THE FEASIBILITY STUDY REPORT ON THE INTEGRATED LPG PROJECT IN THE SOCIALIST REPUBLIC OF THE UNION OF BURMA

MARCH, 1982

JAPAN INTERNATIONAL COOPERATION AGENCY

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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 survey on the Integrated LPG Project and entrusted the survey to the Japan International Cooperation Agency (JICA). The JICA sent to Burma a survey team headed by Mr. A. Hijikata from September 26 to October 15, 1981.

The team had discussions with the officials concerned of the Government of Burma and conducted a field survey. After the team returned to Japan, further studies were made and the present report has been prepared.

I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

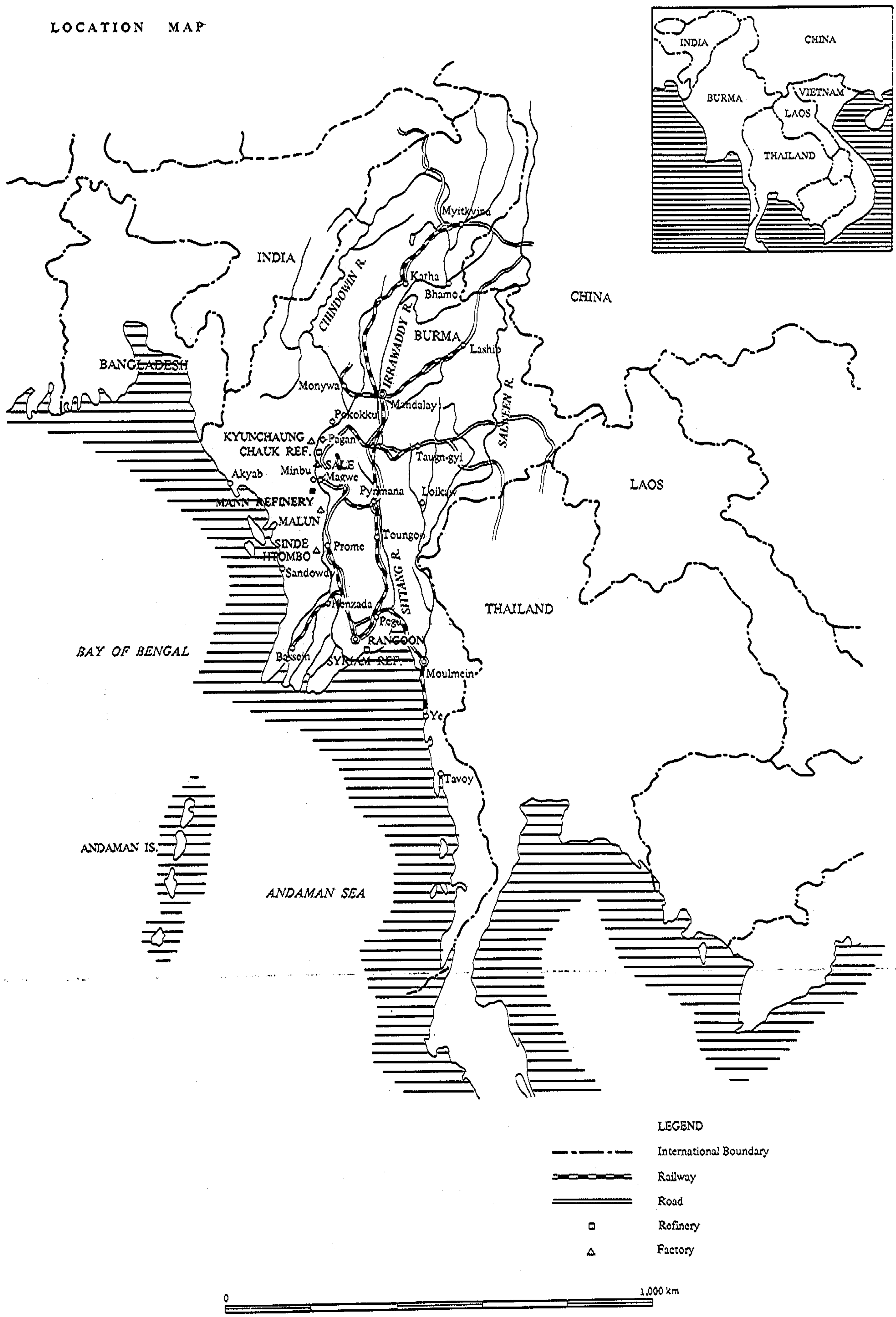
I wish to express my deep appreciation to the officials concerned of the Government of the Socialist Republic of the Union of Burma for their close cooperation extended to the team.

March, 1982

Keisuke Arita

Keisuke Arita
President
Japan International Cooperation Agency

LOCATION MAP



ABBREVIATIONS

LPG	Liquefied Natural Gas
PIC	Petrochemical Industries Corporation
TSC	Technical Service Corporation
MOC	Myanma Oil Corporation
JAL	Japan Air Lines
TG	Thai International Air Ways
GOCS	Gas & Oil Collecting Station
G.D.P.	Gross Domestic Product
R/P	Reserves / Production
RF	Reformer
SPI	Smoke Point Improver
LR	Long Residue
FOB	Free On Board
CIF	Cost Insurance and Freight
MDO	Marine Diesel Oil
CFO	Marine Fuel Oil
PCS	Petro-Chemical of Singapore
HIC	Heavy Industry Corporation
EPC	Electric Power Corporation
HF	Hydrogen Fluoride
SCF	Standard Cubic Foot
BBL	Barrel
I.G.	Imperial Gallon
BPCD	Barrel Per Calendar Day
BPSD	Barrel Per Stream Day
Y	Year
M	Month
D	Day
H	Hour
Min	Minute
Sec	Second
Km	Kilometer
m	Meter
Km^2	Square Kilometer

m^2	Square Meter
mm^2	Square Millimeter
ha	Hectar (10,000 m^2)
m^3	Cubic Meter
Kl	Kiloliter
l	Liter
T, Ton	Metric Ton
Kg	Kilogram
g	Gram
V	Volt
KV	Kilovolt
KVA	Kilovolt Ampere
KW	Kilowatt
KWh	Kilowatt-hour
Hz	Hertz (Frequency)
°C	Degree Centigrade
%	Percent
JIS	Japanese Industrial Standard
CTN	Contribution to Nation

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INTRODUCTION

I. Background of Survey

1) Oil situation in Burma

In Burma there exist three oil refineries in operation with a total crude oil processing capacity of 34,000 BPSD, as is mentioned below. In case Mann Refinery now under construction with a processing capacity of 25,000 BPSD should come to operate in February 1982 as scheduled, the crude oil processing capacity in Burma would greatly be expanded.

Table In.-1. Refineries in Burma

Name of refinery	Operation started in	Atmospheric distillation capacity
Chauk Refinery	1954	6,000 BPSD
Syriam Refinery		
Bench A	1957	6,000 BPSD
Bench B	1963	14,000 BPSD
Bench C	1980	6,000 BPSD
Malun Refinery	1978	2,000 BPSD
Present total crude oil processing capacity		34,000 BPSD
Mann Refinery under construction is scheduled to start operation in 1982		25,000 BPSD

The output of crude oil and natural gas is on the increase yearly. In 1980, 11 million barrels of crude oil and 20,000 million cubic feet of natural/associated gas were produced. Besides, oil and gas wells are being exploited briskly.

Table In.-2. Actual Output of Crude Oil and Natural Gas

Output	1976/77	1977/78	1978/79	1979/80	1980/81
1. Crude Oil					
No. of flowing wells	141	124	104	109	301
No. of pumping wells	310	338	388	434	381
Annual output (10^3 BBL)	8,586	9,556	9,999	11,020	11,180
2. Natural gas					
No. of gas wells	26	33	19	21	30
Annual output (10^6 SCF)	8,481	8,784	9,892	12,030	20,016

Like that, the crude oil processing capacity and crude oil output are being expanded; and with the purpose of utilizing the natural resources effectively and of promoting exports for earning of foreign currency, a plan was formed to recover LPG from refinery oil and associated gas.

2) LPG recovery project in Burma

Regarding the project the Petrochemical Industries Corporation prepared "Project Proposal for Integrated LPG Project" on May 4, 1981, announcing the profitability of the project which involves the LPG recovery, extraction, collection and shipment. Fig. 1 shows the location.

Fig. In.-1. Location Map

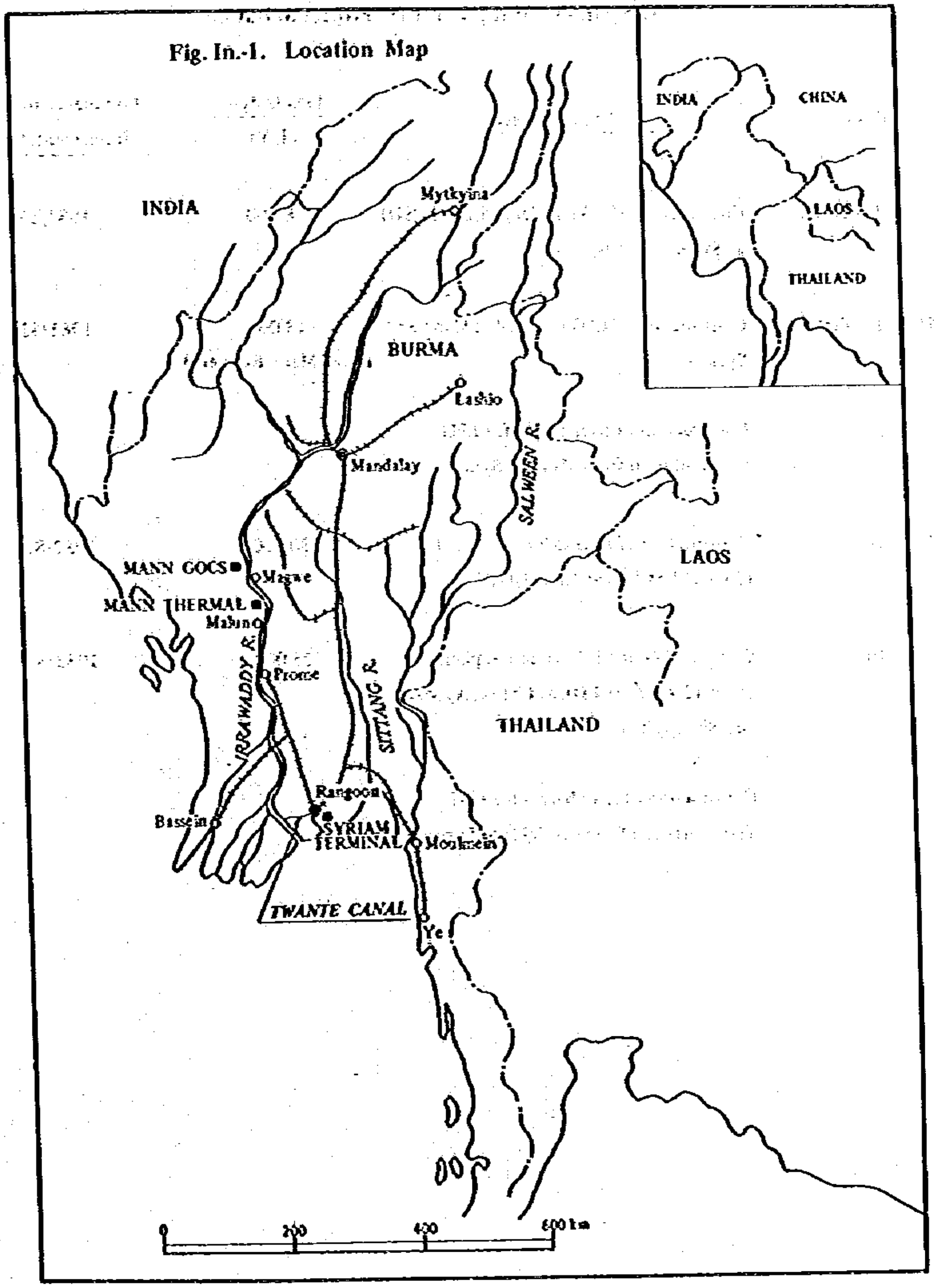


Table In.-3. Integrated LPG Project in Burma

Phase	Outline of Project	LPG Output (T/Y)	Commencement of Implementation
Phase I – Part 1	Construction of coking plant (5,200 BPSD) at Syriam Refinery	8,000	1981/82
Phase I – Part 2	Construction of LPG terminal at Mann and Syriam	18,000 (from Mann Refinery)	1981/82
	Construction of river barges for LPG transportation from Mann to Syriam		
Phase II	Construction of LPG extraction plant (24×10^6 SCFD) at Mann GOCS	30,000	1982/83
Phase III	Construction of LPG extraction plant (each 12×10^6 SCFD), at Chauk, Ayadaw and Shwepyitha	25,000	1983/84
	Construction of river barges for LPG Transportation from gas fields to Syriam		

3) Survey on LPG recovery project by JICA team

In response to the request of the Government of Burma to the Government of Japan, Japan International Corporation Agency (JICA) dispatched a preliminary survey team consisting of six members led by Mr. S. Kishida from August 22 to 27, 1981, prior to the dispatch of the present team, and held discussions with the Burmese side on the scope and schedule of the feasibility study. As a result, they exchanged "Minutes of the Meeting on the Feasibility Study on the Integrated Liquefied Petroleum Gas Project in the Socialist Republic of the Union of Burma" dated August 26, 1981.

Based on this "Minutes", JICA dispatched to Burma the present survey team consisting of eight members headed by Mr. A. Hijikata from September 26 to October 15, 1981. The survey team, after returning to Japan, examined the data they obtained in Burma, and prepared this report, The present feasibility survey was performed only on Phase I – Part 2 and Phase II according to the above "Minutes".

2. Objective of the Survey

The objective of survey is to investigate the feasibility of Phase I – Part 2 and Phase II of the Burmese LPG recovery project. The following are the items to be studied:

1) Study on the supply possibility of LPG resources (reserves and production)

2) Demand for LPG

3) Study on the scale and configuration of LPG recovery plant

4) Study on the construction site of LPG recovery plant

5) Study on the transportation of LPG material gas and product LPG

6) Study on the transportation of machinery, equipment and materials at the time of construction

7) Study on machinery, equipment and materials for plant construction

8) Study on the dispatch of supervisor for construction and test run

9) Study on construction schedule

10) Study on operation plan of LPG recovery plant

11) Study on related infrastructures

12) Making of construction plan of LPG recovery plant

13) Estimation of required capital investment

14) Financial evaluation of the project

15) Economic evaluation of the project

3. Members of the Survey Team

The survey team was composed of the following members;

Team leader:	Mr. Akifumi Hijikata
Assistant leader:	Mr. Kuniaki Kudo
Project manager:	Mr. Masatoshi Harada
Civil engineer:	Mr. Akira Nagumo
Economist:	Mr. Yasuhiro Kuriyama
Industrial engineer:	Mr. Yasuki Murakami
Process engineer:	Mr. Masahide Furuzono
Industrial economist:	Mr. Shojiro Mori
Advisor:	Mr. Junsaku Koizumi

4. Field Survey

The survey team exerted every effort to obtain necessary data through discussions with the Burmese side during their stay in Burma. The team also collected a great deal of information by inspecting the project construction site and the existing jetties.

The details of the itinerary of the survey team are as follows:

Itinerary of the Survey Team

Date	Day	Description
Sep. 26th	Sat.	Arrived at Rangoon by TG305. Had discussions with Burmese Side.
Sep. 27th	Sun.	Had discussions among members.
Sep. 28th	Mon.	Morning: Courtesy call to Japanese Embassy. Afternoon: Had discussions with Burmese side (PIC and TSC).
Sep. 29th	Tue.	Had discussions with Burmese side (PIC, TSC and MOC).
Oct. 1st	Thu.	
Oct. 2nd	Fri.	Visited Syriam Refinery (accompanied by PIC and TSC).
Oct. 3rd	Sat.	Surveyed the candidate site of Syriam terminal and existing jetties. (Mr. Y. Kuriyama joined to the team).
Oct. 4th	Sun.	Had discussions among members.
Oct. 5th	Mon.	Went to Malun to survey the Mann area, (accompanied by PIC and TSC).
Oct. 6th	Tue.	Surveyed Mann Refinery, candidate site of Mann Terminal, and jetties.
Oct. 7th	Wed.	Surveyed Mann oil field (GOCS) and Mann GOCS LPG extraction plant. Visited the factory of Matsushita Electric Factory of HIC at Malun to survey the demand for LPG. Visited Malun Refinery.
Oct. 8th	Thu.	Went to Rangoon from Malun (accompanied by PIC and TSC).

Date		Day	Description	
Oct.	9th	Fri.	Had discussions with Burmese side.	
Oct.	10th	Sat.	Had discussions among members and prepared an interim report. (Mr. J. Koizumi, advisor, Joined to the team on October 10.)	
Oct.	11th			
Oct.	12th	Mon.	Morning:	Had discussions with Burmese side (PIC and TSC).
			Afternoon:	Visited Japanese Embassy, explaining on outline of field survey.
Oct.	13th	Tue.	Mr. J. Koizumi and Mr. A. Nagumo visited Syriam Refinery (accompanied by PIC). Had discussions with Burmese side (PIC and TSC).	
Oct.	14th	Wed.	Had discussions with Burmese side (PIC). Received Burmese answer to the questionnaire prepared by the team.	
Oct.	15th	Thu.	Morning:	Had discussions with Burmese side (PIC). The survey team submitted the interim report to PIC.
			Afternoon:	Departed from Rangoon by TG-306 flight.

Chapter 1.

SUMMARY AND CONCLUSION

Chapter 1. SUMMARY AND CONCLUSION

With regard to PHASE 1 – Part 2 and PHASE II in "Integrated LPG Project" of the Socialist Republic of the Union of Burma, field surveys were conducted, and on returning to Japan, detailed examination of the findings was made to prepare the present report.

The conclusion of the report endorses the feasibility of the plans to construct the LPG terminal of PHASE I – Part 2 and the LPG extraction plant of PHASE II, in order to recover LPG from refineries and associated gas.

The summary of the present survey is as follows:

1.1 The table below shows the whole project of Burmese LPG recovery, of which the present survey dealt with only PHASE I – Part 2 and PHASE II.

Phase	Outline of plan	LPG output	Commencement of implementation
PHASE I – Part 1	Construction of coking plant (5,200 BPSD) at Syriam Refinery	8,000 T/Y	1981/82
PHASE I – Part 2	Construction of LPG terminals at Mann and Syriam	18,000 T/Y (Mann Refinery)	1981/82
	Construction of river barges for transporting LPG from Mann to Syriam		
PHASE II	Construction of LPG extraction plant (24×10^6 SCFD) at Mann GOCS	30,000 T/Y 2,900 T/Y of gasoline materials	1982/83
PHASE III	Construction of LPG Extraction plant (12×10^6 SCFD each) at Chauk, Ayadaw and Shwepyitha	25,000 T/Y and gasoline materials	1983/84
	Construction of river barges for each extraction plant of transporting LPG from gas fields to Syriam Terminal		

1.2 The projected LPG is to be produced at Syriam Refinery, Mann Refinery and Mann GOCS. In connection with the output of LPG, surveys were made on the operation schedule of both refineries at Syriam and Mann, and also on the reserves of associated gas in the Mann area. As a result, it was confirmed that both refineries would promote the crude oil processing plans that will meet the requirements of their LPG recovery plans. It was also confirmed that the reserves of associated gas at the Mann area is large enough as the source of raw material gas which is to be used at the LPG extraction plant.

1.3 Present LPG demand in Burma is about 700 tons per year, but it has a plan to increase the use of LPG at the factories, hospitals, hotels and other public facilities.

Regarding LPG domestic demand, discussions were held with the Burmese counterpart, and it was decided to adopt 3,000 tons/year in the present feasibility study, i.e. the target of the consumption expansion plan now in progress. As LPG for domestic use is to be shipped by utilizing the facilities at Mann Refinery under construction, which, however, does not fall within the sphere of this feasibility study.

Consequently, out of the LPG to be produced at Mann Refinery, Syriam Refinery and Mann GOCS, 53,000 tons are the quantity of LPG to be dealt with in the present study, and all of which is intended for export.

1.4 Mann GOCS LPG extraction plant will produce 6,850 x 10^6 SCF/year of lean gas and 2,900 tons/year of gasoline materials as by-products. Lean gas is sent back to Mann GOCS to be used for the same purpose as present utilization of natural gas.

As Burma has a plan to export motor spirit when Mann Refinery starts its operation, therefore gasoline materials will be directed to export.

1.5 The construction site of the facilities was selected respectively as follows:

1) Syriam Terminal:
Syriam terminal will be constructed near the existing Syriam jetties, from the point of exporting LPG and of receiving LPG from Mann terminal.

2) Mann Terminal:
Mann terminal will be constructed in the neighborhood of Mann oil products terminal which is located near Mann jetties, in order to receive LPG from Mann

Refinery and Mann GOCS LPG extraction plant, and to ship LPG to Syriam terminal as well as to control the operation of Mann terminal.

3) Mann GOCS LPG Extraction Plant:
LPG extraction plant will be constructed within Mann GOCS to receive feed gas and to ship by-product gas.

1.6 The transportation methods of LPG and others were fixed as below, in connection with the construction site:

Produced at	Description	Transport by	Amount to be handled	Remarks
Syriam Refinery	Syriam terminal	Pipeline	LPG 8,000 T/Y	
Mann Refinery	Mann terminal	Pipeline	LPG 15,000 T/Y	
Mann Refinery	For domestic consumption	Cylinder	LPG 3,000 T/Y	Not covered by present survey
Mann GOCS	Mann GOCS LPG extraction plant	Pipeline	Associated gas 7,920 x 10^6 SCF/Y	
Mann GOCS LPG extraction plant	Mann GOCS	Pipeline	Lean gas 6,850 x 10^6 SCF/Y	
Mann GOCS LPG extraction plant	Mann terminal	Pipeline	LPG 30,000 T/Y	
Mann GOCS LPG extraction plant	Mann oil products terminal	Lorry	Gasoline materials 2,900 T/Y	
Mann terminal	Syriam terminal	River barges	LPG 45,000 T/Y	
Syriam terminal	Export	LPG ocean tankers	LPG 53,000 T/Y	

1.7 In determining the terminal scale, the amount of LPG to be handled was taken into account, and for the LPG extraction plant capacity the associated gas supply ability was taken into consideration. From these points they were fixed respectively as follows:

Facilities	Scale
Syriam terminal	(1) C_3 LPG spherical tank: 1,000 m^3 x 4 units
	(2) C_4 LPG spherical tank: 1,000 m^3 x 1 2,000 m^3 x 3
	(3) C_3 LPG shipping pump: 150 m^3/H x 3
	(4) C_4 LPG shipping pump: 150 m^3/H x 3
Mann terminal	(1) C_3 LPG spherical tank: 800 m^3 x 2
	(2) C_4 LPG spherical tank: 1,000 m^3 x 1 2,000 m^3 x 1
	(3) C_3 LPG shipping pump: 100 m^3/H x 3
	(4) C_4 LPG shipping pump: 100 m^3/H x 3
Mann GOCS LPG extraction plant	24 x 10^6 SCFD (amount of gas to be processed.)

As regards utility facilities, construction will be made only where it is impossible to get necessary utility from the existing facility in the neighborhood (namely, Syriam Refinery, Mann Refinery or Mann GOCS).

Syriam terminal was planned to have a capacity of 78,000 tons a year, the target to be handled at the time of completion of PHASE III, from the point of economy and safety operation measures.

1.8 Regarding river barges to be used for transporting LPG (45,000 tons/year) from Mann terminal to Syriam terminal, it was decided to construct four barges, each with a capacity of carrying 500 tons, by considering the LPG receiving and shipping schedule and the number of navigation days of barges.

1.9 As auxiliary facilities, the following are included: facilities for waste water treatment, fire fighting, communications, pipeline, building, maintenance equipment and tools, analyzing instruments, safety and protection facilities, flarestack, spares (two years' stock), construction machinery and materials.

1.10 The required construction cost is estimated as follows:

	Foreign Currency Portion (1,000 ¥)	Local Currency Portion (1,000 K)
PHASE I – Part 2		
Material terminal	1,220,000	) 11,686
Syriam terminal	2,985,000	
River barges	1,800,000	-
Construction machinery	760,000	21,560
Transportation and insurance	560,000	3,889
Contingency	336,250	1,857
Sub-total	7,691,250	38,992
PHASE II		
Mann GOCS LPG extraction plant	5,940,000	10,100
Construction machinery	235,000	17,530
Transportation and insurance	275,000	3,769
Contingency	322,500	1,570
Sub-total	6,772,500	32,969
Total	14,463,750	71,961

Notes:

1) Interest during the period of construction is not included in the amount.

2) The portion covered by local currency does not include the import duties for machinery and equipment, according to discussions with the Burmese side.

3) The construction cost covered by foreign currency is based on the assumption that the contract is signed on October 1, 1982 and becomes effective on January 1, 1983 for PHASE I – Part 2; and the contract for PHASE II is signed on October 1, 1983, which becomes effective on January 1, 1984, and that the date of delivery for each PHASE is 24 months after the contracts became effective.

1.11 The purchase price of LPG and feed gas as well as the selling prices of by-products will exert a great influence upon the financial evaluation of the project.

The prices of those, therefore, were fixed as below, as a result of discussions with the Burmese side and of the detailed study conducted by the survey team:

Article	Price	Price was fixed based on	Description
LPG (for domestic use)	US$60/T	Current kerosene price in Burma	This becomes LPG price payable to Mann and Syriam refineries by present project
Associated gas	1.05 K/10^3 SCF	The same with the price which PIC is paying to MOC at present	This becomes the material gas price payable by Mann GOCS LPG extraction plant
LPG (for export)	US$170/T	The LPG FOB Rnagoon price was adopted the mean price of supposed destinations which would be competitive with the price of Middle East LPG.	FOB price Rangoon by destination for example: Japan: US$121/T South Korea: US$136/T Taiwan: US$170/T Philippines: US$179/T Hongkong: US$200/T Singapore: US$260/T
Lean gas	1.05 K/10^3 SCF	The same price with that of associated gas	
Gasoline materials	US$295/T	Estimated as equal to FOB price Singapore	

1.12 Financial Evaluation

1.12.1 Financial analysis was made to know the financial condition of the present project, which resulted as below. The following are the prerequisite conditions to that analysis:

1. Project life (Economic life)
   Both PHASE I – Part 2 and PHASE II are to be completed simultaneously; and on this basis the project life was fixed respectively as follows:

PHASE I — Part 2 21 years
PHASE II 20 Years

2. Exchange rate

The exchange rate used in this financial calculation is the average value in the month of September 1981; i.e. US$1.00 = ¥231 or 7.58 kyat.

3. Funds raising plans

It is assumed to raise the necessary foreign currency portion through the government-to-government long-term loan according to the following financing terms:

Annual interest rate:	2.25%
Repayment method:	Principal is to be repaid by semiannual equal installments method.
Repayment period:	Repayment is to be made in 30 years including a 10-year grace period.

4. Depreciation

The straight line method is used for depreciation. The depreciation period of all machinery and equipment is 20 years, with 10% salvage. The depreciation period of commissioning cost, pre-operation cost, working capital, and interest during the construction was fixed as 5 years, without residual value.

5. Contribution to state (corporation tax)

According to the Burmese taxation system, the contribution to state (CTS) was fixed as 30% of the taxable income.

From the above conditions, results of the financial analysis by the present project can be defined as follows:

Internal rate of return on invested capital (IRROI):	3.52%
Internal rate of return on own equity (IRROE):	25.04%

(1) IRROI, profit indicator, for the present project itself is 3.52%, which is not so high, but it shows that the project is profitable.

(2) IRROE, profit indicator, for on equity, which PIC invests in the present

project, is 25.04%. IRROE is a result of calculation based on PIC's own equity amount and on the financing terms of loan supposed in the present survey. Accordingly, when the financing terms should change, IRROE would also change.

Although profitability of the present project itself is not so high, the project will be sufficiently feasible if the funds with a very low interest rate and a long repayment date can be obtained as assumed in the present project.

1.12.2 In order to enhance the profitability of the project, the following are recommended to do:

1. Efforts should be made to raise funds that can be borrowed with an advantageously low rate of interest and with a long repayment date.

2. Efforts should be made to reduce tanker freight by exporting LPG to neighboring countries and to improve LPG export selling price.

3. In case the construction cost increases, say, 15%, the aforesaid IRROI will decrease from 3.52% to 2.34%, and the present project will become barely payable. In this way, an increase in the construction cost will have a great effect on the profitability. Therefore, it is essential to implement the project as scheduled.

1.13 From the economic point of view the present project is supposed to bring benefits to Burma by:

1. The influence of this project on the future economic development and improvement of living standards in Burma through the development of the LPG market.

2. The influence of the price for procuring LPG from Mann and Syriam Refineries on the profitability of the project.

3. Evaluation of the entire Integrated LPG Recovery Project, inclusive of Phase I – Part 1 and Part 2, Phase II and Phase III.

4. Foreign currency revenue effect of LPG Recovery Project.

5. Effect of technology transfer through LPG Recovery Project.

6. Employment promotion effect of LPG Recovery Project.

1.14 In order to complete the construction as scheduled and to perform smooth operation, it is necessary for the Burmese side to take the best possible measure for what are recommended in Chapter 12.

Chapter 2.

RAW MATERIALS FOR LPG RECOVERY AND PRODUCTION PLANS

Chapter 2. RAW MATERIALS FOR LPG RECOVERY AND PRODUCTION PLANS

2.1 Summary

There are two kinds of LPG which are dealt with in the present project, one is LPG to be produced at oil refineries (PHASE I – Part 2) and the other to be produced from associated gas in oil fields (PHASE II).

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.

Regarding the crude oil reserves a detailed investigation was already made when Mann Refinery construction plan was examined. According to that report, the reserves is estimated to be available for 20.7 years (R/P) calculating from 1985, and will pose no problem at all for the execution of the present project.

The reserves of associated gas in the Mann area is 191,847 x 10^6 SCF according to the data shown by the Burmese side in the present survey, which is available for 20.2 years, and is thought enough to execute the present project.

When LPG output is estimated according to the present crude oil processing plan and the associated gas production plan, it becomes as Table 2-1 below.

Table 2-1. LPG Production Plan

(Unit: T/Y)

	Phase I – Part 2		Phase II	Total
	Syriam Refinery	Mann Refinery	Mann GOCS	
1982	-	1,000	-	1,000
1983	-	2,000	-	2,000
1984	-	3,000	-	3,000
1985	8,000	16,100	-	24,100
1986	8,000	17,600	30,000	55,600
1987	8,000	18,000	30,000	56,000
1988	8,000	18,000	30,000	56,000
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.

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

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

Area	Kind
Letpando	Natural gas
Pagan	Natural gas
Mann	Associated gas
Peppi	Natural gas
Chauk	Natural gas
Tenangyaung	Natural gas, Associated gas
Myanaung	Natural gas, Associated gas
Shwepyitha	Natural gas
Prome	Natural gas, Associated gas
Pyalo	Natural gas

The geographical locations of these oil fields are shown in Fig. 2-1, and the gas reserves and gas composition in representative areas are shown in Table 2-2.

1) Gas reserves in Mann area

Of the above gas fileds, it is the Mann area in PHASE II, which is concerned with the present project. The gas reserves in this area is 191,847 x 10^6 SCF of associated gas which is isolated from crude oil pumped from wells.

2) Output and consumption of associated gas

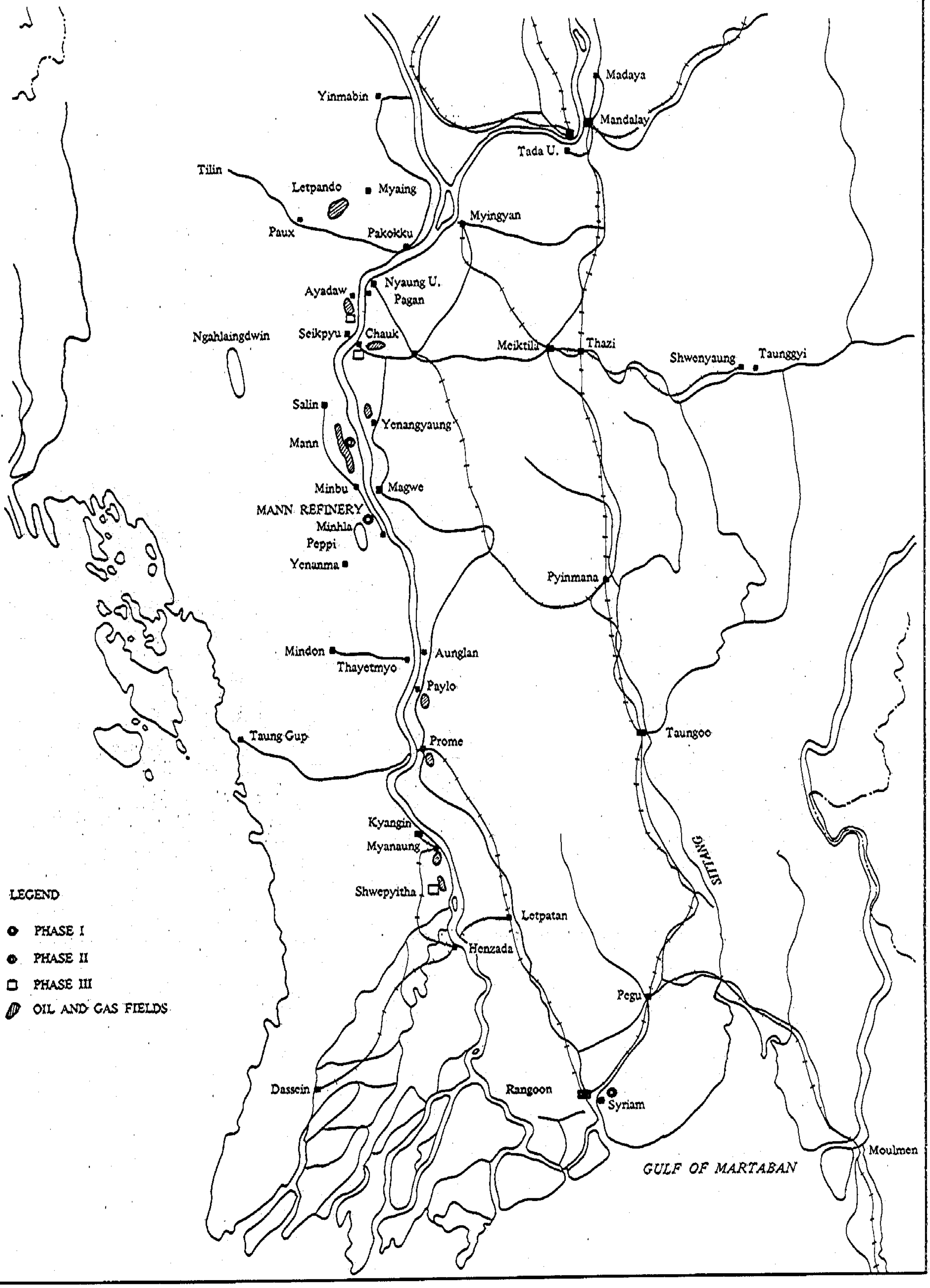
In the Mann area six GOCS (Gas & Oil Collecting Station) are engaged in the production. And one more GOCS is under construction. A total number of wells now in operation is 265, composed of 105 flowing wells, 111 pumping wells and 49 gas lifting wells. In the Mann area about 21,500 B/D of crude oil and about 26 x 10^6 SCFD of associated gas are being produced. In case another GOCS under construction is completed, it will result in producing about 30 x 10^6 SCFD. Consumption of associated gas by purpose is as follows:

	Purpose	Consumption, SCF/M
(a)	Gas lifting	405.5 x 10^6
(b)	Mann gas turbine power station	76.5 x 10^6
(c)	Gas compressors	60.0 x 10^6
(d)	Htaukshabin oil field	21.5 x 10^6
(e)	Malum Refinery and HIC*	11.8 x 10^6
(f)	Field use	10.0 x 10^6
(g)	Others	4.7 x 10^6
(h)	To atmosphere	180.0 x 10^6
	Total	770.0 x 10^6 (= 25.7 x 10^6 SCFD)

* HIC (Heavy Industry Corporation)

Of the above purposes, gas used for a), c), d), and f) is injected into wells giving pressure within the wells to pump the oil, and their gas composition is disregarded. Accordingly, lean gas remaining after recovery of LPG from associated gas can be used. MOC in charge of

Fig. 2-1. BURMA – OIL AND GAS FIELDS



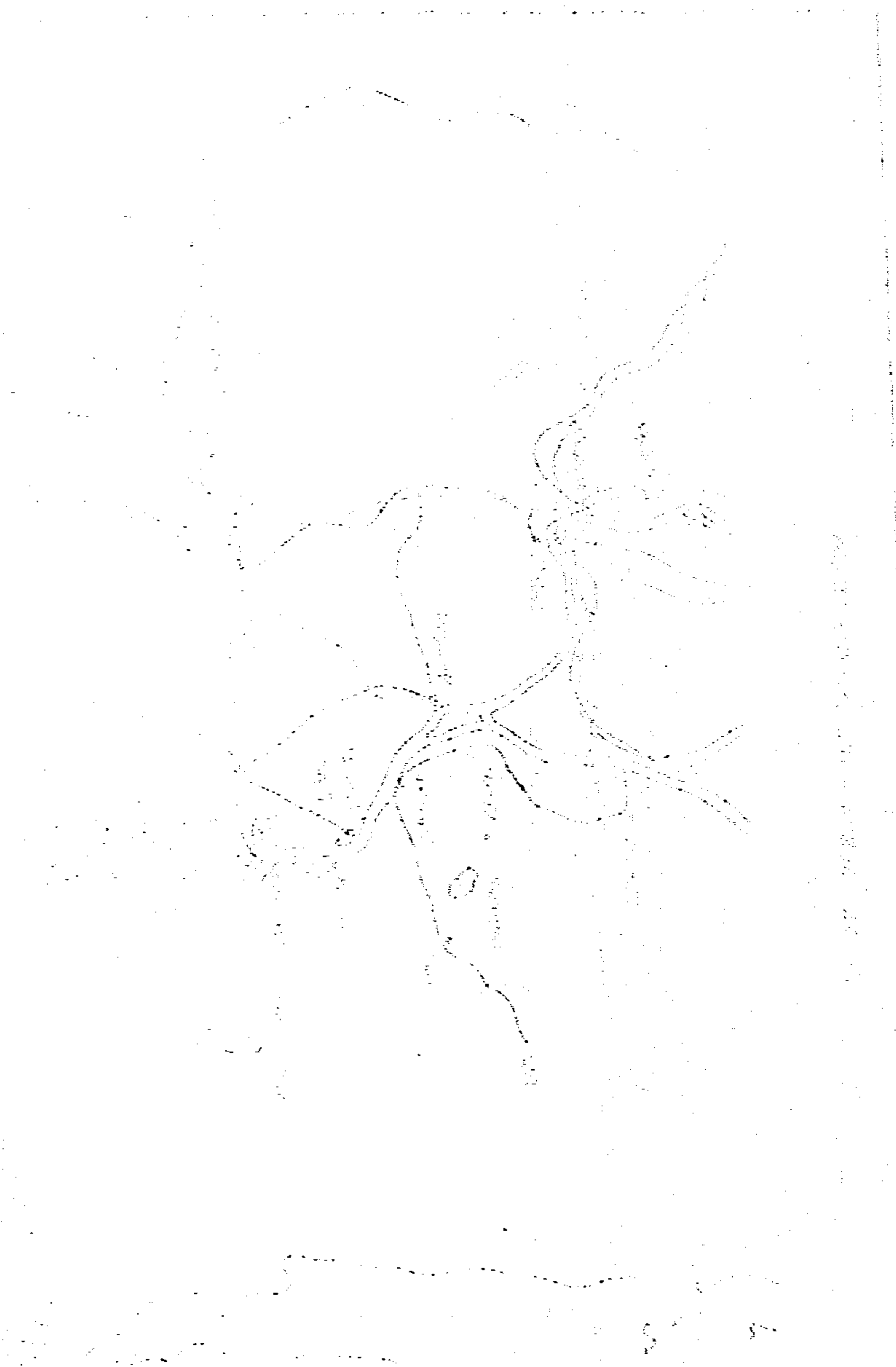


Table 2-2. Gas Reserves and Composition

1. Area	Myanaung Shwepyitha		Prome		Pyalo	Mann	Chauk	Ayadaw Yenangyat
2. Reserves (10^6 SCF)								
2-1 Associated gas	11,213		29,494		-	191,847	-	-
2-2 Natural gas	146,153		25,955		170,237	-	251,302	406,125
Total	157,366		55,449		170,237	191,847	251,302	406,125
3. Properties (%)	AG	NG	AG	NG	NG	AG	NG	NG
C_1	88.00	93.33	88.86	96.81	97.79	86.34	93.26	94.00
C_2	3.90	2.81	3.79	1.05	0.51	5.85	2.42	2.22
C_3	2.61	1.78	4.32	0.94	0.48	3.49	1.96	1.86
C_4	3.39	1.87	2.96	1.18	0.86	3.58	2.55	1.76
C_5+	0.68	0.26	0.07	0.02	0.36	0.74	0.11	0.18

producing crude oil and gas has a plan to use pumps in place of gas lifting, and when the plan is carried out, it becomes no longer necessary to use gas for lifting, and merely gas injection will suffice to enhance the gas yield.

Regarding Gas to be used for b) and e), lean gas after extracting LPG will deteriorate in the calorific value per unit volume, but this defect can be covered by quantity, and thus lean gas after LPG extraction is usable as a substitute. Consequently, lean gas is to be used when the present project is implemented. In view of this, almost all quantity of associated gas (approximately 26×10^6 SCFD) can be used as raw material of the LPG extraction plant.

3) Available years of associated gas

Calculating the available years of associated gas from the present reserves and output, it is assumed to be R/P = 20.2 years.

4) Available years of crude oil

As regards the crude oil reserves, it is described in details in "The Socialist Republic of the Union which of Burma – Feasibility Study on Refinery Construction Plan". According to this report, the proved reserves ascertained as of January 1, 1976 is 217×10^6 BBL, and the probable reserves + possible reserves = 212×10^6 BBL.

The available years of crude oil as of 1980 is estimated to be 22.3 years and also the available years as of 1985 is 20.7 year; from which it is considered that the LPG material at oil refineries is secured.

2.3 Present Status of Refineries and Future Prospects

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 a small and simple refinery at Malun. In addition, there is Mann Refinery which is expected to start operation in the beginning of 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 gas 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 (coker). The atmospheric distillation plant, vacuum distillation plant and thermal cracking plant in Bench A were constructed in 1957. Further, another atmospheric distillation plant was constructed for Bench B in 1963, and for Bench C in October 1980. They compose the plants existing at present.

Products of the Refineries are gasoline, kerosene, jet fuel, gas oil, fuel oil and cokes. The output of each product is shown in Table 2-3.

Table 2-3. Products and Output in Each Refinery

1. Refinery	Chauk Refinery	Syriam Refinery			Mann Refinery
		Bench A	Bench B	Bench C	
2. Constructed Year	1954	1957	1963	1980	Under construction
3. Product (BPSD)					
C_3 LPG	-	-	-	-	107 BPCD
C_4 LPG	-	-	-	-	460 BPCD
Motor Gasoline	1,383	1,387	3,235	1,387	6,137 BPCD
Kerosene	782	198	462	198	3,298 BPCD
ATF (Jet Fuel)	-	226	528	226	829 BPCD
Diesel Oil	1,865	1,775	4,141	1,775	7,274 BPCD
Fuel Oil	1,910	2,114	5,494	2,554	3,686 BPCD
Cokes (T/D)	-	45	-	-	-
Waxes (T/D)	25	-	-	-	1,042 T/D

Syriam Refinery has a plan to scrap the superannuated thermal cracking plant and to install a new 5,200 BPSD delayed coking plant (PHASE I – Part 1). The plan involves a coking plant, LPG merox plant, de-olefinizer plant (polymer gasoline plant) and LPG extraction plant, and is intended to produce 8,000 T/Y of LPG. When the coking plant is completed, Syriam Refinery will come to have such a configuration plants as per Fig. 2-2.

The Refinery has the following crude oil processing plan.

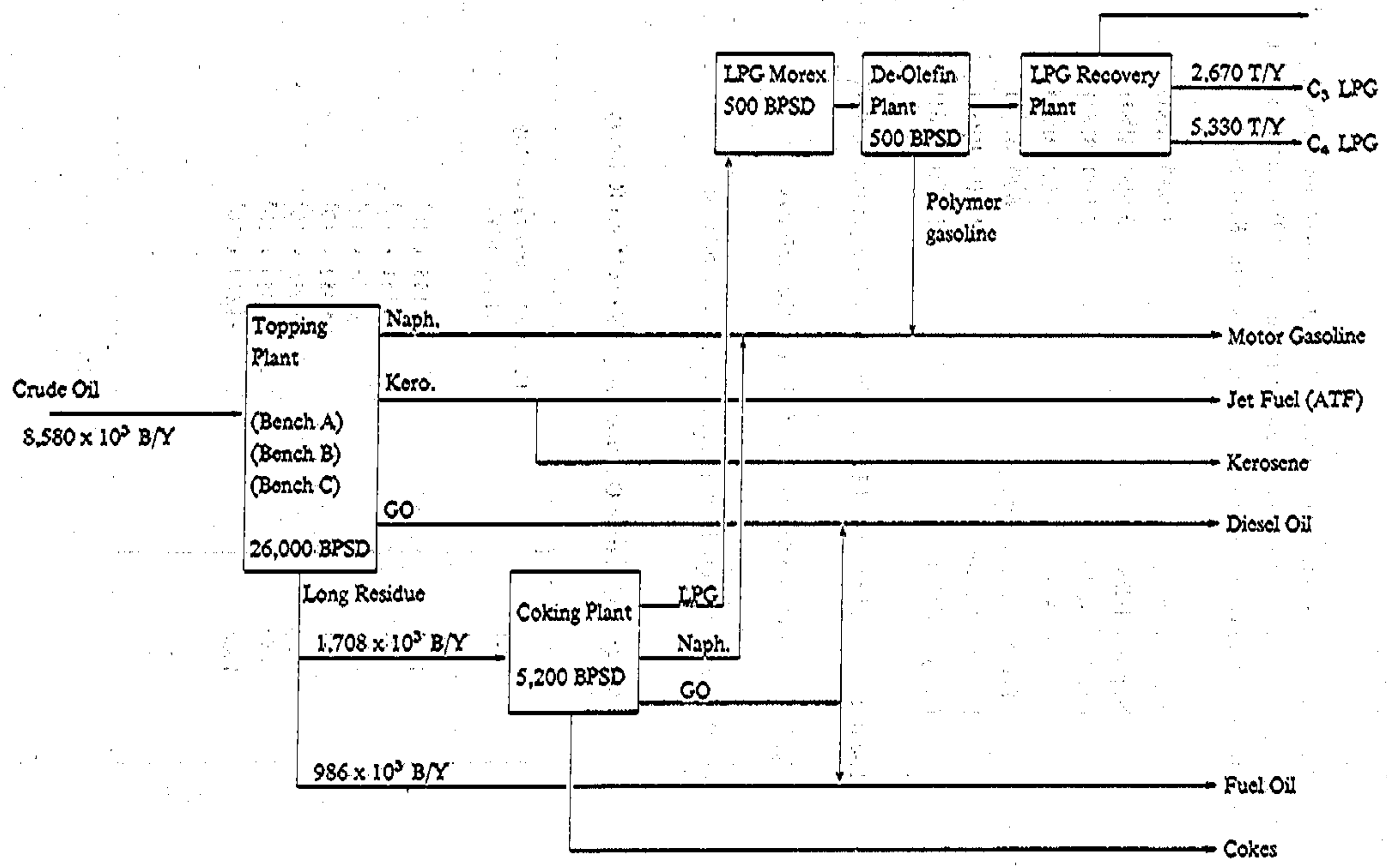
Table 2-4. Crude Oil Processing Plan at Syriam Refinery

Year	Crude oil processing quantity (Unit: B/Y)
1982	$2,964 \times 10^3$
1983	$5,964 \times 10^3$
1984	$6,564 \times 10^3$
1985	$7,221 \times 10^3$
1986	$8,151 \times 10^3$
1987	$8,580 \times 10^3$
1988	$8,580 \times 10^3$
.	.
.	.
.	.

3) Malun Refinery is such a small, simple refinery that has only a 2,000 B/D atmospheric distillation plant.

The Refinery produces gasoline, kerosene, gas oil and fuel oil, meting the demand in the neighborhood. It is said that the Refinery will mainly be used for a training purpose when Mann Refinery under construction commences its operation.

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



4) Mann Refinery

This Refinery is under construction having a processing capacity of 25,000 BPSD crude oil. It is expected to be completed toward the end of 1981 and to start operation early in 1982. The following are the plants and their capacities at the Refinery:

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

The Refinery will produce LPG, gasoline, kerosene, jet fuel, gas oil and fuel oil.

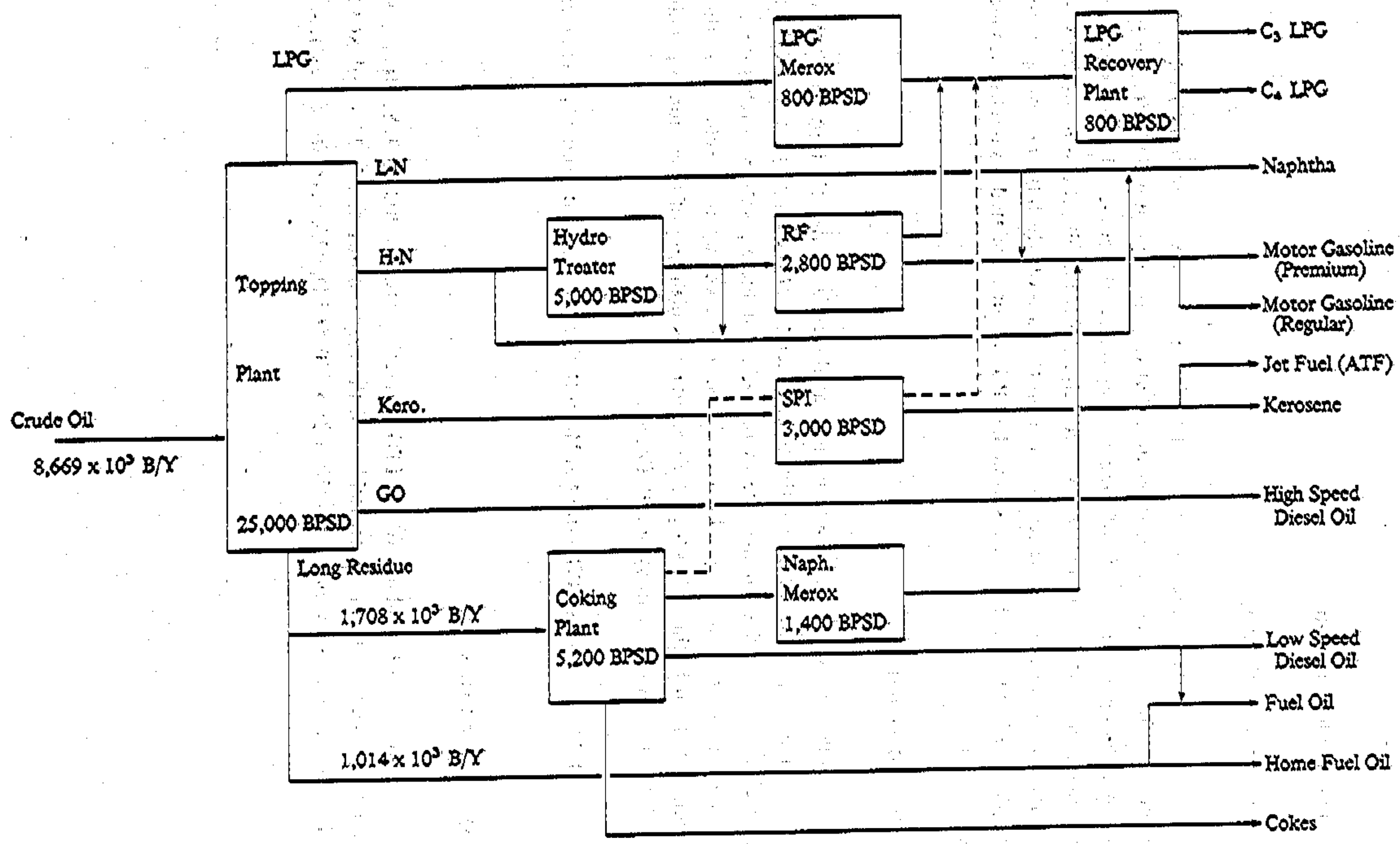
Fig. 2-3 shows the configuration of plant at the Refinery.

The Refinery has a crude oil processions plan as follows:

Table 2-5. Crude Oil Processing Plan at Mann Refinery

Year	Crude oil processing quantity (Unit: B/Y)
1982	$5,595 \times 10^3$
1983	$5,881 \times 10^3$
1984	$6,166 \times 10^3$
1985	$6,452 \times 10^3$
1986	$8,235 \times 10^3$
1987	$8,669 \times 10^3$
1988	$8,669 \times 10^3$
⋮	⋮

Fig. 2-3. Configuration of Mann Refinery



2.4 LPG Production Plan

1) Syriam Refinery

The crude oil processing plan at Syriam Refinery was shown in Table 2-6. In view of the demand for light fraction, it is planned that the coking plant will maintain as high rate of operation as possible. The yield of long residue against the crude oil processing quantity at Syriam Refinery is 31.4% at present. Accordingly, the crude oil processing quantity and yield will decide on the output of long residue; and on the basis of which the rate of operation of the coking plant will be fixed. Table 2-6 shows the LPG output calculated from what was mentioned above.

2) Mann Refinery

LPG of this Refinery is generated at three places, namely topping plant, catalytic reformer, and coking plant. LPG quantity to be generated at the topping plant and the catalytic reformer changes depending on the rate of operation of these plants, and relies directly upon the crude oil processing quantity. LPG produced at the coking plant relies upon the rate of operation, and Mann Refinery has a plan to maintain as high rate of operation as possible of its coking plant, as is the case with Syriam Refinery.

Table 2-7 shows LPG output at Mann Refinery calculated from what was mentioned above.

3) Mann GOCS

LPG output at Mann GOCS LPG extraction plant is 30,000 T/Y. Its material gas is associated gas coming from the oil fields, and the required quantity is 24×10^6 SCFD. Associated gas being produced at present is about 26×10^6 SCFD, which is sufficient as quantity.

Table 2-6. LPG Production Plan at Syriam Refinery

	Crude oil processing quantity	LR* output	Coking Plant		Product of C_3 LPG	Product of C_4 LPG
			Charge	Operation rate		
	Unit 10^3 B/Y	10^3 B/Y	10^3 B/Y	%	T/Y	T/Y
1982	2,964	931	-	-	-	-
1983	5,964	1,873	-	-	-	-
1984	6,564	2,061	-	-	-	-
1985	7,221	2,267	1,708	100	2,670	5,330
1986	8,151	2,559	↓	↓	↓	↓
1987	8,580	2,694	↓	↓	↓	↓
1988	↓	↓	↓	↓	↓	↓
1989	↓	↓	↓	↓	↓	↓
1990 ~ 2004	↓	↓	↓	↓	↓	↓

Note *: LR: Long Residue

Table 2-7. LPG Production Plant at Mann Refinery

	Refinery		LR*1 output	Coking plant		LPG generation quantity			Total generation quantity	LPG recovery (Recovery rate 77.1%)	LPG output		Total output
	Crude oil processing quantity	Operation rate		LR*1 processing quantity	Operation rate	TP	RF	Coking plant			C_3 LPG	C_4 LPG	
Unit	10^3 B/Y	%	10^3 B/Y	10^3 B/Y	%	10^3 B/Y	10^3 B/Y	10^3 B/Y	10^3 B/Y	10^3 B/Y	T/Y	T/Y	T/Y
1982	5,595	64.5	1,757	1,708	100.0	56.1	16.0	156.6	229	176	2,600	12,800	*2(15,400) 1,000
1983	5,881	67.8	1,847	↓	↓	58.9	16.8	↓	232	179	2,600	13,000	*2(15,600) 2,000
1984	6,166	71.1	1,936	↓	↓	61.8	17.7	↓	236	182	2,600	13,200	*2(15,800) 3,000
1985	6,452	74.4	2,026	↓	↓	64.6	18.5	↓	240	185	2,700	13,400	16,100
1986	8,235	95.0	2,586	↓	↓	82.5	23.6	↓	263	202	2,900	14,700	17,600
1987	8,669	100.0	2,722	↓	↓	86.9	24.8	↓	268	207	3,000	15,000	18,000
1988	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	
1989	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	
1990 ~ 2004	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	

Note *1: LR: Long Residue

*2: ( ) shows the output attainable.
In reality production is made to the domestic demand.

Chapter 3.

LPG DEMAND

Chapter 3. LPG DEMAND

3.1 Trend of LPG Demand and its Forecast

3.1.1 Present LPG Demand in Burma

The United Nations' energy statistics says that Burma produced 4,000 tons of LPG in 1978 and 2,000 tons in 1979, and all of which was consumed in the country, and nothing was exported nor imported.

According to what the Burmese side explained in the present survey, HIC's plants use some 700 tons of LPG a year, importing it in bottles from Japan. LPG consumption in Burma is very small at present.

The Burmese answer to the survey team's questionnaire says that no LPG has been supplied nor sold in Burma from 1975 to 1980.

3.1.2 Forecast of LPG Demand in Burma

1) LPG supply plan

Burma is expected to produce the following quantities of LPG in and after 1982:

Table 3-1. LPG Supply Plan

Unit: ton

	Mann Refinery	Syriam Refinery	Mann GOCS	Total
1982	1,000			1,000
1983	2,000			2,000
1984	3,000			3,000
1985	16,100	8,000		24,100
1986	17,600	8,000	30,000	55,600
1987	18,000	8,000	30,000	56,000

When the LPG extraction plant of PHASE III starts its LPG extraction from natural gas, Burma will come to produce another 25,000 tons a year.

2) Domestic demand

When viewed from Burmese population of about 34,000,000, there seems to be a potential LPG demand of about 5,000 tons a year for residential uses. However, Mann Refinery is said to introduce the physical distribution system for the first time, starting its LPG filling early in 1982, it seems almost impossible to popularize LPG use in general households for the next several years. Besides, consideration must also be given to the effective use of natural gas intended in the industrial sector. Under such circumstances, it may be difficult to expect a rapid and remarkable increase in LPG demand.

Because of the situation described above, it was decided to adopt what the Burmese side showed in the present survey as the future prospects of LPG demand in Burma.

The following quantities of LPG are expected to be used at such places as:

(a)	HIC	700 tons/year
(b)	Glassworks	300 tons/year
(c)	Hospitals, hotels, public organizations	1,000 – 1,500 tons/year
(d)	Others	500 tons/year
	Total	2,500 – 3,000 tons/year

LPG demand in Burma is anticipated to expand at the following paces:

3,000 to 5,000 tons/year	15% expansion per year
5,000 to 7,000 tons/year	10% expansion per year
Over 7,000 tons/year	7% expansion per year

This, however, being a mere target including PHASE III, it was decided in the discussion with the Burmese side to adopt the above 3,000 tons/year for the present feasibility survey.

To meet the domestic LPG demand of 3,000 tons/year the Burmese side is thinking of using butane for the whole quantity and also using propane depending on purposes. In installing LPG equipments in hospitals, hotels and other public organizations and in introducing the physical distribution system, due consideration should be given to the use of both propane and butane instruments so as to cope flexibly with a change in overseas LPG demand.

3) Exportable quantities

From the prospects of the above production and domestic demand, the following may be possible to export:

Table 3-2. LPG Exportable Quantities

Unit: ton/year

	Propane	Butane	Total
1985	5,370	15,730	21,100
1986	16,770	35,830	52,600
1987	16,870	36,130	53,000
1988 onward*	25,570	52,430	78,000

Note *: Phase III

3.1.3 Present Situation of International LPG Market and Forecast

1) Present LPG demand and supply in the world

The United Nations' energy statistics carries the following figures as the actual LPG demand and supply in the world during the ten years from 1970 to 1979.

The statistics says that the world's LPG output in 1979 registered 110,810,000 tons and consumption 113,787,000 tons, showing that the output increased 42% during the ten years from 1970 and consumption 47%.

By country (1) USA consumed 55,803,000 tons in 1979, (2) Japan 13,897,000

Table 3-3. Actual LPG Demand & Supply (by United Nations)

Unit: 1,000 tons

		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
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
Export	1970	2,665	2,250	94	147	723	15	2,786	5,680
	1971	2,746	2,304	120	502	1,221	18	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
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

tons, (3) USSR 8,180,000 tons, (4) Mexico 3,620,000 tons and (5) West Germany 3,125,000 tons. It shows that these five countries occupy 74.4% of the world's consumption.

The imports by country in 1979 are as follows: (1) Japan 9,419,000 tons, (2) USA 6,805,000 tons, (3) Spain 1,240,000 tons, (4) Norway 555,000 tons, and (5) Argentina 425,000 tons. This indicates that the five countries occupy 80.6% 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 1979 are: (1) Saudi Arabia exported 5,725,000 tons, (2) Canada 4,204,000 tons, (3) Australia 1,400,000 tons, (4) Kuwait 1,200,000 tons, and (5) Venezuela 1,035,000 tons; which shows that these five countries share 68.6% of the entire exports.

However, the United Nations' statistics lack the figures on 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 1979 exceeding the exports as much as 3,113,000 tons. Nevertheless, the statistics well indicate the trend by region like this:

(a) Asia region embracing Japan, a great importing country, imports 60% of its consumption.

(b) The Middle East and Oceania are exporting regions. In the Middle East, Saudi Arabia exports 97% of its output (5,725,000 tons in 1979). With a future expansion of LPG output in other oil producing countries in the Middle East, the export trend in this region may become more and more conspicuous.

2) Forecast of world LPG demand

1979 was the year when LPG demand in the world increased a great deal. The reason is 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 supply power. Especially in Europe the demand for LPG in terms of petrochemical raw materials increased 12.6%, and in Japan 8%. Consequently, LPG price rose over that of crude oil, and the average price of propane and butane reached US$320/ton FOB Ras Tanura, Saudi Arabia, in May, 1980. This is 2.69 times the US$119/ton as of October, 1978. During that time the price of crude oil of Arabian Light increased 2.2 times from US$12.70/barrel to US$28/barrel.

Reacting against that, LPG demand decreased in 1980 with USA, the biggest consuming country, experienced a 10% decrease or so, and world consumption is estimated to have fallen to the 98% level, compared with the previous year.

In the meantime part of the LPG recovery plants of Saudi Arabia's master gas plan began operation, expanding the LPG supply power in the Middle East, and brought about a surplus in LPG supply earlier than crude oil. And in May 1981 the LPG posted price in oil producing countries in the Middle East was cut down by US$40/ton (13.6%) under the guidance of Saudi Arabia Petromin, as it is seen today.

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

(a) Economic activity
(b) LPG supply power, 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 in USA published in the autumn of 1980 on the basis of their field surveys and comprehensive analysis. (Refer to Table 3-4 on p. 3-7.)

This forecast of demand and supply was made on the assumption that the ratio of price by weight between LPG and crude oil is 1.4 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 October 1, 1981 the ratio between Saudi Arabia Petromin posted price of US$225/ton and Arabian Light crude oil posted price of US$34/barrel is 1.01; which means that LPG has become competitive in price. This is attributed to the fact that LPG price was reduced as much as US$40/ton in May, 1981, and Arabian Light crude oil was raised from US$32/barrel to US$34/barrel as of October, 1981 as a result of OPEC's reunified crude oil price. Should the price correlation between LPG and crude oil be maintained at this level, LPG surplus in the 1980's would possibly be improved by the development of demand.

Table 3-4. Total LPG Supply/Demand

Unit: Thousands of Tonnes

	Historical			Est.	Projected							
	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Supply												
North America	43,832	43,633	47,561	47,794	41,902	42,171	42,815	42,581	41,994	41,100	39,183	37,549
Europe	14,237	14,653	14,904	16,286	16,335	16,970	18,655	19,205	19,285	19,315	20,370	21,250
Asia	5,802	5,941	6,222	6,779	6,955	7,302	7,645	7,900	8,220	8,595	9,340	10,410
Oceania	1,736	1,959	2,463	2,588	2,593	2,600	2,607	2,585	2,830	2,950	3,285	3,025
Latin America	7,920	8,358	8,447	9,244	10,467	11,558	12,954	14,290	14,797	16,658	17,888	19,345
Africa	1,301	1,145	1,325	1,674	2,098	2,753	3,060	3,691	4,756	7,308	13,852	16,021
Middle East	6,772	8,123	9,181	10,802	11,720	17,365	22,125	24,660	26,745	28,800	30,220	31,210
Total	81,600	83,812	85,103	90,107	92,070	100,719	109,861	114,912	118,627	124,926	134,138	138,810
Demand												
North America	44,951	42,891	42,452	45,559	41,933	42,091	42,287	42,532	42,787	43,768	44,234	45,501
Europe	14,718	14,702	15,483	17,428	17,337	18,270	19,330	19,135	19,700	20,279	21,415	23,872
Asia	12,980	13,825	15,246	16,443	17,066	18,007	18,964	20,042	20,937	22,022	24,193	27,950
Oceania	511	501	557	608	640	675	725	800	890	980	1,110	1,390
Latin America	8,068	7,993	8,492	9,033	9,812	10,607	11,256	12,392	13,392	14,054	15,123	16,863
Africa	1,184	1,247	1,440	1,550	1,450	1,782	1,948	2,107	2,269	2,434	2,740	3,247
Middle East	940	1,006	1,076	1,189	1,335	1,476	1,687	1,913	2,164	2,395	2,838	3,583
Total	83,352	82,163	84,746	91,810	89,773	92,908	96,192	98,921	101,779	105,332	111,643	122,406
Surplus (Deficiency)												
North America	(1,119)	742	109	(2,765)	(31)	80	528	49	(773)	(1,868)	(5,051)	(7,952)
Europe	(481)	(49)	(579)	(1,142)	(1,002)	(1,300)	(675)	70	(415)	(964)	(1,045)	(2,622)
Asia	(7,178)	(7,884)	(9,024)	(9,664)	(10,111)	(10,705)	(11,319)	(12,142)	(12,717)	(13,427)	(14,843)	(17,540)
Oceania	1,225	1,458	1,906	1,980	1,953	1,925	1,882	1,785	1,940	1,970	2,175	1,635
Latin America	(148)	365	(45)	211	435	951	1,698	1,896	1,745	2,604	2,765	2,482
Africa	117	(102)	(115)	64	448	971	1,112	1,584	2,487	4,874	11,112	12,774
Middle East	5,832	7,117	8,105	9,613	10,385	15,889	20,443	22,747	24,581	26,405	27,387	27,672
Total(1)	(1,752)	1,647	357	(1,703)	2,297	7,811	13,669	15,991	16,848	19,594	22,495	16,404

Note (1): Beginning in 1980, these applies are available for additional market development.

August 1980, PURVIN & GERTZ., INC.

3) The world's major supply regions

The world's major LPG supply regions in the 1980's are the Middle East, Africa, South America and Oceania. (Canada is included in the North America region and belongs to the import area.)

(a) The Middle East

In the Middle East LPG is mainly recovered from associated gas with crude oil production. Particularly, Saudi Arabia is expected to implement its master gas plan, making an effective use of the gases, whose rates of use were hitherto low, and thus methane and ethane will be directed to fuel and petrochemical materials, propane and butane to LPG, C_5+ to exports in terms of naphtha. The exportable quantities from the Middle East are predicted by Purvin & Gertz as follows:

Table 3-5. LPG Exportable Quantities of Middle East

Unit: 1,000 tons

	Iran	Iraq	Saudi Arabia	Kuwait	Qatar	United Arab Emirates	Others	Total
1981	550	-	9,610	2,350	739	2,420	220	15,889
1982	1,160	130	12,500	2,340	748	3,350	215	20,443
1983	1,550	1,380	12,960	2,340	757	3,560	200	22,747
1984	1,700	2,635	13,260	2,330	746	3,720	190	24,581
1985	1,700	3,770	13,580	2,730	725	3,730	170	26,405
1987	1,700	3,530	14,950	2,720	682	3,640	160	27,382
1990	1,700	3,200	15,800	2,700	617	3,520	90	27,627

What was predicted by the American company is reasonable when viewed as a trend of a long period, while viewed as a trend of a short period, it ought to revise the exportable quantities as below because of the deteriorating crude oil production level and the influence of the Iran-Iraq war: 13,000,000 tons in 1981, 15,000,000 tons in 1982 and 17,700,000 tons in 1983.

(b) Africa

Africa is anticipated to become an LPG supply region to Europe in the future, of which Algeria, where it is expected to recover LPG from natural gas, will become a major supplier. Table 3-6 shows the exportable quantities of Africa.

Table 3-6. LPG Exportable Quantities of Africa

Unit: 1,000 tons

	Libya	Algeria	Nigeria	Others	Total
1981	390	901	117	(-)437	971
1982	385	927	144	(-)344	1,112
1983	515	1,183	151	(-)265	1,584
1984	540	2,049	148	(-)250	2,487
1985	630	4,355	144	(-)255	4,874
1987	610	8,322	2,535	(-)355	11,112
1990	625	8,960	3,719	(-)530	12,774

(c) South America

Until 1979 South America was an importing region except Venezuela, and as a whole South America belonged to the area of imports. However, in and after 1980 Mexico increased its oil production, becoming an LPG exporting country. In this way, South America may become an LPG supply region in and after 1982, with North America as its major market.

Exportable quantities of South America are as follows:

Table 3-7. LPG Exportable Quantities of South America

Unit: 1,000 tons

	Argentina	Brazil	Mexico	Venezuela	Others	Total
1981	(-)100	(-)90	458	863	(-)180	951
1982	50	30	787	981	(-)150	1,698
1983	90	(-)11	982	1,012	(-)175	1,898
1984	110	(-)41	920	986	(-)230	1,745
1985	130	(-)31	1,357	1,378	(-)230	2,604
1987	90	(-)20	1,754	1,211	(-)270	2,765
1990	100	(-)60	1,945	987	(-)490	2,482

(d). Oceania

Australia and Indonesia have an export supply power. Australia uses its LPG produced in refineries for domestic consumption, while LPG they recover from natural gas in the Bass Strait which started operation in 1970, is chiefly exported to Japan. In and after 1983 LPG amounting to about 300,000 tons/year will be recovered from natural gas at Cooper Basin in South Australia.

Indonesia is exporting mainly to Japan and USA about 300,000 tons of a refrigerated type a year from Ardjuna and about 150,000 tons of pressurized type from Santan, but their oil-field structure is deteriorating faster than that of the Middle East, and Indonesia's exportable quantity is inclined to decrease. However, Indonesia is studying to export 300,000 to 500,000 tons of the propane-butane-mixed pressurized LPG in and after 1984. But this has not yet definitely been decided on, and was excluded from the exportable quantities of Oceania.

Table 3-8. LPG Exportable Quantities of Oceania

Unit: 1,000 tons

	Australia	Indonesia	Total
1981	1,475	450	1,925
1982	1,442	440	1,882
1983	1,365	420	1,785
1984	1,530	410	1,940
1985	1,610	360	1,970
1987	1,890	285	2,175
1990	1,460	175	1,635

3.2 Trend of LPG Selling Price in Burma

3.2.1 For Domestic Demand in Burma

It being very difficult to forecast the selling price for the future, discussions were held with the Burmese side, deciding to adopt US$60 per ton, which corresponds to the current kerosene price for domestic use. Accordingly, LPG price from Mann and Syriam Refineries for export was fixed at US$60/ton too.

3.2.2 For Exports

LPG export price envisaged under the present project must be competitive with the international price, which is influenced by the price of LPG from the Middle East, world biggest export source, particularly by that of Saudi Arabia, greatest exporting country.

The changes in the posted prices of crude oil and LPG in and after 1973 in Saudi Arabia are as follows:

Table 3-9. Change in FOB Price of Crude Oil / LPG (Saudi Arabia)

Year	Month	FOB Price			FOB Price (US$/barrel)			FOB Price (US$/MMBTU)			Premium Value	
		Crude oil (US$/barrel)	Propane (US$/ton)	Butane (US$/ton)	Crude oil	Propane	Butane	Crude oil (A)	Propane (B)	Butane (C)	(B)/(A)	(C)/(A)
1973	Apr.	2.2	18.2	18.2	2.2	1.47	1.69	0.42	0.38	0.39	0.90	0.93
	Jul.	2.48	25.0	25.0	2.48	2.02	2.33	0.46	0.52	0.53	1.13	1.15
1974	Jan.	9.00	80.0	65.0	9.00	6.46	6.05	1.52	1.67	1.39	1.10	0.91
	Apr.	9.50	119.5	101.5	9.50	9.65	9.44	1.60	2.50	2.16	1.56	1.35
	Oct.	10.15	128.0	111.0	10.15	10.33	10.32	1.72	2.68	2.37	1.56	1.38
1977	Jul.	12.70	130.0	110.0	12.70	10.50	10.23	2.14	2.32	2.35	1.27	1.10
	Oct.	12.70	133.0	110.0	12.70	10.74	10.23	2.14	2.78	2.78	1.30	1.10
1978	Apr.	12.70	130.0	110.0	12.70	10.50	10.23	2.14	2.72	2.35	1.27	1.10
	Oct.	17.70	126.0	112.0	12.70	10.18	10.42	2.14	2.64	2.39	1.23	1.12
1979	Jan.	13.34	125.0	115.0	13.34	10.10	10.70	2.25	2.62	2.45	1.16	1.09
	Apr.	14.55	123.0	125.0	14.55	9.92	11.63	2.45	2.57	2.67	1.05	1.09
	Jul.	18.00	160.0	180.0	18.00	12.71	16.74	3.04	3.35	3.84	1.10	1.26
	Aug.	18.00	185.0	215.0	18.00	14.94	20.00	3.04	3.87	4.58	1.27	1.51
	Sept.	18.00	200.0	230.0	18.00	16.15	21.35	3.04	4.18	4.90	1.38	1.61
	Oct.	18.00	210.0	250.0	18.00	16.16	23.25	3.04	4.30	5.33	1.44	1.75
	Nov.	24.00	220.0	275.0	24.00	17.77	25.58	4.05	4.60	5.86	1.14	1.45
	Dec.	24.00	240.0	290.0	24.00	19.32	26.57	4.05	5.02	6.18	1.24	1.53
1980	Jan.	26.00	275.0	330.0	26.00	22.30	30.43	4.38	5.75	7.07	1.31	1.61
	Apr.	28.00	300.0	325.0	28.00	24.33	30.23	4.72	6.30	6.94	1.33	1.47
	May	28.00	315.0	325.0	28.00	25.44	30.23	4.72	6.62	6.94	1.40	1.43
	Jun.	28.00	315.0	370.0	28.00	25.44	29.76	4.72	6.62	6.82	1.40	1.45
	Jul.	28.00	315.0	310.0	28.00	25.44	28.83	4.72	6.02	6.63	1.40	1.40
	Aug.	30.00	315.0	300.0	30.00	25.44	27.80	5.06	6.62	6.41	1.31	1.27
	Sept.	30.00	315.0	295.0	30.00	25.44	27.44	5.06	6.62	6.31	1.31	1.25
	Oct.	30.00	305.0	290.0	30.00	24.63	26.93	5.06	6.41	6.19	1.27	1.22
	Nov.	32.00	305.0	290.0	32.00	24.03	26.97	5.40	6.41	6.19	1.19	1.15
	Dec.	32.00	305.0	295.0	32.00	24.62	27.44	5.40	6.41	6.30	1.19	1.19
1981	Feb.	32.00	305.0	298.0	32.00	24.63	27.72	5.40	6.41	6.36	1.19	1.18
	Apr.	32.00	300.0	298.0	32.00	24.23	27.74	5.40	6.30	6.36	1.17	1.18
	May	32.00	275.0	295.0	32.00	23.83	27.44	5.40	6.20	6.30	1.15	1.17
	May (19)	32.00	255.0	255.0	32.00	20.59	23.72	5.40	5.36	5.45	0.88	1.01
	Oct.	34.00	255.0	255.0	34.00	20.59	23.72	5.72	5.36	5.45	0.94	0.95

It is difficult to forecast the future prices of crude oil and LPG. The price correlation between crude oil and LPG was shown in the above table. Although there was a change in the international price, there existed a premium value of LPG against crude oil. Since LPG supply power has risen worldwide centering around the Middle East, crude oil and LPG may posssibly move on in parity for FOB Middle East in terms of heating value during the next several years. (Unless a change occurs in the world's energy situation caused by a war or some other political reasons.)

With this price level, it may be possible to develop LPG demand as was already mentioned.

Because of the difficulty of foreseeing the international price, it is also difficult to foresee the export price of Burmese LPG. And as a result of discussions with the Burmese side, it was decided to examine the present project on the basis of the current international price, that is US$255/ton, FOB Arabian Gulf.

1) Tanker freight

i) Burmese LPG is to be exported in pressurized form, and as was mentioned in 2-3-2, the construction of a 1,000-ton high pressure tanker is anticipated to be completed in 1984 for a long-term service; and on the basis of this and other factors, the freight rate from Rangoon to each supposed destination was calculated.
(The factors taken into consideration in determining the freight rate of a high-pressure tanker.)

A) Hire cost

Annual cost (average for five years)	¥396,946,000
(Construction cost (to be completed in 1984)	¥1,000,000,000)
(a) Depreciation Salvage value 10% Amount fixed for 11 years	¥81,818,000

(b)	Interest on repayment Payable in 10 years Rate 10%	¥75,000,000
(c)	Insurance Japanese crew Insured for ¥1,000,000,000	¥11,117,000
(d)	Fixed property tax Salvage value x ½ x 14/1,000	¥5,855,000
(e)	Crew wages 15 men ¥734,339/man/month 5% up each year	¥146,077,000
(f)	Repair & maintenance Inspections and fixing of repairng expenses for the first and fourth year 5% up per annum in and after the fifth year	¥17,739,000
(g)	Administration costs ¥15,000,000 for the first year 5% up per annum after that	¥16,577,000
(h)	Ships store ¥4,000,000 for the first year 7% up per annum after that	¥4,601,000
(i)	Lubricating oil ¥6,600,000 for the first year 5% up per annum after that	¥7,294,000
(j)	Miscellaneous expenses ¥3,500,000 for the first year 5% up per annum after that	¥3,868,000

B) Running cost

(a) Speed 12.5 knots hour

(b) Fuel MOD US$340/ton
CFO US$230/ton

Consumption

Navigation	CFO	8.0 tons/day
Anchor	MDO	0.6 ton/day
Cargo	MDO	2.0 tons/day

(c) Port expenses

Rangoon	US$5,000/navigation
Manila	US$4,000/navigation
Singapore	US$5,000/navigation
Pusan	US$3,500/navigation
Hongkong	US$4,000/navigation
Bangkok	US$3,500/navigation
Kaoshsiung	US$3,500/navigation
Yokohama	US$4,000/navigation

(d) Works

Loading	Two days
Unloading	One day

Table 3-10. Freight by supposed Destinations

Exchange Rate: ¥231/US$

Destinations	Distance (mile)	Freight (US$/ton)
Singapore	1,120	76.69
Bangkok	1,964	112.64
Manila	2,463	135.23
Hongkong	2,546	139.12
Kaoshiung	2,745	147.28
Pusan	3,631	185.96
Yokohama	4,025	203.51

ii) Transportation cost by a refrigerated tanker from Ras Tanura in Middle East to Japan was calculated this way: The current freight of an LPG tanker from Kuwait to Japan is US$34/ton (75,000 m^3 type). Taking a 4% annual rise into account, the freight between Ras Tanura and Japan in 1985 was estimated at US$40/ton. As regards other destinations, calculation was made simply by using a ratio between the base rate of the world scale (which is effective from July 1 to December 31, 1981) from Ras Tanura to Japan and the base rate from the Middle East to each destination. Of course the type of a ship may change depending upon a destination, which causes a change also in freight. The effect of such a change, however, was omitted from the calculation.

Table 3-11. Freight from Middle East to Destinations

Route	World Scale Base Rate (US$/ton)	Freight (US$/ton)
Ras Tanura – Japan	19.04	40
Ras Tanura – Yoesu	17.64	37
Ras Tanura – Kaoshiung	15.59	33
Ras Tanura – Manila	14.40	30

2) FOB price Rangoon

In case Burmese C&F price at its destination is equal to the Middle East's LPG price payable at an import terminal of the same destination, the Burmese price will become competitive. On this assumption, FOB price Rangoon was estimated for each destination as follows:

Table 3-12. Estimated LPG Price (FOB) in Rangoon

Unit: US$/ton

		Japan (Yokohama)	Korea (Yoesu)	Taiwan (Kaoshiung)	Philippines (Manila)
Estimated cost of Middle East LPG	Ras Tanura FOB	255	255	255	255
	Refrigerated tanker freight	40	37	33	30
	Estimated terminal cost	30	30	30	30
	Total	325	322	318	315
High pressure tanker freight from Rangoon		203.51	185.96	147.28	135.23
FOB price Rangoon		121.49	136.04	170.72	179.77

As result of the above calculation and on the basis of discussions with the Burmese side, the LPG FOB Rangoon price was adopted the mean price of supposed destinations from the convenience of calculation, and fixed US$170/ton as FOB price Rangoon in the present feasibility study. The Philippines and Taiwan are of course the destinations supposed only for calculation and not actual destinations.

The current market price in Southeast Asia is estimated at US$330 to 350/ton in terms of C&F at each destination. If calculation is made with the above freight of a high-pressure tanker from Rangoon, it may be able to anticipate such a price level as US$260 for Singapore and US$200/ton for Hongkong.

3.3 Future Prospects of Burmese LPG

3.3.1 Quality Improvement of Burmese LPG

Of the LPG, in the present project, the one to be produced in a coker plant contains 15 to 20% unsaturated things such as propylene and butylene, which Syriam is supposed to eliminate by a de-olefinizer and Mann with hydrogenation by a smoke-point improver, before the export.

LPG containing such an unsaturated thing as olefin will pose no problem depending on its use, but for the reasons cited below, its marketability is limited; and in order to secure a stabilized sales and profits, it may be necessary to have the whole LPG saturated.

1) LPG sold in international trade is chiefly the one recovered from natural gas or crude oil associated gas. They do not contain olefin.

2) The use of LPG containing olefin is restricted depending on purposes. (For instance, as raw material for making ethylene.)

3) Even for simple combustion, that kind of LPG is not welcomed in the trade from the point of combustion.

4) A secondary import terminal and a filling station have no special tank for such LPG that contains olefin.

3.3.2 Handling of High-Pressure LPG

The end use of LPG is in high-pressure gas. As LPG is dealt with in large quantities in the present international trade, it is mostly of a refrigerated type (propane: about -43°C, and butane: about -4°C).

The most important point in LPG trade and transportation is the cost of transportation. When LPG is transported under high pressure, its quantity is limited, which incurs a high cost and is not economical for a long-distance trade. However, the advancement in refrigerating technique and improvement in metals and the 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 terminal, and after converting it into high-pressure LPG, they transport it to their secondary terminal or send it by pipeline. 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 where they demand relatively a little from the point of transportation cost and of receiving facilities.

Also, the high-pressure-type LPG receiving tank at the terminal is small in capacity. In Japan either, there is no secondary terminal where they can receive more than 1,000 tons of LPG per lot, except the terminals of some limited consumers. Therefore, in examining the present project, shipping of 1,000 tons/lot must be considered as a basis, and such a capacity high-pressure tanker be used in principle for transportation.

3.3.3 Future Prospects of Burmese LPG Export

1) Present LPG demand in Asia and its forecast

LPG of the present project being of a 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 3.1.3 (1) on the present LPG demand and supply in the world, Asia is a region where they import as a whole 60% 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 1980, estimated for major LPG consuming countries but Japan.

Table 3-13. Actual Demand (1980) in Destinations

Unit: 1,000 tons

	Demand	Domestic Production	Import (Export)
Taiwan	610	460	150
Korea	380	320	60
Hongkong	120	-	120
Thailand	200	130	70
Philippines	240	180	60
Singapore	60	220	(160)
Malaysia	100	70	30
Total	1,710	1,380	330

Based on Purvin & Gertz's forecast of LPG demand and supply in those countries for 1985, the following estimation was made:

Table 3-14. Future Demand (1985) in Destinations

Unit: 1,000 tons

	Demand	Domestic Production	Import (Export)
Taiwan	1,150	740	410
Korea	1,050	880	170
Hongkong	199		199
Thailand	453	658	(205)
Philippines	350	240	110
Singapore	85	305	(220)
Malaysia	150	470	(320)
Total	3,437	3,293	144

As is shown above, Thailand and Malaysia will become exporting countries as they are scheduled to start recovering of LPG from natural gas.

Thailand:

Natural gas in the Gulf of Siam, which had been being developed by Union Oil of Thailand, Mitsui Oil Exoloration Co., South East Petroleum Exploration Co. and Taxes Pacific, started its commercial production in 1981. Petroleum Authority of Thailand (PTT) is now pushing on an LPG recovering project, utilizing that natural gas. When the project goes smoothly, PTT will come to export LPG toward the end of 1984. According to PTT's plan, it is possible for them to export 205,000 tons in 1985, but as their estimate of domestic demand is thought too large, their export power will increase more than that figure.

Malaysia:

With the export of LNG in Bintulu, LPG will also come to be extracted and recovered beginning in 1984, and about 300,000 tons will be exported a year. In addition, Malaysia is studying to recover 200,000 tons of LPG from natural gas in Trengganu and to export it as a high-pressure type.

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, a 15,000-ton refrigerating tank is under construction in Taiwan, which is expected to start operation toward the end of 1981. Also, Korea is building an import terminal having a 240,000-ton underground-type refrigerating tank at Yoesu, which is scheduled to commence operation in the beginning of 1983. Further, in the Philippines Shell has a plan to construct a 45,000-ton refrigerating import terminal at Manila, which is anticipated to be completed toward the end of 1983.

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.

3) LPG marketing by Burma

When the various situations described above are taken into account, it is necessary for Burma to make further efforts regarding LPG marketing in order to make stabilized exports of the projected LPG with high price.

(i) LPG is enjoying a stabilized demand in people's livelihood and is also expected to expand its demand in other fields as energy, substituting crude oil and other petroleum products.

(ii) Unlike crude oil, LPG has no great difference in quality by producing center. In view of this, if Burma ignores the price fluctuation to be caused by short-term, spot purchases and take a reasonable sales policy maintaining its international competitive price, Burma will succeed in its marketing.

As was mentioned repeatedly, when the quantity and type of the projected LPG are considered, its profitability will be affected by how LPG is exported to countries requiring a little transportation cost; and marketing should be studied by giving consideration to that point. For that reason, the survey team would like to give the following advice on marketing:

a) Marketing should be started immediately after deciding to execute the project.

b) In this case, importance is attached to energetic negotiations with consumers in the neighboring countries like Singapore, the Philippines and Hongkong.

c) Avoid a short-term, spot trade and make efforts to conclude long-term contracts (three to five years) according to a reasonable price formality.

Although it may be a mere idea at this moment, Burma can consider the sales of LPG as chemical materials to PCS (Petro-Chemical of Singapore) which is scheduled to start operation in autumn, 1982.

Note: Regarding the prospects of demand and supply in Asia for 1985, nothing was mentioned in 3.3.3, but it may be possible to anticipate a demand for LPG in Singapore as raw material.

The ethylene plant (300,000 tons/year) a joint venture of Singapore and Japan, is expected to commence operation in autumn, 1982. They have a plan to utilize naphtha and LPG as raw materials from 1984, consuming 700,000 to 800,000 tons of naphtha and 200,000 to 300,000 tons of LPG a year. When this plan is carried out as is scheduled Singapore may convert from an LPG exporting country to an importing country, though the quantity may be small. They also seem to adopt a high-pressure type tank.

3.4 Demand and Price of By-products

3.4.1 Gasoline Materials, By-Products

The outputs of motor gasoline, kerosene and gas oil as well as crude oil during the five years from 1976 to 1980 in Burma are shown in Table 3-15. The Petroleum products are all consumed within the country and no crude oil or petroleum products are imported.

As Table 3-15 clearly indicates, the production of crude oil has increased 18% in the five years, while gasoline 19% and gas oil 25%, each of these two showing a more increase than crude oil. For this reason, the production pattern of oil refineries has changed, resulting in the decrease of kerosene in its yield and output. This shows that kerosene users have switched to other sources of energy.

Table 3-15. Output of Petroleum Products and Crude Oil

	Gasoline	Kerosene	Gas oil	Crude oil
	Unit 10^3 T/Y	10^3 T/Y	10^3 T/Y	10^3 T/Y
1976	200	127	279	8,584
1977	213	160	313	9,555
1978	216	84	326	9,998
1979	239	72	364	11,017
1980	238	42	348	10,109

A gasoline supply plan is shown in Table 3-16, which says that motor gasoline is anticipated to increase by 79% in the five years from 1981 to 1985 and to export gasoline from 1983. This may be due to the commencement of operation at Mann Refinery from 1982, increasing the output of gasoline.

Table 3-16. Gasoline Supply Plan

	For Domestic Use	Export
	Unit 10^3 T/Y	10^3 T/Y
1981	240	-
1982	268	-
1983	377	98
1984	403	113
1985	430	130

Accordingly, gasoline component produced as by-products at Mann GOCS LPG extraction plant will find it difficult to get a market within the country and will possibly be destined for export.

In Burma the market price of gasoline is 3.50 kyat/IG (about ¥23/ℓ) and the ex-factory price is 1.50 kyat/IG (about ¥10/ℓ). In case of exports, it is difficult to evaluate it as gasoline because of octane number, and is evaluated as naphtha.

US$295/ton, which remains after deducting the transportation cost of from Mann GOCS to Singapore via Rangoon out of the market price of US$519/ton in Singapore, will be fixed as the ex-factory price.

3.4.2 Lean Gas

Lean gas means the gas that remain after removing the residues heavier than LPG out of the associated gas from oil fields. Methane and ethane are principal ingredients of lean gas, which can be used for the same purposes as natural gas. Lean gas coming out of Mann GOCS LPG extraction plant as a by-product can be used in place of associated gas as it is. Practically, lean gas will be handed over to MOC at the battery limit of the LPG extraction plant, and will be used for the purposes described in Chapter 2.2.2 or will be sold. The delivered price of lean gas is 1.05 kyat/1,000 SCF, the same with the purchase price of associated gas.

Chapter 4.

BASIC PLAN FOR LPG RECOVERY FACILITIES

Chapter 4. BASIC PLAN FOR LPG RECOVERY FACILITIES

4.1 Outline of LPG Recovery Facilities

The facilities plan for Phase I – Part 2 and Phase II in 'Integrated LPG Project of Burma' is as shown in the following table.

Table 4-1. Outline of LPG Recovery Facilities

Phase	Facilities Plan	
	Facilities	Outline of Facilities
Phase I – Part 2	Syriam Terminal	(1) Jetties for river barges (existing jetties to be used), spherical LPG tanks, LPG pipelines and ancillary facilities are to be provided as LPG collection facilities for receiving LPG from Mann Terminal, Syriam Refinery and natural gas field LPG Extraction Plants. (2) Jetties for LPG oceantanker (existing jetties to be used), shipping pumps and LPG pipelines are to be provided as LPG shipping (export) facilities.
	Mann 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 use), 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) A pipeline is to be provided for pumping LPG to Mann Terminal.

4.2 Determining the Scale of LPG Recovery Facilities

4.2.1 Syriam LPG Receiving, Storing and Shipping Facilities

1) Factors influencing the terminal scale

In general, the following factors will have to be studied when determining the scale of the terminal:

- o Volume of LPG handled
- o Schedule for LPG receiving and shipping

(a) Volume of LPG handled

The volume of LPG handled will be a vital criterion for determining the scale of the terminal.

The basic plan is to carry out Integrated LPG Project in the stages of Phase I to Phase III. Accordingly, the volume of LPG handled at the Syriam Terminal, which is the LPG Export Terminal, will increase as the project proceeds. In this respect, determining Syriam Terminal's ultimate designed LPG handling volume as of the completion of Phase III of the project shown in Table 4.2 is conceived to be the most advantageous policy from the economic standpoint owing to the following reasons:

- o From the aspects of safety, it is undesirable to erect the new LPG tanks at the Terminal which has been under operation.

- o Ancillary equipments other than the terminal tanks can generally be installed without being influenced by the total volume of LPG handled. Constructing only the tanks in stages will rather increase their costs.

Table 4-2. Syriam Terminal's Ultimate Designed 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	8,000	8,000	-
Phase I – Part 2	Mann Refinery	18,000	15,000	3,000
Phase II	Mann GOCS LPG Extraction Plant	30,000	30,000	-
Phase III	Natural Gas LPG Extraction Plants	25,000	25,000	-
	Total	81,000	78,000	3,000
Syriam Terminal's ultimate designed LPG handling volume		78,000 T/Y		

(b) LPG receiving and shipping schedule

The LPG receiving and shipping schedule will be a most vital factor determining the scale of Syriam Terminal.

The LPG receiving and shipping schedule is drafted on the basis of the following considerations:

- o Dispersion of LPG receiving and shipping in order to prevent over-concentration.
- o Maintain the allowance of tank storage capacity.
- o Containment of the frequency of use of jetties for LPG receiving and shipping within the practical range of operation of these jetties.

o Extension of due thought to decreases in terminal capacity by factors such as the maintenance needs of tanks and other facilities.

2) Determination of terminal scale

The scale shown in Table 4-3 is conceived optimum for Syriam Terminal as a result of careful study of related scale determinants:

Table 4-3. Scale of Syriam Terminal

Item	Scale of Terminal	Remarks
1. LPG handling volume	C_3 LPG: 25,570 T/Y C_4 LPG: 52,430 T/Y Total 78,000	
2. Tank capacity	C_3 LPG: 1,000 m^3 x 4 C_4 LPG: 1,000 m^3 x 1 2,000 m^3 x 3	Storage capacity equivalent to 20 days
3. Shipping pump capacity	C_3 LPG: 150 m^3/h x 3 C_4 LPG: 150 m^3/h x 3	Loading into ocean tankers is to be done in the daytime (within 7 hrs.)

3) LPG receiving and shipping schedule

The designed LPG receiving and shipping schedule of Syriam Terminal is as shown in Tables 4-5, 4-6, 4-7 and 4-8.

The schedule was drafted on the basis of the following conditions:

(a) Receiving of LPG from river barges and unloading of LPG into LPG ocean tankers will not be carried out simultaneously as is a critical condition.

(b) LPG ocean tanker will have a loading capacity of 1,000 tons, and C_3, C_4 LPG are to be loaded into these tankers separately.

(c) Jetties for use by river barges and by LPG ocean tankers are to be available for 20 times/month, respectively, in accordance with the conditions stipulated by the Burmese side.

As a result, the mean stock as well as receiving tolerances of the C_3 and C_4 LPG tanks will be as shown in Table 4-4 and the terminal scale indicated earlier is conceived to be the most appropriate in view of the terminal's operation schedule.

Table 4-4. 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	25,570 T/Y	77.5 T/D	1,730 T	580 T (15 days' equivalent)	1,290 T (6 days' equivalent)
C_4 LPG Tank	52,430 T	159.0 T	3,500 T	990 T (15 days' equivalent)	1,920 T (10 days' equivalent)

4.2.2 Mann LPG Receiving, Storing and Shipping Facilities

1) Determination of terminal scale

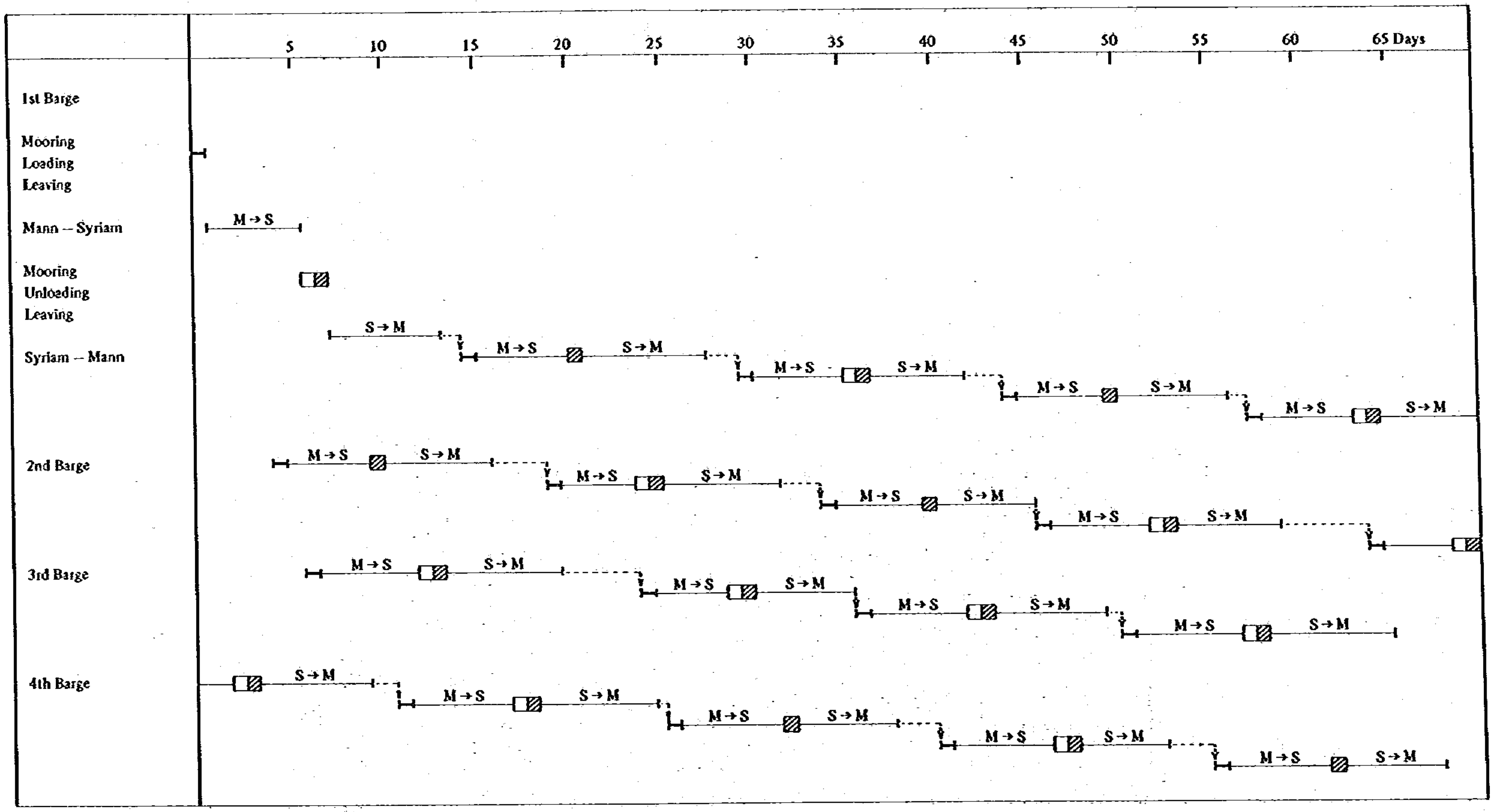
A study of the scale determinants in the same manner as with Syriam Terminal led to the conclusion that the scale shown in Table 4-9 will be the most optimum for Mann Terminal.

Table 4-5. LPG Receiving and Shipping Conditions of Syriam Terminal

LPG Transportation Method	LPG Receiving and Shipping Volume			Transportation Speed	Volume/Shipment	Mean Transportation Frequency	Longest LPG Receiving and Shipping Interval	Remarks
	C_3 or C_4	T/Y	T/D (mean)					
Pipeline Transportation Syriam Refinery – Terminal	C_3 C_4 Sub-total	2,670 5,330 8,000	8.1 16.2 24.3	20 m^3/H (C_3: 9.6 T/H C_4: 11.1 T/H)	C_3: 60 T C_4: 115 T	C_3, C_4 both once/ 7 days	7 days (in view of tank stock of Syriam Refinery)	Refer to Tables 4-5 & 4-6.
River Barge Transportation a. Mann Terminal – Terminal	(Mann Refinery) C_3 C_4 Sub-total	 3,000 12,000 15,000	 9.1 36.4 45.5	13 days/voyage	500 tons/ship	9.2 ships/month	10 days (in view of tank stock of Mann Terminal	
	(Man GOCS) C_3 C_4 Sub-total	 11,200 18,800 30,000	 33.9 57.0 90.9					
b. Gas Fields – Terminal (Phase III)	C_3 C_4 Sub-total	8,700 16,300 25,000	26.4 49.4 75.8	(——)	500 tons/ship	4.6 ships/month	(10 days)	Figure in ( ) indicated estimated value.

Export of LPG	C_3 or C_4	Export Volume	Navigation Schedule	Tanker Capacity	Shipping Frequency	Remarks
Syriam Terminal – Export	C_3 C_4	25,570 T/Y 52,430 T/Y	Mean 25 days/voyage	1,000 tons	Mean 7.1 ships/month	

Table 4-6. River Barge Schedule



Note: 1. Required time between Mann and Syriam
In dry season (Nov./Apr.)
to Syriam 5 days
to Mann 6 days
In rainy season (May/Oct.)
to Syriam 4 days
to Mann 6 days

2.
Loading to Barge
Sailing
C_3 LPG Unloading to Syriam Terminal
C_4 LPG Unloading to Syriam Terminal

Table 4-7. C_3 LPG Receiving and Shipping Schedule of Syriam Terminal

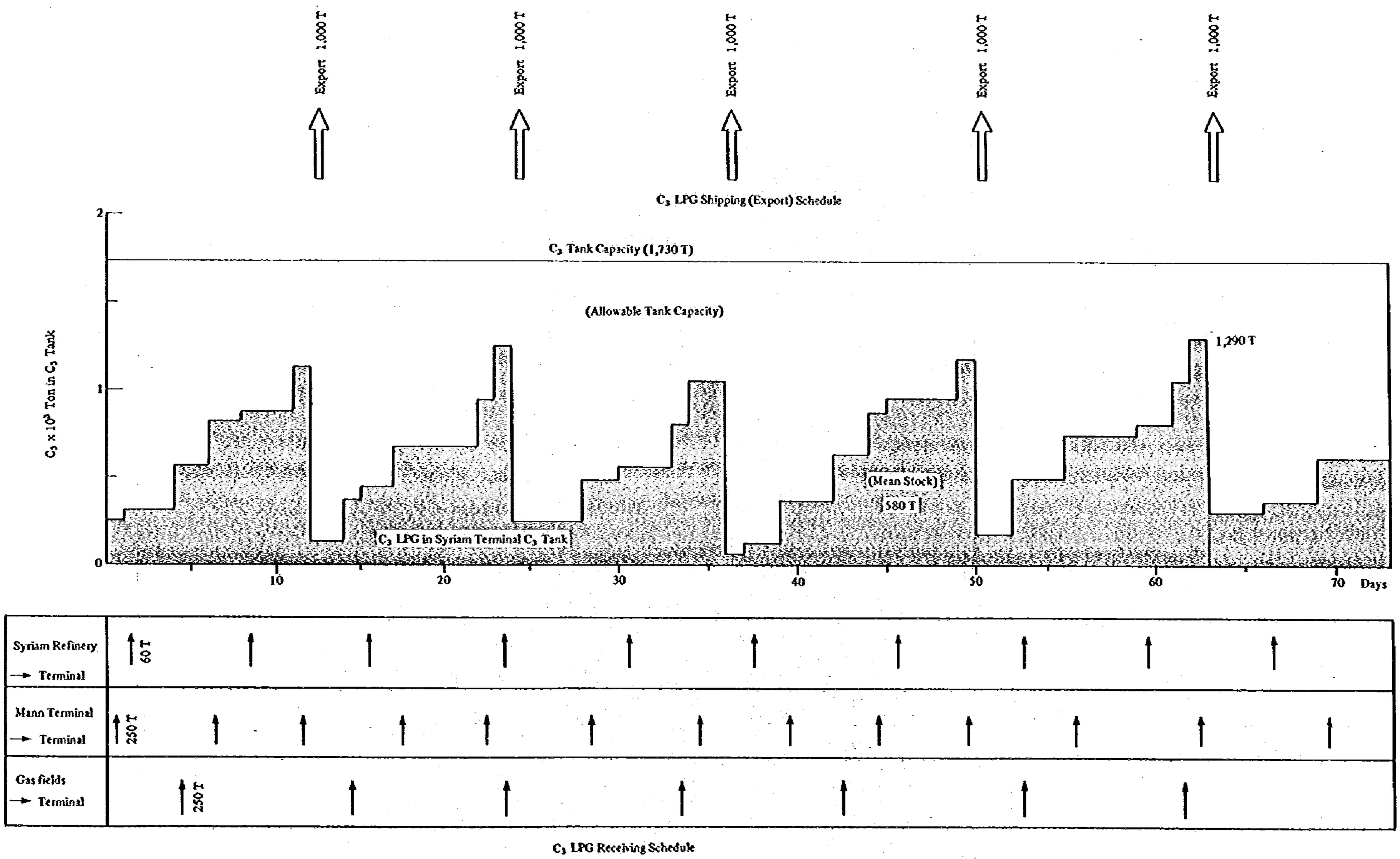
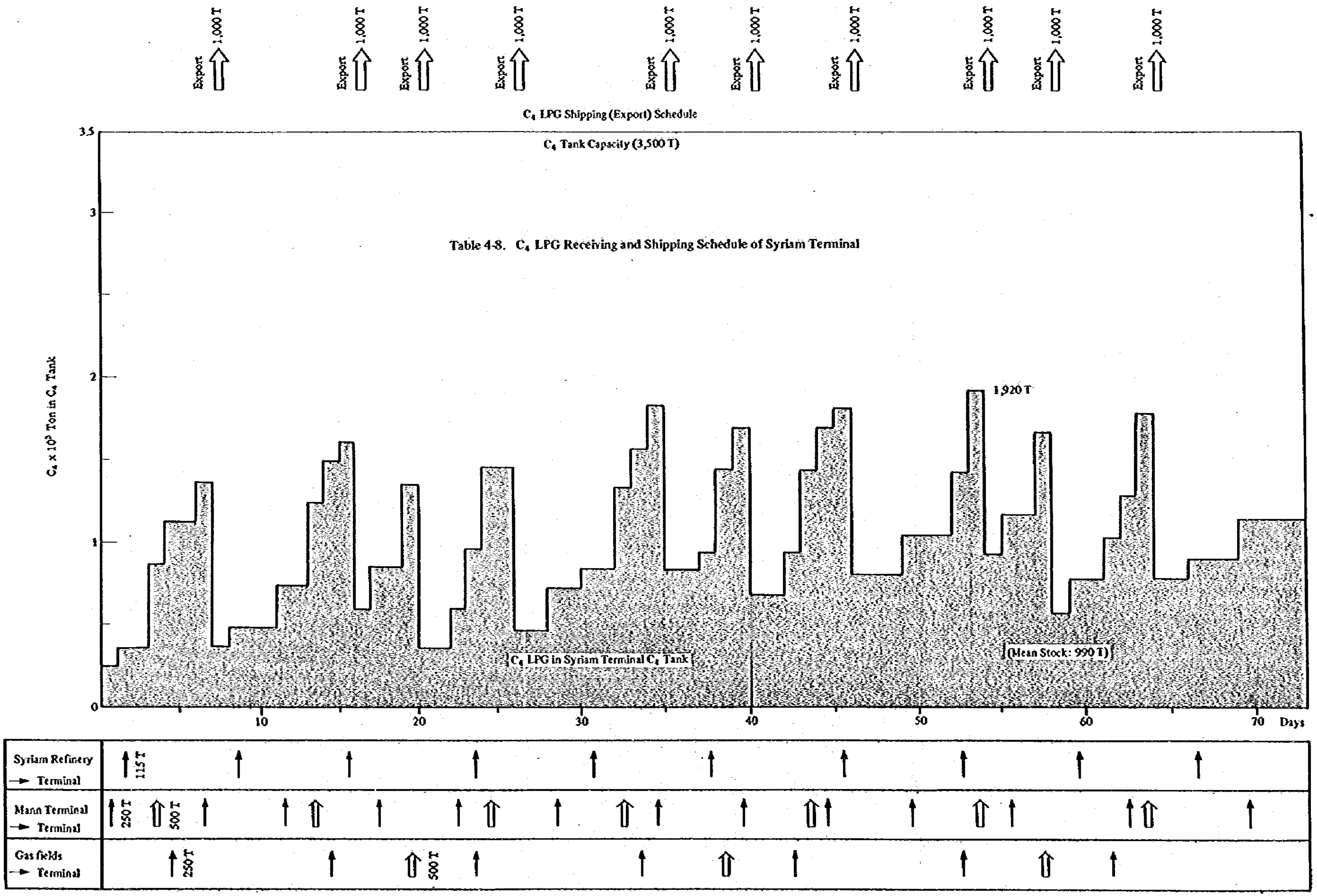


Table 4-8. C_4 LPG Receiving and Shipping Schedule of Syriam Terminal



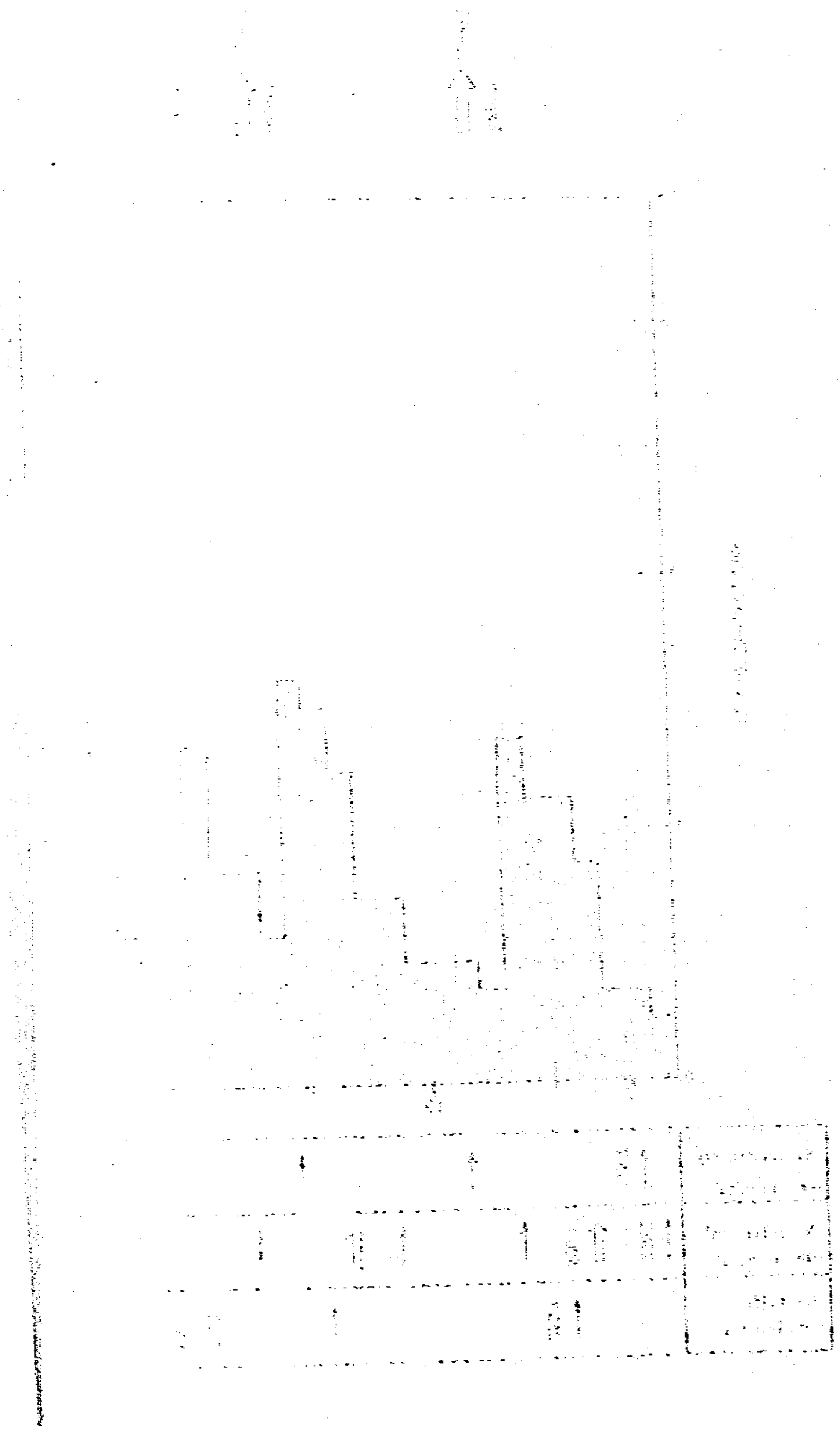


Table 4-9. Scale of Mann Terminal

Item	Scale of Terminal	Remarks
1. LPG handling volume	C_3 LPG: 14,200 T/Y C_4 LPG: 30,800 T/Y Total 45,000 T/Y	
2. Tank capacity	C_3 LPG: 800 m^3 x 2 units C_4 LPG: 1,000 m^3 x 1 2,000 m^3 x 1	Storage capacity equivalent to 15 days
3. Shipping pump	C_3 LPG: 100 m^3/h x 3 units C_4 LPG: 100 m^3/h x 3	Loading into river barges to be done in the daytime (within 7 hrs).

2) LPG receiving and shipping schedule

The designed schedule for LPG receiving and shipping of Mann Terminal will be shown in Tables 4-11 and 4-12.

The condition of use of LPG tanks in conformance with this schedule is shown in Table 4-10, leading to the conclusion that the scale determined earlier for Mann Terminal is appropriate.

Table 4-10. Condition of Use of Tanks at Mann Terminal

Tank	LPG Handling Volume		Tank Capacity	Mean Stock (Receiving tolerance)	Maximum Stock (Receiving tolerance)
	Annual	Daily Mean			
C_3 LPG Tank	14,200 T/Y	43.0 T/D	690 T	170 T (12 days' equivalent)	370 T (7 days' equivalent)
C_4 LPG Tank	30,800 T/Y	93.4 T/D	1,500 T	550 T (10 days' equivalent)	1,000 T (6 days' equivalent)

Table 4-11. C_3 LPG Receiving and Shipping Schedule of Mann Terminal

Note: While batch transfer of LPG from GOCS to Mann Terminal is being considered as the critical conditions in view of the LPG receiving and shipping schedule, LPG is actually to be continuously by transported pipeline. The same method is applied to the LPG receiving and shipping schedule.

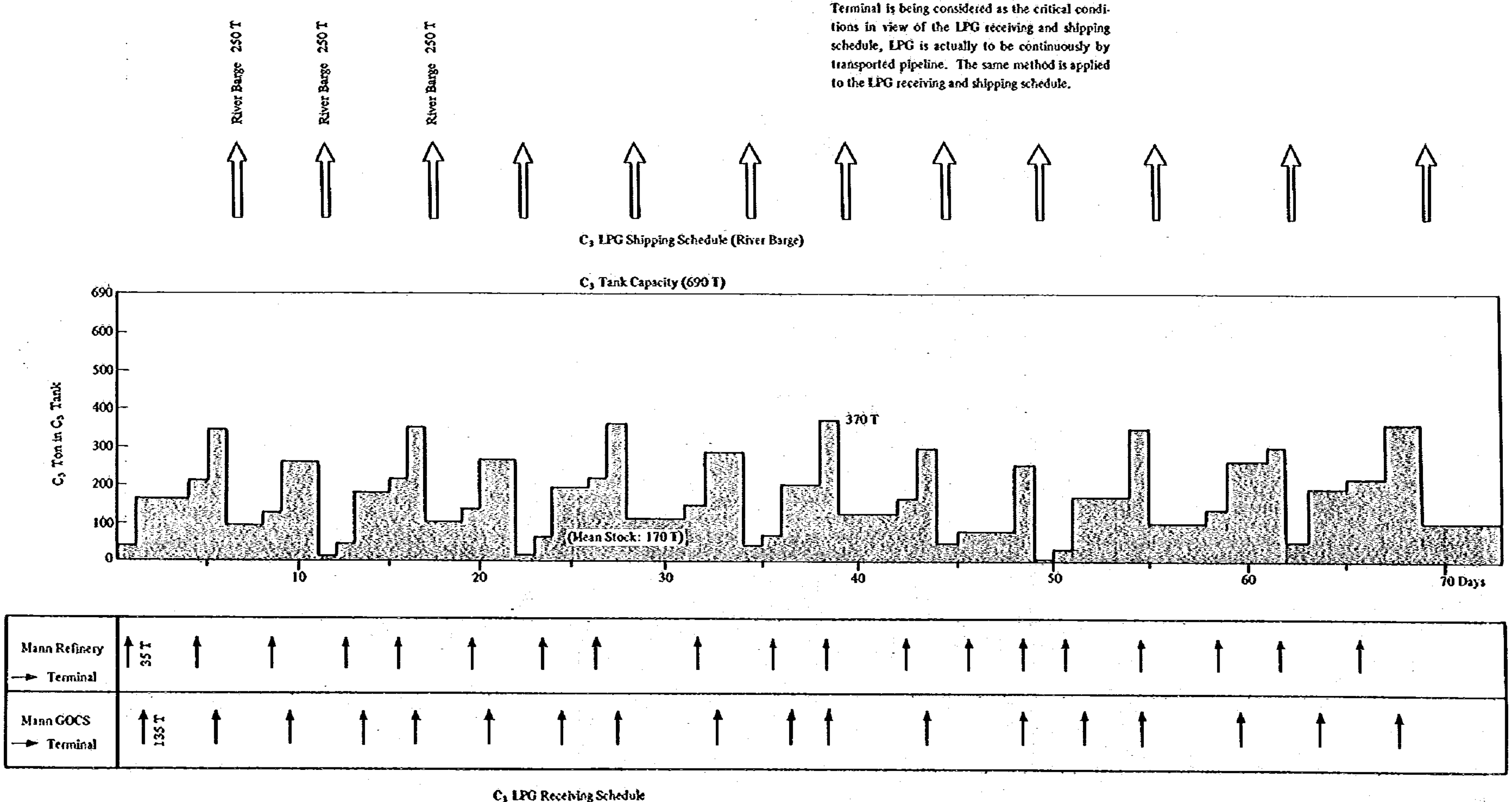
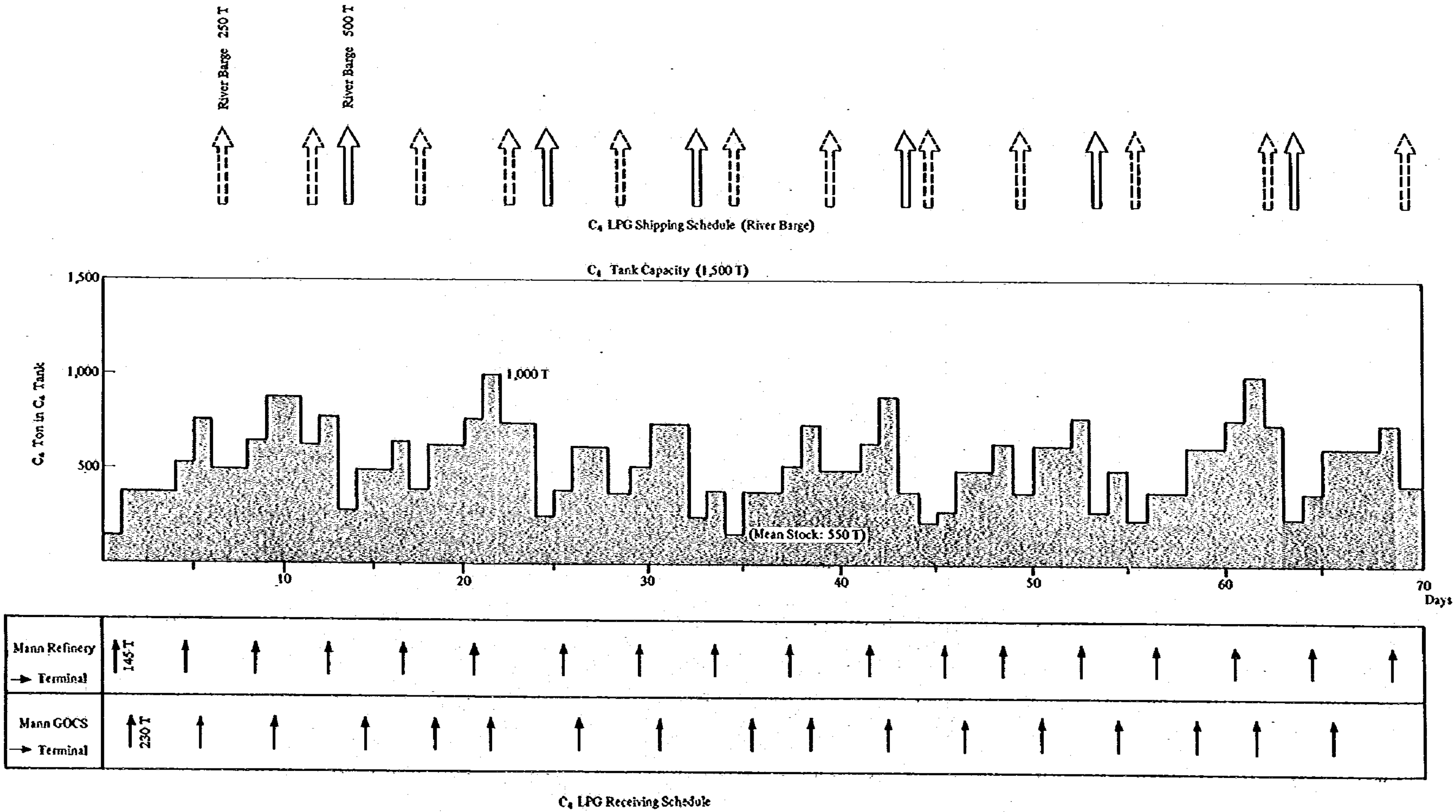
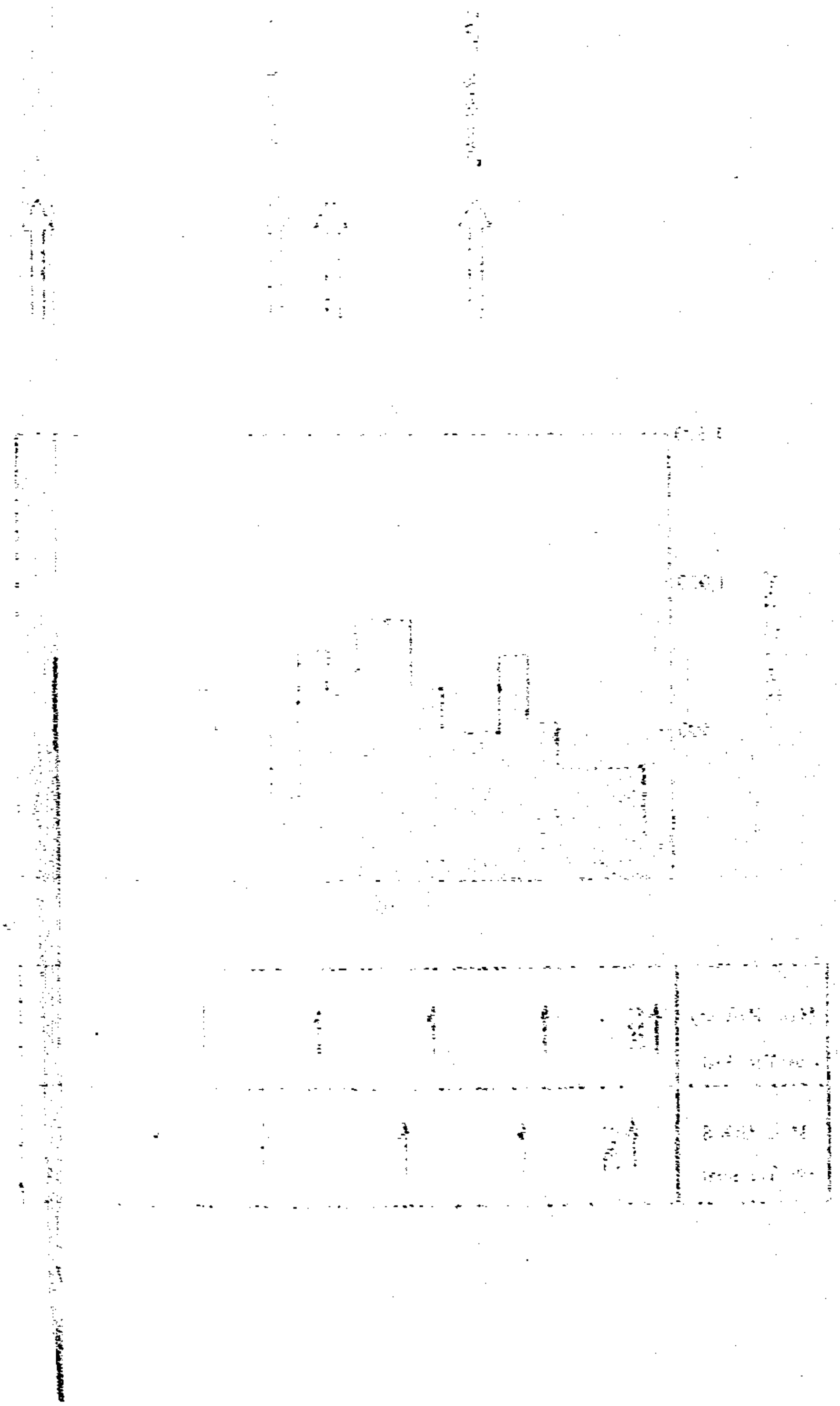


Table 4-12. C_4 LPG Receiving and Shipping Schedule of Mann Terminal





4.2.3 Transportation of Product LPG

1) In this project, LPG is produced at the following four places:

(1) Syriam Refinery (8,000 tons/yr)
(2) Mann Refinery (18,000 tons/yr)
(3) Mann GOCS LPG Extraction Plant (30,000 tons/yr)
(4) Natural Gas Field LPG Extraction Plants (25,000 tons/yr)

With the exception of 3,000 tons/yr of LPG earmarked for domestic use, 78,000 tons/yr of LPG are to be exported at the stage of completion of Phase III of this project.

2) In connection with LPG transportation, the adoption of the LPG transportation system indicated in Fig. 4-1 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) As for the transportation capacity of the river barges used for LPG transportation from Mann Terminal to Syriam Terminal, the following plan is regarded as the most suitable, in accordance with the study of the river barge operation schedule in Item (3), Section 4.2.1:

- o Loading capacity per barge: 250 tons x 2
- o Number of barges: 4 barges

4.2.4 Mann GOCS LPG Extraction Plant

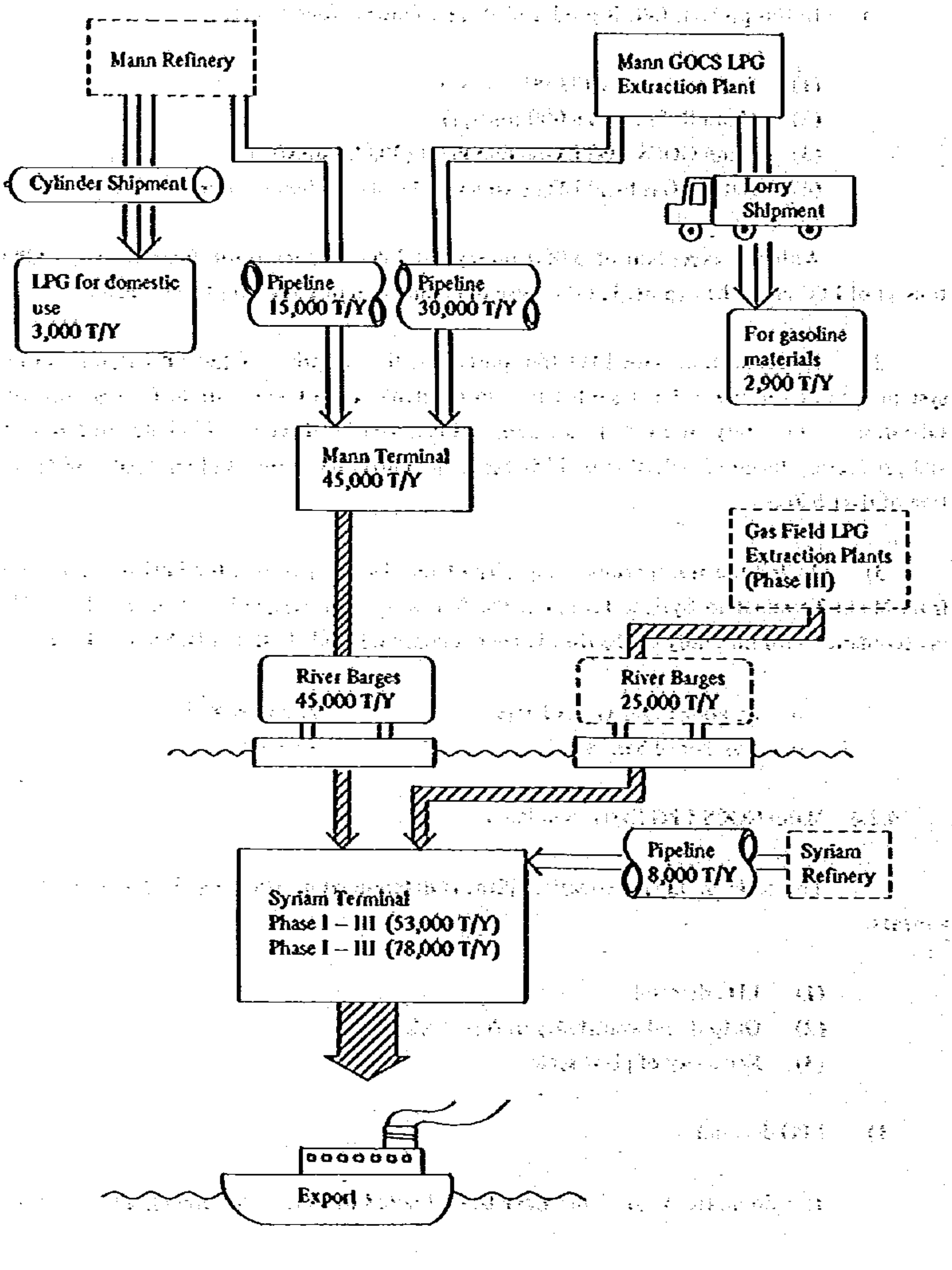
The scale of LPG Extraction Plant is determined by studying the following determinants:

(1) LPG demand
(2) Output and availability of feedstock gas
(3) Economy of plant scale

1) LPG demand

The domestic demand for LPG being limited in Burma, the LPG Extraction Plant

Fig. 4-1. LPG Transportation System



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 feedstock gas

The present output and volume of use of associated gas at Mann GOCS are approximately 26 x 10^6 SCFD as pointed out in Section 2.2. Almost the entire volume of associated gas that is being used presently will be usable as feestock gas by this LPG Extraction Plant upon completion of LPG extraction facilities.

3) Economy of plant scale

Normally, the construction costs of 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.

Item 1) and 3) 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 feedstock gas available as indicated in Item 2). Accordingly, the plant scale of 24 x 10^6 SCFD based on feedstock gas is determined by making allowances for some fluctuation in the present output of associated gas. Specifically, by calculating the LPG output from the composition of Mann GOCS associated gas, we get an annual production level of roughly 30,000 tons.

4.3 Selection of Plant Sites

In selecting the sites for LPG Terminals and LPG Extraction Plant, the following factors were studied carefully and the sites judged most advantageous for this project were selected:

- o LPG producing and transportation conditions
- o Product LPG marketing and transportation conditions
- o Plant construction costs

- Meteorological and geological (soil properties, etc.) conditions
- Utilities conditions
- Management organization of plants and terminals
- Environmental conditions

As a result, the sites for the terminals and plant were selected as shown in Table 4-13.

Table 4-13. Selection of Plant Sites

Item	Syriam Terminal	Mann Terminal	Mann GOCS LPG Extraction Plant
1. Proposed plant site	Paddy field area on land side of existing No. 2 Jetty (See Fig. 4-2).	Land adjoining Mann Refinery Oil Terminal presently under construction (See Fig. 4-3).	Near existing No. 3 GOCS (See Fig. 4-4).
2. Reasons for selection			
(1) The place of LPG production and transportation conditions	Syriam being equipped with four jetty facilities for transporting Syriam Refinery products, it is suitable for unloading river barges coming from the Mann Terminal. Also, since the site lies relatively close to the Syriam Refinery, it is convenient for pipeline transportation from the Syriam Refinery.	Direct transportation of LPG from Mann Refinery and Mann GOCS to Syriam Terminal will be probematical in view of the production scale and transporting distance, and a terminal serving as a relay point will be most effective.	It will be necessary to construct the Extraction Plant near GOCS since it has to receive feedstock gas from GOCS and return lean gas to GOCS after recovery of C_3 and C_4.
(2) Product LPG marketing and transportation conditions	Since 96% of the LPG output of this project is to be exported, the Syriam region is optimum in that it permits use of existing jetties and is suitable for docking of LPG ocean tankers.	Locating the terminal near Mann Refinery jetties will be necessary for loading product LPG on river barges by using the existing jetties for transport to the Syriam Refinery for LPG export.	No particular limitation is observed in aspects of the plant's location for pipeline transfer of product LPG to Mann Terminal.
(3) Plant construction costs	The site is suitable also as observed from the aspects of conveyance of construction equipments and materials, supply of utilities for construction purposes, and relationship with existing facilities.	Same as left.	Same as left.
(4) Meteorological and geological conditions	While the proposed site will require additional costs for refilling the existing paddy fields with earth and for pipe driving, there is no other site that appears more advantageous than the proposed site from a general observation.	No particular problem (Driving of foundation piles unnecessary).	Same as left.
(5) Utilities conditions	A power transmission line for receiving electricity from the Syriam Refinery, also a pipeline for receiving water, will be necessary. The other utility facilities inside the Terminal will have to be provided newly.	All necessary utilities are to be supplied by the Mann Refinery.	While utility facilites will have to be provided newly in the compounds of the LPG Extraction Plant, electricity will be provided by EPC, and water by GOCS.
(6) Plant management organization	Since PIC will be responsible for Terminal management, the nearness of the proposed site to the Syriam Refinery and jetty facilities will be convenient for overall management.	Since the Mann Terminal will be under Mann Refinery supervision, oil near the Mann Refinery. Terminal will be advantageous for the Terminal's integrated management.	Since the LPG Extraction Plant managed by PIC is to be set up Mann GOCS area, an organization such as PIC branch office will be necessary.
(7) Environmental conditions	Since there are no dwellings near the proposed site, the location provides a safe distance from residential areas for handling pressurized LPG. In addition, there will be no fear of the terminal's waste water and exhaust gas to cause environmental pollution.	Same as left.	Since the Extraction Plant constitutes a source of fire hazard (heating furnace, construction work), its location as far as possible away from existing GOCS facilities is desirable. In addition, there are no dwelling near the proposed site.

Fig. 4-2. Syriam Terminal Site

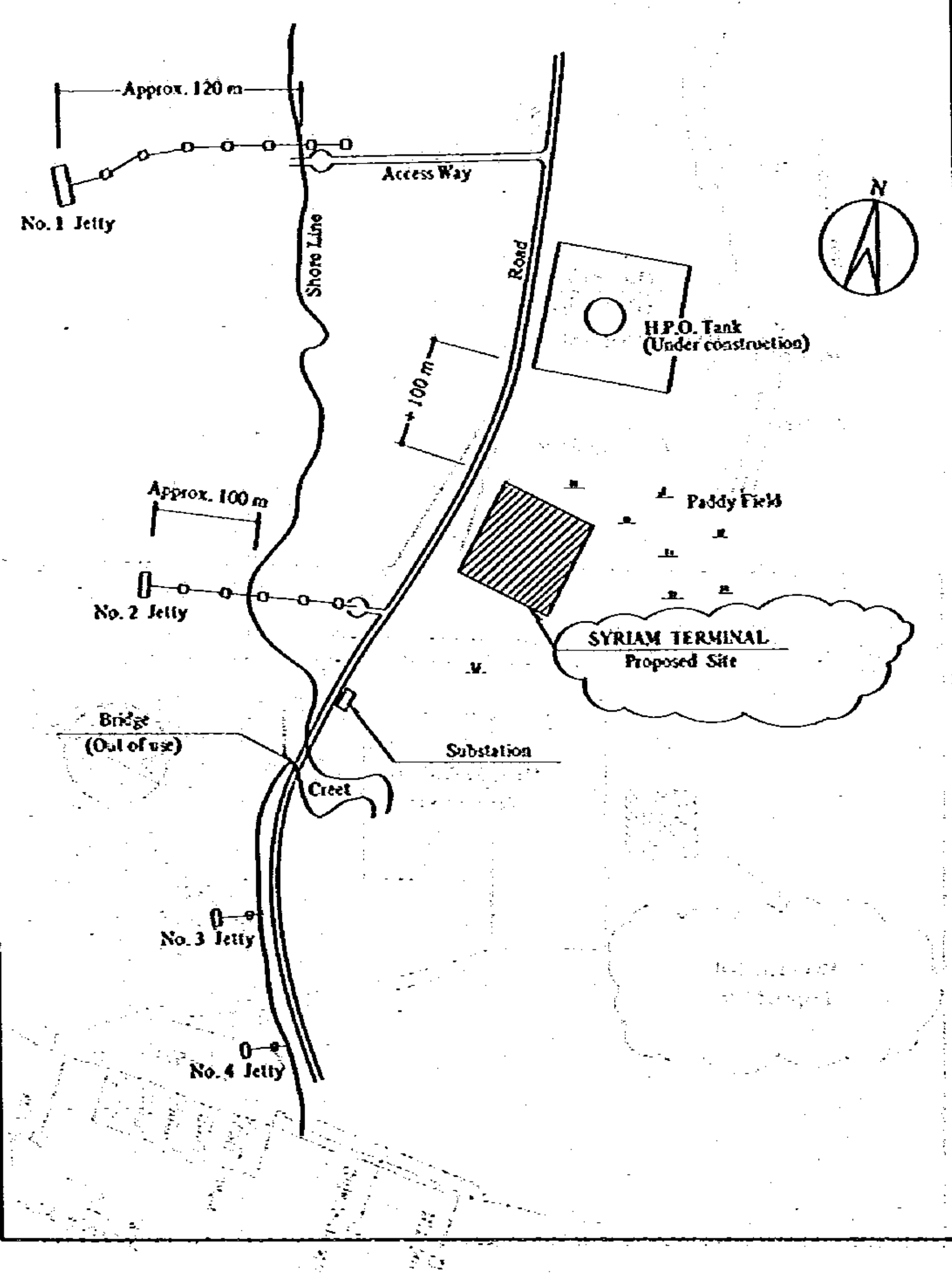


Fig. 4-3. Mann Terminal (Thanbiyagan)

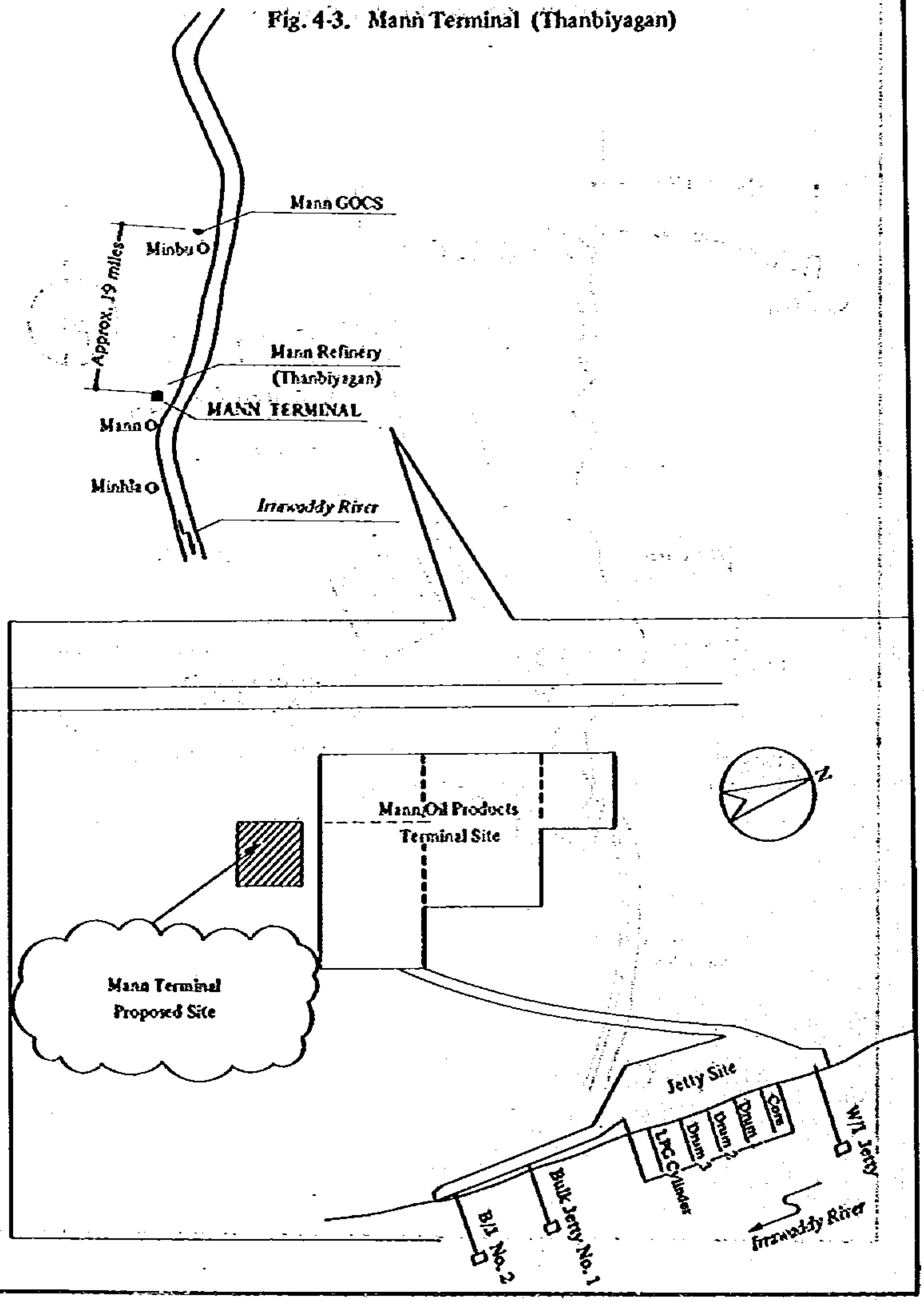


Fig. 4-4. Mann GOCS (Combined with GOCS 1 & 2)