

(15)

August 9, 1979.

Mr. Tammachart Sirivadhanakul,
Director of Regulatory Division,
National Energy Administration.

Dear Mr. Tammachart,

Re: LPG PRODUCTION FROM NATURAL GAS

I study LPG production from 100% of natural gas (from well head), and whether Thailand can export LPG to Japan or not.

I do not use computer, but the calculation is based on Fluor's report and Chiyoda's estimation, so the result is not so much different.

When LPG is manufactured from 100% of natural gas (from well head), the dew point control unit is unnecessary. Therefore, the cost of dew point control operation must be minused from the cost of LPG unit. I suppose that the cost of dew point control unit is 15 -30% on the cost of LPG unit. In my report, I apply for 15% of that.

I LPG PRODUCTION QUANTITY IN THAILAND

Natural Gas Production	LPG Production			
		T/Y		
		C ₃ LPG	C ₄ LPG	Total
350 MMscf/D (in 1983)		196.2	107.8	304.0
500 MMscf/D (after 1984)	In 1984	272.5	150.0	422.5
700 MMscf/D (after 1988)	In 1988	360.0	199.1	559.1
LPG From Refinery	In 1979			181.0

I suppose that LPG production from the refinery after the expansion and new refinery completion, LPG from these refineries is excess for domestic requirement, because these refineries will

1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes that proper record-keeping is essential for the transparency and accountability of the organization. This section also outlines the various methods and tools used to collect and store data, ensuring that all information is readily accessible and secure.

2. The second part of the document details the internal controls and procedures implemented to prevent fraud and ensure the integrity of the financial statements. It describes the segregation of duties, the approval process for transactions, and the regular audits conducted to verify the accuracy of the records. These measures are designed to minimize the risk of errors and misstatements.

3. The third part of the document addresses the reporting requirements and the preparation of financial statements. It explains how the collected data is analyzed and summarized into meaningful reports for the management and the board of directors. This section also discusses the compliance with applicable laws and regulations, ensuring that all reporting is done in a timely and accurate manner.

4. Finally, the document concludes with a summary of the key findings and recommendations. It highlights the areas where further improvements can be made to enhance the efficiency and effectiveness of the record-keeping process. The recommendations include the implementation of new technologies, the training of staff, and the establishment of a robust internal control system.

have a lot of cracking units. Thai LPG demand in 1982 will be 244 MT, so Thailand could not export before the completion of the expansion and new refinery.

Accordingly, the most of LPG from natural gas should be exported to Japan (Japan is the best LPG market for Thailand), to obtain foreign currency, but after the completion of the expansion and new refinery.

After 1983, Thailand will be available to export for 300×10^3 T/Y and after 1988 for 560×10^3 T/Y.

II LPG USAGE

Every countries are saving crude oil, therefore, they are going to substitute petroleum products (from crude oil) to natural gas and LPG.

New usage of LPG for Thailand

1. Motor car
2. Gas turbine fuel for electric generators of EGAT in province.
3. Others (such as refrigerator)

III MARKETING RESEARCH IN JAPAN

Thai LPG Production from Natural Gas

in 1983	304×10^3 T
after 1988	559×10^3 T

Japanese LPG Domestic Production and Import

Domestic in 1983	$5,917 \times 10^3$ T	33.8 %
Import in 1983	$11,589 \times 10^3$ T	66.2 %
<hr/>		
Total	$17,506 \times 10^3$ T	100.0 %

Japan is very good LPG market for Thailand.

The following table shows the results of the regression analysis. The dependent variable is the log of the number of employees. The independent variables are the log of the number of sales, the log of the number of assets, and the log of the number of liabilities. The results show that the log of the number of sales is positively correlated with the log of the number of employees, while the log of the number of assets and the log of the number of liabilities are negatively correlated with the log of the number of employees.

Variable	Coefficient	Standard Error	t-Statistic	p-Value
Log of Sales	0.15	0.02	7.5	< 0.001
Log of Assets	-0.05	0.01	-5.0	< 0.001
Log of Liabilities	-0.03	0.01	-3.0	< 0.01
Constant	2.5	0.5	5.0	< 0.001

The results of the regression analysis are consistent with the hypothesis that the log of the number of sales is positively correlated with the log of the number of employees, while the log of the number of assets and the log of the number of liabilities are negatively correlated with the log of the number of employees.

IV FEASIBILITY STUDY

FOB Price of C₃ LPG and C₄ LPG

	C ₃ LPG \$/T	C ₄ LPG \$/T
1979 Jan.	133	111
1989 Jan.	125.5	115.50
1989 April	126.50	127.50
1989 July	160.00	180.00
Price on Spot		
1989 July	200.00	300.00

Latest FOB price of C₃ LPG is 160 \$/T and C₄ LPG is 180 \$/T (before the 2nd oil crisis), the price up is according to tight of all over the world LPG market.

The FOB price of them will be going up very rapidly.

THAI LPG COST VS LPG FOB PRICE

Unit: \$

Natural Gas Price (from pipeline) \$/MMBTU	C ₃ LPG \$/T 160	168	177	187	192
	C ₃ LPG \$/T 180	189	199	210	216
1.50	+12.26	+20.16	+30.16	+40.16	+45.16
1.70* ¹	+ 1.96	+ 9.86	+19.86	+29.86	+84.86
1.78	- 9.11	- 1.21	+ 8.79	+18.79	+23.79
2.06* ²	-30.70	-22.80	-10.80	- 0.8	+ 4.2

Note: *1 1.70 \$/MMBTU may be current natural gas price including transportation fee.

*2 Fuel oil 1,200" equivalent price on calorific value.

Natural gas production is 500 Mmscf/D..

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From the above mentioned table, at present status, if C_3 LPG FOB price is 192 \$/T and C_4 LPG FOB price is 216 \$/T, the profit is nearly zero. In other word, FOB LPG price should be higher than equivalent price of fuel oil 1,200". Anyhow, C_3 and C_4 FOB price will be immediately going up.

So, NGOT should watch a movement of LPG FOB price.

V SALES NATURAL GAS IS DECREASED ACCORDING TO LPG PRODUCTION INCREASE

When LPG production is 100% from natural gas (from well head), the sales natural gas is decreased. Fluor LPG production is not from 100% of natural gas (from well head).

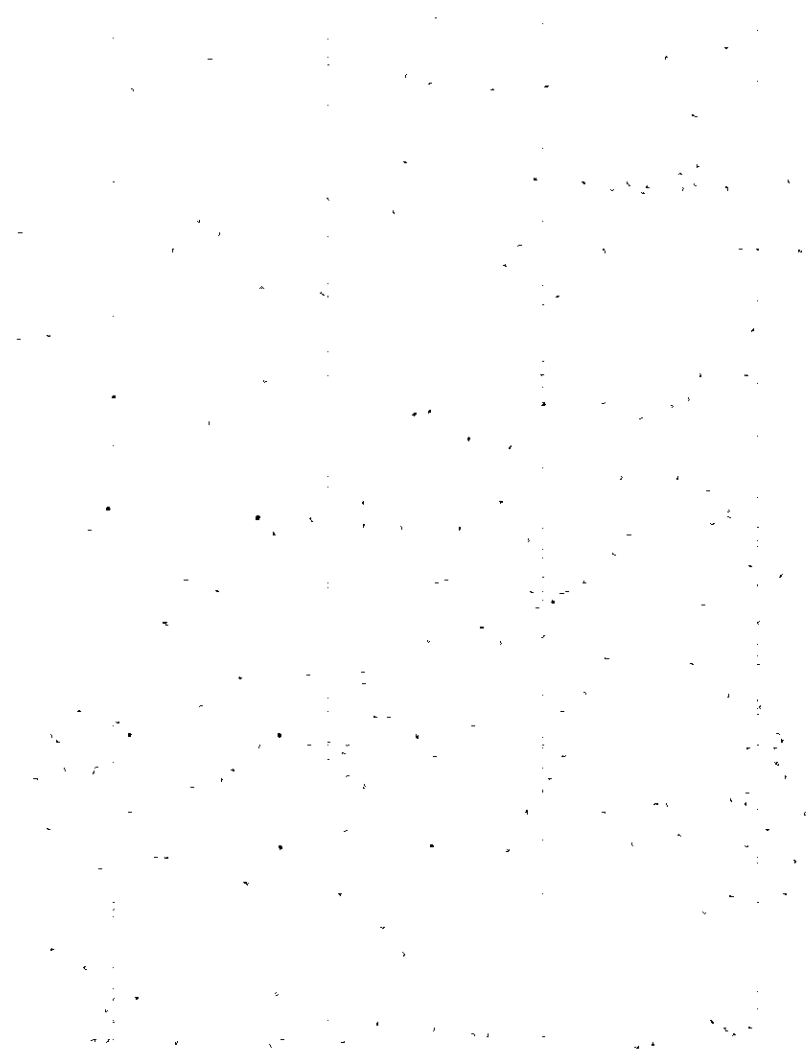
Unit: MMSCFD

	1981	1982	1983	1984	1985
Decreased Sales Natural Gas	18.20	31.91	36.00	52.02	46.42
Sales Natural Gas For Existing Industry (50%)	8.77	18.55	30.57	42.66	55.23
	1986	1987	1988	1989	1990
Decreased Sales Natural Gas	52.64	46.16	51.61	44.45	36.97
Sales Natural Gas For Existing Industry (50%)	58.17	59.17	62.13	64.47	66.80

VI LOCATION OF NATURAL GAS PROCESSING UNIT

Thailand has many water ways. LPG transportation cost by water is very cheap. And Thailand has possibility to export LPG to Japan. Therefore, the location of natural gas processing unit should not be far from sea-shore.

If LPG is increased production, NGOT can not supply sales natural gas to the existing industry even if 50% on total consumption,



because sales natural gas is decreased according to LPG production increase.

I appreciate if my report is useful for you.

Sincerely yours,

Y. Kawase

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LPG PRODUCTION FROM NATURAL GAS

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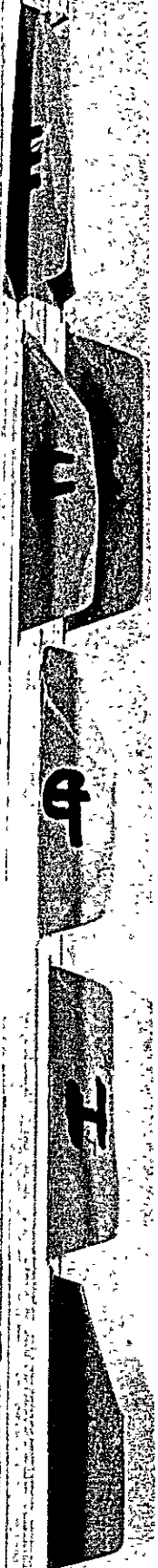
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LPG PRODUCTION FROM NATURAL GAS

FOREWORD

I study LPG production from natural gas. Flour Ocean Services International Inc. reported LPG production from natural gas but not 100% of the gas from pipeline, only 61% in 1990. LPG production from refineries which will be included LPG from the expansion and new refinery is guessed larger than domestic requirement, but nobody can estimate because plants of the expansion and new refinery are not decided. It is evident that the expansion and new refinery should have much cracking units, so LPG production should be large.

Accordingly, whole or mostly of LPG which will be produced from natural gas should be exported, to get foreign currency, but LPG production should make much profit.

Another way to utilize LPG must be developed to increase domestic consumption, such as (1) motor car fuel (2) industrial use (3) small gas turbine of EGAT in province.

II DEFINITION OF LPG

C_3 LPG is liquefied propane and propene, and C_4 LPG is liquefied butanes and butenes, and ordinary LPG is mixture of C_3 s and C_4 s which is propene, propane, butanes and butenes. Actually, C_3 s and C_4 s cuts can not be perfectly separated to pure C_3 s and C_4 s, always mixed a small quantity of before and after cuts. For instance, C_3 LPG is mainly C_3 s and a small quantity of C_2 and C_4 cut are mixed.

III PHYSICAL PROPERTY OF LPG

Physical property of LPG must be very important, when composition of LPG is changed. TABLE-1 (ATTACH.1) shown the physical property of LPG for recalculation.

Vapor pressure of LPG is very important, because pressure test of LPG vessel is very important when components are changed. Vapor pressure of C_2 , C_3 , C_4 , C_5 mixture is calculated by vapor-liquid

1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes that this is crucial for ensuring transparency and accountability in the organization's operations.

2. The second part outlines the various methods and tools used to collect and analyze data. This includes both traditional manual methods and modern digital technologies, highlighting the benefits of automation and data integration.

3. The third part focuses on the challenges faced in data management, such as data quality, security, and privacy. It provides strategies to address these challenges and ensure that the data remains reliable and secure.

4. The fourth part discusses the role of data in decision-making and strategic planning. It explains how data-driven insights can help organizations identify trends, opportunities, and risks, leading to more informed and effective decisions.

5. The fifth part covers the importance of data governance and compliance with relevant regulations. It outlines the key principles of data governance and provides guidance on how to implement a robust data governance framework.

6. The sixth part addresses the future of data management, including emerging trends like artificial intelligence, machine learning, and cloud computing. It discusses how these technologies will shape the way data is managed and analyzed in the coming years.

7. The seventh part provides a summary of the key points discussed in the document and offers final thoughts on the importance of data in the modern business landscape.

equivalent calculation. This calculation takes long time without computer, but from Fig.1 VAPOR PRESSURE OF PROPANE AND PROPYLENE (ATTACH.2) and Fig.2 VAPOR PRESSURE OF BUTANES AND BUTENES (ATTACH.3), we can know outline.

When highest temperature of Thailand is 44.5°C at Uttradit province on April 27, 1960, C_3s and C_4s vapor pressure at 44.5°C is as follows:

44.5°C	=	112.1°F
		Vapor Pressure at 44.5°C
Propene		17.8 atm.
Propane		14.5 atm.
i-Butane		5.6 atm.
c-Butane		3.5 atm.

When C_3 percentage of C_3 and C_4 mixed LPG is high, LPG vapor pressure is closed to 17.8 atm., and if C_4 percentage of C_3 and C_4 mixed LPG is high, LPG vapor pressure is closed to 3.5 atm. Maximum vapor pressure difference which is according to composition of C_3 and C_4 is nearly $17.8 - 3.5$ atm. And when C_4 LPG is used, heating for vaporisation is needed, so vapor pressure of C_4 vapor pressure is higher than ordinal temperature.

The LPG specification of Thailand is 30% propane and 70% butanes, but LPG composition from natural gas is about 35.5% butanes and about 64.5% propane, thus vapor pressure of natural gas LPG is very higher than it of refinery LPG, but difference of vapor pressure is less than 14.3 atm. the pressure test of LPG vessel must be checked.

IV LPG SPECIFICATION

Thai industrial specification of LPG is shown in TABLE-2 (ATTACH.4). And Japanese industrial specification is shown in TABLE-3 (ATTACH.5).

Difference of LPG (C_3 and C_4 mixed LPG for household) between Thailand and Japan is big. Rate of C_3 and C_4 component in Thailand is 30 : 70, in Japan 80 : 20 in winter and 70 : 30 in summer.



Standard specification of LPG imported in Japan is shown in TABLE-4 (ATTACH.6).

V LPG DEMAND FORECAST

LPG demand forecast in Thailand (NEA), JAPAN (MITI) are shown in TABLE-5 (ATTACH.7). And it of Mitsui's estimation is shown in TABLE-6 (ATTACH.8).

In Japanese statistics (TABLE-5 and 6. ATTACH.7 and 8), LPG demand forecast and each service as break-down are shown. As TABLE-5 (ATTACH.7) LPG demand in Thailand is very small compared with Japan. Moreover in Japan, town gas which is very similar to LPG consumption is very big, but Thailand has no town gas. So, Thailand must be developed the utilization of LPG for household, commerce and industry.

VI LPG USAGE

LPG usage in Japan is shown in Japanese specification of TABLE-3 (ATTACH.5) and LPG demand forecast of TABLE-5 and 6 (ATTACH.7 and 8). I explain the use of LPG more detail as follows :

VI.1 Household and Commerce

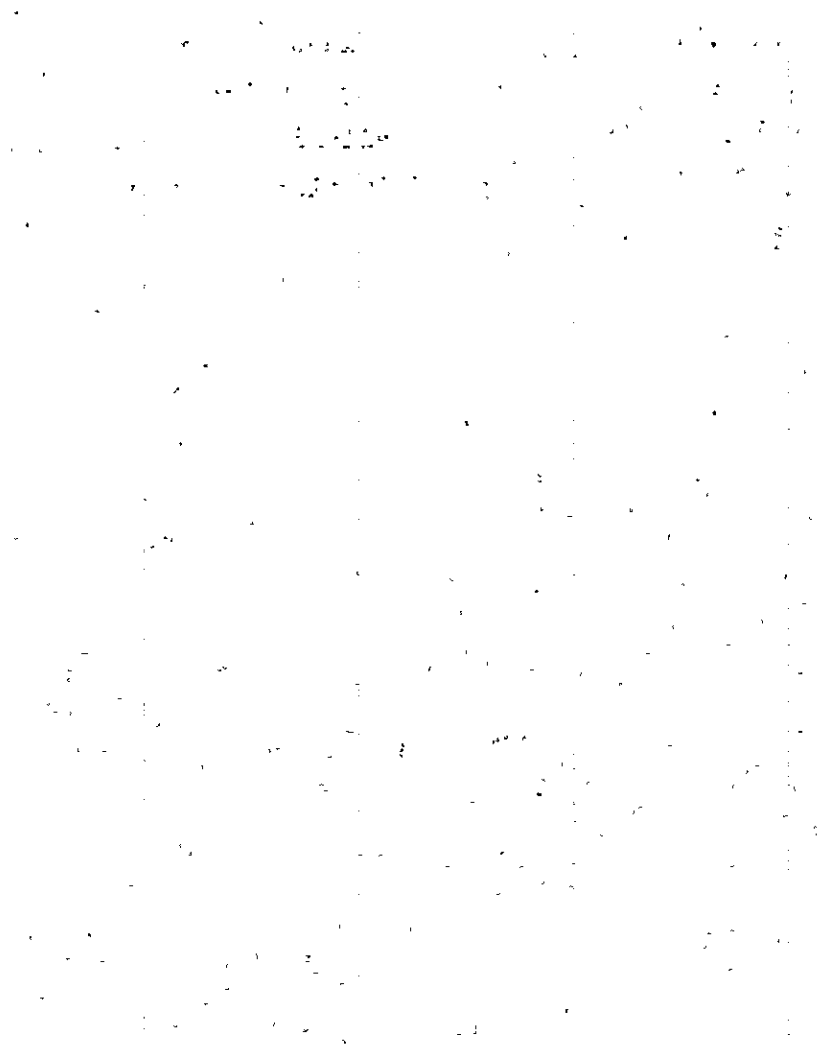
LPG is used as room heating, cooking, hot water and refrigerator for household and commerce.

VI.2 Industry

Butane utilization for industry has been increased recently.

Fuel of coal, fuel oil (kerosene, gas oil, fuel oil) have been replaced by LPG because of an economical point, preventing air pollution (low sulfur content) and no ash and soot (products are not contaminated by ash and soot), moreover, heating value is high, temperature control and handling are very easy.

- Metal industry (melting decarbonizing, gas reforming, hardening, quenching, annealing, cutting and scarfing forging)



- Ceramic industry (pottery, tile, whetstone, lime calcining, glass melting and molding work)

- Textile industry (gassed thread, plastic thread, plastic treating and dyeing)

- Foodstuffs (cake, ham, bread)

- Printing and Painting

VI.3 Agriculture Industry (drying of tobacco leaf, grain, pasture, and ageing of fluts, and green house, and poultry farming and pig raising)

VI.4 Town Gas

C_3 and C_4 are mixed with coal gas to increase calorific value.

VI.5 Internal Combusion Engine

- Taxis in big city are using LPG, octane number of C_3 is 96, and it of C_4 is 90.

- Tractor

- Forklift

VI.6 Petrochemical

Raw material of ethylene, ammonia, hydrogen and synthetic gas.

polyethylene (resin)

styrene butadiene (rubber)

polystyrene (resin)

Tetoron (polyester fiber)

polyester (resin)

surface active gent (detergent)

ethanol (solvent, raw material)

polyvinyl chloride (resin)

polyvinylidene resin & fiber

Ethand -----



4-ethyl lead (additive)
dioctyl phthalate (plasticizer)
butyl acetate (solvent)
acetic acid (raw material)
ethyl acetate (solvent, raw material)
pentacrythritol (resin)
higher alcohols (detergent, plasticizer)

iso propyl alcohol (solvent)
acetone (solvent)
methacrylic resin
epoxy resin
urethane foam
acrylic fiber
detergent
butyl rubber
polypropylene glutamic acid (ajinomoto)

Propylene -----

methylethylketone (solvent)
polyester resin
polybutene (rubber)
styrene butadiene rubber
nitrile butadiene rubber
polybutene 1 (rubber)
polybutadiene (rubber)
Nylon 66 (fiber)
butyl gum
polyisoprene rubber

C₄ cuts

n-butene
butadiene
isobutene

VII MARKETING RESEARCH IN JAPAN

VII.1 Japanese LPG Import by Supply Sources

Japan imported LPG from Middle East (Saudi Arabia, Kuwait, Iran), Australia, Canada and Venezuela as TABLE-7 (ATTACH.9) and about a half of total import is from Saudi Arabia which is shown in FIG.3 (ATTACH.10).

VII.2 LPG Import Quantity of Each Company in Japan

LPG import quantity of each company in Japan is shown in TABLE-8 (ATTACH.11), and share of LPG import in Japan is shown in FIG.4 (ATTACH.12).

VII.3 Import Terminal Capacity in Japan

LPG import terminal in Japan is spreaded in mainland and Kyushu Island which is shown in FIG.5 (ATTACH.13).

LPG import terminal capacity by area is shown in TABLE-9 (ATTACH.14) and by company in TABLE-10 (ATTACH.15).

VII.4 LPG Sales Quantity of Each Company in Japan

LPG sales quantity of each company in Japan is shown in TABLE-11 (ATTACH.16), and share of LPG sales in Japan is shown in FIG.6 (ATTACH.17).

VII.5 LPG Supply and Demand Forecast in Japan

LPG supply and demand forecast was shown in TABLE-6 (ATTACH.8). In Japan, LPG demand is very big but domestic production is small.

		1978	1979	1980	1981	1982	1983
Supply:							
Domestic	%	36.2	34.7	35.8	34.3	34.4	33.8
Import	%	63.8	65.3	64.2	65.7	65.6	66.2
Total		100.0	100.0	100.0	100.0	100.0	100.0

Japan is big LPG importing country, and LPG domestic production is growing up corresponding to crude oil throughput but LPG demand is growing up year by year more than LPG domestic production. Thus, domestic production percentage was 36.2% on demand in 1978 and will be 33.8% in 1983.

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VII.6 Japan Petroleum Development Corporation (JPDC)

Japanese Government has 100% share of JPDC, he assists a half of investment for exploratory drilling in country and foreign countries. And when crude oil and natural gas is discovered and commercial production is commenced, the fund is returned to JPDC, and if well is dry, the fund is not necessary returned to JPDC. But, the fund is tax from nation thus if Thailand excess product from natural gas and wants to export, Japanese Government expects that Thailand export them to Japan in proportion to share hold.

VIII MATERIAL BALANCE OF C₃ AND C₄ LPG (FROM NATURAL GAS)

C₃ and C₄ cuts in the gas from pipeline is shown in TABLE-12 (ATTACH.18). As was noted previously, C₃ and C₄ cuts separation (yield) must be estimated by computer, and 100% of them can not be recovered, so, I assume that C₃ yield is 90% on total C₃ in natural gas, and C₄ yield is 98% on total C₄ in natural gas (see TABLE-12, ATTACH.18).. These yields are based on Chiyoda's information.

I calculate material balance and heat balance of C₃ and C₄ LPG which are met the standard of specification of LPG imported in Japan (see TABLE-4, ATTACH.6), are shown in TABLE-13-1 and-2, (ATTACH.19-1 and -2). (13)-(19) of TABLE-13-2 shows calculation of heating value of C₃ LPG and C₄ LPG. These physical data are applied from TABLE-14-1 and -2 (ATTACH.20-1 and -2). SOURCE: DATA BOOK ON HYDROCARBONS), afterward I will use data from same tables.

Then, I calculate production of C₃ and C₄ LPG, and show in TABLE-15 (ATTACH.21) as Lb/H.

C₃ and C₄ LPG production is shown in TABLE-16 (ATTACH.22) as ton.

C₃ and C₄ LPG value and their average value are shown in TABLE-17 (ATTACH.25).

Note: When I calculated heating value, it is gross heating value not net heating value, because natural gas price is based on gross heating value. And T means MT and \$ means US\$.

1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes that proper record-keeping is essential for ensuring transparency and accountability in financial operations. This section also highlights the role of internal controls in preventing fraud and errors.

2. The second part of the document focuses on the implementation of robust risk management strategies. It outlines various risk assessment techniques and provides guidance on how to identify, measure, and mitigate potential risks. The text stresses the need for a proactive approach to risk management to protect the organization's assets and reputation.

3. The third part of the document addresses the importance of effective communication and reporting. It discusses the need for clear and concise communication channels and the role of regular reporting in keeping stakeholders informed. This section also touches upon the importance of maintaining accurate financial statements and the role of external auditors in verifying the accuracy of these reports.

4. The fourth part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes that proper record-keeping is essential for ensuring transparency and accountability in financial operations. This section also highlights the role of internal controls in preventing fraud and errors.

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IX LPG FOB BANGKOK PRICE (EXPORT LPG)

LPG price in Thailand (domestic LPG price) is very high, so LPG from natural gas is to make much profit according to Mr. Shishido's report last year.

LPG (CIF) price which was imported to Japan about 2 months ago was \$143/T, if freight rate between Thailand and Japan is assumed as about \$15/T, FOB Thailand might be \$128/T.

FOB price of Kuwait D/D LPG is shown in FIG.7 (ATTACH.23) C_3 price was higher than C_4 price, but recently both prices have been closed, because C_4 LPG demand has been grown up.

- o The Nippon Economic Newspaper reported as following :

Dated on June 24, 1979

Kuwait FOB Price (price in April - June in 1979)

C_3 LPG	126.5 \$/T	Note: See the above mentioned \$128/T.
C_4 LPG	127.5 \$/T	

Price on spot at Houston, USA

C_3 LPG	150 \$/T
C_4 LPG	300 \$/T

- o The same newspaper

Dated on July 5, 1979

Kuwait FOB Price (in July 1979)

C_3 LPG	160 \$/T
C_4 LPG	180 \$/T

Price on spot

C_3 LPG	200 \$/T
C_4 LPG	300 \$/T

1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes that this is crucial for ensuring transparency and accountability in the organization's operations.

2. The second part of the document outlines the various methods and tools used to collect and analyze data. It highlights the need for consistent and reliable data collection processes to support informed decision-making.

3. The third part of the document focuses on the role of technology in data management and analysis. It discusses how modern software solutions can streamline data collection, storage, and reporting, thereby improving efficiency and accuracy.

4. The fourth part of the document addresses the challenges associated with data management, such as data quality, security, and privacy. It provides strategies to mitigate these risks and ensure that data is used responsibly and ethically.

5. The fifth part of the document concludes by summarizing the key findings and recommendations. It stresses the importance of ongoing monitoring and evaluation to ensure that data management practices remain effective and aligned with the organization's goals.

o FOB Persian Gulf (Mitsui & Co.estimated)

April - June in 1979		July - Sept. in 1979	
C ₃ LPG	C ₄ LPG	C ₃ LPG	C ₄ LPG
125 - 126.5	123 - 127.5	159 - 160	177 - 180

Freight of Persian Gulf to Japan may be 22 - 25 \$/T.

Freight of Siam Gulf to Japan may be 15 \$/T.

All over the world, LPG is very tight, because C₄ is mixed in gasoline and used as petrochemical raw material (substituted naphtha).

The LPG price is risen in July 1979, being caused by LPG shortage not by crude oil price up. Change of crude oil standard price is shown in FIG.8 (ATTACH.24).

I calculate average price of C₃ and C₄ LPG produced from Siam Gulf natural gas (the gas from pipeline), and show it in TABLE-17 (ATTACH.25).

Ratio of C₃ LPG and C₄ LPG of produced from the gas from pipeline is 64.5 : 35.5 (wt), and average price is 167.1 \$/T when C₃ LPG price is 160 \$/T and C₄ LPG price is 180 \$/T.

According to Mr. Shishido's report (in 1978), exrefinery price of LPG in Thailand is as follows : (For your reference)

$$\begin{aligned} \text{Exrefinery Price} &= 3.1397 \text{ \$/Kg}^* \\ &= 154.096 \text{ \$/T} \end{aligned}$$

Note: * Exrefinery price of LPG was not changed before July 1979.

The price of LPG in Thailand (in June 1979) was higher than the LPG of FOB Kuwait price (April and June 1977).



X CASE-1 EXPENDITURE AND REVENUE IN CASE OF NATURAL GAS PRICE 1.50\$/MMBTU, C₃ LPG PRICE 160\$/T AND C₄ LPG PRICE 180 \$/T (500 MMscf/D)

X.1 Operation Cost

X.1.1 Production

In Mr. Shishido's report "THE PRELIMINARY ECONOMIC STUDY OF LPG RECOVERY FROM NATURAL GAS", LPG production was estimated as follows :

C ₃	220,000	T/Y
C ₄	160,000	T/Y
Total	380,000	T/Y

My calculation of LPG production (in case of 500 MMscf/D natural gas production schedule) is as follows: (in 1987)

C ₃ LPG	272.52	MT/Y
C ₄ LPG	149.88	MT/Y
Total	422.40	MT/Y (see TABLE-16, ATTACH.22)

X.1.2 Construction Cost of LPG Production

Construction cost was estimated by Chiyoda Chemical Engineering and Construction Company based on 380,000 T/Y LPG production.

Designed recovery ratio is as follows:

C ₃	:	more than	90%
C ₄	:	more than	98%

CO₂ removal unit is necessary when natural gas charge to LPG plant, CO₂ content must be less than 1%, because turboexpand is applied :



	Chiyoda Estimate	Correction of Production rate	Correction 1979 Plant Cost	Plant Cost per Ton
	MM \$	MM \$	MM \$	\$/T
LPG Unit	70			
CO ₂ Removal Unit	16			
Total	86	92.610^{*1}	98.112	232.27^{*3}

Note: *1 $86.000 \text{ MM\$} \times \left(\frac{422,400 \text{ T/Y}}{380,000 \text{ T/Y}} \right)^{0.7} = 92.610 \text{ MM\$}$

*2 $92.610 \text{ MM\$} \times 1.07 \% = 98.112 \text{ MM\$}$
 7% up/year of construction cost

*3 $98.112 \text{ MM\$} \div 422.40 \text{ MT} = 232.27 \text{ \$/T}$

Fluor's estimation of gas plant (the end of 1979)

200 MMscf/D 68,301 MM\$

500 MMscf/D x

$x = 68,301 \text{ M\$} \times \left(\frac{500}{200} \right)^{0.7} = 129,714$

$129,714 \text{ M\$} \times \left(1 + \frac{0.07}{2} \right) = 134,254$

$\frac{134,254 \text{ M\$}}{98,112 \text{ M\$}} = 1.37 \text{ (37\% higher than Japan)}$

The difference could not be clarified, it might be caused by different process and price of machine and equipment. And it is contained the cost of the dew point control unit.

X.1.3 Dew Point Control Unit

When LPG recovery is from 100% natural gas (the gas from pipeline), the dew point control unit is unnecessary. Thus, LPG recovery acts as dew point control duty, the duty is not for LPG production. Thus, the operation cost of dew point control must be eliminated from the cost of LPG production.

The first part of the document discusses the importance of maintaining accurate records of all transactions. It emphasizes that every entry should be clearly dated and described, and that the accounts should be kept up-to-date at all times. This ensures that the financial position of the business is always known and can be relied upon for decision-making.

The second part of the document provides a detailed account of the business's operations over the past year. It includes a breakdown of sales, expenses, and profits, and compares these figures to the previous year. This analysis shows that the business has grown significantly, with sales increasing by 15% and profits by 10%. This growth is attributed to a combination of factors, including improved marketing, better customer service, and more efficient operations.

The third part of the document outlines the business's financial goals for the coming year. These goals include increasing sales by 20%, reducing expenses by 5%, and maintaining a healthy profit margin. To achieve these goals, the business plans to invest in new marketing campaigns, hire additional staff, and streamline its operations. It also plans to continue to focus on providing excellent customer service, as this is a key factor in its success.

The fourth part of the document discusses the business's overall financial health and its ability to meet its obligations. It notes that the business has a strong cash flow and is able to pay its bills on time. It also has a good credit rating, which allows it to obtain financing at a low interest rate. This financial strength is a result of the business's careful management and its commitment to maintaining accurate records.

The fifth part of the document provides a summary of the business's performance and its outlook for the future. It concludes that the business has had a successful year and is well-positioned to continue its growth in the coming year. It expresses confidence in the business's ability to meet its goals and maintain its financial health.

The cost of dew point control can not calculate at this stage. I assumed for 15% of total operation cost of LPG production.

X.1.4 Operation Cost \$/T of LPG Production

Expense

A. Natural gas price is 1.5 \$/MMBTU

	% on Construction Cost	\$/T
(1) Depreciation (20 years)	5	11.61
(2) Interest for Construction Cost	5	11.61
(3) Tax and Insurance	2	4.65
(4) Maintenance	3	6.97
(5) Administration	2	4.65
(6) Overhead	2	4.65
Total	19	44.14

Note: Construction cost is 232.27 \$/T

B. Interest of working capital

C₃ and C₄ LPG average price is 167.1 \$/T (from TABLE-17, ATTACH.25)

$$167.1 \text{ $/T} \times 422,400 \text{ T/Y} = 70.58 \text{ MM $/Y}$$

$$70.58 \text{ MM $/Y} \times \frac{1.5 \text{ Mon.}}{12 \text{ Mon.}} = 8.82 \text{ MM $/Y}$$

$$8.82 \text{ MM $/Y} \times 8\% = 0.71 \text{ MM $/Y}$$

.. 8% is interest.

$$0.71 \text{ MM $/Y} \div 422,400 \text{ T/Y} = 1.68 \text{ $/T}$$

C. Utility

Natural gas consumption is :

For LPG plant	9 MMscf/D
Cor CO ₂ plant	18 MMscf/D
Total	27 MMscf/D



(Heating value of the natural gas was assumed as 1,050 BTU/scf by Mr. Shishido).

Natural Gas Price

Mr. Shishido's Estimation	1.555 \$/MMBTU (compressor station at off-shore)
	1.544 \$/MMBTU (compressor station at on-shore)
Fluor's Report	1.50 \$/MMBTU
In the report, 2 natural gas prices were applied	1.75 \$/MMBTU
My Calculation	1.50 \$/MMBTU

The price is not included the transportation charge from the natural gas processing unit to end user. So, I apply for 1.50 \$/MMBTU of natural gas charge.

$$27 \text{ MMscf/D} \times 1,050 \text{ BTU/scf} \times \frac{1.50 \$}{1 \text{ MMBTU}} = 42.525 \$/D$$

$$= 15.52 \text{ MM\$/Y}$$

$$15.52 \text{ MM\$/Y} \times \frac{422,400 \text{ T/Y}}{380,000 \text{ T/Y}} \div 422,400 = 40.84 \$/T$$

D. Labor cost

$$15 \text{ persons} \times 4 \text{ shifts} = 60 \text{ persons}$$

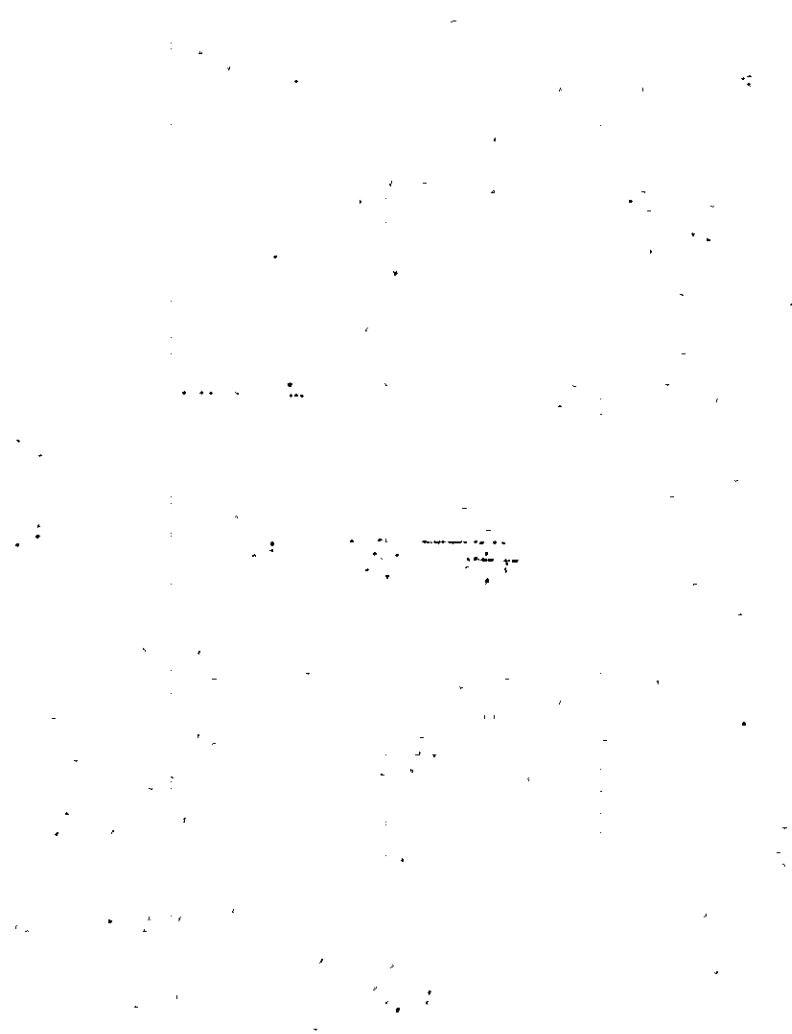
Salary and other expense is assumed as 200 \$/Mon. Month

$$200 \$/\text{Mon month} \times 60 \text{ persons} \times 12 \text{ months} = 0.144 \text{ MM\$/Y}$$

$$0.144 \text{ MM\$/Y} \div 422,400 \text{ T/Y} = 0.34 \$/T$$

E. Operation cost

	\$/T
(1) Expense	44.14
(2) Interest for Working Capital	1.68
(3) Utility	40.84
(4) Labor Cost	0.34
<u>Total</u>	<u>87.00</u>



F. Operation cost minus the cost of dew point control unit

$$87.00 \text{ \$/T} \times (100 - 15)\% = 73.95 \text{ \$/T}$$

X.2 Cost of Natural Gas Charge

$$50.92 \text{ MMBTU/T} \times \frac{1.5 \text{ \$/MMBTU}}{\text{MMBTU}} = 76.38 \text{ \$/T}$$

Note: * is come from TABLE-20 (ATTACH.28).

TABLE-20 (ATTACH.28) is calculated from TABLE-18 and -19 (ATTACH.26 and 27).

X.3 Expenditure

	\\$/T
Cost Natural Gas Charge	76.38
Operation Cost	73.95
<hr/>	
Total	150.33

Selling charge (including shipping) is assumed as 3% on total expenditure.

Expenditure is as follows :-

$$150.33 \text{ \$/T} \times (1 + 0.03) = 154.84 \text{ \$/T}$$

X.4 Revenue

C₃ and C₄ LPG average FOB Bangkok price is 167.1 \\$/T which is from TABLE-17-7 (ATTACH.25).

X.5 Profit or Loss

$$167.1 \text{ \$/T} - 154.84 \text{ \$/T} = +12.26 \text{ \$/T}$$

$$12.26 \text{ \$/T} - 154.84 \text{ \$/T} \times 100 = +7.9\%$$

In this case, profit is 12.26 \\$/T.

(see TABLE-21, ATTACH.29)



X' CASE-1' EXPENDITURE AND REVENUE IN CASE OF NATURAL GAS PRICE 1.70 \$/MMBTU, C₃ LPG PRICE 160 \$/T AND C₄ LPG PRICE 180 \$/T (500 MMSCF/D)

In X, I applied 1.50 \$/MMBTU of natural gas, but actual natural gas price in 1979 may be 1.70 \$/MMBTU, so I calculate in case of 1.70 \$/MMBTU as follows :

X'.1 Utility

$$27 \text{ MMscf/H} \times 1,050 \text{ BTU/scf} \times \frac{1.70 \text{ \$}}{1\text{MM}} = 48,195 \text{ \$/D}$$
$$= 17.59 \text{ MM\$/Y}$$

$$17.59 \text{ MM \$/Y} \times \frac{422,400 \text{ T/Y}}{380,000 \text{ T/Y}} \div 422,400 \text{ T/Y} = 46.29 \text{ \$/T}$$

X'.2 Operation Cost

	\$/T	
(1) Expense	44.14	no change
(2) Interest for Working Capital	1.68	no change
(3) Utility	46.29	
(4) Labor Cost	0.34	no change
Total	92.45	

$$92.45 \text{ \$/T} \times (100 - 15)\% = 78.58 \text{ \$/T}$$

X'.3 Cost of Natural Gas Charge

$$50.92 \text{ MMSTU/T} \times \frac{1.7 \text{ \$}}{\text{MMBTU}} = 86.56 \text{ \$/T}$$

X'.4 Expenditure

	\$/T
Cost of natural gas charge	86.56
Operation cost	78.58
Total	165.14



X'.5 Profit and Loss

$$167.1 \text{ ¢/T} - 165.14 \text{ ¢/T} = + 1.96 \text{ ¢/T}$$

$$1.96 \text{ ¢/T} \div 165.14 \text{ ¢/T} = + 1.2\%$$

In this case, profit is 1.96 ¢/T.

XI CASE-2 EXPENDITURE AND REVENUE IN CASE OF NATURAL GAS PRICE EQUIVALENT TO FUEL OIL PRICE (2.063 ¢/MMBTU) (500 MMSCF/D)

XI.1 Natural Gas Price Equivalent to Fuel Oil 1,200"

$$\text{Fuel Oil 1,200"} \quad 1.6157 \text{ ¢/lit} \quad (\text{May 1, 1978})$$

$$1.6157 \text{ ¢/lit} = 0.0792 \text{ ¢/lit}$$

$$1\text{ ¢} = 20.4 \text{ ¢}$$

Heating value (Gross)

$$400" \quad 9,371 \text{ Kcal/lit}$$

$$1,500" \quad 9,826 \text{ Kcal/lit}$$

$$1,200" \quad 9,675 \text{ Kcal/lit (assumed)}$$

$$9,675 \text{ Kcal/lit} = 38,392.86 \text{ BTU/lit}$$

$$1 \text{ Kcal} = 3.96825 \text{ BTU}$$

$$0.0792 \text{ ¢/lit} - 38,392.86 \text{ BTU/lit} \times \text{MMBTU} = 2.063 \text{ ¢/MMBTU}$$

XI.2 Utility

$$27 \text{ MMscf/D} \times 1,050 \text{ BTU/scf} \times \frac{2.063 \text{ ¢}}{\text{MMBTU}} = 58,486 \text{ ¢/D}$$

$$= 21.35 \text{ MM¢/Y}$$

$$21.35 \text{ MM¢/Y} \times \frac{422,400 \text{ T/Y}}{380,000} \div 422,400 \text{ T/Y} = 56.18 \text{ ¢/T}$$

XI.3 Operation Cost

¢/T

(1) Expense 44.14 no change

(2) Interest for Working Capital 1.68 no change

(3) Utility 56.18

(4) Labor Cost 0.34 no change

Total 102.34

1. The first step in the process of a scientific investigation is to ask a question. This question should be based on observation and should be something that can be tested. For example, a scientist might observe that a plant grows taller in the sun than in the shade and ask, "Does the amount of sunlight affect the height of a plant?"

2. Next, the scientist makes a hypothesis, which is a prediction about the answer to the question. In the example above, the hypothesis might be, "If a plant receives more sunlight, then it will grow taller." This hypothesis is based on the observation that plants need sunlight to grow.

3. The scientist then designs an experiment to test the hypothesis. This involves setting up a controlled environment where only one variable is changed at a time. In the example, the scientist might grow two identical plants in the same soil and water, but one in the sun and one in the shade. The scientist would measure the height of both plants at regular intervals.

4. After the experiment is completed, the scientist collects data and analyzes it. This involves comparing the heights of the two plants and seeing if there is a significant difference. If the plant in the sun is significantly taller than the plant in the shade, the hypothesis is supported.

5. Finally, the scientist draws a conclusion based on the results of the experiment. If the hypothesis is supported, the scientist might conclude that sunlight does affect the height of a plant. If the hypothesis is not supported, the scientist might conclude that sunlight does not affect the height of a plant, or that there is another factor that is affecting the plant's growth.

Total operation cost minus the cost of dew point control unit.

$$102.34 \text{ \$/T} \times (100 - 15)\% = 86.99 \text{ \$/T}$$

XI.4 Cost of Natural Gas Charge

$$50.92 \text{ MMBTU/T} \times \frac{2.063 \text{ \$}}{\text{MMBTU}} = 105.05 \text{ \$/T}$$

XI.5 Expenditure

	\$/T
Cost Natural Gas Charge	105.05
Operation Cost	86.99
<hr/>	
Total	192.04

Selling charge (including shipping) is assumed as 3% on total expenditure.

$$192.04 \text{ \$/T} \times (1 + 0.03)\% = 197.80 \text{ \$/T}$$

XI.6 Revenue

C₃ and C₄ LPG average FOB Bangkok price is 167.1 \$/T which is come from TABLE-17 (7) (ATTACH.25).

XI.7 Profit and Loss

$$167.1 \text{ \$/T} - 197.80 \text{ \$/T} = -30.7 \text{ \$/T}$$

$$-30.7 \text{ \$/T} \div 197.80 \text{ \$/T} = -15.5\%$$

In this case, loss is 30.7 \$/T.

XII CASE-3 EXPENDITURE AND REVENUE IN CASE OF NATURAL GAS PRICE IS MIDDLE OF CASE-1 AND CASE-2 (1.78 \$/MMBTU) (500 MMscf/D)

XII.1 Natural gas price

CASE-1	1.50	\$/MMBTU
CASE-2	2.063	\$/MMBTU
CASE-3	1.78	\$/MMBTU

Average of CASE-1 and CASE-2 is 1.78 \$/MMBTU.



XII.2 Utility

$$27 \text{ MMscf/D} \times 1,050 \text{ BTU/scf} \times \frac{1.78 \text{ \$}}{\text{MMBTU}} = 50,463 \text{ \$/D}$$
$$= 18.42 \text{ MM \$/Y}$$

$$18.42 \text{ MM\$/Y} \times \frac{422,400 \text{ T/Y}}{380,000 \text{ T/Y}} \div 422,400 \text{ T/Y} = 48.47$$

XII.3 Operation Cost

	\$/T	
(1) Expense	44.14	no change
(2) Interest for Working Capital	1.68	no change
(3) Utility	48.47	
(4) Labor Cost	0.34	no change
<hr/>		
Total	94.63	

Total operation cost minus the cost of dew point control unit

$$94.63 \text{ \$/T} \times (100 - 15)\% = 80.44 \text{ \$/T}$$

XII.4 Cost of Natural Gas Charge

$$50.92 \text{ MMBTU/T} \times \frac{1.78 \text{ \$}}{\text{MMBTU}} = 90.64 \text{ \$/T}$$

XII.5 Expenditure

Cost Natural Gas Charge	90.64 \\$/T
Operation Cost	80.44 \\$/T
<hr/>	
Total	171.08 \\$/T

Selling charge (including shipping) is assumed as 3% on total expenditure.

$$171.08 \times (1 + 0.03)\% = 176.21 \text{ \$/T}$$



XII.6 Revenue

C₃ and C₄ LPG average FOB Bangkok price is 167.1 \$/T which is come from TABLE-17 (7) (ATTACH.25).

XII.7 Profit and Loss

$$167.1 \text{ \$/T} - 176.21 \text{ \$/T} = -9.11 \text{ \$/T}$$

$$-9.11 \text{ \$/T} \div 176.21 \text{ \$/T} = -5.2 \%$$

In this case, loss is 9.11 \$/T.

XIII RESULT OF CASE-1, CASE-1', CASE-2 AND CASE-3 (500 MMSCF/D)

When C₃ LPG price is 160 \$/T and C₄ LPG price is 180 \$/T, average 167.1 \$/T, natural gas price must be 1.66 \$/T at profit zero point which is shown in FIG.9 (ATTACH.30). These calculations are based on 272.52 x 10³ T/Y of C₃ LPG production, and 149.88 x 10³ T/Y of C₄ LPG production in 1984 (see TABLE-16, ATTACH.22).

In FIG.9 (ATTACH.30) another 4 lines of 175 \$/T, 185 \$/T, 195 \$/T, 200 \$/T for C₃ and C₄ LPG average price are as following :

Natural gas price vs C₃ and C₄ LPG average price is as under :

Natural gas production 500 MMscf/D

NATURAL GAS PRICE \$/MMBTU	C ₃ and C ₄ LPG AVERAGE PRICE (\$/T)*				
	167.1	175	185	195	200
	PROFIT OR LOSS (\$/T)				
CASE-1 1.50	+12.26	+20.16	+30.16	+49.16	+45.16
CASE-1' 1.70	+ 1.96	+ 9.86	+19.86	+29.86	+34.86
CASE-2 2.063	-30.7	-22.80	-10.80	- 0.80	+ 4.2
CASE-3 1.78	- 9.11	- 1.21	+ 8.79	+18.79	+23.79

Note: * FOB Bangkok price

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Then C_3 and C_4 LPG price is 167.1 $\$/T$ and natural gas price is 1.50 $\$/MMBTU$ (CASE-1), profit is 12.26 $\$/T$, but when these are 1.78 $\$/T$ (CASE-3) and 2.063 $\$/MMBTU$ (CASE-2) of natural gas price, all are loss. Namely, even if fuel oil equivalent 2,063 $\$/MMBTU$ and C_3 and C_4 LPG 1.955 $\$/T$, profit is still not so big (see FIG.9, ATTACH.30).³

In the above table, C_3 and C_4 average price is indicated, their average prices are breakdown as follows but approximately.

		C_3 LPG	C_4 LPG
Line	165.9 $\$/T$	160 $\$/T$	180 $\$/T$
Line	175 $\$/T$	168 $\$/T$	189 $\$/T$
Line	185 $\$/T$	177 $\$/T$	199 $\$/T$
Line	195 $\$/T$	187 $\$/T$	210 $\$/T$
Line	200 $\$/T$	192 $\$/T$	216 $\$/T$

Note: Data of calculated. above number are approximately.

Natural gas price is 2.063 $\$/MMBTU$ which is equivalent to fuel oil 1,200", when C_3 LPG and C_4 LPG prices are going up to 192 $\$/T$ and 216 $\$/T$ individually (price is going up about 40 $\$/T$ higher than the present price of C_3 LPG and C_4 LPG), but it is almost no profit and loss.

As a consequence, NGOT will not able to produce C_3 and C_4 LPG at present price, but C_3 and C_4 LPG price will be going up rapidly in near future according to C_3 and C_4 LPG market is becoming tight.

XIV CASE-4 EXPENDITURE AND REVENUE IN CASE OF NATURAL GAS PRICE 1.50 $\$/MMBTU$, C_3 LPG PRICE 160 $\$/T$ C_4 LPG PRICE 180 $\$/T$ (700 MMSCF/D)

LPG production which was noted above is from 500 MMscf/D, LPG production from bigger size is cheaper than from smaller size.



XIV.1 Construction Cost

380,000 T/Y 86 MM\$

$$86 \text{ MM\$} \times \left(\frac{559.15 \text{ T/Y}}{380,000 \text{ T/Y}} \right)^{0.7} = 112.70 \text{ MM\$}$$

$$= 120.59 \text{ MM\$} \quad 7\% \text{ up}$$

$$120.59 \text{ MM\$} - 559.15 \text{ T} = 215.67 \text{ \$/T}$$

Note: * come from TABLE-15 (ATTACH.21)

$$63.83 \text{ Kg/H} \times 24 \text{ h} \times 365 \text{ days} = 559.15 \text{ T/Y}$$

XIV.2 Operation Cost

XIV.2.1 Natural gas price 1.5 \$/MMBTU

	% on Construction Cost	\$/T
1) Depreciation (20 years)	5	10.78
2) Interest for Construction	5	10.78
3) Tax and Insurance	2	4.31
4) Maintenance	3	6.47
5) Administration	2	4.31
6) Overhead	2	4.31
Total	19	40.96

Note: Construction cost is 215.67 \$/T

XIV.2.2 Interest of working capital

Same as X.1.4, B

Namely, it is 1.68 T/Y.

XIV.2.3 Utility

Same as X.1.4, C

Namely, it is 40.84 \$/T.

XIV.2.4 Labor cost

$$16 \text{ persons} \times 4 \text{ shifts} = 64 \text{ persons}$$

Salary and other expense is assumed as 200 \$/Man.Month.

$$200 \text{ $/Man. Month} \times 64 \text{ persons} \times 12 \text{ months} \div 559.150 \text{ T/Y} = 0.27 \text{ $/T}$$

XIV.2.5 Operation cost

	\$/T	
(1) Expense	40.96	(change)
(2) Interest for Working Capital	1.68	
(3) Utility	40.84	
(4) Labor Cost	0.27	(change)
<hr/>		
Total	83.75	

XIV.2.6 Total operation cost minus the cost of the dew point control unit

$$83.75 \text{ $/T} \times (100 - 15)\% = 71.19 \text{ $/T}$$

XIV.3 Cost of Natural Gas Charge

$$50.94^* \text{ MMBTU/T} \times \frac{1.5 \text{ \$}}{\text{MMBTU}} = 76.41$$

Note: * come from TABLE-20 (ATTACH.28)

XIV.3 Expenditure

	\$/T
Cost of Natural Gas Charge	76.41
Operation Cost	71.19
<hr/>	
Total	147.6

Selling charge (including shipping) is assumed as 3% on total expenditure.

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Expenditure is as follows :

$$147.6 \text{ \$/T} \times (1 + 0.03)\% = 152.03 \text{ \$/T}$$

XIV.5 Revenue

Same as X.5

Namely, it is 167.1 \\$/T

XIV.6 Profit and Loss

$$167.1 \text{ \$/T} - 152.03 \text{ \$/T} = 15.07 \text{ \$/T}$$

$$15.07 \text{ \$/T} \div 152.03 \text{ \$/T} = 9.0\%$$

In this case, profit is 15.07 \\$/T.

XV COMPARISON OF LPG PRODUCTION FROM 500 MMSCF/D AND 700 MMSCF/D
(NATURAL GAS PRICE 1.50 \\$/MMBTU)

	Expenditure \$/T	Revenue \$/T	Profit \$/T	Profit %
From 500 MM/D Natural Gas	155.59	167.1	+10.31	6.6
From 700 MM/D Natural Gas	152.20	167.1	+15.07	9.9

LPG from 700 MMscf/D natural gas is 4.59 \\$/T more profit, but
LPG production unit can not be bigger than 700 MMscf/D unit.

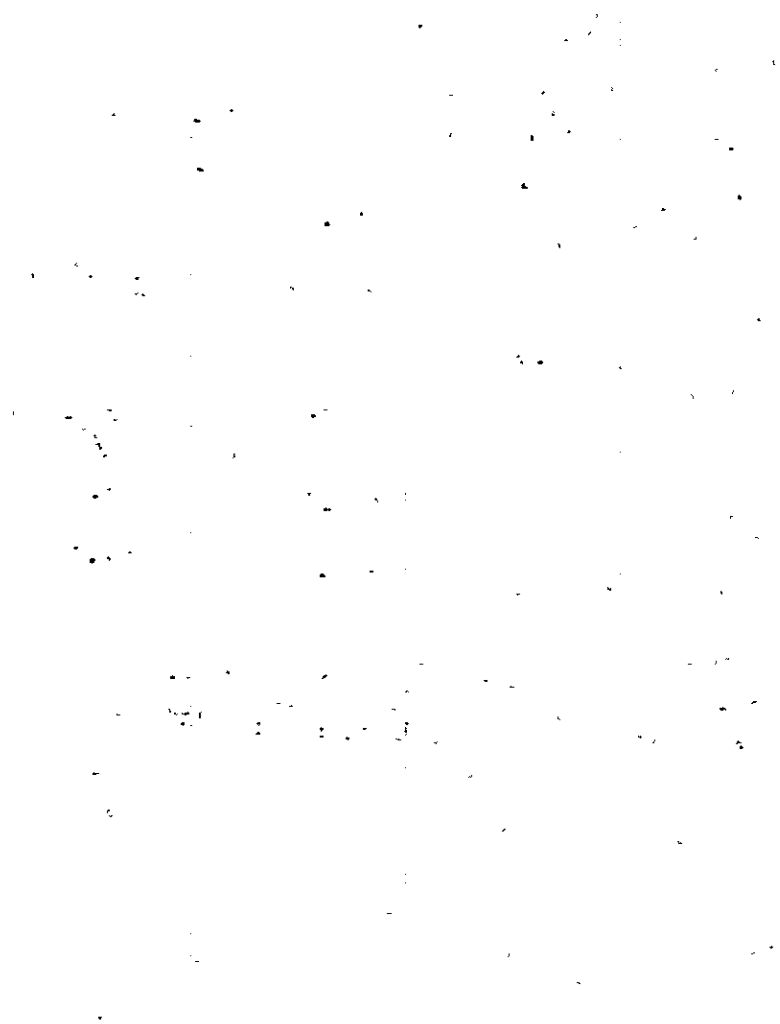
XVI CONCLUSION

(1) Export LPG State

When LPG is exported, LPG must be separate C₃ LPG and C₄ LPG.
And LPG state is not high pressure and atmospheric temperature must
be low.

(2) Expected LPG Production and LPG to Export to Japan

When Thailand intends to export the products and by products
(energy) from Siam Gulf natural gas, Japan expects to import the
products and by products on proportion to the share hold.



Thai natural gas production from 700 MMscf/D natural gas from pipeline and quantity of imported LPG in Japan are as follows :

Thai LPG Production from Natural Gas (from pipeline)

in 1983	3,040 x 10 ³ T
(after 1988	5,590 x 10 ³ T)

Japanese LPG Domestic Production and Import

Domestic in 1983	5,917 x 10 ³ T	33.8 %
Import in 1983 (forecast)	11,589 x 10 ³ T	66.2 %
Total	17,506 x 10 ³ T	100.0 %

Japanese import LPG will be grown up every year.

Japanese LPG market is good for Thailand.

(3) LPG price

I estimate the Thai LPG cost from natural gas as of 1979 before the 2nd oil crisis.

Calculation conditions of Thai LPG cost from natural gas CASE-2 are as follows :

Natural gas production	500 MMscf/D
Natural gas price	2.063 \$/MMBTU
C ₃ LPG price	160 \$/T
C ₄ LPG price	180 \$/T
C ₃ LPG : C ₄ LPG	64.5 : 35.5

Results are as follows :

C ₃ LPG and C ₄ LPG average FOB price	167.1 \$/T
Thai LPG selling price (cost) from natural gas	197.8 \$/T
Loss	30.7 \$/T

Note: *1 come from XI.7

*2 come from TABLE-17 (7) (ATTACH.25)

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According to the above table, the price of natural gas from pipeline is very high compared with other natural gas produced country, so Thai LPG cost from natural gas is very high.

In accordance with circumstances of Thai economics, the export LPG price must be higher than fuel oil price based on calorific power. If export LPG price is lower than fuel oil price, LPG can not export, because of big loss money.

As the above table, at present status, Thailand can not produce and export LPG from natural gas.

(4) Possibility of LPG export

LPG FOB Kuwait price has been going up rapidly.

in 1979			
	April - June	July	on Spot
C ₃ LPG	126.5 \$/T	160 \$/T	150 - 200
C ₄ LPG	127.5 \$/T	180 \$/T	300

The above mentioned price up is not according to crude oil price up, to tight of LPG market.

Therefore, it seems that LPG price will be going up more than 200 \$/T in very near future.

(5) Export port condition

In case of Japan, the port condition and vessel are as follows :

1. Port condition

75,000 M³ cargo is acceptable.

2. Tanker size

50,000 DWT

LOA (length over all) 225 M

Draft 12 M

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3. Cargo lot : about 43,000 T

43,000 T of one LPG lot is following days production.

in 1982 62 days

in 1984 37 days

in 1990 28 days

4. Fleight from Bangkok

Bangkok to Japan 15 \$/T

Comments

(1) If NGOT exports LPG to Japan, he negotiates export port conditions with Japanese importer to fit production scale and port condition of Thailand.

(2) According to NGOT plan, the gas processing unit is about 20 Km far from sea-shore. It is too far for low temperature and very low pressure LPG transportation by pipeline. It is better that the gas processing unit is very close to sea-shore.

Even if, LPG is not exported, LPG must be transported by tanker in inland, tanker transportation fee is cheaper than other way.

(3) C₄ LPG export price is higher than C₃ LPG export price, so C₄ LPG from the refineries is exported and C₃ LPG from natural gas is back to the refineries on same heating value. Therefore, Thai LPG specification is needed to change when more C₄ LPG is exported.

(4) I assumed that the cost of dew point control is 15% on LPG production expense, it has big influence on LPG cost, so the cost of dew point control must be calculated exactly.

Summary

(1) Present LPG FOB price is not feasible for Thai LPG production from natural gas, but in near future LPG FOB price would be going

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up and it will become feasible. NGOT should be watched a movement of LPG FOB price.

(2) Natural gas processing unit should be moved to sea-shore.

end.

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TABLE-1

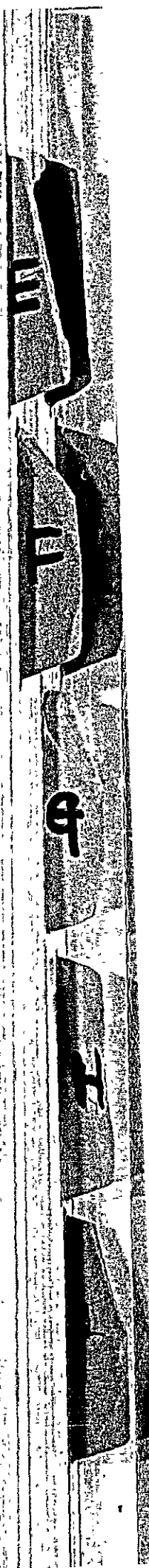
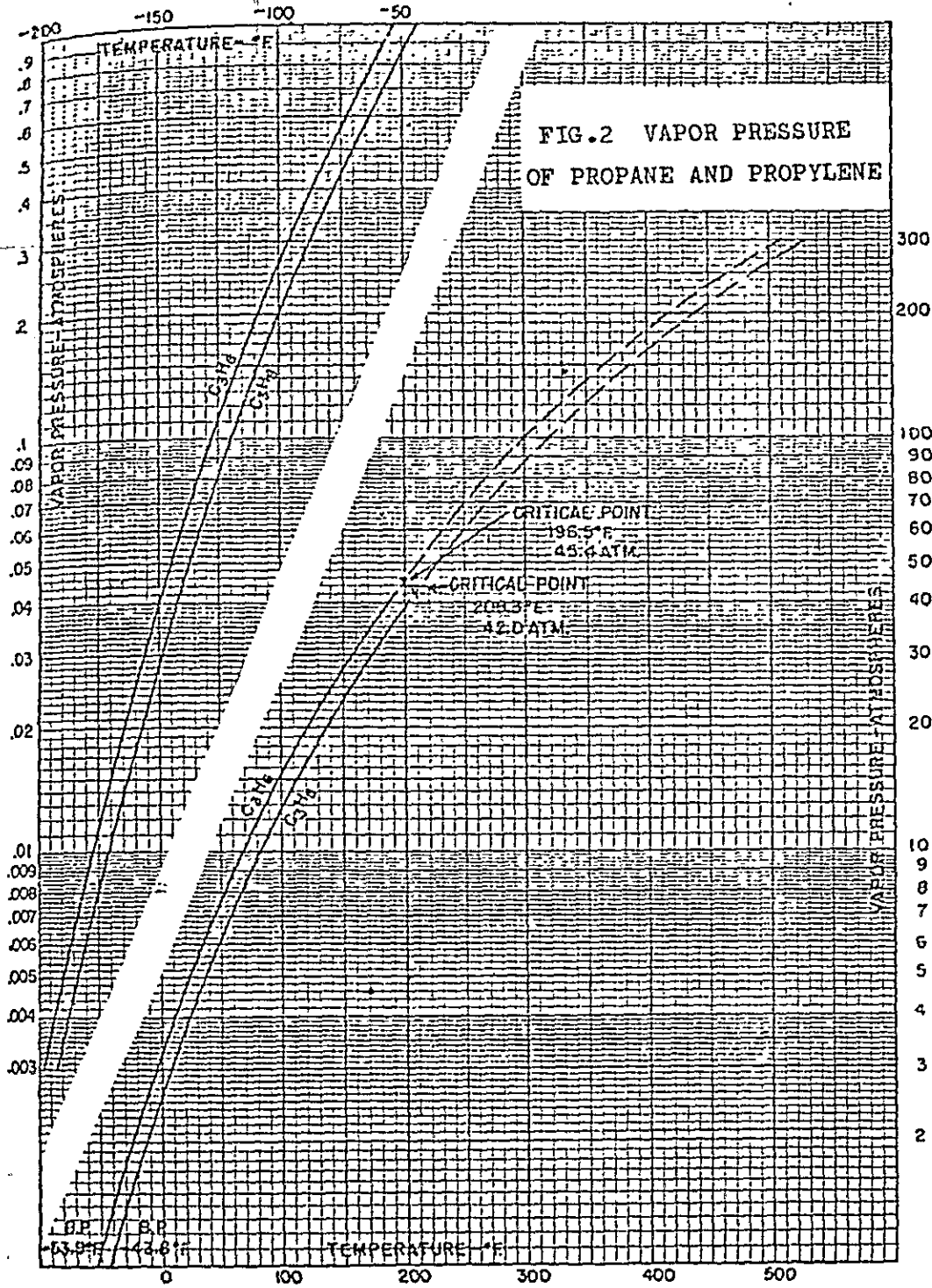
PHYSICAL PROPERTY OF LPG

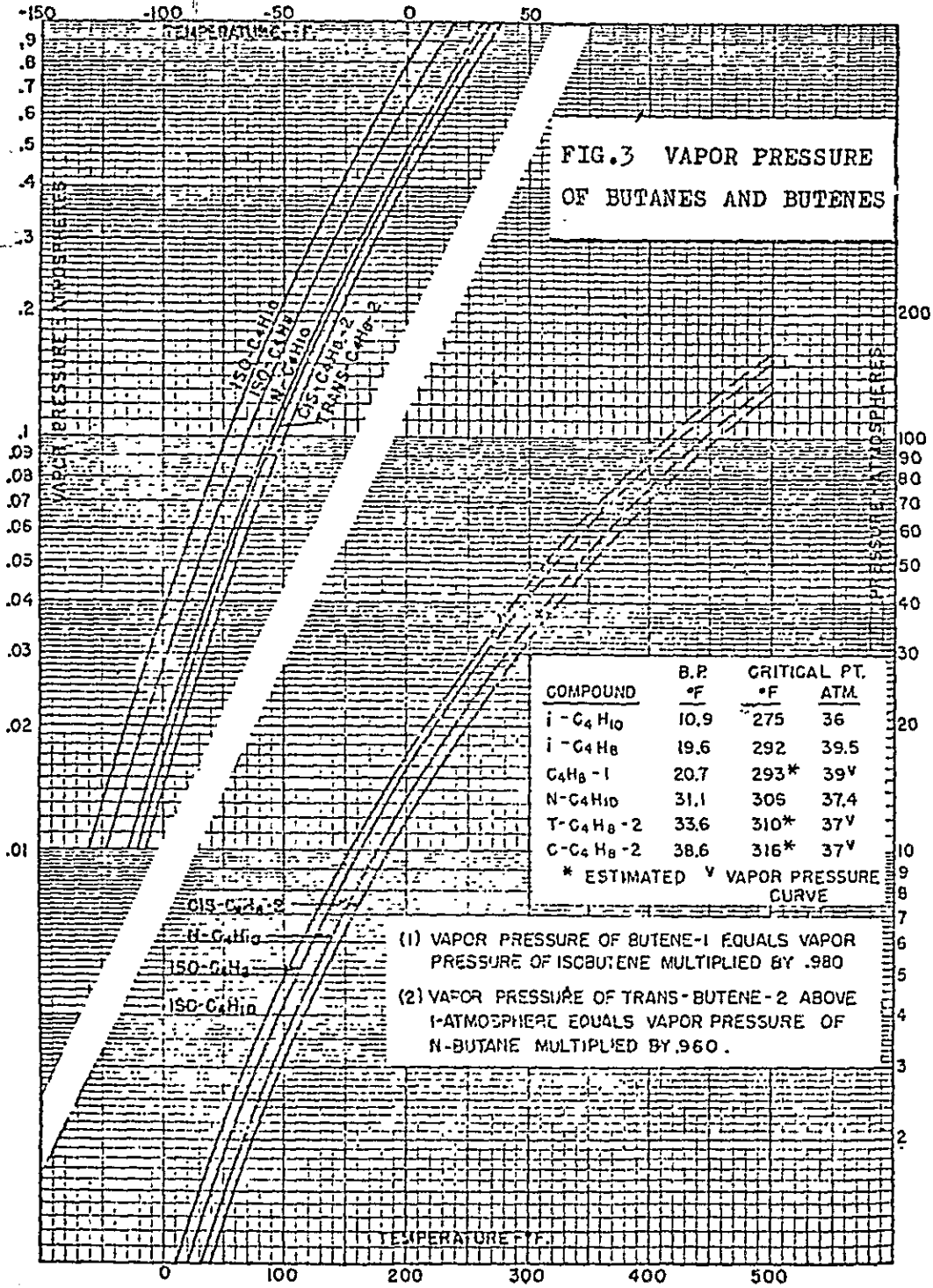
ATTACH.1

	Propane	(Propylene) Propene	n-Butane	i-Butane	(i-Butylene) i-Butene	l-Butene	t-Butene	c-Butene
Molecular Formular	C_3H_8	C_3H_6	C_4H_{10}	C_4H_8	C_4H_8	C_4H_8	C_4H_8	C_4H_8
Molecular Weight	44.1	42.1	58.1	56.1	56.1	56.1	56.1	56.1
Boiling Point (1 atm) ($^{\circ}C$)	-42.1	-47.1	-0.5	-11.7	-6.3	-6.9	0.9	3.7
Melting Point (1 atm) ($^{\circ}C$)	-187.7	-185.3	-138.4	-159.6	-185.4	-140.4	-105.6	-138.9
Specific Gravity Liquid (15 $^{\circ}C$) (g/ml)	0.508	0.523	0.585	0.563	0.601	0.601	0.610	0.627
Gas (15 $^{\circ}C$) (Kg/m^3)	1.895	1.805	2.538	2.529	2.443	2.442	-	2.442
Vapor Pressure (37.8 $^{\circ}C$) (Kg/cm^2A)	13.4	15.9	3.6	5.0	4.4	4.4	3.5	3.2
Gross Heating Value (25 $^{\circ}C$) (Kcal/Kg)	12,020	11,690	11,830	11,800	11,580	11,510	11,530	11,550
(15.6 $^{\circ}C$) ($Kcal/m^3$)	22,830	21,120	30,050	29,850	28,300	28,110	28,170	28,210
(60 $^{\circ}F$) (BTU/lb)	21,650	21,040	21,290	21,240	20,840	20,720	20,750	20,780
Net Heating Value (25 $^{\circ}C$) (Kcal/Kg)	10,930	10,940	10,890	10,840	10,830	10,760	10,780	10,800
(15.6 $^{\circ}C$) ($Kcal/m^3$)	21,000	19,750	27,730	27,540	26,450	26,260	26,330	26,360
(60 $^{\circ}F$) (BTU/Kg)	19,930	19,690	19,670	19,610	19,490	19,370	19,400	19,430
Latent Heat (B.P. 1 atm) (Kcal/Kg)	101.8	104.6	92.1	87.6	93.4	94.2	96.9	99.5
Sensible Heat Gas) (25 $^{\circ}C$) (Kcal/Kg $^{\circ}C$)	0.399	0.368	0.401	0.398	0.365	0.380	0.374	0.336
Sensible Heat Liquid (25 $^{\circ}C$) (Kcal/Kg $^{\circ}C$)	0.602	0.611	0.575	0.582	0.549	0.558	0.544	0.537
Explosion Limit (in air) (vol %)	2.1 - 9.5	2.0 - 10.0	1.8 - 8.4	1.8 - 8.4	1.6 - 9.3	-	-	-
Ignition Temperature (in air) ($^{\circ}C$)	481	548	441	544	443	443		
Gas Specific Gravity (15.6 $^{\circ}C$, 1 atm) (air = 1)	1.550	1.477	2.076	2.068	1.998	1.997	-	1.997

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TABLE-2 THAI INDUSTRIAL SPECIFICATION OF LPG

LIQUEFIED PETROLEUM GAS		LIMITS	TEST METHODS
VAPOR PRESSURE @ 37.8°C	MIN	4.22	ASTM-D-1267
5% BOILING POINT °C	MAX	2.2	ASTM-D-1837
PENTANE AND HEAVIERS VOL % (VAPOR)	MAX	2	ASTM-D-2163
COPPER STRIP CORROSION	MAX	COPPER NO.1	ASTM-D-1838
TOTAL SULPHUR GRAINS/m ³	MAX	0.05	ASTM-D-1266
RESIDUE AFTER EVAPORATION 100 ml	MAX	0.05	ASTM-D-2158
WATER			
ODOR		MARKETABLE	

$C_{3B} : C_{4B} = 3 : 7$ (by volume)

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Item No.	Vapor Pressure (40 °C) (kg/cm ²)	Sulfur wt. %	Component (Mol %)				Usage
			Ethane + Ethylene	Propane + Propylene	Butanes + Butenes	Butadienes	
1	15.8 Max.	0.02 Max.	-	90 Min.	-	-	Industry, Motor car, and Others.
2	15.8 Max.	0.02 Max.	-	50 Min. 90 Max.	-	-	
3	12.7 Max.	0.02 Max.	-	-	40 Min. 90 Max.	-	Industry, Motor car, and Others.
4	5.3 Max.	0.02 Max.	-	-	90 Min.	-	
R	15.6 Max.	0.015 Max.	8 Max.	60 Min. 80 Max.	-	2 Max.	Household (general use)
C	15.6 Max.	0.015 Max.	8 Max.	80 Min.	-	2 Max.	Household (for very cold weather area in winter)

ATTACH.5

9

Handwritten text, possibly bleed-through from the reverse side of the page. The text is extremely faint and illegible due to the quality of the scan. It appears to be organized into several columns and rows, possibly representing a list or a table of data.

TABLE-4 STANDARD OF SPECIFICATION OF LPG
IMPORTED TO JAPAN

	C ₃ LPG Mol%	C ₄ LPG Mol%
C ₂	2.0 Max.	-
C ₃	96.0 Min.	-
C ₄	2.5 Max.	95.0 Min.
C ₅		2.0 Max.



TABLE-5 LPG DEMAND FORECAST IN THAILAND AND JAPAN (CAPITAL ESTIMATION)

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
IN THAILAND											
10 ³ Kl	147	195	188	197	223	240	292	317	356	396	444
10 ³ T	84*	112	108	123	128	138	167	182	204	227	254
IN JAPAN											
10 ³ T											
Household	4,208	4,616	4,833	4,990	5,265	5,275	5,453	5,690	5,937	6,195	6,461
Industry	1,586	2,009	2,131	2,438	2,750	3,067	3,627	4,093	4,328	4,592	4,853
Town gas	407	401	493	563	692	674	777	981	1,070	1,163	1,345
Motor Car	1,506	1,495	1,448	1,558	1,655	1,677	1,707	1,736	1,753	1,769	1,786
Petrochemical Raw Material	1,087	1,194	1,069	866	806	932	977	1,030	1,034	1,038	1,041
Export	30	50	10	8	5	1	8	8	8	8	8
Total	8,824	9,765	9,990	10,423	11,173	11,626	12,549	13,538	14,130	14,765	15,494

Note: * Specific gravity C_{3s} 0.5155 x 30% = 0.15465
 C_{4s} 0.5978 x 70% = 0.41846
 147 x 0.573 = 84
 0.573

Handwritten text, possibly a list or notes, with some illegible characters and symbols. The text is arranged in several lines and appears to be a collection of entries or observations.

SUPPLY/DEMAND	YEAR	1978			1979			1980	1981	1982	1983
		1st half	2nd half	Total	1st half	2nd half	Total				
SUPPLY											
DOMESTIC		4,668	2,320	2,610	4,930	5,244	5,483	5,735	5,917		
IMPORT		8,232	4,545	4,714	9,259	9,413	10,436	10,922	11,589		
TOTAL		12,900	6,865	7,324	14,189	14,657	15,969	16,657	17,506		
DEMAND											
HOUSEHOLD USE		5,340	2,404	3,126	5,532	5,712	5,898	6,090	6,288		
INDUSTRIAL FUEL		3,316	1,765	1,853	3,618	3,798	4,010	4,218	4,439		
ELECTRIC POWER		344	330	135	465	509	966	1,243	1,486		
TOWN GAS		942	451	726	1,177	1,344	1,436	1,597	1,623		
AUTOMOBILE FUEL		1,721	849	876	1,725	1,748	1,776	1,796	1,814		
CHEMICAL FEEDSTOCK		1,271	614	750	1,564	1,471	1,522	1,553	1,576		
EXPORT		41	20	20	40	40	40	40	40		
TOTAL		12,975	6,433	7,488	13,921	14,621	15,650	16,537	17,265		
INVENTORY		970	1,402	1,238	1,238	1,274	1,593	1,713	1,954		

TABLE-7 JAPANESE LPG IMPORT BY SUPPLY SOURCES.

ATTACH.9

UNIT: 1,000M/T

COUNTRY \ YEAR	1971	1972	1973	1974	1975	1976	1977
SAUDI ARABIA	1,003	1,101	1,750	2,654	2,799	3,464	3,911
AUSTRALIA	553	741	1,029	1,008	1,097	1,084	1,255
KUWAIT	1,158	1,249	1,303	929	823	853	997
IRAN	575	678	771	767	703	708	704
CANADA	250	267	224	223	252	249	241
VENEZUELA	71	259	103	27	25	-	26
OTHERS	11	130	34	70	232	212	180
TOTAL	3,621	4,425	5,214	5,678	5,911	6,570	7,314

1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes that proper record-keeping is essential for ensuring transparency and accountability in financial operations.

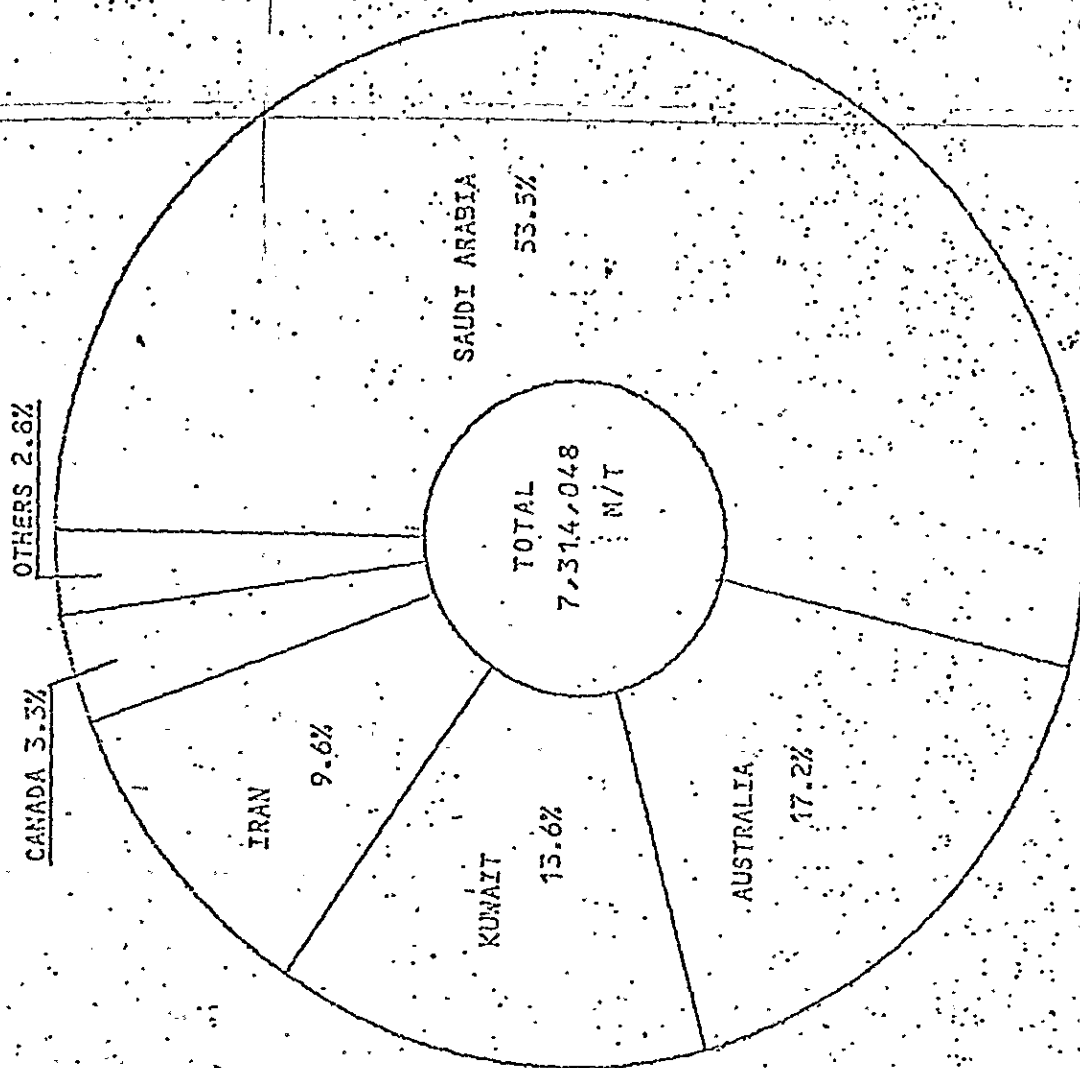
2. The second part of the document outlines the various methods and tools used to collect and analyze data. It highlights the need for consistent data collection procedures and the use of advanced analytical techniques to derive meaningful insights from the data.

3. The third part of the document focuses on the challenges and risks associated with data management. It identifies common pitfalls such as data loss, corruption, and security breaches, and provides strategies to mitigate these risks through robust backup and security protocols.

4. The fourth part of the document discusses the importance of data privacy and compliance with relevant regulations. It stresses the need for clear policies and procedures to protect sensitive information and ensure that all data handling activities are in full compliance with applicable laws.

5. The fifth part of the document concludes by summarizing the key findings and recommendations. It reiterates the importance of a proactive approach to data management and the need for continuous monitoring and improvement of data practices.

FIG.3 SHARE OF JAPANESE LPG IMPORT BY SUPPLY SOURCES (AS OF 1977)



9

COMPANY	1972	1973	1974	1975	1976	1977
NIPPON PET. GAS	681	771	1,135	1,332	1,385	1,363
NETSU & BRIDGESTONE LIQ. GAS GROUP	1,326	1,464	1,473	1,146	1,297	1,338
IDEMITSU SEKIYU	293	372	652	638	673	919
MITSUBISHI LIQ. GAS	511	598	494	432	572	859
GENERAL SEKIYU	191	227	335	348	530	565
MARUZEN SEKIYU	217	181	278	468	501	495
KYODO SEKIYU	455	616	543	474	411	429
ESSO	150	201	147	286	364	397
SHELL	119	225	200	227	307	379
NIKKO LIQ. GAS	283	311	286	252	250	242
OTHERS	195	212	237	328	398	274
TOTAL	4,421	5,178	5,760	5,911	6,688	7,260

1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes that proper record-keeping is essential for ensuring transparency and accountability in financial reporting.

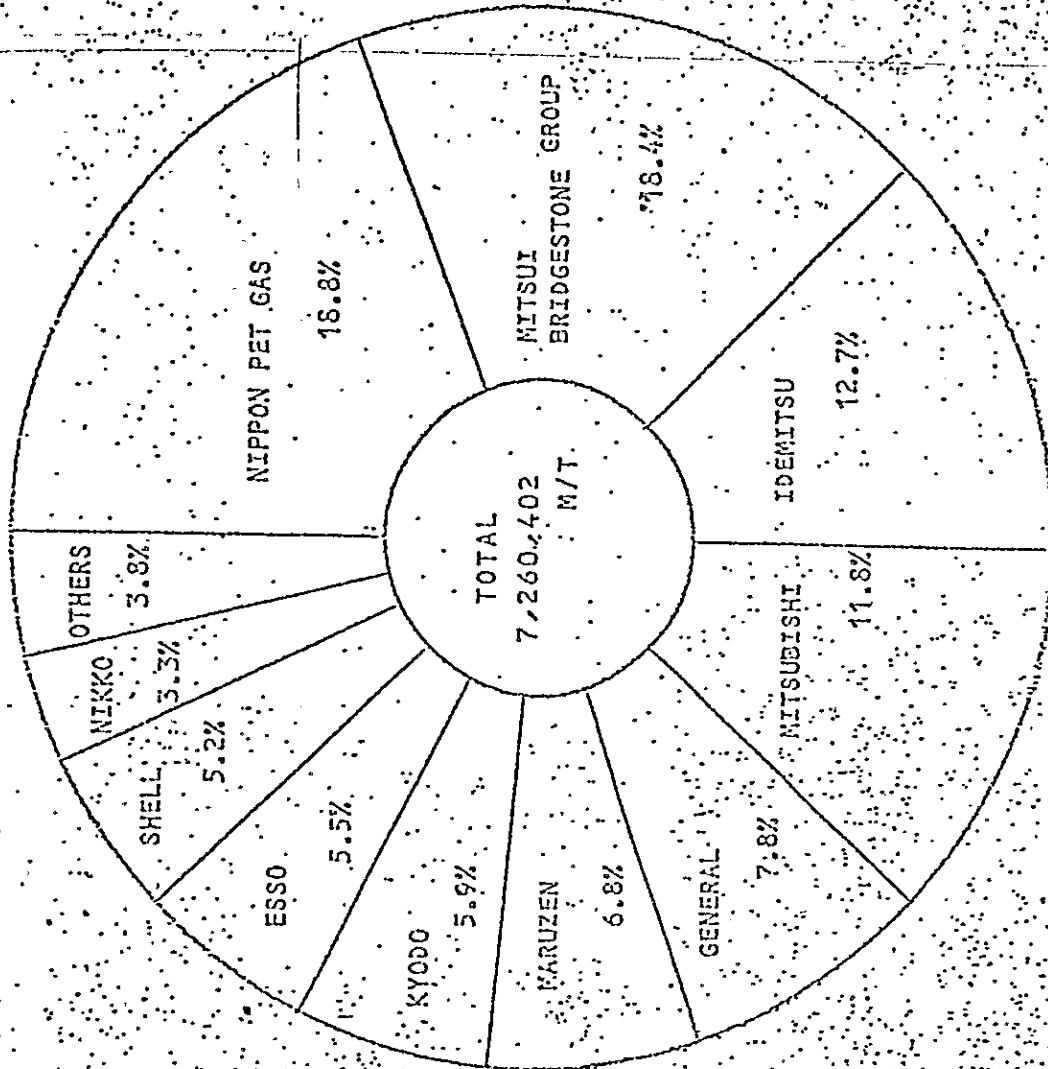
2. The second part of the document outlines the various methods and techniques used to collect and analyze data. It highlights the need for consistent and reliable data collection processes to ensure the validity of the results.

3. The third part of the document focuses on the analysis and interpretation of the collected data. It discusses the various statistical and analytical tools used to identify trends, patterns, and relationships within the data.

4. The fourth part of the document discusses the implications and conclusions drawn from the analysis. It highlights the key findings and their potential impact on the organization's operations and decision-making processes.

5. The fifth part of the document provides a summary of the overall findings and recommendations. It emphasizes the need for continuous monitoring and evaluation to ensure the effectiveness of the implemented measures.

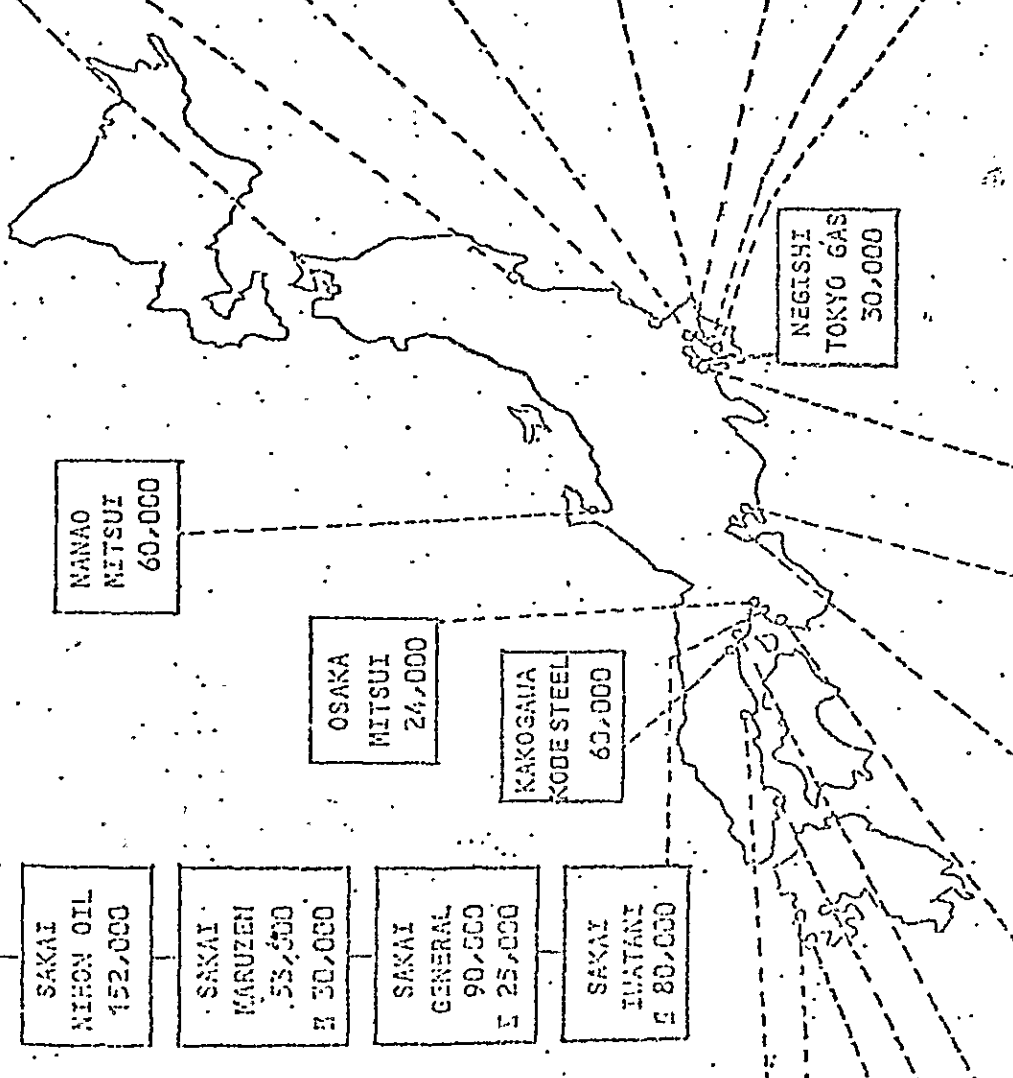
FIG.4 SHARE OF LPG IMPORT IN JAPAN (AS OF 1977)



COUNTRIES UNDER CONSTRUCTION / BEING PLANNED

LOCATIONS (COUNTRIES)

MIYAZAKI GROUP	389,000
MIYAZAKI	240,000
MIYAZAKI OIL GAS	216,000
MIYAZAKI	165,000
KYODO	147,000
ESSO	131,000
GENERAL	124,000
TEPCO	118,000
MIYAZAKI LIC. GAS	94,000
KOBE STEEL	60,000
FUJIKEN	53,000
TOKYO GAS	52,000
SEMIKAWA METAL	43,000
TOTAL	1,353,000
MIYAZAKI GROUP	12,000
MIYAZAKI	180,000
MIYAZAKI	80,000
MIYAZAKI	30,000
MIYAZAKI	74,000
MIYAZAKI	74,000
MIYAZAKI	52,000
MIYAZAKI	30,000
MIYAZAKI	25,000
TOTAL	591,000



SEIDAI	30,000
MIYAZAKI	12,000
MIYAZAKI	105,000
KASHIWA	107,000
KYODO	107,000
CHIBA	80,000
MIYAZAKI (HARUJEN)	80,000
CHIBA	60,000
MIYAZAKI	60,000
ANEGASAKI	112,000
TEPCO	74,000
TOYOSU	22,000
TOKYO GAS	22,000
SODEGAURA	131,000
ESSO	131,000
ICHIHARA	160,000
MIYAZAKI	160,000

NAWAO
MIYAZAKI
60,000

OSAKA
MIYAZAKI
24,000

KAKOGAWA
KOBELCO
60,000

NEGISHI
TOKYO GAS
50,000

SAKAI
GENERAL
90,000

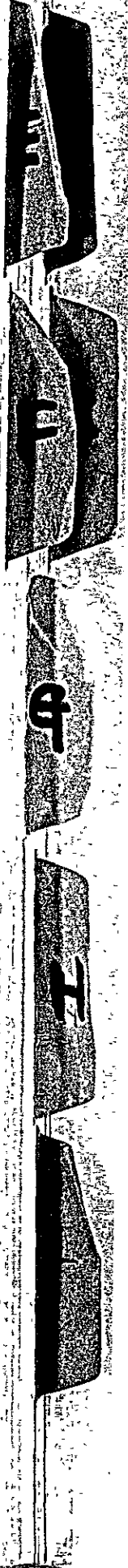
SAKAI
IZUMI
80,000

SAKAI
NIHON OIL
152,000

SAKAI
MARUZEN
53,000

KAWASAKI	73,000
MIYAZAKI	180,000
CHITA	180,000
HEKINAN	78,000
SHELL	78,000
NIHON OIL	64,000
KAWASAKI	64,000
KAWASAKI	40,000
KYODO	40,000
GENERAL	35,000
KAWASAKI	35,000
KAWASAKI	36,000
MIYAZAKI	36,000
MIYAZAKI	48,000
SUMITOMO	48,000
METAL	48,000
KOBE	60,000
MIYAZAKI	60,000
TOKUYAMA	20,000
MIYAZAKI	20,000

* TEPCO: TOKYO ELECTRIC POWER COMPANY
** IDEMITSU ETC. IDEMITSU/NIHON OIL GAS/DAIKYO ETC.



1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes that proper record-keeping is essential for transparency and accountability, particularly in financial reporting and compliance with regulatory requirements. The text notes that incomplete or inaccurate records can lead to significant legal and financial consequences for the organization.

2. The second part of the document outlines the various methods and tools used to collect and analyze data. It highlights the importance of using reliable and validated data sources to ensure the integrity of the information. The text also discusses the challenges associated with data collection, such as ensuring data privacy and security, and the need for robust data management systems to handle large volumes of information effectively.

3. The third part of the document focuses on the analysis and interpretation of the collected data. It describes the various statistical and analytical techniques used to identify trends, patterns, and correlations within the data. The text emphasizes that a thorough understanding of the data is crucial for making informed decisions and developing effective strategies. It also notes that the interpretation of data should be done in the context of the organization's goals and objectives.

4. The final part of the document discusses the implications of the findings and the need for ongoing monitoring and evaluation. It stresses that the information gathered from the data analysis should be used to inform decision-making and to drive positive change within the organization. The text concludes by noting that the process of data collection and analysis is an iterative one, and that organizations should be prepared to adapt and refine their approaches as they gain more insight into their operations.

Tokyo Area (Kei-Yo Area)

Chiba (Mitsui + Marubeni) 80,000
 Chiba (Idemitsu) 60,000
 Anegasaki (Tokyo Electric Power Co.) 74,000 (under construction)
 Toyosu (Tokyo Electric Power Co.) 22,000
 Ichihara (Mitsui/Mobil) 180,000 (under construction)
 Sodegaura (ESSO) 131,000
 Negishi (Tokyo Gas) 30,000
 Kawasaki (Mitsui) 36,000
 " (General) 36,000
 " (Kyodo) 40,000
 " (Nihon Oil) 64,000

Total

753,000

Nagoya Area (Chukyo Area)

Hekinan (Shell) 78,000 (under construction)
 Chita (Idemitsu) 180,000

Total

258,000

Osaka Area (Ken-Hanshin Area)

Osaka (Mitsui) 24,000
 Katagawa (Kobe Steel) 60,000
 Sakai (Mitsui) 80,000
 " (Nihon Oil) 152,000
 " (Maruzen) 53,000
 " (General) 30,000 (under construction)
 " (General) 90,000
 " (Iwatani) 25,000 (under construction)
 Wakayama (Sumitomo Metal) 80,000 (under construction)
 Kobe (Mitsubishi) 48,000
 Kobe (Mitsubishi) 60,000

Total

702,000

Others

716,000

Grand Total

2,429,000

ATTACH.14

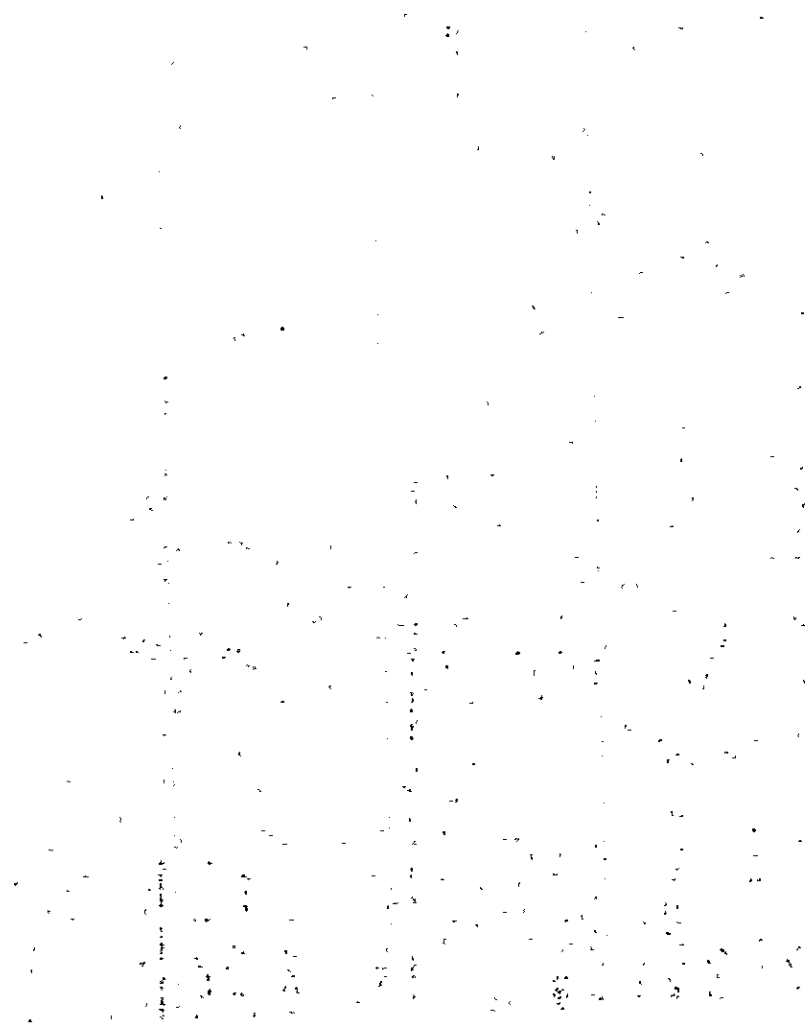
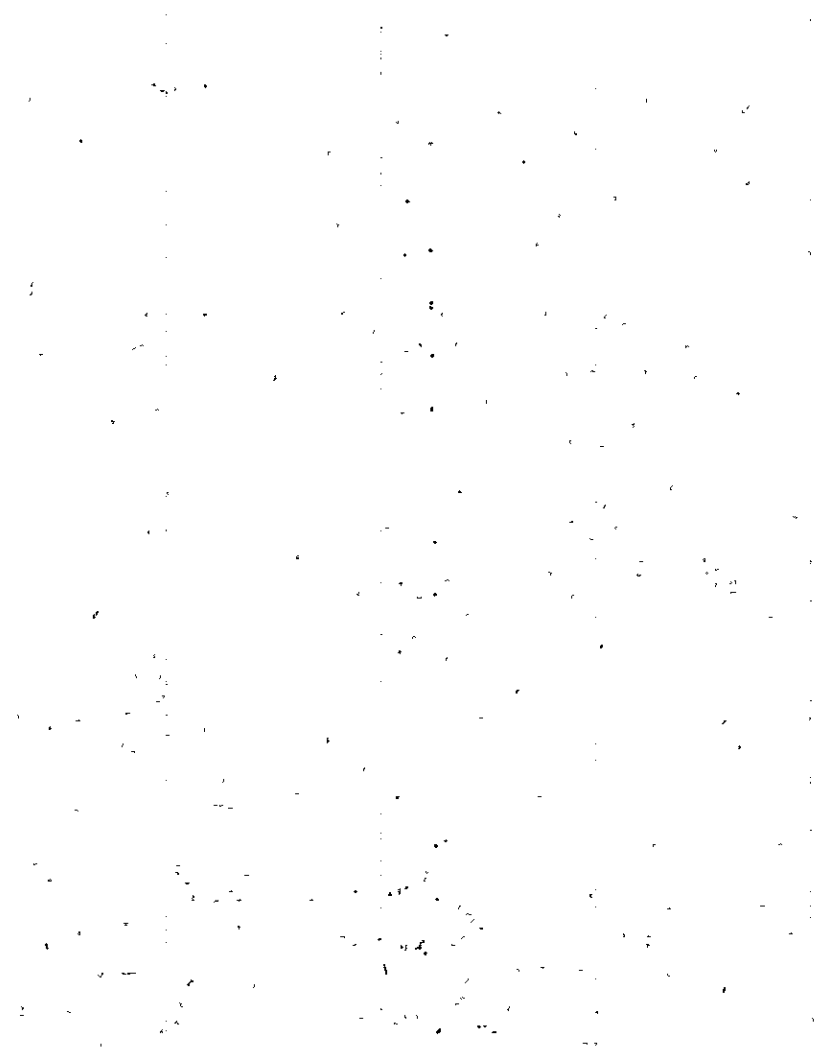


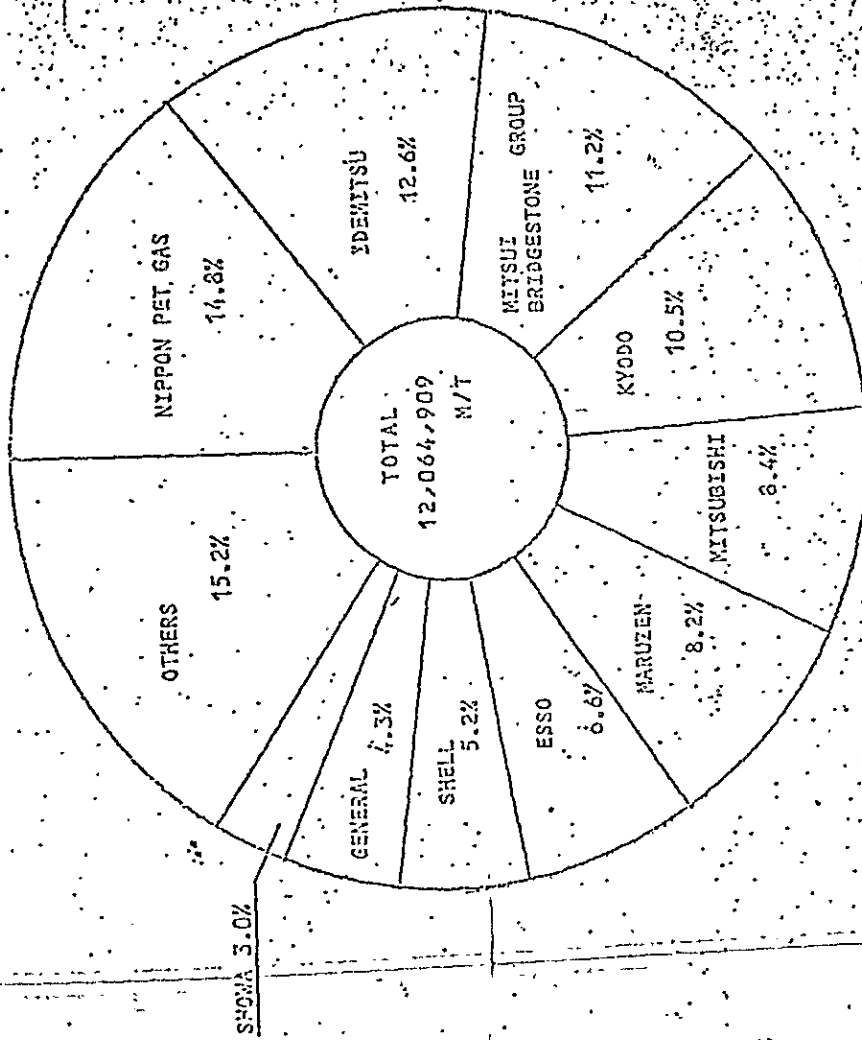
TABLE-10 LPG IMPORT TERMINAL CAPACITY BY COMPANY

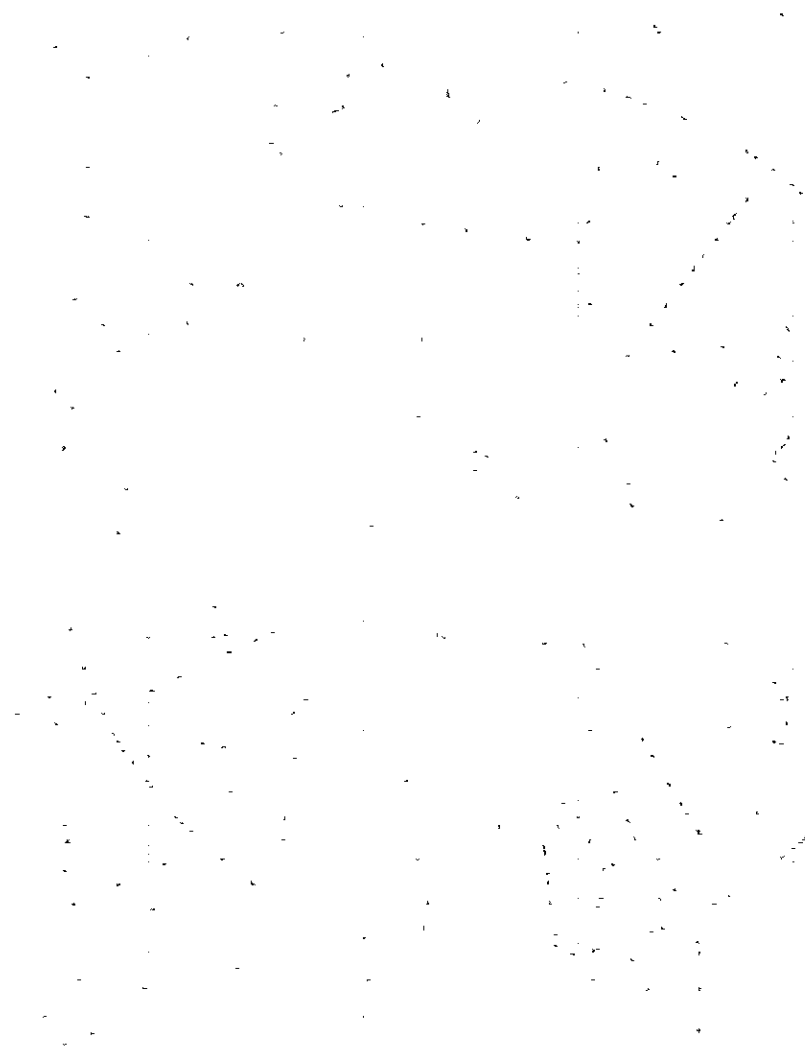
	T
Mitsui Group	388,000
	12,000 (under construction)
Mitsui/Mobil	180,000 (" ")
Idemitsu	240,000
	80,000 (under construction)
Idemitsu etc.	32,000 (" ")
Nohon Pet. Gas	216,000
Mitsubishi	165,000
Kyodo	147,000
ESSO	131,000
General	126,000
	25,000 (under construction)
Tokyo Electric Power Co.	118,000
	74,000 (under construction)
Nikko Liq. Gas	94,000
Kobe Steel	60,000
Maruzen	53,000
	30,000 (under construction)
Tokyo Gas	52,000
Suwitomo Metal	48,000
Iwatani	80,000 (under construction)
Shell	78,000 (" ")
Total	2,429,000



COMPANY	1972	1973	1974	1975	1976	1977
NEPPON PET GAS	1,031	1,178	1,416	1,612	1,790	1,783
IDEMITSU	1,193	1,209	1,219	1,214	1,345	1,521
MIITSUI ERLDGESTONE GROUP	1,298	1,437	1,326	1,174	1,157	1,348
KYODO	815	999	1,092	1,092	1,317	1,275
MIITSUBISHI	767	775	793	852	912	1,012
MARUZEN	740	761	788	921	975	986
ESSO	761	851	814	783	712	794
SHELL	360	422	463	561	602	631
GENERAL	422	400	422	488	490	523
SHOWA	205	205	200	250	303	365
OTHERS	1,794	1,940	1,978	1,642	1,651	1,829
TOTAL	9,386	10,177	10,511	10,769	11,454	12,065

FIG.6 SHARE OF LPG SALES IN JAPAN (AS OF 1977)

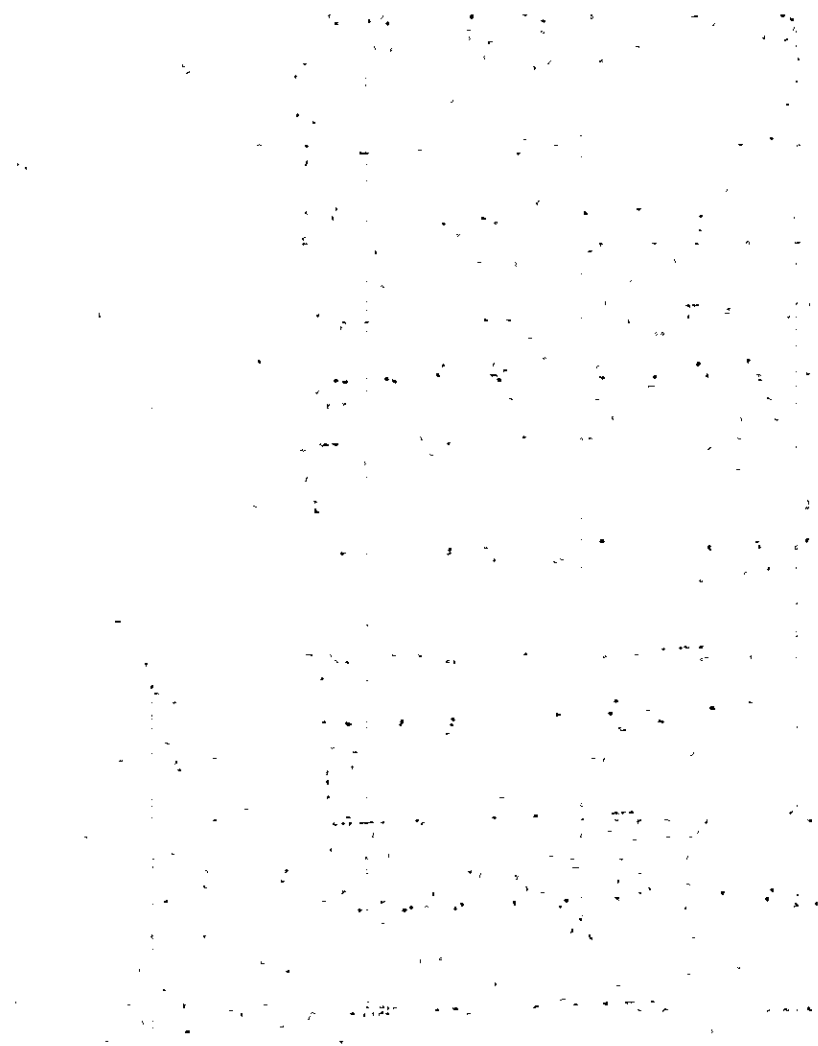




	C ₃					C ₄				
	(1)	(2)	(3)	(4)	(5)	(1')	(2')	(3')	(4')	(5')
	Gas From Pipeline Lb-Mol/H	(1)x379÷10 ³ 10 ³ scf/H	(2)x90% ³ 10 ³ scf/H	(3)÷379x44.094 ² 10 ³ Lb/H	(4)÷2.2 T/H	Gas From Pipeline Lb-Mol/H	(1')x379÷10 ³ 10 ³ scf/H	(2')x98% 10 ³ scf/H	(3')÷379x58.12 ² 10 ³ Lb/H	(4')÷2.2 T/H
1981	595.7	225.8	203.2	23.6	10.7	239.3	90.7	88.9	13.6	6.2
1982	993.4	376.5	338.9	39.4	17.9	404.9	153.5	150.4	23.1	10.5
1983	1,191.6	451.6	406.4	47.3	21.5	484.8	183.5	179.8	27.6	12.5
1984	1,655.7	627.5	564.8	65.7	29.9	674.8	255.7	250.6	38.4	12.9
1985	1,655.7	627.5	564.8	65.7	29.9	674.8	255.7	250.6	38.4	12.9
1986	1,920.6	727.9	655.1	76.2	34.6	785.0	297.5	291.6	44.7	20.3
1987	1,920.6	727.9	655.1	76.2	34.6	785.0	297.5	291.6	44.7	20.3
1988	2,186.2	828.6	745.7	86.8	39.5	895.4	339.4	332.6	51.0	23.2
1989	2,186.2	828.6	745.7	86.8	39.5	895.4	339.4	332.6	51.0	23.2
1990	2,186.2	828.6	745.7	86.8	39.5	895.4	339.4	332.6	51.0	23.2

Note: *1 Fluor's report
 *2 Molecular Weight
 *3 Yield of C₃ and C₄ recovery





(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Specification	Adjusting	Molecular Weight	(2) x (3)	(4) x 0.4536 ¹	(2) x 379 ²	(6) x 0.0267 ^{*3}	BTU/lb (Gross)	(4) x (8)	(9) x (6) x 10 ⁶
Mol %	Mol %	lb	lb	Kg	scf	MM ³	(Gross)	MM BPU	BTU/scf (Gross)
C ₂ LPG	1.8	30.068	54.12	24.55	682.2	18.2	22,300	1.21	
C ₃	96.0	44.094	4,233.02	1,920.10	36,384.0	971.4	21,650	91.64	
C ₄	2.2	58.120	127.86	58.00	833.8	22.3	21,265 ^{*4}	2.72	
Total	100.0		4,415.00	2,002.65	37,900.0	1,011.9		95.57	2,522
C ₄ LPG	98.0	58.120	5,695.76	2,583.60	37,142.0	991.7	21,265 ^{*4}	121.12	
C ₅	2.0	72.146	144.29	65.45	758.0	20.2	21,020 ^{*5}	3.03	
Total	100.0		5,840.05	2,649.05	37,900.0	1,011.9		151.15	3,988

Note: data from TABLE-14-1 and-2 (ATTACH.20-1 and-2).

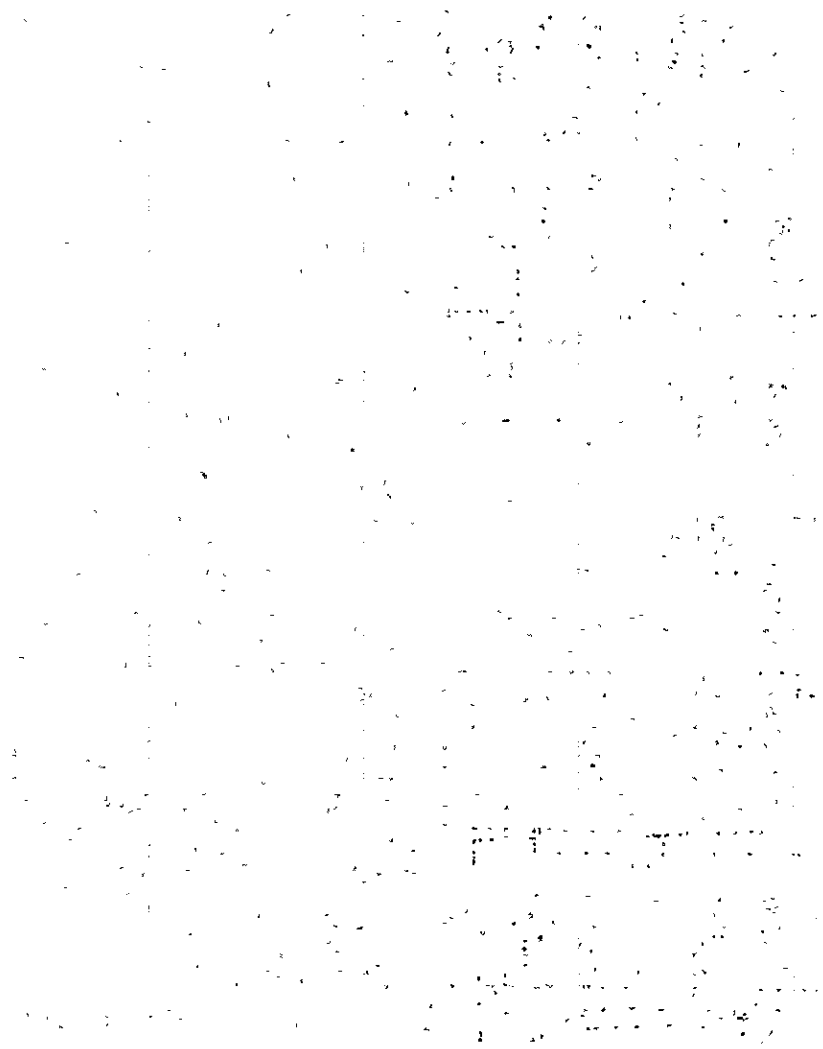
*1 1 lb = 2.2046

*2 1 lb mol = 379 ft³

*3 1 scf = 0.0283 x $\frac{460}{460+(60-32)}$ = 0.0267

*4 Butanes (21,290 + 21,240) ÷ 2 = 21,265

*5 Pentanes (21,070 + 21,030 + 20,960) ÷ 3 = 21,020

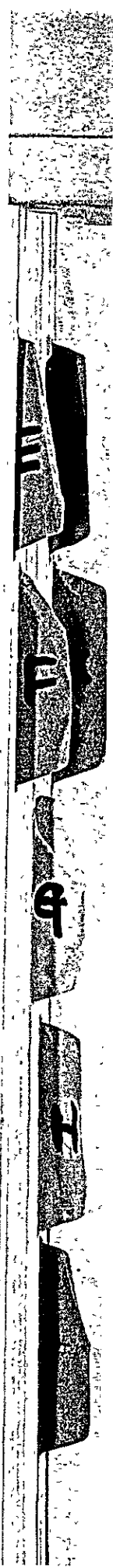


(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
BTU/lb (Net)	(4) x (11) MMBTU	(12) ÷ (6) x 10 ⁹ BTU/sec (Net)	(9) ÷ (4) BTU/lb (Gross)	(12) ÷ (4) BTU/lb (Net)	(14) x 0.5556 ^{*8} Kcal/kg (Gross)	(15) x 0.5556 ^{*8} Kcal/kg (Net)	(16) x 0.5083 ^{*9} Kcal/lit (Gross)	(17) x 0.1746 ^{*9} Kcal/lit (Net)
C ₂ 20,420	1.11							
C ₃ 19,930	84.36							
C ₄ 19,640 ^{*6}	2.51							
Total	87.98	2,321	21,647	19,928	12,027	11,072	6,113	6,362
C ₄ 19,640 ^{*6}	111.86							
C ₅ 19,429 ^{*7}	2.80							
Total	114.66	3,025	25,882	19,634	14,308	10,909	7,309	5,545

Note: *6 Butanes (19,670 + 19,610) = 19,640 BTU/lb *7 Pentanes (19,500 + 19,450 + 19,330) ÷ 3 = 19,427 BTU/lb
*8 1 BTU/lb = 0.5556 Kcal/Kg
*9 Specific Gravity

Ethylene	0.374	Butanes	0.584	Pentanes	0.631
Propane	0.508		<u>0.563</u>		0.625
C ₂ .24.55 x 0.374 = 9.182			0.5735		0.577
C ₃ 1,920.10 x 0.508 = 975.441		C ₄ 2,583.60 x 0.5735 = 1,481.695			0.6177
C ₄ .58.00 x 0.5735 = 33.263		C ₅ 65.45 x 0.6177 = 40.428			
2,002.65 mean	<u>0.5083</u>	2,649.05 mean			

ATTACH. 19-22



1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes that this is crucial for ensuring transparency and accountability, particularly in the context of public administration or financial reporting. The text suggests that such records should be kept in a secure and accessible format, allowing for easy review and audit.

2. The second part of the document addresses the need for regular communication and reporting. It states that stakeholders should be kept informed of progress and any challenges encountered. This involves establishing clear channels of communication and providing timely updates. The document also highlights the importance of listening to feedback and incorporating it into the ongoing process.

3. The third part of the document focuses on the importance of collaboration and teamwork. It notes that achieving the organization's goals requires the input and effort of all team members. This involves fostering a culture of mutual respect and support, where individuals feel valued and motivated to contribute their best work. The text also suggests that regular team meetings and open lines of communication are essential for maintaining this collaborative spirit.

4. The fourth part of the document discusses the importance of continuous learning and improvement. It states that the organization should be committed to staying up-to-date with the latest industry trends and best practices. This involves investing in training and development programs for employees, as well as encouraging a culture of innovation and experimentation. The document also suggests that regular performance reviews and feedback loops are essential for identifying areas for improvement and implementing necessary changes.

5. The fifth part of the document concludes by reiterating the importance of these key principles and encouraging the organization to embrace them fully. It states that by doing so, the organization can ensure its long-term success and the well-being of its stakeholders. The text ends with a call to action, urging all team members to take ownership of their roles and contribute to the organization's overall mission.

TABLE-14-1 PHYSICAL CONSTANTS OF HYDROCARBONS

	FORMULA	MOLEC. WT.	BOILING POINT °F	MELTING POINT °F	DENSITY			CRITICAL CONSTANTS			HEAT OF COMBUSTION @ 60°F-BTU/lb	
					API	Sp Gr. 60°/60°	Lb/cu ft	t °F	P Atm	D G/ml	Gross	Net
NORMAL PARAFFINS												
Methane.....	CH ₄	16.0	-258.9	-290.6	340	0.30	2.50	-110.3	45.8	0.182	23,800*	21,500*
Ethane.....	C ₂ H ₆	30.1	-128.0	-297.8	247	.374	3.11	+ 90.1	48.2	.203	22,300*	20,420*
Propane.....	C ₃ H ₈	44.1	-43.8	-305.7	147	.508	4.23	206.3	42.0	.226	21,650*	19,930*
Butane.....	C ₄ H ₁₀	58.1	+ 31.1	-216.9	111	.584	4.80	306	37.4	.225	21,290*	19,670*
Pentane.....	C ₅ H ₁₂	72.1	90.9	-201.5	92.7	.631	5.25	386.5	32.6	.232	21,070*	19,500*
Hexane.....	C ₆ H ₁₄	86.2	157.7	-139.5	81.6	.664	5.53	455.0	29.4	.234	20,780	19,240
Heptane.....	C ₇ H ₁₆	100.2	209.2	-131.1	74.2	.688	5.73	512.5	26.5	.234	20,870	19,160
Octane.....	C ₈ H ₁₈	114.2	239.2	- 70.3	68.6	.707	5.89	565	24.5	.233	20,690	19,100
Nonane.....	C ₉ H ₂₀	128.2	303.4	- 64.5	64.5	.722	6.01	612	23	—	20,530	19,050
Decane.....	C ₁₀ H ₂₂	142.3	315.2	- 21.5	61.3	.734	6.11	651	22	—	20,480	19,020
Undecane.....	C ₁₁ H ₂₄	156.3	381.4	- 14.1	58.7	.744	6.19	695	20	—	20,450	19,000
Dodecane.....	C ₁₂ H ₂₆	170.3	421.3	+ 14.7	56.4	.753	6.27	731	18	—	20,420	18,980
ISO-PARAFFINS												
Isobutane.....	C ₄ H ₁₀	58.1	10.9	-255.0	120	.563	4.69	275	36	.234	21,240*	19,610*
2-Methylbutane (Isopentane).....	C ₅ H ₁₂	72.1	82.2	-255.5	94.9	.625	5.20	369.5	32.4	.234	21,030*	19,450*
2,2-Dimethylpropane (Neopentane).....	C ₅ H ₁₂	72.1	49.0	+ 2.1	103	.597	4.97	329	35	—	20,960*	19,330*
2-Methylpentane (Isohexane).....	C ₆ H ₁₄	86.2	140.5	-245	83.5	.558	5.49	437	31	—	20,750	19,210
3-Methylpentane.....	C ₆ H ₁₄	86.2	145.9	-180	80.0	.659	5.57	443	30	—	20,760	19,220
2,2-Dimethylbutane (Neohexane).....	C ₆ H ₁₄	86.2	121.5	-147.6	84.9	.664	5.44	415	31	—	20,700	19,160
2,3-Dimethylbutane (Diisopropyl).....	C ₆ H ₁₄	86.2	136.4	-198.6	81.0	.669	5.54	441	31	.241	20,740	19,200
2-Methylhexane (Isoheptane).....	C ₇ H ₁₆	100.2	194.1	-160.8	75.7	.683	5.68	490	28	—	20,630	19,140
3-Methylhexane.....	C ₇ H ₁₆	100.2	197.5	-162.9	73.0	.692	5.76	504	28.5	—	20,600	19,150
3-Ethylpentane.....	C ₇ H ₁₆	100.2	200.2	-161.5	69.8	.703	5.85	508	28.5	—	20,670	19,160
2,2-Dimethylpentane.....	C ₇ H ₁₆	100.2	174.0	-190.6	77.2	.678	5.64	475	28.5	—	20,600	19,090
2,3-Dimethylpentane.....	C ₇ H ₁₆	100.2	193.6	-	70.6	.700	5.83	498	29	—	20,640	19,130
2,4-Dimethylpentane.....	C ₇ H ₁₆	100.2	176.9	-183.1	77.2	.678	5.64	477	28.5	—	20,620	19,110
3,3-Dimethylpentane.....	C ₇ H ₁₆	100.2	186.9	-211.0	71.2	.696	5.81	487	28	—	20,620	19,110

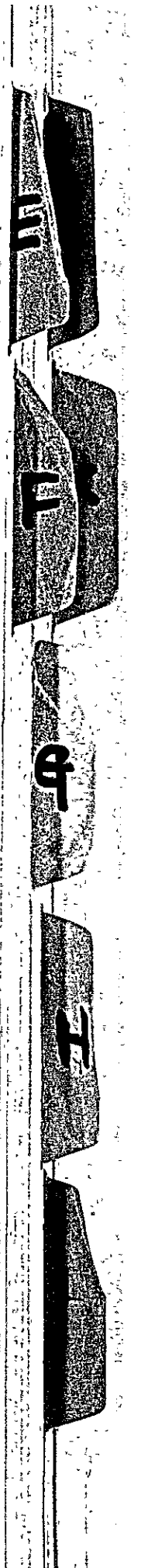


TABLE-14-2

PHYSICAL CONSTANTS OF HYDROCARBONS

ATTACH.20-2

Compound	C_p/H_v	100.2	177.6	-13.0	72.1	0.695	5.78	480°	29.5	20,820	19,110
2,2,3-Trimethylbutane (Triptano)	C_7H_{16}	100.2	177.6	-13.0	72.1	0.695	5.78	480°	29.5	20,820	19,110
2-Methylheptane (Isooctane)	C_8H_{18}	114.2	243.8	-165.1	70.1	.702	5.84	549°	26°	20,570	19,080
3-Ethylhexane	C_8H_{18}	114.2	245.4	—	85.6	.718	5.98	551°	25°	20,570	19,080
2,3-Dimethylhexane (Diisobutyl)	C_8H_{18}	114.2	228.4	-130	71.2	.698	5.81	530	25	20,550	19,060
2,2,4-Trimethylpentane ("Isooctane")	C_8H_{18}	114.2	210.0	-161.2	71.8	.695	5.79	515°	27°	20,540	19,050
OLEFINS											
Ethylene	C_2H_4	28.0	-154.7	-272.5	273	.35	2.91	50	51	21,640°	20,290°
Propylene	C_3H_6	42.1	-53.9	-301.4	140	.522	4.35	196.5	45.4	21,040°	19,090°
Butene-1	C_4H_8	56.1	20.7	—	104	.601	5.00	293°	39°	20,840°	19,490°
Cis-Butene-2	C_4H_8	56.1	38.0	-218.0	91.2	.627	5.22	316°	37°	20,780°	19,430°
Trans-Butene-2	C_4H_8	56.1	33.6	-187.7	100	.610	5.08	310°	37°	20,750°	19,400°
Isobutene	C_4H_8	56.1	19.0	-230.6	104	.600	4.99	292.5	39.5	20,720°	19,370°
Pentene-1 (Amylene)	C_5H_{10}	70.1	86.2	-216.4	87.2	.647	5.38	385°	36°	20,710°	19,360°
Cis-Pentene-2	C_5H_{10}	70.1	98.0	-290.2	82.0	.661	5.50	378°	35°	20,660°	19,310°
Trans-Pentene-2	C_5H_{10}	70.1	90.8	-211.0	84.9	.654	5.41	376°	35°	20,640°	19,290°
2-Methylbutene-1	C_5H_{10}	70.1	88.0	—	84.5	.655	5.45	387°	36°	20,610°	19,260°
3-Methylbutene-1 (Isomylene)	C_5H_{10}	70.1	88.4	-292.0	92.0	.633	5.27	363°	37°	20,660°	19,310°
2-Methylbutene-2	C_5H_{10}	70.1	101.2	-297.0	80.6	.607	5.55	401°	35°	20,570°	19,220°
Hexene-1	C_6H_{12}	84.2	140.4	-218.0	77.2	.678	5.64	463°	34°	20,450	19,100
Cis-Hexene-2	C_6H_{12}	84.2	155.4	-231.0	73.9	.689	5.73	473°	31°	20,420	19,070
Trans-Hexene-2	C_6H_{12}	84.2	154.2	-207.0	75.7	.683	5.68	470°	34°	20,400	19,050
Cis-Hexene-3	C_6H_{12}	84.2	153.7	-211.0	75.4	.684	5.60	472°	31°	20,420	19,070
Trans-Hexene-3	C_6H_{12}	84.2	151.6	-171	70.0	.682	5.68	473°	31°	20,400	19,050
DIOLEFINS											
Propadiene	C_3H_4	40.1	-30.1	-213.0	106	.595	4.95	219	70	20,880°	19,930°
Butadiene-1,2	C_4H_6	54.1	50.5	—	83.5	.658	5.48	343°	—	—	—
Butadiene-1,3	C_4H_6	51.1	24.1	-161.0	91.2	.627	5.22	308	45	20,230°	19,180°
Pentadiene-1,2	C_5H_8	68.1	112.8	-85.0	71.5	.697	5.80	420°	—	—	—
Cis-Pentadiene-1,3	C_5H_8	68.1	111.6	—	71.8	.690	5.79	420°	—	—	—
Trans-Pentadiene-1,3	C_5H_8	68.1	108.1	—	76.0	.682	5.68	415°	—	—	—
Pentadiene-1,4	C_5H_8	68.1	78.9	-231.0	81.3	.665	5.53	350°	—	—	—
3-Methylbutadiene-1,2	C_5H_8	68.1	104	-181.0	82.0	.685	5.70	410°	—	—	—
2-Methylbutadiene-1,3 (Isoprene)	C_5H_8	68.1	93.3	-231.0	74.8	.650	5.71	395°	—	20,060°	18,950°

* Heat of combustion as a gas—otherwise as a liquid.

* Estimated.

* Critical temperature-boiling point correlation.

* Vapor pressure curve or correlation.

* Mixture of cis- and trans-isomers

** Sublimes.



TABLE-15

C₃ AND C₄ LPG PRODUCTION (LB/H) OF EACH YEAR

	C ₃ LPG				C ₄ LPG		
	C ₂ 10 ³ Lb/H	C ₃ 10 ³ Lb/H	C ₄ 10 ³ Lb/H	Total 10 ³ Lb/H	C ₄ 10 ³ Lb/H	C ₅ 10 ³ Lb/H	Total 10 ³ Lb/H
1981 ^{*1} (Kg/H)	0.44	23.6 ^{*1}	0.54	24.58 ^{*3} (11.17)	13.06 ^{*2}	0.27	13.33 (6.0)
1982 (Kg/H)	0.74	39.4	0.90	41.04 (18.65)	22.20	0.45	22.65 (10.0)
1983 (Kg/H)	0.89	47.3	1.08	49.27 (22.40)	26.52	0.54	27.06 (12.0)
1984 (Kg/H)	1.23	65.7	1.51	68.44 (31.11)	36.89	0.75	37.64 (17.0)
1985 (Kg/H)	1.23	65.7	1.51	68.44 (31.11)	36.89	0.75	37.64 (17.0)
1986 (Kg/H)	1.43	76.2	1.75	79.38 (36.08)	42.95	0.88	43.83 (19.0)
1987 (Kg/H)	1.43	76.2	1.75	79.38 (36.08)	42.95	0.88	43.83 (19.0)
1988 (Kg/H)	1.63	86.8	1.99	90.42 (41.10)	49.01	1.00	50.01 (22.0)
1989 (Kg/H)	1.63	86.8	1.99	90.42 (41.10)	49.01	1.00	50.01 (22.0)
1990 (Kg/H)	1.63	86.8	1.99	90.42 (41.10)	49.01	1.00	50.01 (22.0)

Calculation way

Note: *1 come from TABLE-12 (4) (ATTACH.18)

*2 TABLE-12 (4) (ATTACH.18) minus C₄
in C₃ LPG of this Table
13.6 - 0.54 = 13.06

*3

C₂C₃C₄

100%

TABLE-15 C₃ AND C₄ LPG PRODUCTION (LB/H) OF EACH YEAR

	C ₃ LPG				C ₄ LPG			Total				
	C ₂ 10 ³ Lb/H	C ₃ 10 ³ Lb/H	C ₄ 10 ³ Lb/H	Total 10 ³ Lb/H	C ₄ 10 ³ Lb/H	C ₅ 10 ³ Lb/H	Total 10 ³ Lb/H	C ₂ 10 ³ Lb/H	C ₃ 10 ³ Lb/H	C ₄ 10 ³ Lb/H	C ₅ 10 ³ Lb/H	Total 10 ³ Lb/H
1981 ^{*1} (Kg/H)	0.44	23.6 ^{*1}	0.54	24.58 ^{*3} (11.17)	13.06 ^{*2}	0.27	13.33 ^{*4} (6.06)	0.44	23.6	13.6	0.27	37.91 (17.23)
1982 (Kg/H)	0.74	39.4	0.90	41.04 (18.65)	22.20	0.45	22.65 (10.30)	0.74	39.4	23.1	0.45	63.69 (28.95)
1983 (Kg/H)	0.89	47.3	1.08	49.27 (22.40)	26.52	0.54	27.06 (12.30)	0.89	47.3	27.6	0.54	76.33 (34.70)
1984 (Kg/H)	1.23	65.7	1.51	68.44 (31.11)	36.89	0.75	37.64 (17.11)	1.23	65.7	38.4	0.75	106.08 (48.22)
1985 (Kg/H)	1.23	65.7	1.51	68.44 (31.11)	36.89	0.75	37.64 (17.11)	1.23	65.7	38.4	0.75	106.08 (48.22)
1986 (Kg/H)	1.43	76.2	1.75	79.38 (36.08)	42.95	0.88	43.83 (19.92)	1.43	76.2	44.7	0.88	123.21 (56.00)
1987 (Kg/H)	1.43	76.2	1.75	79.38 (36.08)	42.95	0.88	43.83 (19.92)	1.43	76.2	44.7	0.88	123.21 (56.00)
1988 (Kg/H)	1.63	86.8	1.99	90.42 (41.10)	49.01	1.00	50.01 (22.73)	1.63	86.8	51.0	1.00	140.43 (63.83)
1989 (Kg/H)	1.63	86.8	1.99	90.42 (41.10)	49.01	1.00	50.01 (22.73)	1.63	86.8	51.0	1.00	140.43 (63.83)
1990 (Kg/H)	1.63	86.8	1.99	90.42 (41.10)	49.01	1.00	50.01 (22.73)	1.63	86.8	51.0	1.00	140.83 (63.83)

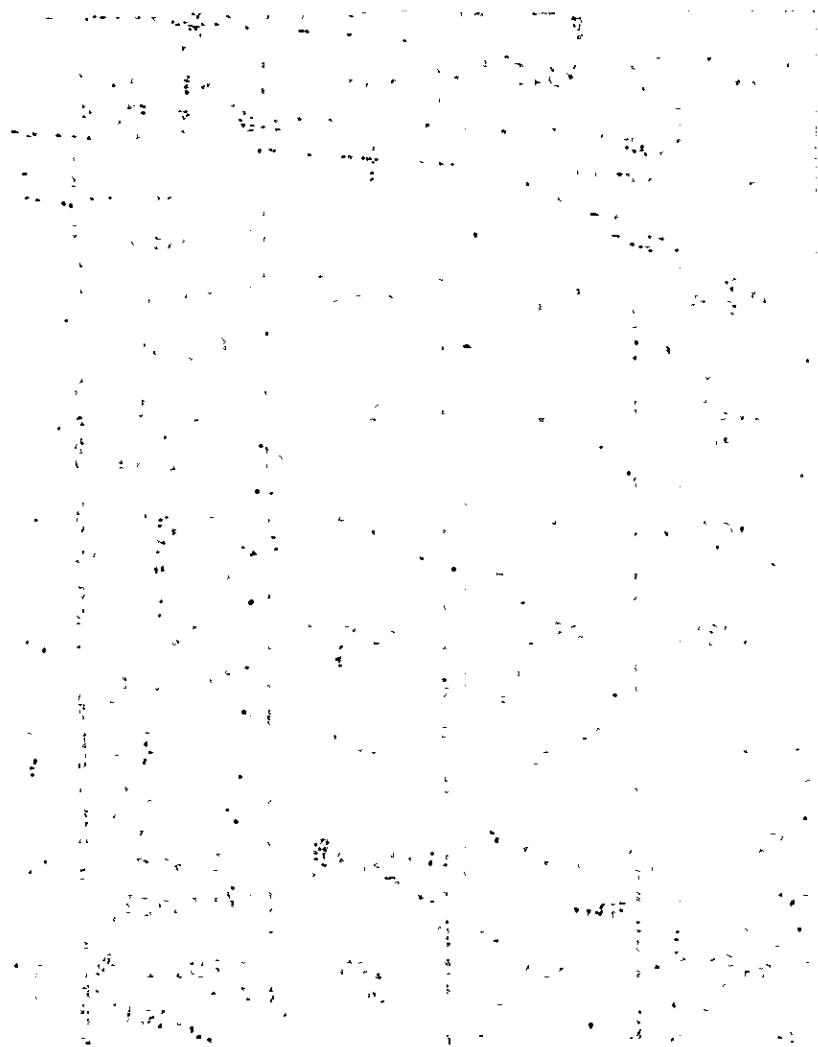
Calculation way

Note: *1 come from TABLE-12 (4) (ATTACH.18)

*2 TABLE-12 (4) (ATTACH.18) minus C₄
in C₃ LPG of this Table

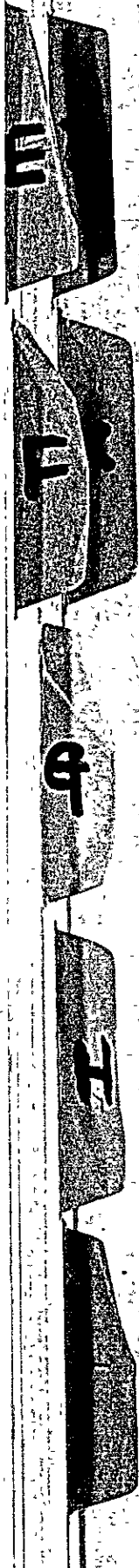
$$13.6 - 0.54 = 13.06$$

	*3 C ₃ LPG		*4 C ₄ LPG		
	%	Lb/H	%	Lb/H	
C ₂	1.8	0.44	C ₄	98	13.06
C ₃	96.0	23.60	C ₅	2	0.27
C ₄	2.2	0.54			
	100.0	24.58	100		13.33



	C ₃ LPG			C ₄ LPG			Total			REMARK NATURAL GAS PRODUCTION MM scf/D
	T/H*	T/D	10 ³ T/Y	T/H*	T/D	10 ³ T/Y	T/H*	T/D	10 ³ T/Y	
	1981	11.17	268.08	97.85	6.06	145.44	53.08	17.23	413.52	
1982	18.65	447.6	163.39	10.30	247.20	90.23	28.95	694.80	253.60	300
1983	22.40	537.6	196.22	12.30	295.20	107.75	34.70	883.80	303.97	350
1984	31.11	746.64	272.52	17.11	410.64	149.88	48.22	1,157.28	422.40	500
1985	31.11	746.64	272.52	17.11	410.64	149.88	48.22	1,157.28	422.40	500
1986	36.08	865.92	316.06	19.92	478.08	174.50	56.00	1,344.00	490.56	600
1987	36.08	865.92	316.06	19.92	478.08	174.50	56.00	1,344.00	490.56	600
1988	41.10	986.40	360.04	22.73	545.52	199.11	63.83	1,531.92	559.15	700
1989	41.10	986.40	360.04	22.73	545.52	199.11	63.83	1,531.92	559.15	700
1990	41.10	986.40	360.04	22.73	545.52	199.11	63.83	1,531.92	559.15	700

Note: * from TABLE-15 (ATTACH.21)



1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes that this is essential for ensuring transparency and accountability in the organization's operations.

2. The second part of the document outlines the various methods and tools used to collect and analyze data. It highlights the need for consistent data collection procedures and the use of advanced analytical techniques to derive meaningful insights from the data.

3. The third part of the document focuses on the role of technology in data management and analysis. It discusses how modern software solutions can streamline data collection, storage, and processing, thereby improving efficiency and reducing the risk of errors.

4. The fourth part of the document addresses the challenges associated with data security and privacy. It stresses the importance of implementing robust security measures to protect sensitive information and ensure compliance with relevant regulations.

5. The fifth part of the document provides a summary of the key findings and recommendations. It concludes that a comprehensive data management strategy is crucial for the organization's success and that ongoing monitoring and improvement are necessary to stay ahead of the competition.