FEASIBILITY STUDY REPORT

ON

REFINERY PROJECT

IN

THE REPUBLIC OF GUATEMALA

[SUMMARY]

AUGUST 1984

JAPAN INTERNATIONAL COOPERATION AGENCY

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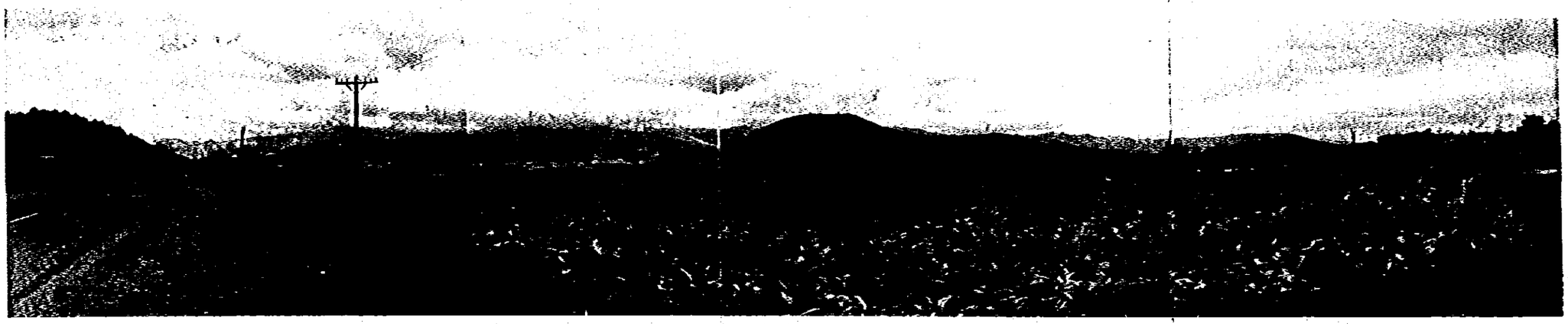
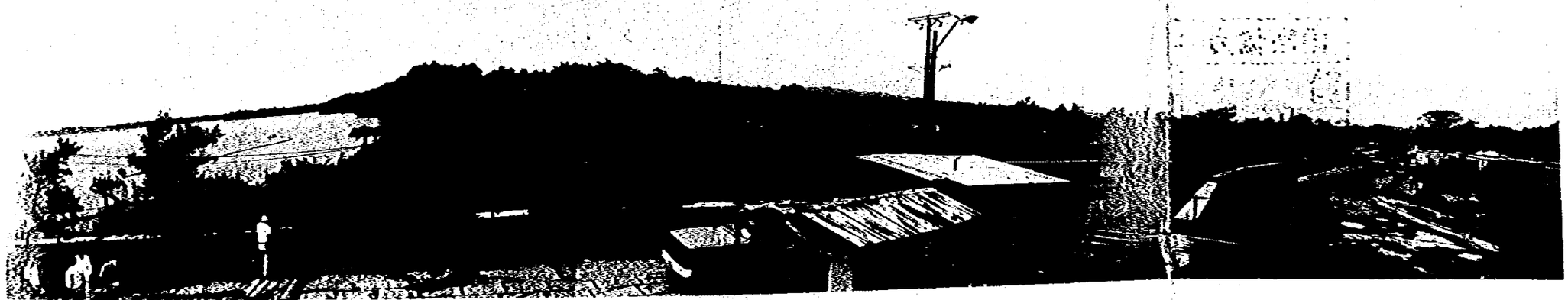
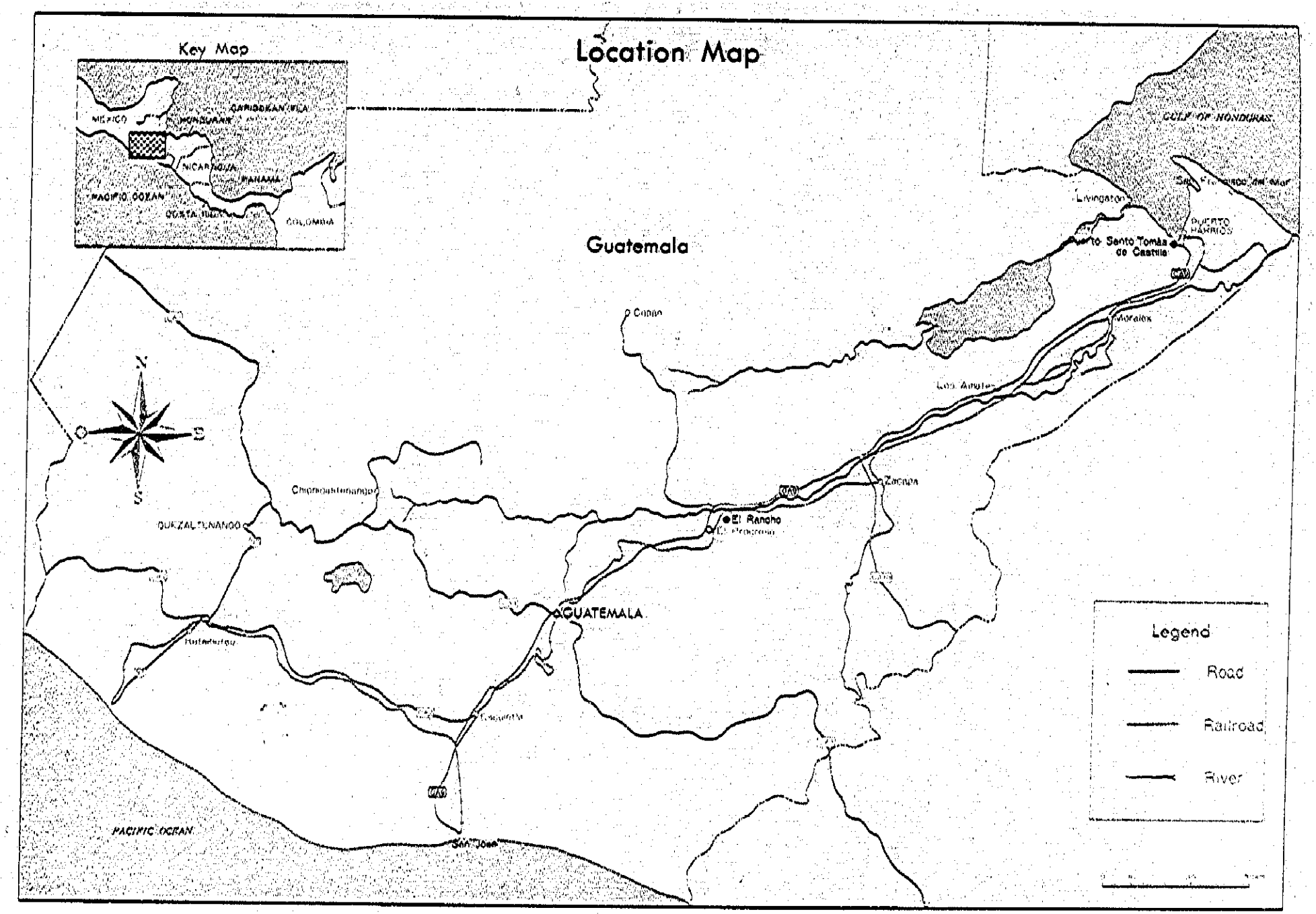
Selected Refinery Site

"Area C"



Selected Terminal Site




Location Map
Key Map
MEXICO
HONDURAS
CARIBBEAN SEA
NICARAGUA
PANAMA
PACIFIC OCEAN
COSTA RICA
COLOMBIA
Guatemala
GULF OF HONDURAS
Livingston
Puerto Santo Tomás de Castilla
Morales
Los Angeles
Zacapa
El Rancho
Chiquimulilla
QUEZALTENANGO
GUATEMALA
Retalhuleu
San José
PACIFIC OCEAN
Legend
Road
Railroad
River

ABSTRACT

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1. Outline of This Project

(1) General

1) Total capital requirement

Construction of the refinery, terminal and pipeline costs about 673 million quetzales and about 121 million quetzales are required for other expenses. The total capital requirement amounts to about 794 million quetzales.

2) Schedule

It takes three years to construct the above.

3) Time of starting a commercial operation

A commercial operation starts in January, 1989.

(2) Outline of refinery facilities

1) Crude oil processing capacity

40,000 bbl/d

Guatemalan crude oil	10,000 bbl/d
Mexican Maya crude oil	15,000 bbl/d
Mexican Isthmus crude oil	15,000 bbl/d

2) Processes to be used

Because crude oil available is heavy and the demand for petroleum products centers on light products, the ebullated-bed hydrocracking process and fluid catalytic cracking process are used as heavy oil cracking process.

3) Location
El Rancho

4) Construction cost
About 510 million quetzales

(3) Outline of terminal facilities

1) Total tank capacity
200,000 kl

2) Location
Puerto Santo Tomas de Castilla

3) Construction cost
About 67 million quetzales

(4) Outline of pipeline facilities

1) Pipeline length and pipe diameter
Pipeline length : 220 km
Pipe diameter : 16 inches

2) Construction cost
About 95 million quetzales

2. Financial Evaluation

The financial internal rate of return on investment is 11.2% and indicates that this project pays, although its profitability is not very high. The financial internal rate of return on equity is 17.6% and exceeds the loan interest of 9%.

3. Economic Evaluation

The economic internal rate of return is 8.6%. The economic value of this project is not very high but economically rewarding.

4. Overall Evaluation

According to financial and economic evaluation, this project is rather feasible, although its profitability is not so high. However, the profitability of this project is greatly influenced by costs of crude oil and prices of petroleum products according to the results of sensitivity analysis. This project might lose its appeal, depending on the above costs and prices, for example in such a case as the costs of crude oil will rise abnormally, while the prices of petroleum products are not high enough to cover such costs.

The Guatemalan economy at present depends for 40% of its total exports on coffee, cotton and other agricultural products and its economic structure is easily influenced by weather and market conditions of crops, and Guatemala is therefore, oriented for industrialization. Taking the above into account, it would be preferable to implement and execute this project.

However, in implementing the project, it should be necessary to study and examine the project from a national macro-economic standpoint, since it requires a vast amount of funds amounting to about 794 million quetzales.

SUMMARY AND CONCLUSION

SUMMARY AND CONCLUSION

– CONTENTS –

I. BACKGROUND AND PURPOSE OF STUDY

(1) The Republic of Guatemala started production of crude oil in 1976 and produced two million bbl/y in 1982. Most of crude oil output is exported except for some domestic consumption for power generation. As to the production of petroleum products, only one refinery is operating in Guatemala at a low operation rate using imported crude oil. About half of petroleum product requirements is imported.

(2) Under such circumstances, the government of Guatemala planned to construct a national refinery and made a request to the Japanese government in November 1982 to conduct a feasibility study on the construction of a refinery including its pipeline and terminal.

(3) The Japanese government despatched a pre-survey team in July 1983 to discuss basic matters necessary for the study with the Guatemalan government and the Scope of Work (hereinafter referred to as S/W) on the study was concluded between both parties on July 19.

(4) The field survey was conducted from November 12 to December 4, 1983 in accordance with S/W dated July 19, 1983. Based on results of the field survey, home work was conducted from December 1983 to May 1984.

(5) This report shows general study on technical and commercial feasibility of a new refinery and summarizes its results.

II. FORECAST OF DEMANDS FOR PETROLEUM PRODUCTS

The input-output analysis method and econometric model method are generally used to forecast the demands for petroleum products.

This survey uses elasticity analysis by the econometric model method widely used for macroscopic demands forecast, because demands for petroleum products must be forecast for the period of 20 years. The regression analysis is used as a means to calculate elasticity.

Demands forecast procedures by the econometric model method are shown below.

(1) Trend of demands and prices in the past

The trend of demands for petroleum products and prices in Guatemala is investigated for the period of the past ten years.

(2) Demands structure and economic indices

Investigation is made on how structure of demands for petroleum products is correlated with an economic index.

(3) Demands trend analysis

Relations between demands for petroleum products and economic indices during the past ten years are analyzed to obtain a structural equation for each petroleum product. The structural equation thus obtained shows a very good correlation with the past demands.

(4) Demands forecast

The possibility of the application of the structural equation obtained in (3) above to the future has been studied and if necessary, elasticity has been corrected. With respect to Guatemala's economic indices correlated with those of U.S., the forecasting equation obtained from U.S. economic indices has been applied demands forecast.

Results of the forecast are shown in Table 1. Table 1 shows the following average growth rates of respective petroleum products in 1989 to 2008.

- o Liquefied petroleum gas 3.7%/y
- o Gasoline 4.3%/y
- o Kerosene 5.0%/y
- o Gas oil 5.4%/y
- o Fuel oil 6.8%/y

Table 1 Summary of Forecasted Demands for Petroleum Products

(Unit: 10^3 bbl/y)

YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
LPG	617.100	640.190	664.143	688.993	714.772	741.516	769.261	798.043	827.903	858.880	891.016	924.354
Premium G.	1535.313	1632.459	1685.269	1739.687	1792.078	1848.347	1925.087	2022.528	2125.918	2234.608	2348.045	2467.016
Regular G.	1535.313	1632.459	1685.269	1739.687	1792.078	1848.347	1925.087	2022.528	2125.918	2234.608	2348.045	2467.016
Kerosene	674.945	704.024	734.346	765.963	798.930	833.305	869.147	906.518	945.483	986.110	1028.469	1072.634
Jet Fuel	309.784	309.313	310.943	310.598	310.647	311.177	317.984	325.096	332.567	340.022	347.561	355.275
Gas Oil	4827.589	5017.854	5261.037	5499.221	5750.772	6017.291	6352.272	6706.229	7080.714	7473.138	7885.366	8319.319
Fuel Oil	2566.400	2758.427	2962.740	3180.124	3411.416	3657.507	3919.341	4197.928	4494.339	4809.713	5145.265	5502.285
Asphalt	116.111	116.373	115.190	113.534	111.993	110.590	110.718	110.883	111.094	111.264	111.415	111.568
Total	12184.560	12811.102	13418.948	14037.811	14682.690	15368.084	16188.901	17089.758	18043.939	19048.346	20105.185	21219.470
bbl/day	36922.911	38821.523	40663.480	42538.822	44493.000	46569.951	49057.278	51787.146	54678.604	57722.261	60924.804	64301.424

YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
LPG	958.940	994.819	1032.041	1070.656	1110.716	1152.275	1195.388	1240.115	1286.515	1334.651	1384.589	1436.394
Premium G.	2592.318	2724.763	2862.850	3007.529	3160.920	3321.749	3489.999	3667.884	3854.436	4049.851	4256.475	4472.621
Regular G.	2592.318	2724.763	2862.850	3007.529	3160.920	3321.749	3489.999	3667.884	3854.436	4049.851	4256.475	4472.621
Kerosene	1118.680	1166.688	1216.741	1268.925	1323.330	1380.050	1439.184	1500.833	1565.104	1632.107	1701.958	1774.777
Jet Fuel	363.246	371.548	379.565	388.096	396.877	405.697	414.668	424.163	433.463	443.214	453.251	463.219
Gas Oil	8776.976	9260.378	9763.912	10297.734	10860.362	11450.639	12071.348	12728.910	13415.607	14141.720	14909.012	15708.247
Fuel Oil	5882.147	6286.312	6716.336	7173.872	7660.680	8178.634	8729.727	9316.077	9939.942	10603.721	11309.968	12061.401
Asphalt	111.740	111.943	112.050	112.226	112.413	112.569	112.718	112.926	113.061	113.239	113.429	113.570
Total	22396.367	23641.218	24946.349	26326.569	27786.222	29323.367	30943.035	32658.796	34462.568	36368.359	38383.160	40502.852
bbl/day	67867.781	71640.055	75594.997	79777.483	84200.675	88858.688	93766.774	98966.048	104432.025	110207.149	116312.607	122735.917

III. LOCATION

(1) Oil refinery

In the first stage, El Rancho and Puerto Santo Tomas de Castilla have been compared and El Rancho has been selected.

In the second stage, A, B and C sites have been compared and the site C has been finally chosen, because 980,000 m² necessary for a refinery is available only on C site. Fig. 1 shows sites A, B and C.

(2) Crude oil terminal

In the first stage, Puerto Santo Tomas de Castilla and San Francisco del Mar have been compared and Puerto Santo Tomas de Castilla has been finally selected.

In the second stage, and exact location of the proposed crude oil terminal has been determined as shown in Fig. 2, because the location is adjacent to port facilities.

(3) Pipeline route

Three pipeline routes along the national road CA9, railway and the river Motagua have been considered as the 220 km route connecting the oil refinery with the terminal.

Finally, the route along the national road CA9 has been selected for convenience of operation and maintenance. Fig. 3 shows the selected pipeline route.

Fig. 1 Selected Refinery Site

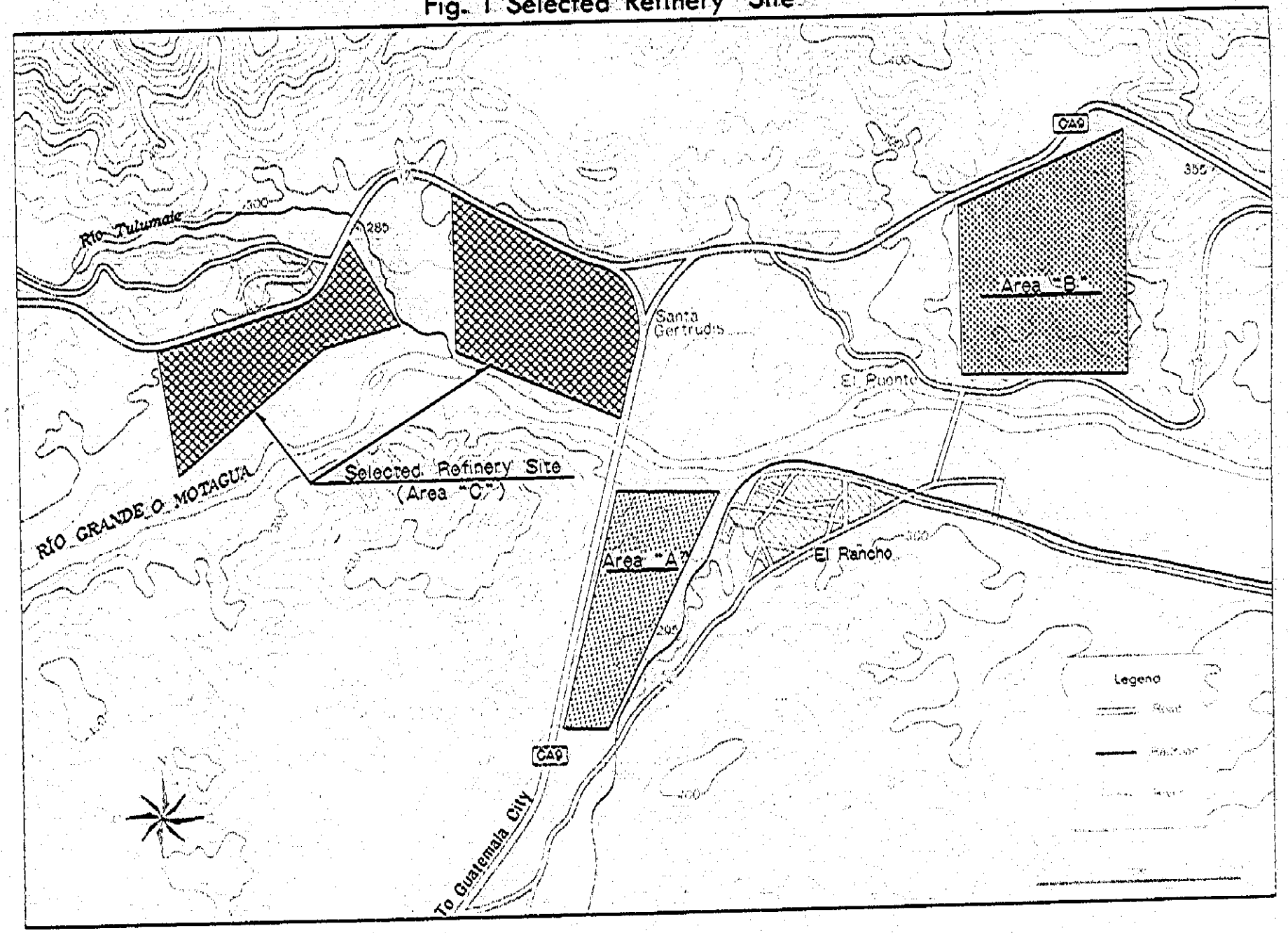

Fig. 2 Selected Terminal Site

Fig. 3 Pipe line Route

IV. BASIC PLAN FOR FACILITIES

The basic plan for facilities has been made as precondition of the conceptual design.

1. General Major Premise

(1) Related law, code and regulation

In making the conceptual design of refinery, terminal and pipeline facilities, U.S. or Japanese laws and regulations have been applied.

(2) Structural design standards

Seismic force has been in accordance with U.S. Uniform Building Code. The most severest local factor of 1.0 has been used, because earthquake is frequent in Guatemala. Wind pressure has been in accordance with Japan Petroleum Institute standards.

(3) Kinds of crude oil

Recoverably crude oil reserves in Guatemala are now estimated to be 40 million bbl. Even if the estimated amount is doubled to 80 million by oil exploration activated by the new petroleum law, the output amounts to some 10,000 bbl/d. (Divided by the project life of 20 years) Therefore, if the refinery capacity is 40,000 to 50,000 bbl/d as suggested by the Ministerio de Energía y Minas (hereinafter referred to as MEM), crude oil is in short supply and such shortage must be covered by imports. Mexican Maya crude oil is studied at first as suggested by MEM. However, Maya crude oil is very heavy, being poorly balanced with demands for petroleum products in Guatemala. At present, no cracking technology has been introduced for such heavy crude oil. Such being the case, Mexican Maya crude oil blended with light Isthmus is to be used at blending ratio of fifty-fifty as the imported crude oil.

(4) Natural condition

Natural condition in El Rancho and Puerto Santo Tomas de Castilla is obtained from INSIVUMEH and summarized.

(5) Bearing capacity of the soil

Boring data in El Rancho and Puerto Santo Tomas de Castilla were sought during field survey but no data were available. Therefore, a portable cone was used for measurement to estimate bearing capacity of the soil on two sites.

(6) Specifications of petroleum products

The specifications of the Guatemalan petroleum products have been basically applied to petroleum products to be produced from the new refinery. However, those of gasoline and jet fuel are considered not to be practical on some items which have been modified with the approval of MEM, referring to Japanese and U.S. specifications.

2. Oil Refinery

(1) Capacity

Two refinery capacities including 40,000 bbl/d and 45,000 bbl/d have been studied on the basis of demands forecast on petroleum products.

In case of 45,000 bbl/d, the output of petroleum products exceeds demands during the initial operation stage and the refinery is compelled to run at a low operation rate unless petroleum products are exported. 40,000 bbl/d is selected as its capacity from such economic viewpoint.

Accordingly, the following amount of crude oil has been used on the average.

- o Guatemalan crude oil 10,000 bbl/d
- o Mexican Maya crude oil 15,000 bbl/d
- o Mexican Isthmus crude oil 15,000 bbl/d

However, taking into consideration the two cases to process Guatemalan crude oil only and mixture of Maya and Isthmus crude oils at a fifty-fifty ratio for a short period of time, the refinery has been designed to cover both cases.

(2) Basic flow pattern

When Guatemalan crude oil or mixture of Mexican Maya and Isthmus crude oils at a fifty-fifty ratio is processed in the refinery, the crude oil in both cases has high viscosity and high sulfur content with about 27 API degree. On the other hand, demands for gasoline and gas oil in Guatemala exceed 60% of the total demands for petroleum products, that is, the demands center on light products. Therefore, introduction of cracking processes is absolutely necessary to meet such demands.

The basic flow pattern has been determined in accordance with the types of cracking processes used. Therefore, the following three cases have been studied:

- o Coker + Fluid catalytic cracking
- o Ebullated-bed hydrocracking + Fluid catalytic cracking
- o Bbullated-bed hydrocracking + Fixed-bed hydrocraking

As a result of the comparative study, it has been concluded to adopt the combination of ebullated-bed hydrocracking and fluid catalytic cracking process whereby quality of petroleum products has no problem and output of petroleum products is relatively agreeable with the demands pattern of petroleum products.

The process flow diagrams in this case are shown in Fig. 4 (Guatemalan crude oil is processed) and Fig. 5 (where mixture of Mexican Maya and Isthmus crude oils at a fifty-fifty ratio is processed).

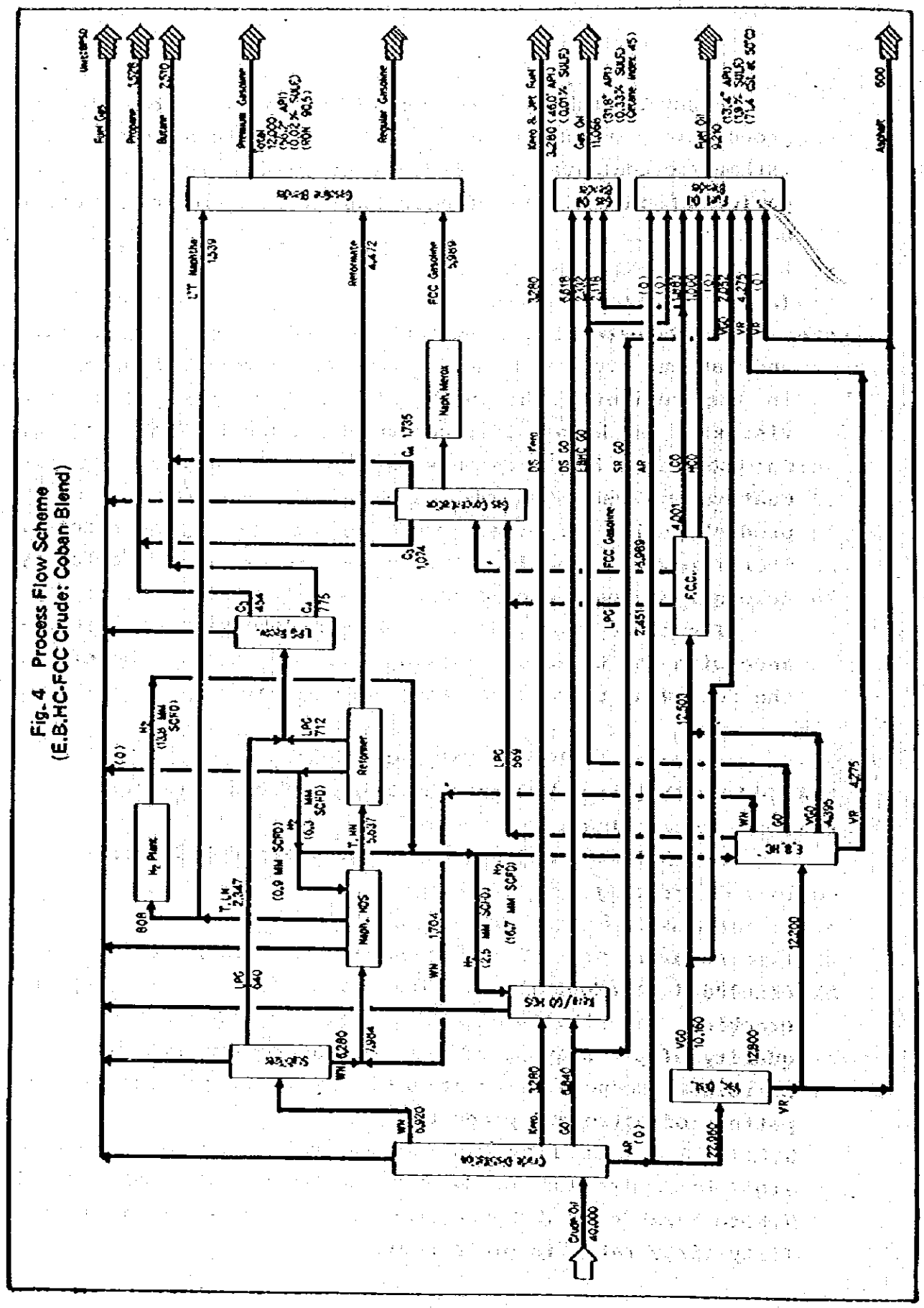

Fig. 4 Process Flow Scheme
(E.B.HC-FCC Crude: Coban Blend)

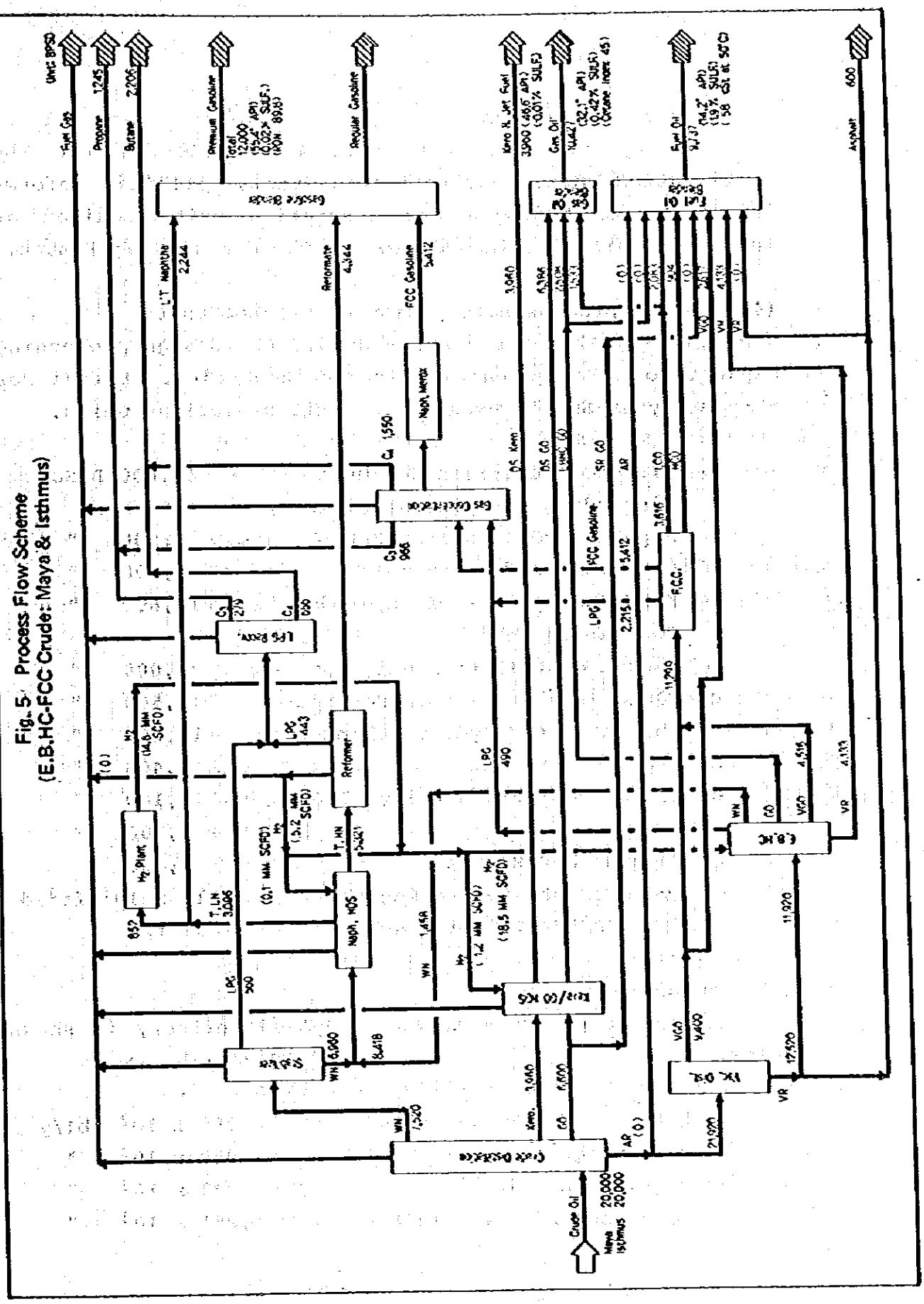
Fig. 5 Process Flow Scheme
(E.B.HC-FCC Crude: Maya & Isthmus)

(3) Process selection

The optimum processes have been selected for the distillation unit, desulfurization unit, catalytic reforming unit and hydrogen gas generating unit required as refinery facilities in addition to the cracking equipment.

(4) Design processing capacity of various units

As a result of the above study, the design processing capacity of various units is summarized below. Barrel Per Stream Day (BPSD) is used as the unit of various units.

o Crude oil distillation unit (including gasoline stabilizer)	40,000	BPSD
o Naphtha hydrodesulfurization unit	8,500	"
o Catalytic reforming unit	5,700	"
o Kerosene and gas oil hydrodesulfurization unit	10,600	"
o Vacuum distillation unit	23,000	"
o Fluid catalytic cracking unit	12,500	"
o Bbullated-bed hydrocracking unit	12,200	"
o LPG recovery unit	1,400	"
o Gas concentration unit : LPG	3,100	"
: Naphtha	7,500	"
o Naphtha Merox unit	7,500	
o Hydrogen gas generating unit	16 x 10^6	ft^3/d
o Waste water treating unit	32	t/d

(5) Output of products

Output of products in the proposed refinery is shown below.

o LPG	759 x 10^3	bbl/y
o Premium gasoline	1,980 x 10^3	"
o Regular gasoline	1,980 x 10^3	"
o Kerosene and jet fuel	1,251 x 10^3	"

- o Gas oil 3,494 x 10^3 bbl/y
- o Fuel oil 2,671 x 10^3 "
- o Asphalt 198 x 10^3 "

(6) Off-site and utility facilities

1) Tank plan

o Crude oil tank

Crude oil tank in the terminal has a capacity to store oil for 30 days. Crude oil tank in the refinery has a capacity to store oil for 10 days. The total crude oil tank capacity in the terminal and the refinery stores oil for 40 days.

o Intermediate tank

In consideration of operation stability of the refinery, an intermediate tank is planned between units with 15 days' capacity.

o Component tank

Gasoline, gas oil and fuel oil are stored in a component tank temporarily for blending and then sent to the product tank. The component tank capacity is designed for 15 days' oil quantity.

o Product tank

The product tank stores the product during regular repair of the refinery and is the supply base to consumers. Therefore, the capacity of the product tank is designed for 30 days' oil quantity.

2) Utilities facilities

The capacity of utilities facilities is designed with allowance as shown below.

- o Water intake and treating facility 320 t/h
- o Cooling water facility 9,500 t/h
- o Boiler facility 65 t/h x 3 units

- o Generator — 9 MW x 3 units
- o Boiler feed water equipment — 1,560 t/d
- o Condensate recovery facility — 120 t/h
- o Air compressor — 4,000 Nm^3/h
- o Nitrogen gas generator — 1,000 Nm^3/h
- o Home consumption fuel facility
  - Gas fuel — 20 t/h
  - Liquid fuel — 40 kl/h

(7) Security and environmental protection measure

1) Security measure

Fire-fighting facility in the refinery has been designed in accordance with U.S. National Fire Protection Association standards. Security squad is organized within the refinery to patrol and check up within the premises. When a fire breaks out, it engages in fire-fighting activities.

2) Environmental protection measure

After the start of the operation of the refinery, air pollution, water pollution, offensive smell, noise and vibration will be hazardous to surrounding environment. The environmental protection facilities for prevention of the above factors have been planned in accordance with Japanese laws and regulations. Special attention has been paid to water quality, because waste water is discharged to the upstream of river Motagua and the water is used again downstream.

3. Crude Oil Terminal

(1) Size of tankers arriving at the berth and berthing days

The maximum tanker size is 24,000 dead weight ton (DWT) which the Puerto Santo Tomas de Castilla port has ever received. The berthing days are 3.

(2) Crude oil tank capacity

The tank capacity has been designed to cover 30 days' refinery processing capacity or 200,000 kl.

(3) Crude oil tank capacity per one tank and number of tanks

Capacity of one tank has been designed to be big enough to receive crude oil from a tanker or 40,000kl. 5 tanks have been planned to store 200,000 kl. (40,000 kl x 5 tanks = 200,000 kl)

4. Pipeline

(1) Pipe diameter

14, 16 and 18 inches being studied, 16 inch pipe diameter has been finally selected.

(2) Booster stations

Two booster stations are installed.

(3) Operation of booster stations

Booster stations are not attended. Two persons patrol every day to check up their operating condition.

V. CONCEPTUAL DESIGN

Based on the basic plan for facilities studied in Volume IV, the conceptual design is prepared for the refinery, terminal and pipeline.

1. Refinery

(1) Process flow

The process flow of the refinery is as shown in Fig. 4 and 5. Reference is to be made to detailed process flow. Tank flow is shown in Fig. 6.

(2) Plot plan

980,000 m² is necessary for the site of the refinery. According to the topography in El Rancho area, the site is divided into eastern and western parts and various facilities are plotted. The plot plan of the eastern part is shown in Fig. 7, while the plot plan of the western part is shown in Fig. 8.

(3) List of main equipment

The list of main equipment is omitted. Reference is to be made to the Study Report.

2. Crude Oil Terminal

(1) Process flow

The process flow of the terminal is shown in Fig. 9.

(2) Plot plan

The plot plan of the terminal is shown in Fig. 10.

(3) List of main equipment

The list of main equipment is omitted. Reference is to be made to the Study Report.

3. Pipeline

(1) Pipeline flow

The pipeline flow is shown in Fig. 11.

(2) List of of main equipment

The list of main equipment is omitted. Reference is to be made to the Study Report.

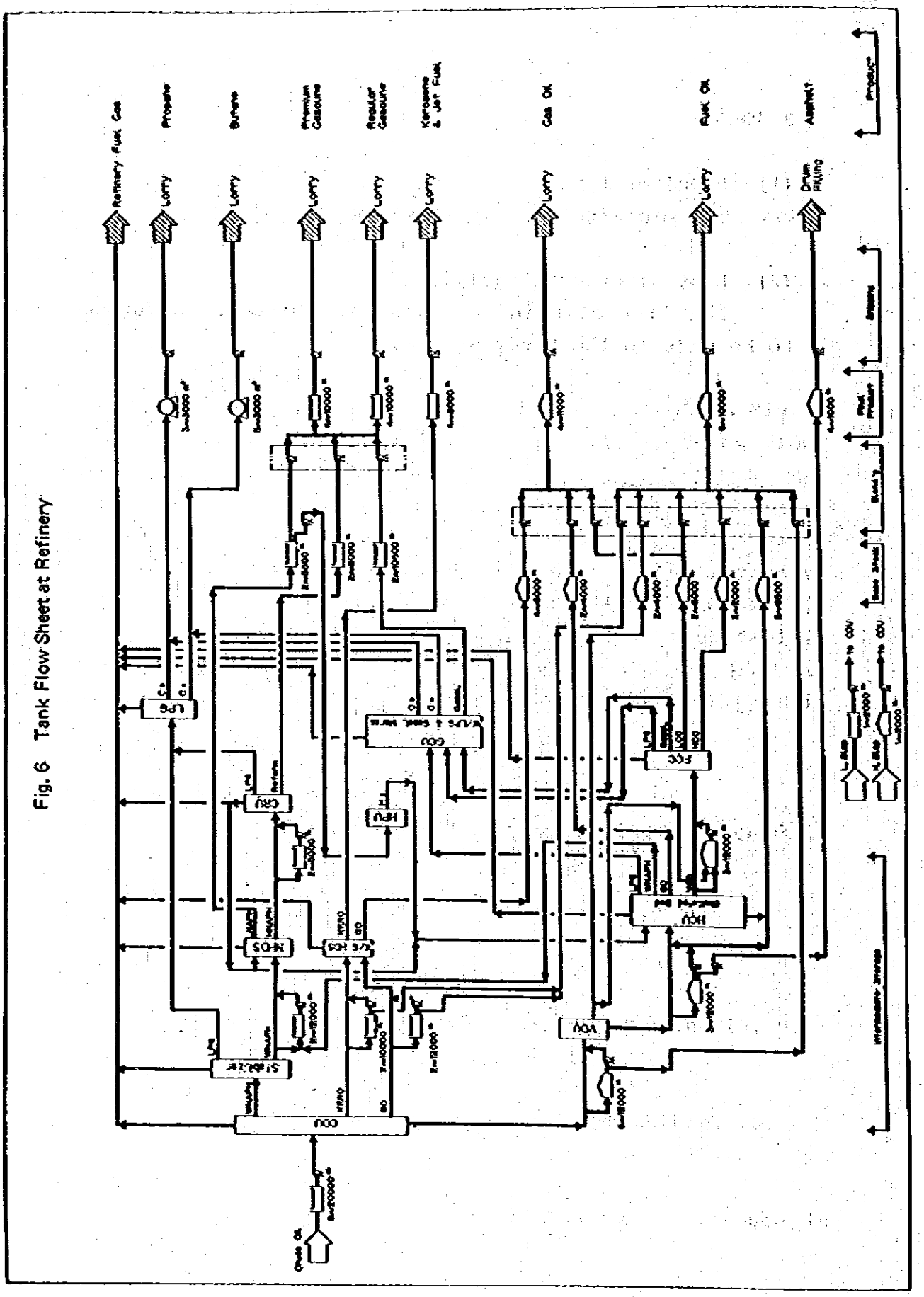

Fig. 6 Tank Flow Sheet at Refinery

Fig. 7 Plot Plan (Eastern Part)

(Area : 674,400 m²)

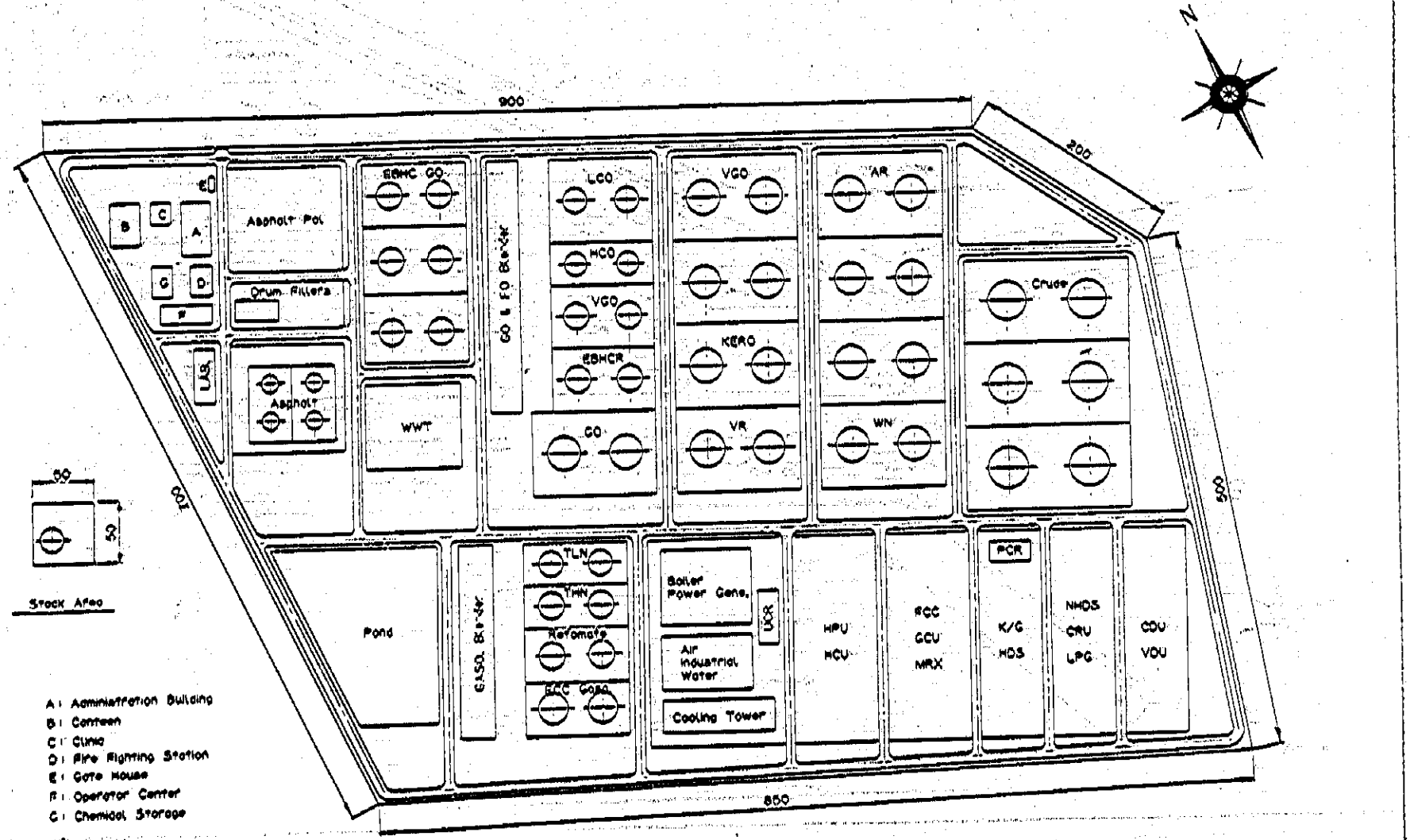

Fig. 8 Plot Plan (Western Part)

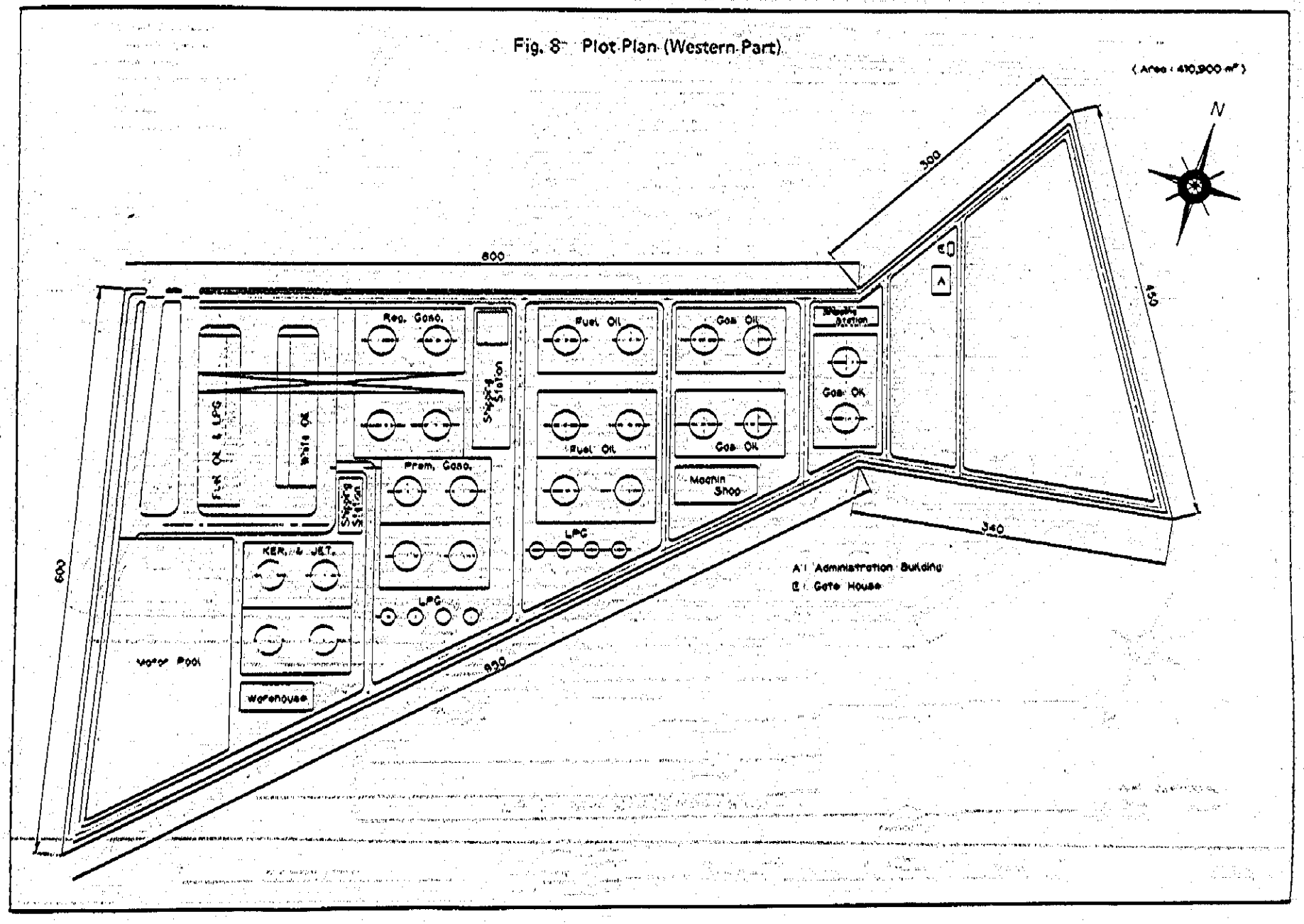

Fig. 9 Flow Diagram of Crude Oil Terminal

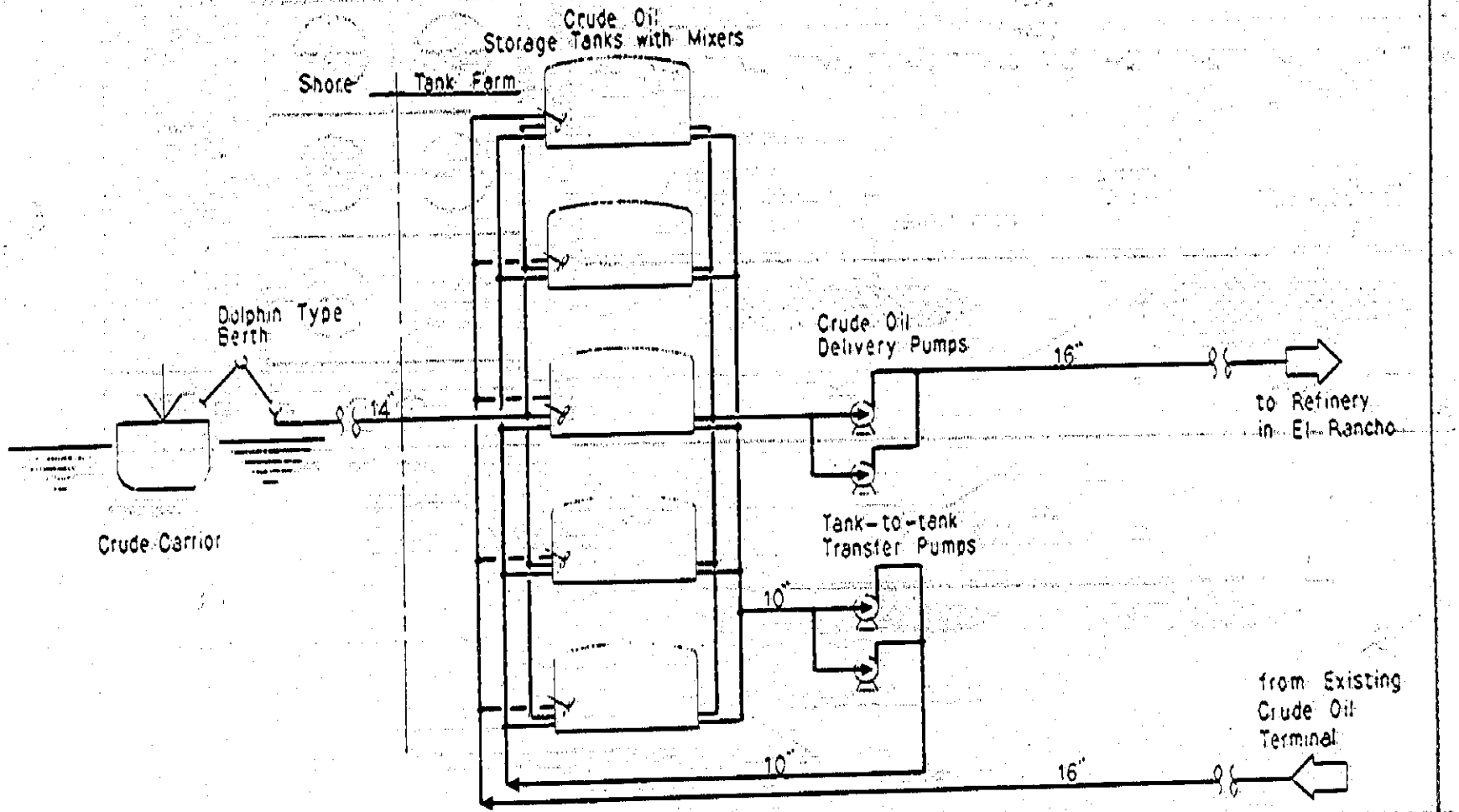

Fig. 10 Plot Plan of Curde Oil Terminal

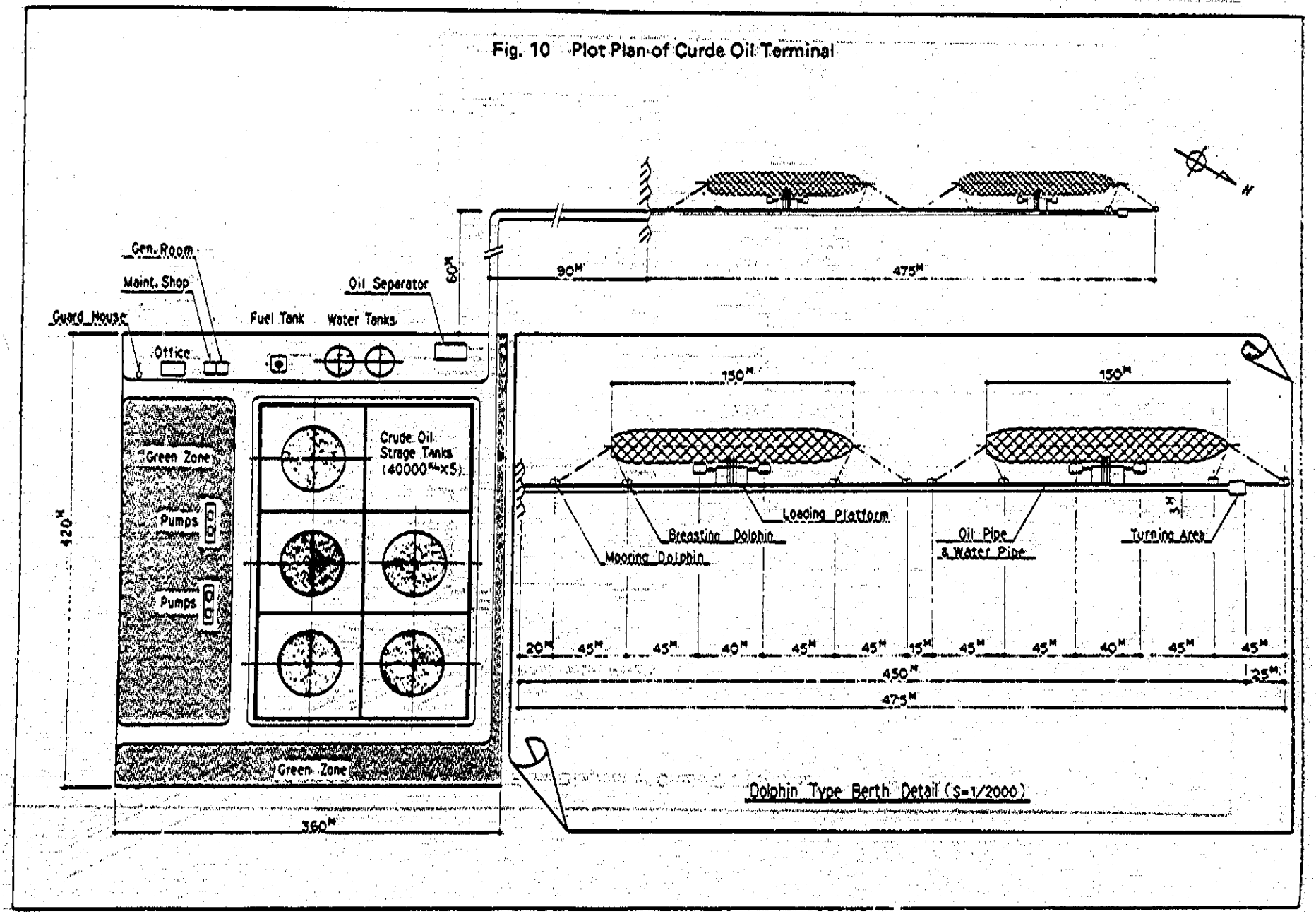

Fig. 11 Pipeline

VI. CONSTRUCTION PLAN

1. Transportation of Heavy Machinery and Equipment

The following two routes are investigated to transport heavy machinery and equipment for the construction of the refinery.

- o Route I: From San Jose port on the Pacific coast to El Rancho
- o Route II: From the Puerto Santo Tomas de Castilla on the Atlantic coast to El Rancho

It has been concluded that the route II is better than the route I for the transportation of heavy machinery and equipment, judging from road curvature radius and bridge conditions. The route diagram is shown in Fig. 12.

2. Construction Schedule

3 years are required from the start of basic design until the start of the commercial operation of the refinery. To put it into the commercial operation in January 1989, a contractor must be decided and the basic design has to start in January 1986. For this purpose, the Owner must be established as soon as possible to drive this project. The construction schedule is shown in Fig. 13.

3. Labor Mobilization Plan for Construction Work

A total of 63,000 man-months must be mobilized for construction of the refinery, terminal and pipeline. Reference is to be made to the detailed mobilization plans classified by facility written in the Study Report.

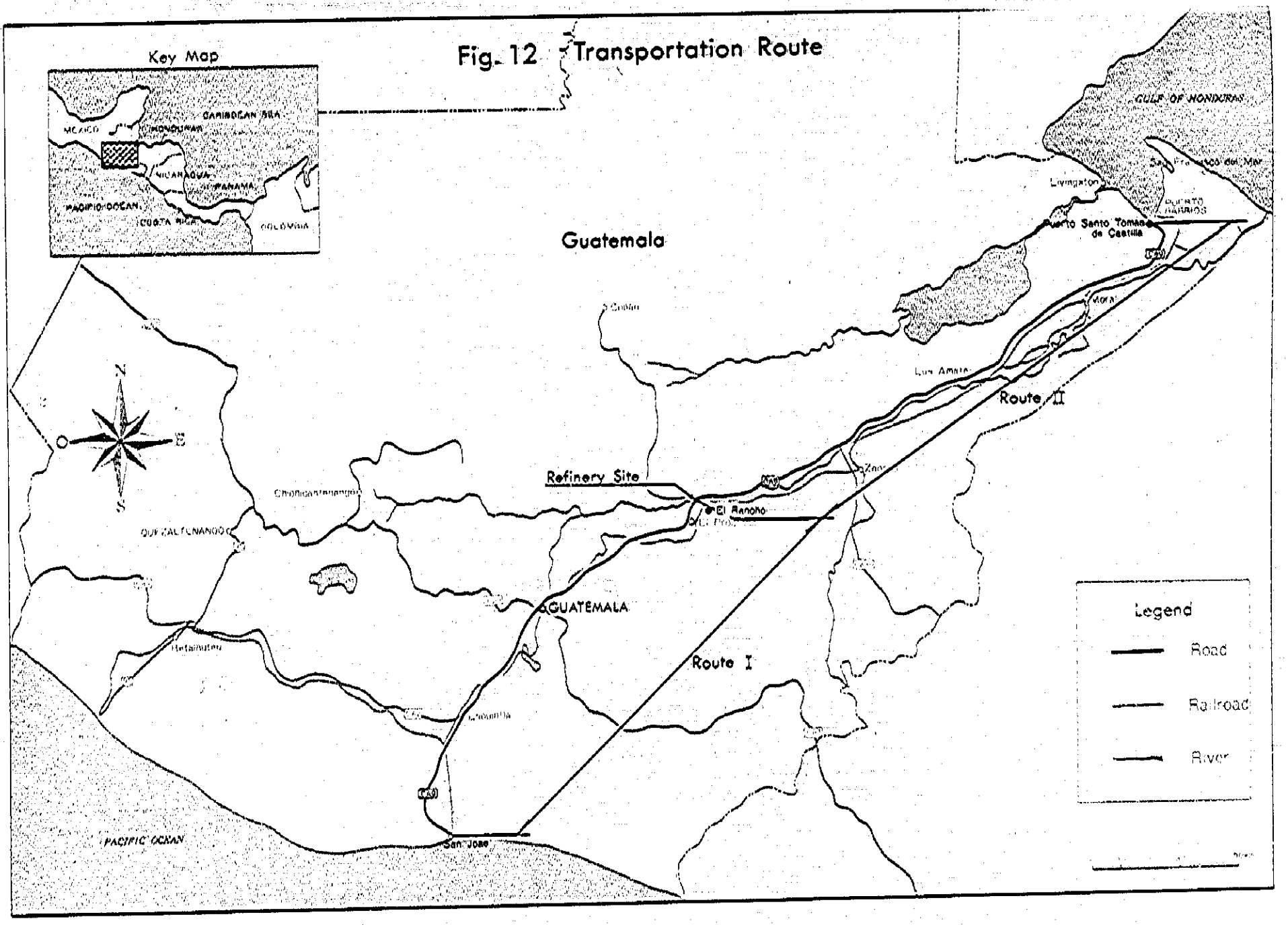
Fig. 12 Transportation Route
Key Map
MEXICO
CARIBBEAN SEA
HONDURAS
NICARAGUA
PANAMA
PACIFIC OCEAN
COSTA RICA
COLOMBIA
Guatemala
GULF OF HONDURAS
Livingston
Puerto Santo Tomas de Castilla
Route II
Refinery Site
El Rancho
GUATEMALA
Route I
San Jose
PACIFIC OCEAN
Legend
Road
Railroad
River

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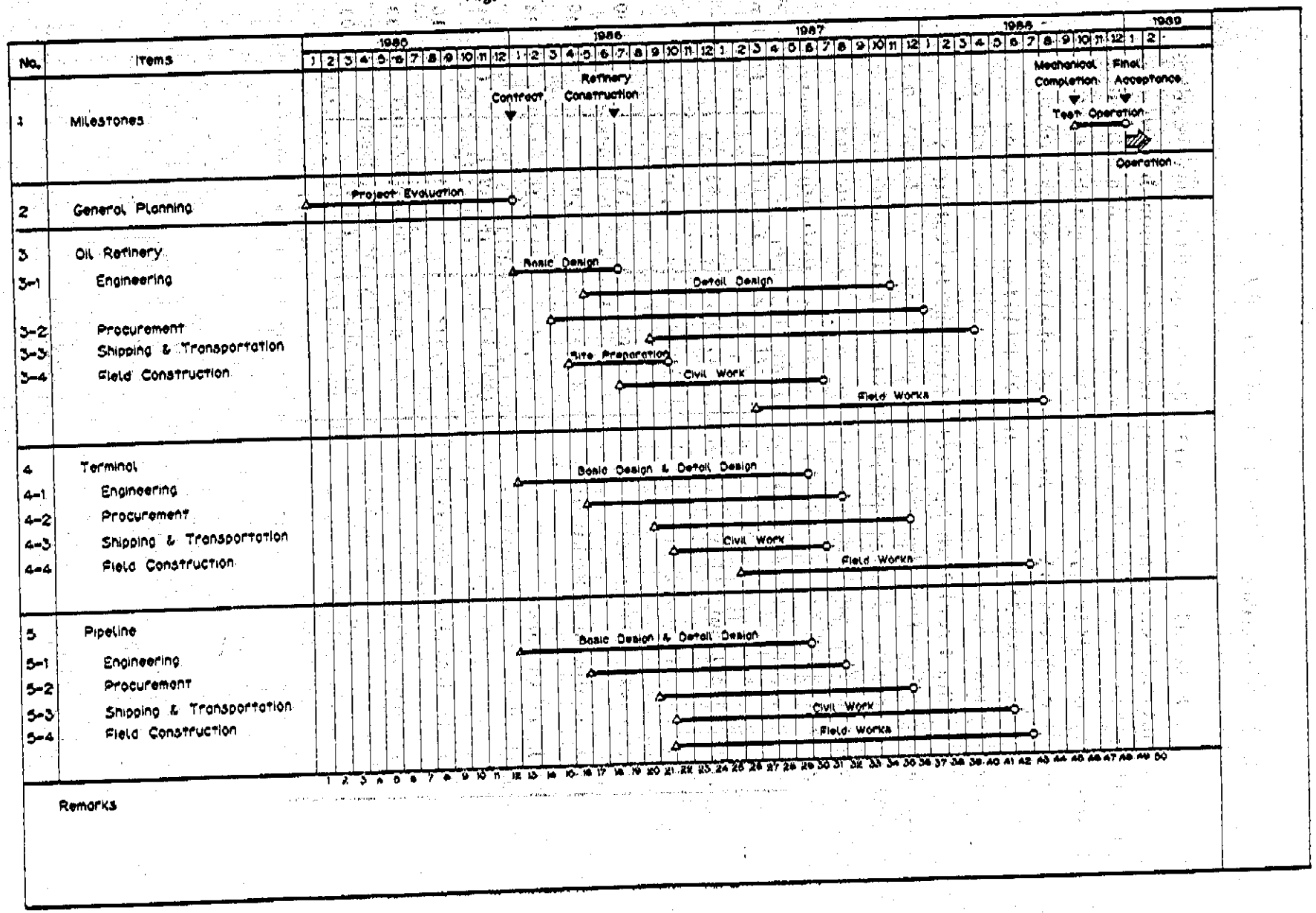
Fig. 13 Schedule for Guatemala Oil Refinery



4. Construction Cost

A total of about 673 million quetzales is estimated as construction cost. The breakdown is shown below.

- o Refinery About 510 million quetzales
- o Terminal About 69 million quetzales
- o Pipeline About 95 million quetzales

The breakdown by item is shown in Table 2.

Table 2 Construction Cost

(Unit: 10^3 Quentzales)

	Refinery	Terminal	Pipeline
(1) Land Acquisition	2,106	536	—
(2) Site Preparation	20,861	2,701	—
(3) Civil & Buildings	81,012	26,119	5,690
(4) Equipment & Machinery	255,150	1,670	23,530
(5) Field Works	92,806	27,168	44,334
Sub-Total	(451,935)	(58,194)	(73,554)
(6) Engineering & Supervising	35,532	8,733	10,116
(7) Contingency	22,597	1,744	11,033
Total	510,064	68,671	94,703
Grand Total	673,438		

VII. OPERATION PLAN

1. Supply and Demand of Petroleum Products

Supply and demand of petroleum products for the period of 20 years from 1989 to 2008 are shown in Table 3. Table 3 indicates that

- o Gas oil is in much short supply even after operation of the new refinery.
- o Gasoline, kerosene, jet fuel and fuel oil show some surplus for some five years after the start of the operation of the refinery. The operation rate of either the refinery owned by Texas Petroleum Company or the new refinery must be lowered.
- o In 2002 or 13 years after the operation of the refinery having started, the construction of another new refinery must be planned.

2. Organization and Manpower

(1) Refinery

A total of 508 persons is required for the refinery. Its organization chart is shown in Fig. 14.

(2) Terminal and pipeline

A total of 35 persons is required for the terminal and pipeline. Its organization chart is shown in Fig. 15.

3. Operation Instruction and Training Plan

(1) Operation instruction

100 men x 3 months = 300 man-months are expected to receive operation instruction.

(2) Training plan

Operating staff of the new refinery are trained as follows:

- o Training abroad
  50 men x 3 months (Dividing into 3 groups)
- o Training at home
  100 men x 2 months (Divided into 5 groups)

Table-3 Demand-Supply Projection

(Unit 10^3 bbl/y)

		1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Demand																					
	LPG	715	742	769	798	828	859	891	924	959	995	1,032	1,071	1,111	1,152	1,195	1,240	1,287	1,335	1,385	1,436
	Gasoline	3,584	3,696	3,850	4,046	4,250	4,470	4,696	4,934	5,184	5,450	5,726	6,016	6,322	6,644	6,980	7,336	7,708	8,100	8,512	8,950
	Kerosene & Jet Fuel	1,110	1,144	1,187	1,232	1,278	1,326	1,376	1,428	1,482	1,539	1,597	1,657	1,720	1,786	1,854	1,925	1,998	2,075	2,155	2,238
	Gas Oil	5,751	6,017	6,352	6,706	7,081	7,473	7,885	8,319	8,777	9,260	9,764	10,298	10,860	11,451	12,071	12,729	13,416	14,142	14,907	15,706
	Fuel Oil	3,411	3,658	3,919	4,198	4,494	4,810	5,145	5,502	5,882	6,286	6,716	7,174	7,661	8,179	8,730	9,316	9,940	10,604	11,310	12,061
	Asphalt	112	111	111	111	111	111	112	112	112	112	112	112	112	113	113	113	113	113	113	114
Supply																					
New Refinery	LPG	531	683	759																	759
	Gasoline	2,772	3,564	3,960																	3,960
	Kerosene & Jet Fuel	876	1,126	1,251																	1,251
	Gas Oil	2,446	3,145	3,494																	3,494
	Fuel Oil	1,870	2,404	2,671																	2,671
	Asphalt	139	178	198																	198
Texaco	LPG	25																			25
	Gasoline	845																			845
	Kerosene & Jet Fuel	419																			419
	Gas Oil	1,476																			1,476
	Fuel Oil	1,627																			1,627
Surplus (=) or Deficit (-)																					
	LPG	-159	-34	+15	-14	-44	-75	-107	-140	-173	-211	-248	-287	-327	-368	-411	-456	-503	-551	-601	-652
	Gasoline	-33	+713	+955	+759	+555	+335	-109	-129	-379	-645	-921	-1,211	-1,517	-1,839	-2,175	-2,531	-2,903	-3,295	-3,707	-4,145
	Kerosene & Jet Fuel	+185	+401	+483	+438	+392	+344	-294	-242	-188	-131	-73	-13	-50	-116	-184	-255	-328	-405	-485	-568
	Gas Oil	-1,829	-1,396	-1,382	-1,736	-2,111	-2,503	-2,915	-3,342	-3,807	-4,290	-4,794	-5,328	-5,890	-6,481	-7,101	-7,759	-8,446	-9,172	-9,937	-10,738
	Fuel Oil	+86	+373	+379	+100	-196	-512	-847	-1,204	-1,584	-1,988	-2,418	-2,876	-3,363	-3,881	-4,432	-5,018	-5,642	-6,306	-7,012	-7,763
	Asphalt	-27	+67	+87	+87	+67	+87	+86	+86	+86	+86	+86	+86	+86	+85	+85	+85	+85	+85	+85	+84

Fig. 14 Organization of Oil Refinery

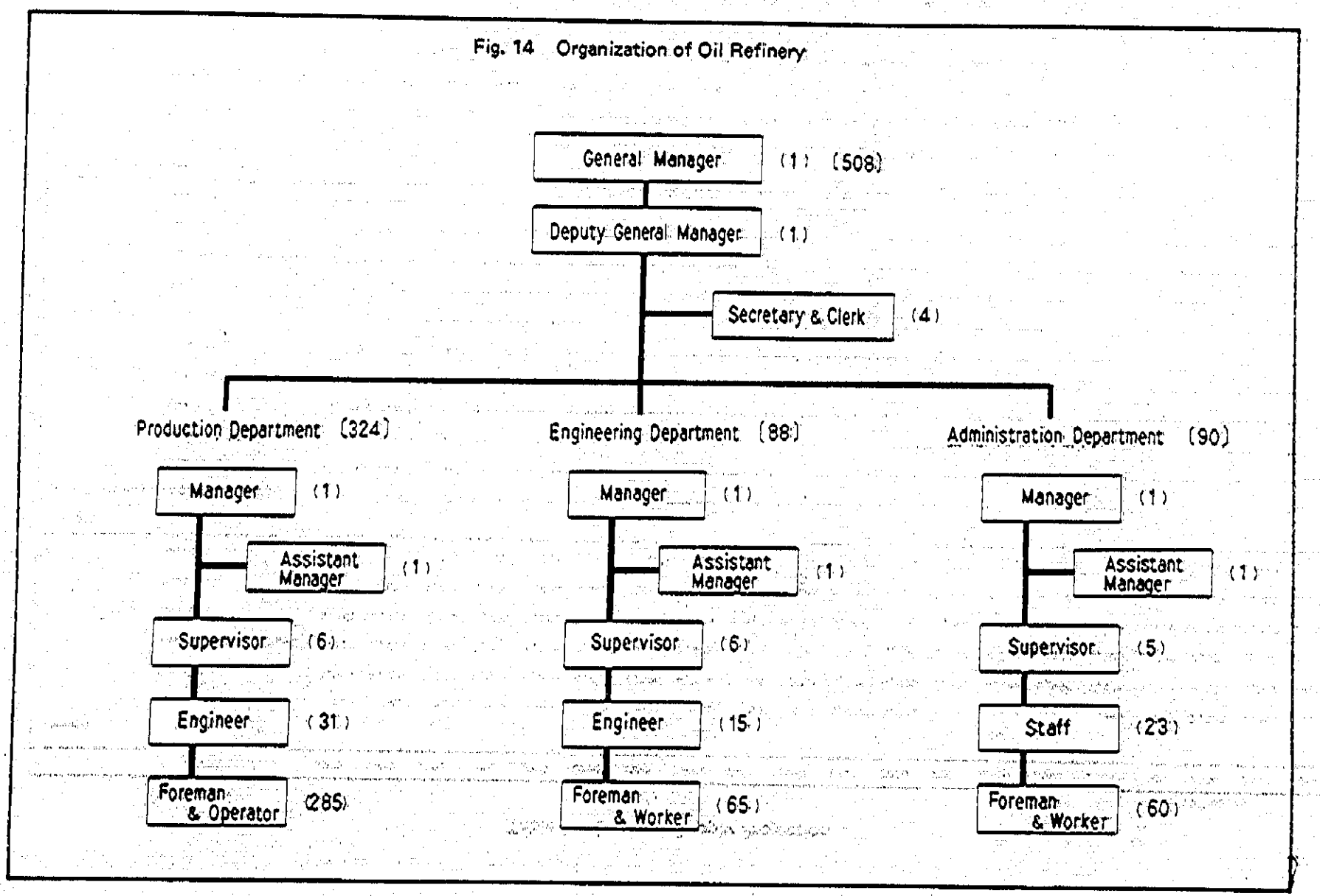
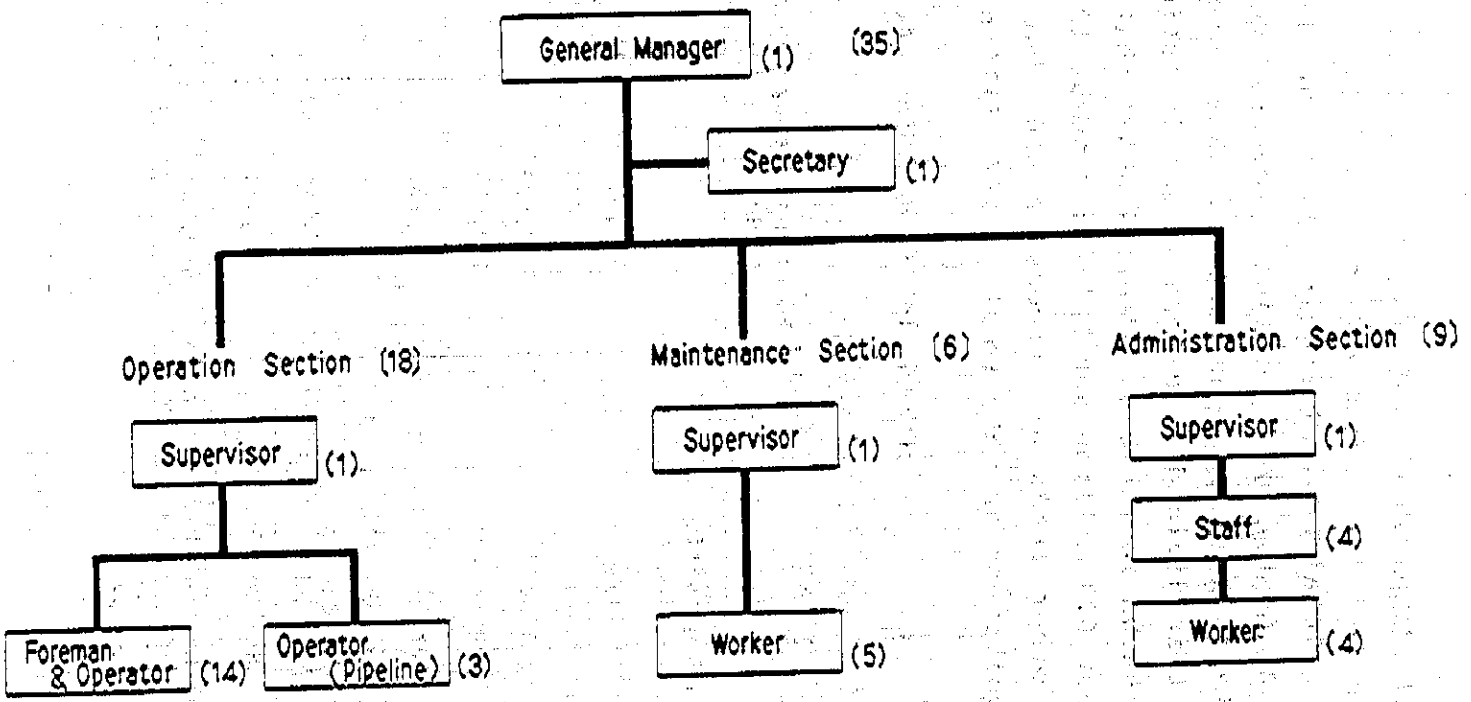


Fig. 15 Organization of Terminal & Pipeline



VIII. FINANCIAL ANALYSIS

1. Total Capital Requirement

Total capital requirement is an aggregate of construction cost, pre-operating expense, working capital and interest during construction. The total capital requirement is divided into foreign and domestic currency portions as shown in Table 4. Table 4 shows that construction costs about 673 million quetzales and about 121 million quetzales as other funds are necessary and that the total capital requirement amounts to about 794 million quetzales.

Table 4 Total Capital Requirement

(Unit: 10^3 Quetzales)

	Foreign Currency Portion	Domestic Currency Portion	Total
Land Acquisition and Construction Cost			
Refinery	336,307	173,757	510,064
Terminal	30,845	37,826	68,671
Pipeline	42,803	51,900	94,703
Sub-Total	409,955	263,483	673,438
Pre-operating Expense	1,236	6,662	7,898
Working Capital	0	4,711	4,711
Interest during Construction	69,638	38,331	107,969
Sub-Total	70,874	49,704	120,578
Total Capital Requirement	480,829	313,187	794,016

2. Operating Cost

Operating cost can be roughly classified into variable cost and fixed cost. The variable cost includes cost of raw materials, chemicals, catalysts and utility. The fixed cost includes cost of direct labor, plant overhead and other expenses, maintenance and insurance. Table 5 shows operating cost.

Table 5 Operating Cost

(Unit: 10^3 Quetzales)

Year	1y	2y	3y - 20y
Variable Cost			
Raw Material	247,932	318,770	354,189
Chemical	605	779	865
Catalyst	1,438	1,848	2,054
Utility	2,760	3,548	3,942
Fixed Cost			
Direct Labor	3,656	3,656	3,656
Plant Overhead and Others Expense	3,901	3,901	3,901
Maintenance	15,823	15,823	15,823
Insurance	4,696	4,696	4,696
Total	280,811	353,021	389,126

(Note: 1y = 1989, 2y = 1990, 3y - 20y = 1991 - 2008)

Table 5 shows that material cost is predominant in the variable cost and accounts for about 90% in 3rd to 20th year.

3. Financial Analysis

(1) Major premises for financial analysis

- o Project period

  Construction period 3 years

  Operation period 20 years

- o Base price

  The prices are based on those as of end 1983 with no escalation considered.

- o Stream factor of the refinery

  1st year 70%

  2nd year 90%

  3rd year and thereafter 100%

If the new refinery is operated at the above operation rates, production exceeds demand for the first five years or so but supply and demand are balanced by Texas Petroleum Company. The above operation rates are planned for the new rifiney.

- o Depreciation

  Straight line depreciation is applied and depreciation is made in 5 to 15 years depending on the type of facilities.

- o Income tax

  Because this project is state-owned, it has been supposed that income tax is exempted.

(2) Sales plan

- o Sales volume

  All of products produced from the new refinery are to be sold.

- o Selling prices

  The selling prices are as shown below based on agreement with MEM.

LPG	28.548	Quetzales/bbl
Premium gasoline	48.132	"
Regular gasoline	46.578	"

Kerosene & jet fuel	48.930	"
Gas oil	45.402	"
Fuel oil	27.832	"
Asphalt	27.832	"

Table 6 shows sales volume and revenue by the first, second and third and subsequent years.

(3) Production cost

Production cost is an aggregate of operating cost, depreciation and loan interest. Calculated results are shown in Table 7.

(4) Financial analysis method

Financial Internal Rate of Return (FIRR) is used to analyze profitability.

- o FIRR on I (FIRR on Investment)
  FIRR on I means IRR when the total investment is covered by the equity and is an index showing a substantial profitability of a project with no regard to effects due to change in loan terms or equity ratio.
- o FIRR on E (FIRR on Equity)
  FIRR on E shows IRR on capital and is an index showing the profitability of equity only excepting loans.

Reference is to be made to the equation to obtain FIRR on I or FIRR on E written in the Study Report.

(5) Results of financial analysis

- o Profitability
  Table 8 shows the profitability of this project.

Table 6 Sales Volume and Revenue

	LPG			Gasoline (P)			Gasoline (R)			Kerosene/Jet Fuel		
	1y	2y	3y - 20y	1y	2y	3y - 20y	1y	2y	3y - 20y	1y	2y	3y - 20y
Prod. Q'ty (bbl)	531,300	683,100	759,000	1,386,000	1,782,000	1,980,000	1,386,000	1,782,000	1,980,000	875,489	1,125,628	1,250,698
Unit Price (Quetzal/bbl)	28.548	28.548	28.548	48.132	48.132	48.132	46.578	46.578	46.578	48.930	48.930	48.930
Revenue (10^3 Quetzales/y)	15,168	19,501	21,668	66,711	85,711	95,301	64,557	83,002	92,225	42,838	55,077	61,197

	Gas Oil			Fuel Oil			Asphalt			Total		
	1y	2y	3y - 20y	1y	2y	3y - 20y	1y	2y	3y - 20y	1y	2y	3y - 20y
Prod. Q'ty (bbl)	2,445,654	3,144,413	3,493,792	1,869,427	2,403,549	2,670,610	138,600	178,200	198,000			
Unit Price (Quetzal/bbl)	45.402	45.402	45.402	27.832	27.832	27.832	27.832	27.832	27.832			
Revenue (10^3 Quetzales/y)	111,038	142,763	158,625	52,030	66,896	74,328	3,858	4,960	5,511	356,200	457,970	508,855

Note: o 1y = 1989, 2y = 1990, 3y - 20y = 1991 - 2008

o The revenue in the table is not adjusted by the changes of inventory and account receivable caused by the change of operating rate.

Table 7 Production Cost

(Unit: 10^3 Quatzales)

Year	Operating Cost			Depreciation	Amortization	Interest	Total
	Variable Cost	Fixed Cost	Sub Total				
1	252,735	28,076	280,811	63,923	8,778	67,796	421,308
2	324,945	28,076	353,021	63,923	8,778	70,242	495,964
3	361,054	28,076	389,126	63,923	8,778	68,092	529,919
4	361,050	28,076	389,126	63,923	8,778	65,350	527,177
5	361,050	28,076	389,126	63,923	8,778	60,994	522,821
6	361,050	28,076	389,126	63,923	7,198	56,637	516,884
7	361,050	28,076	389,126	63,923	7,198	52,280	512,527
8	361,050	28,076	389,126	63,923	7,198	47,924	508,171
9	361,050	28,076	389,126	63,923	7,198	43,567	503,814
10	361,050	28,076	389,126	63,923	7,198	39,210	499,457
11	361,050	28,076	389,126	6,314	7,198	34,853	437,491
12	361,050	28,076	389,126	6,314	7,198	30,497	433,135
13	361,050	28,076	389,126	6,314	7,198	26,140	428,778
14	361,050	28,076	389,126	6,314	7,198	21,783	424,421
15	361,050	28,076	389,126	6,314	7,198	17,427	420,065
16	361,050	28,076	389,126	0	0	13,070	402,196
17	361,050	28,076	389,126	0	0	8,713	397,839
18	361,050	28,076	389,126	0	0	4,356	393,482
19	361,050	28,076	389,126	0	0	0	389,126
20	361,050	28,076	389,126	0	0	0	389,126

Note: The operating cost in the table is not adjusted by the changes of inventory and account payable caused by the operating rate.

Table 8 FIRR for Base Case

FIRR on I (%)	FIRR on E (%)
11.2	17.6

Table 8 shows that FIRR on I is 11.2% and this project pays although its profitability is not very high.

FIRR on E is 17.6% and exceeds the loan interest of 9%.

- o Cash flow table

  Table 9 shows cash flow by year. According to Table 9, cash runs short only in the first year and a short-term loan is required. Thereafter, cash shortage does not occur and finance is put in a sound condition.

- o Major financial indices

  Table 10 shows the major financial indices by year.

(6) Sensitivity analysis

Sensitivity analysis is conducted by fluctuating the following factors in the base case.

- o Change on investment cost (±10%)
- o Change on selling price (±10%)
- o Change on crude oil cost (±10%)
- o Change on variable cost (±20%)
  (except crude oil cost)
- o Change on fixed cost (±20%)
- o Change on interest (4% and 14% interest)
- o Change on capital (capital 20, 30 and 40%)

Results of the sensitivity analysis are shown below with respect to change on investment cost, product selling prices and crude oil costs. Concerning to other factors, reference is to be made to the Study Report.

Table 9 Cash Flow (After commercial operation)

(Unit: 10^3 Quetzales)

Year	Sources of Fund				Application of Fund				
	Sales*2 Income	Long Term Loan	Short Term Loan	Total	Operating*3 Cost	Interest	(For S.T.L.)	Total	Balance
1	297,507	0	40,771	338,277	270,481	67,797	(2,446)	338,277	0
2	439,176	0	-17,924	421,252	351,009	70,243	(4,893)	421,252	0
3	499,892	0	-22,846	477,045	387,919	68,092	(2,742)	456,011	21,035
4	508,566	-48,408	0	460,158	389,260	65,350	0	454,611	5,547
5	508,855	-48,408	0	460,447	389,126	60,994	0	450,120	10,327
6	508,855	-48,408	0	460,447	389,126	56,637	0	445,763	14,683
7	508,855	-48,408	0	460,447	389,126	52,280	0	441,407	19,040
8	508,855	-48,408	0	460,447	389,126	47,924	0	437,050	23,397
9	508,855	-48,408	0	460,447	389,126	43,567	0	432,693	27,753
10	508,855	-48,408	0	460,447	389,126	39,210	0	428,336	32,110
11	508,855	-48,408	0	460,447	389,126	34,853	0	423,980	36,467
12	508,855	-48,408	0	460,447	389,126	30,497	0	419,623	40,824
13	508,855	-48,408	0	460,447	389,126	26,140	0	415,266	45,180
14	508,855	-48,408	0	460,447	389,126	21,783	0	410,910	49,537
15	508,855	-48,408	0	460,447	389,126	17,427	0	406,553	53,894
16	508,855	-48,408	0	460,447	389,126	13,070	0	402,196	58,251
17	508,855	-48,408	0	460,447	389,126	8,713	0	397,839	62,607
18	508,855	-48,408	0	460,447	389,126	4,356	0	393,483	66,964
19	508,855	0	0	508,855	389,126	0	0	389,126	119,729
20	508,855	0	0	508,855	389,126	0	0	389,126	119,729

Note: 1. The last figures in each number are not adjusted, since this table is summary of cash flow from computer output.

2. The figures of sales income are the adjusted numerals by the changes of inventory and account receivable.

3. The figures of operating cost are the adjusted numerals by the changes of inventory and account payable.

Table 10 Major Financial Indices

Year	Profitability Indices			Stability Indices	
	Profit on Sales (%)	Profit on Capital (%)	Profit on Equity (%)	Net Worth Ratio	Currency Ratio
-3	—	—	—	45.0	—
-2	—	—	—	13.9	—
-1	—	—	—	8.6	—
1	-19.3	-9.0	-96.7	0.3	1.2
2	-8.7	-5.3	-57.9	-5.0	1.9
3	-4.3	-2.9	-32.0	-8.4	4.2
4	-3.6	-2.4	-27.0	-12.2	4.5
5	-2.7	-1.9	-26.0	-16.1	4.8
6	-1.6	-1.1	-11.8	-19.4	5.3
7	-0.7	-0.4	-5.4	-22.4	6.0
8	0.1	0.1	1.0	-24.8	6.7
9	1.0	0.7	7.4	-26.4	7.7
10	1.9	1.3	13.8	-26.6	8.8
11	13.5	9.2	100.1	-5.4	9.9
12	14.9	10.1	111.5	15.1	11.3
13	15.7	10.7	117.9	33.5	12.8
14	16.6	11.3	124.4	49.8	14.5
15	17.5	11.9	130.8	64.0	16.3
16	20.9	14.2	156.7	76.7	18.3
17	21.8	14.8	163.5	87.1	20.4
18	22.7	15.4	169.5	95.6	22.7
19	23.5	16.0	176.3	96.3	26.8
20	23.5	16.0	176.3	96.8	30.8

o Change on investment cost

Table 11 shows change on the financial internal rate of return when investment cost increases or decreases by 10%.

Table 11 FIRR Changes on Investment Cost

(Unit: %)

	+10%	Base Case	-10%
FIRR on I	10.2	11.2	12.4
FIRR on E	13.6	17.6	22.2

FIRR on I increases by 1.2% and FIRR on E increases by 4.6% when investment cost in Table 11 is decreased by 10%.

o Change on product selling prices

Table 12 shows FIRR changes when petroleum product selling prices increase or decrease by 10%.

Table 12 FIRR Changes on Product Sales

(Unit: %)

	+10%	Base Case	-10%
FIRR on I	15.7	11.2	5.4
FIRR on E	33.8	17.6	Minus

As shown in Table 12, changes on petroleum product prices exert a great influence on financial internal rates of return. For example, FIRR on I increases by 4.5% and FIRR on E increases by 16.2% when the price goes up by 10%.

o Change on crude oil cost

Table 13 shows FIRR changes when crude oil cost increases or decreases by 10%.

Table 13 FIRR Changes on Crude Cost

(Unit: %)

	+10%	Base Case	-10%
FIRR on I	7.4	11.2	14.5
FIRR on E	Minus	17.6	30.0

As shown in Table 13, change on crude oil cost exerts a great influence on financial internal rates of return. If crude oil cost decreases by 10%, FIRR on I increases by 3.3% and FIRR on E increases by 12.4%.

Results of the sensitivity analysis are summarized in Fig. 16 and 17.

Fig. 16 Summary of Sensitivity Analysis
(FIRR on I to Variation of Financial Parameters)

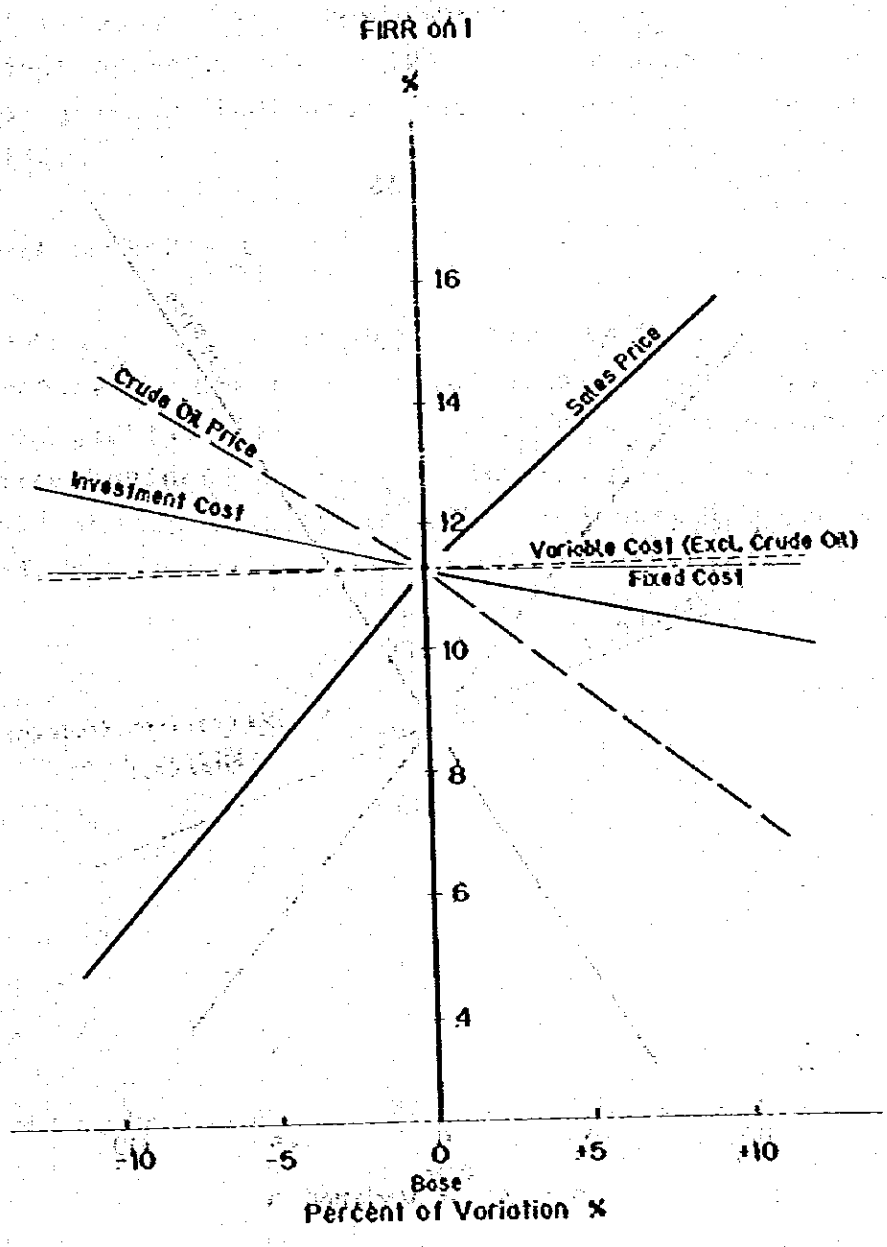
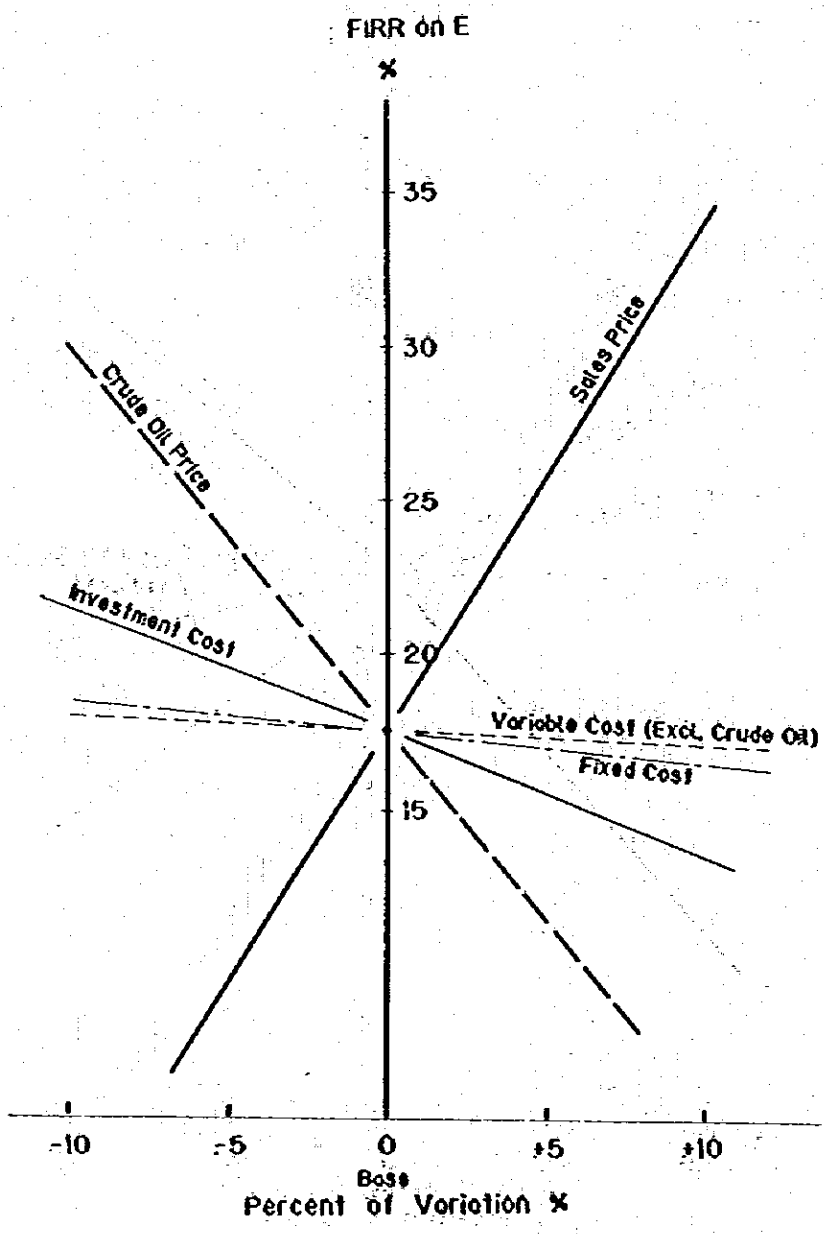


Fig. 17 Summary of Sensitivity Analysis
(FIRR on E to Variation of Financial Parameters)



IX. SOCIAL AND ECONOMIC ANALYSIS

1. Economic Internal Rate of Return

Economic Internal Rate of Return (EIRR) is calculated as 8.6% from economic benefit and expense.

According to the guide line set by various international organs, the criterion for judging implementation of a project by EIRR is 8 to 12%. The internal rate of return in this project indicates that the project is worth implementation.

2. Other Economic Benefit

543 persons are employed directly for the operation of the refinery, terminal and pipeline. Moreover, about 16 million quetzales is spent annually as maintenance cost to increase business of related industries. Much increase in employment opportunity in related industries is thus expected.

X. OVERALL EVALUATION AND RECOMMENDATION

In closing this study, overall evaluation is made in this Volume. Financially feasible conditions for this project are that duties on equipment and materials imported are exempted, the owner is freed from income tax and average 10,000 bbl/d of Guatemalan crude is available for the period of 20 years. Exemption of duties and income tax has been confirmed with MEM. However it is necessary, paying attention to effects of the new petroleum law, to observe the progress of Guatemalan crude oil output in future.

The Processes to be used for the new oil refinery are all commercially proven. Condition of the site and infrasturcture, and technical level in Guatemala in no way hinder implementation of this project. Demands forecast for petroleum products support that the production scale of the new oil refinery is reasonable.

(1) Technical evaluation

The crude oil processing capacity of the new refinery is 40,000 bbl/d. In consideration of demands for petroleum products, the fluid catalytic cracking process and ebullated-bed hydrocracking process have been adopted for heavy crude cracking process. Both processes are already proven commercially but do not exist in Guatemala at present. The existing refinery in Guatemala is operating at a low operation rate but without any trouble. There will be no problem in technology transfer by providing training and operation guidance, although such advanced processes have been unknown in Guatemala. Therefore, it has been concluded that there is no problem from a technical point of view in materializing the new oil refinery.

(2) Financial evaluation

Results of financial analysis on the refinery, terminal and pipeline are summarized below.

1) Total capital requirement

Total capital requirement amounts to about 794 million quetzales including about 673 million quetzales for construction cost and about 121 million quetzales for interest during construction and other funds.

2) Financial internal rate of return

Financial internal rate of return on investment (FIRR on I) is 11.2%, showing that this project pays although its profitability is not very high. Financial internal rate of return on equity FIRR on E) is 17.6%, exceeding loan interest of 9%. The sensitivity analysis conducted reveals that change in selling price of petroleum products and in crude oil cost exerts a great influence on profitability. Change in construction cost also affects profitability considerably.

Change of the financial internal rate of return on investment (FIRR on I), representative indicator on profitability, is shown below.

o Selling prices of petroleum product	10% up	+4.5%
o Crude oil cost	10% down	+3.3%
o Construction cost	10% down	+1.2%

(3) Economic evaluation

Results of social and economic analysis conducted are summarized below.

1) Economic internal rate of return

Economic internal rate of return (EIRR) is 8.6%. The criterion of various international organs on EIRR for judging implementation of a project is 8 to 12%. The above shows that this project pays.

2) Other economic benefit

In addition to 543 persons directly employed for operation of the new refinery, terminal and pipeline, much increase in employment opportunity in related industries can be expected, because about 16 million quetzales is spent annually as facility maintenance cost.

(4) Overall evaluation

According to financial analysis results, the financial internal rate of return on investment (FIRR on I) is 11.2% and indicates that this project pays although its profitability is not very high. According to economic analysis results, the economic internal rate of return (EIRR) is 8.6% and indicates that it is feasible economically. Increase in employment opportunity can be expected as other economic benefit. At present the Guatemalan economy depends mainly on coffee, cotton and other agricultural products, of which economic structure is easily influenced by weather and market conditions of the products, and is orienting itself for industrialization. Taking the above into account, it would be preferable to implement and execute this project.

However, it should be necessary in implementing the project to study and examine this project from a national macro-economic standpoint, since it requires a vast amount of funds amounting to about 794 million quetzales.

(5) Recommendation

1) Establishment of the Owner of the project

A contractor for the new refinery must be decided not later than early 1986. To do this, the Owner must be established as early as possible to promote this project.

2) Incentive to oil exploration

The project is planned to process 3,300,000 bbl of Guatemalan crude oil annually. Output of Guatemalan crude oil under the new petroleum law enforced in 1983 must be carefully watched an incentives must be given to oil developers if necessary.

3) Effect of crude oil cost and product price on profitability of this project

A sensibility analysis is conducted on effect of crude oil cost and product price on profitability in the financial analysis. According to the results, it is found that both costs have a great influence on profitability.

If the crude oil cost increases by 10%, for example, FIRR on I decreases to 7.4% from 11.2%. If the product price decreases by 10%, for example, FIRR on I decreases to 5.4% from 11.2%. In either case, this project loses charm financially.

Therefore, if the crude oil cost and petroleum product prices as of end 1983 are used as a precondition, the project pays but may lose charm depending on trend of both prices. Therefore, it is necessary to carefully watch trends of crude oil cost and petroleum product prices in the future.