4 LPG are transported to the Kyangin LPG Terminal respectively by separate pipelines. By-product naphtha is stored in the tank in Kyangin LPG Extraction Plant and shipped into river barges at the Kyangin LPG jetty by loading pump. Then the loaded naphtha is transported to the Syriam Refinery, and used as gasoline stock or exported as naphtha.

Table 6-1 Design Base of Feed Gas

	Base Case	Severe Case
Associated Gas Source	Shwepyitha 40% Myanaung 40% Htantabin 20%	Htantabin 100%
Feed Gas Specification Composition [mol%]		
CH_4	83.98	85.98
C_2H_6	6.96	5.76
C_3H_8	4.33	4.72
i C_4H_{10}	1.82	1.18
n C_4H_{10}	2.17	1.62
C_5^+	0.62	0.74
CO_2	0.12	–
Low Heat Value [kcal/NM^3]	10,500	

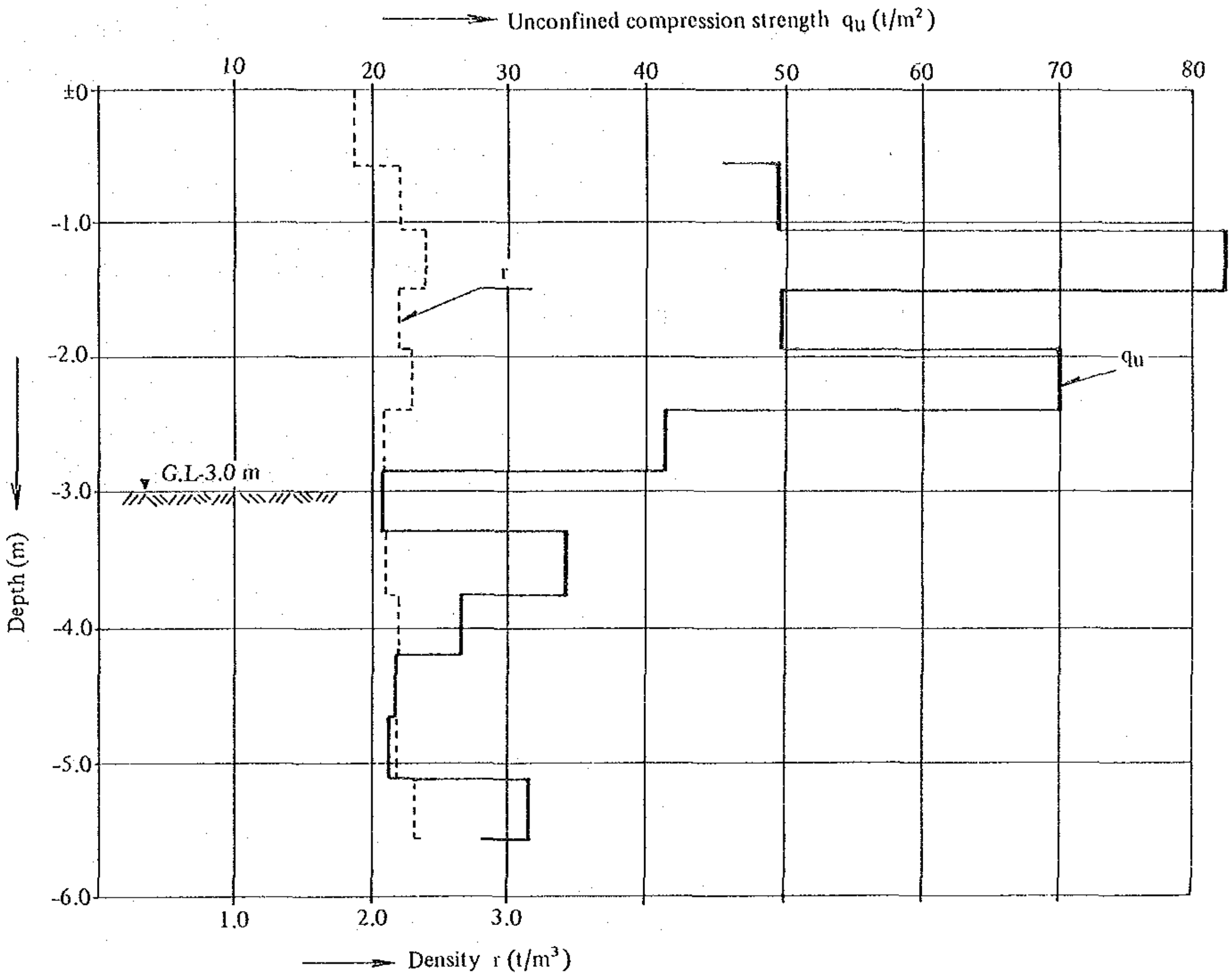
(3) Site conditions

1) Soil conditions

This site is in the place about 2.0 km north east of the Kyangin Cement Mill. The north and south ends of the site are facing the hills of 15 ~ 20 m high, and the site is on the skirt of these hills with gentle slope. Soil survey boring is not performed and correct soil conditions are not clear, however, they may resemble to those of the Cement Mill near this site. The soil conditions of the Cement Mill are shown in Fig. 6-1.

According to this figure, the surface stratus 1. m is made of soft soil but the lower stratum is made of hard soil. From the results of this survey, the bearing

Fig. 6-1 **Soil Test Data in Kyangin Cement Mill**



at GL-3.0m, Allowable Bearing-Power q_a

q_a = 1/3 (αCNc + $\beta\gamma_1$ BNr + γ_2 DfNq)

C = Cohesion = 1/2 x $\overline{qu}$ = 13 t/m^2, $\overline{qu}$ (-2.85m ~ 5.55m) = 25.2 t/m^2

γ_1 = Density of Soil (below the GL-3.0m level) ≑ 2.2 t/m^3

γ_2 = Density of Soil (above the GL-3.0m level) ≑ 2.2 t/m^3

α, β = Coefficient of Shape of Foundation, Square, α = 1.3, β = 0.4

D_f = Depth = 3.0m

Nc, Nq, Nr : Bearing Power Coefficient,

ϕ = 0, Nc = 5.3, Nr = 0, Nq = 3.0

q_a = 1/3 (1.3 x 13 x 5.3 + 2.2 x 3.0 x 3.0)

= 36 t/m^2

capacity when excavation to GL-3.0 m is carried out is obtained from the Modified Terzaghi's Formula as 36 t/m². Thus as the bearing capacity is large, the Cement Mill was directly based.

From this, the Burmese side assumes the bearing capacity to be 36 t/m². In enforcement designs, soil survey boring is made on the places for main facilities and actual bearing capacity should be computed upon the results of boring, but this present, it is conceived as a safe value. Therefore, it is appropriate that the bearing capacity is 20 t/m² or so.

During the field survey, such an information that there is special soil called Black Cotton Soil near here was obtained. This soil is said that when it contains water, it is expanded to bring up the structures. Then careful survey is necessary in enforcement.

2) Natural conditions

Earthquake	: The seismic coefficient should be 0.2.
Rainfall	: According to the data supplied by the Burmese side, the maximum rainfall intensity up to date is 125 mm/hr and the maximum rainfall in 24 hours is 138.7 mm. While the design rainfall intensity for drain of the Kyangin Cement Mill is adopted to be 50 mm/hr, however, this value is considered to be a little smaller judging from the above records, then 60 mm/hr is adopted in this project.
Wind	: According to the data supplied by the Burmese side, the design wind velocity to the structure of 53.3 m/sec is adopted 10 m above the ground.
Lighting	: Since thunderbolts are conceivable, proper measures are to be adopted as required.
Sandstorm	: Sandstorms are conceivable, so proper measures are to be adopted as required.