6.2.3 Import of Petroleum Products

(1) Providers of Imported Petroleum Products

Most of the petroleum products imported to Paraguay so far are supplied, as shown in Table 4.2-2, from YPF of Argentina and PETROBRAS of Brazil, respectively, both the state-run oil companies of the neighboring countries of Paraguay.

Since Paraguay is a fluvial inland country, imported petroleum products must be transported either by river or by land. In view of this fundamental condition, the imports of petroleum products from YPF and PETROBRAS can be regarded as quite a reasonable way for Paraguay to secure a low-cost and stable supply of petroleum products over a long period.

Accordingly, petroleum products to be imported in each alternative case of the future supply plans are supposed to be provided by YPF and PETROBRAS as has been the case.

(2) Suppliers of Petroleum Products to Distribution Centers

As will be discussed in detail in Section 6.2.4, the Villa Elisa Refinery and the Hernandarias Depot will continue to be used as the domestic distribution centers of petroleum products in each of the three cases of the future supply plans. Imported petroleum products are therefore to be received at these two distribution centers.

The types of petroleum products to be handled by each distribution center are supposed, as will be described in 6.2.4, as follows: The Villa Elisa Refinery will cover all the types of products from LPG to asphalt, whereas the Hernandarias Depot will handle only regular gasoline, premium gasoline, and gas oil.

In order to avoid round-trip transportations between the two distribution centers, and also to maintain PETROPAR's traditional policy of importing the products of the two supplier as evenly as possible, it is assumed that the petroleum products to be handled at Villa Elisa would be imported from YPF, and those handled at Hernandarias, from PETROBRAS.

However, LPG and aviation gasoline, both to be covered by Villa Elisa, are assumed to be imported from PETROBRAS, again in accordance with PETROPAR's policy.

For reference purposes, the CIF prices of petroleum products at Villa Elisa and Hernandarias imported from the two suppliers in 1987 are given in Table 6.2-5. Except for LPG and aviation gasoline at Villa Elisa, the CIF price of each product has turned to be lower, when imported from the supplier assumed above. This result, however, can not hold at all times since the import prices of petroleum products from Argentina and Brazil will be affected by the market prices of the products in those countries and by their exchange rates as well. However, as far as the CIF prices in 1987 indicate, it can be said that the supplier assumed for each of the distribution centers as above can be regarded as reasonable from an economic viewpoint.

(3) Routes and Means of Transportation of Imported Petroleum Products

The imported petroleum products in each alternative case of future supply plans are assumed to be transported by the same routes and means as at present (see Fig. 4.2-1).

The products from YPF are to be shipped from the port of either La Plata, Buenos Aires, or San Lorenzo and transported up the Parana River and the Paraguay River to the Villa Elisa Refinery with barges or small tankers each with a capacity of 1,500 - 4,000 kℓ each.

Table 6.2-5 Comparison of 1987 CIF Prices at Villa Elisa and Hernandarias for Supposed Providers

(Unit: US$/Kℓ)

Product \ Provider \ Destination	Villa Elisa Refinery		Hernandarias Depot	
	YPF	PETROBRAS	YPF	PETROBRAS
1. LPG	–	★	No Shipment	
2. Regular Gasoline	◎ 174.12	198.03	188.91 (*)	◎ 188.00
3. Premium Gasoline	◎ 187.70	208.52	202.49 (*)	◎ 198.49
4. Aviation Gasoline	–	★	No Shipment	
5. Kerosene	◎ 192.32	218.73	No Shipment	
6. Jet Fuel	◎ 192.32	218.73	No Shipment	
7. Gas Oil	◎ 181.07	205.30	195.86 (*)	◎ 195.27
8. Fuel Oil	◎ 160.64	181.57	No Shipment	
9. Asphalt (US$/Ton)	◎ 178.42	191.17	No Shipment	

Source: PETROPAR

★ : The supposed provider is in accordance with PETROPAR's past policy.

◎ : The supposed provider's CIF price is lower.

(*) : In order to estimate the CIF price, 14.79 US$/Kℓ of the freight between the refinery and the depot is used, based on the current domestic transportation fee of 12,000 Gs/Kℓ and the annual average exchange rate of 811.24 Gs/US$ for 1987.

On the other hand, the products from PETROBRAS are to be carried to the Villa Elisa Refinery or the Hernandarias Depot with tank-trucks each with a capacity of 30 kℓ (for LPG, 44 kℓ each) from Araucaria, Brazil.

With regard to Case-1, transportation by pipeline will be studied as an alternative means of transportation of imported petroleum products (see Appendix 7).

(4) Required Numbers of Barges and Tank-trucks for Transportation of Imported Petroleum Products

With respect to Case-1 where its imports of petroleum products are the largest among the three cases, the numbers of barges and tank-trucks to transport products imported from YPF and PETROBRAS, respectively, are estimated as follows:

(a) Imported Petroleum Products from YPF

Annual imports of each product from YPF in the year 2000 are as indicated in Fig. 6.3-1. The average loading capacity of barges to be used by type of products is assumed on the basis of the estimated data on the barges actually used in 1987, as listed in Table 4.2-4.

(i) Gas Oil

Assuming, from the estimated data on the barges used in 1987, that the average capacity of barges to transport gas oil would be 4,000 kℓ, a transportation frequency of about 100 per annum is required to carry the total annual imports of 393,800 kℓ in the year 2000 with such one barge.

On the other hand, the frequency of transportation will be 16.5 per year when the following three conditions are supposed: Gas oil will be shipped from Buenos Aires, as has so far been the case; as in the case of gas oil transported with a fleet of two 4,000 kℓ barges, 20 days will be required for a barge or a fleet of barges to go and return between Buenos Aires and the Villa Elisa Refinery, irrespective of the size of the barge or the fleet; 330 days per year will be available for such transportation.

A round of transportation hence requires six 4,000 kℓ barges, or the total loading capacity of 24,000 kℓ.

In 1987, one foreign transportation company and two Paraguayan firms of FLOMERES and COPEX were employed to convey gas oil, as Table 4.2-4 shows. Of the barges owned by the two Paraguayan companies, the barges available for transportation of gas oil have a total capacity of 19,400 kℓ, as estimated from the data given in Table 4.2-3.

On the assumption that the barges of the two companies would be solely used to transport gas oil, there will be a shortage of 4,600 kℓ, the balance between 24,000 kℓ and 19,400 kℓ. However, specific measures would not be needed, since the shortage can be covered by the existing small tankers owned by NAVEMAR.

(ii) Gasoline, Kerosene and Jet Fuel

Supposing, from the estimated data on the barges used in 1987, that the average loading capacity of barges to carry regular gasoline, premium gasoline, kerosene and jet fuel would be 2,000 kℓ, then the transportation frequency for the annual total imports (212,900 kℓ) of these products in the year 2000 will be 106.5 per year.

Assuming, on the other hand, that 20 days will be required for a round of transportation, as in the case of gas oil, then the transportation frequency per year is 16.5, based on a total of 330 days per annum.

Therefore, 6.5 barges with a capacity of 2,000 kℓ each, or a total loading capacity of 13,000 kℓ will be needed for each shipment.

For the transportation of gasoline, kerosene and jet fuel, three Paraguayan companies of FLOMERES, NAVEMAR and TRANSOCEANICA were employed in 1987, as indicated in Table 4.2-4. Since their barges for carrying these products are estimated to have the total loading capacity of approximately 26,000 kℓ from the data shown in Table 4.2-3, the existing barges can deal with the future transportation.

(iii) Heavy Fuel Oil

The total imports of heavy fuel oil in the year 2000 will be 43,300 kℓ, as shown in Fig. 6.3-1. Supposing that the annual imports will all be transported, as in 1987, with two barges (total capacity of about 5,900 kℓ) which are owned by FRANCISCO SGUERA, an Argentine company and used exclusively for heavy fuel oil, then the transportation frequency will be about seven per year.

This means that the existing two barges may transport the annual imports at such a long interval of about 50 days, and thus no specific measures would be necessary.

(iv) Asphalt

Asphalt seems to have so far been transported with tank-trucks owned by foreign transportation companies. It is supposed that the future transportation would be conducted by such foreign firms, accordingly.

(b) Imported Petroleum Products from PETROBRAS

Fig. 6.3-1 shows imports of each product from PETROBRAS for the Villa Elisa Refinery and the Hernandarias Depot, respectively, in the year 2000 for Case-1.

264 days per year (22 days per month on the average) are assumed to be available for receiving each product at the refinery and the depot, respectively, in view of holidays, etc.

(i) LPG

Of the total quantity of 103,900 kℓ LPG to be imported in 2000, some might be transported directly to the tanks of distributors, bypassing the Villa Elisa Refinery, as in 1987. However, it is herein assumed that all of the imported LPG would be received at the Villa Elisa Refinery.

On the assumption that all the LPG will be transported with a tank-truck with an average capacity of 44 kℓ, then the transportation frequency per year will be about 2,360.

On the other hand, it takes for a tank-truck about 1.5 days to go from Araucaria in Brazil to the Villa Elisa Refinery, according to PETROPAR. If another 1.5 days is necessary to unload LPG at the refinery and return to Araucaria, it will require a tank-truck about three days to make a round-trip between Araucaria and the refinery.

Since the number of such round-trips available for a tank-truck per year is about 88, the transportation of the annual LPG imports will need at least 27 tank-trucks with a 44 kℓ capacity each, or a total capacity of 1,188 kℓ.

At present, Paraguayan transportation companies possess LPG tank-trucks with their total loading capacity of 914 kℓ (21 tank-trucks in terms of a 44 kℓ capacity), as shown in Table 4.4-3. Of these, however, nine trucks are supposed to be used for domestic distribution of LPG, as will be discussed in 6.2.4. Consequently, the remaining 12 trucks alone will be available for the transportation of imported LPG, and thus 15 more will be required.

(ii) Regular Gasoline, Premium Gasoline, and Gas Oil

Total annual imports of these products (246,800 kℓ) will all be received at the Hernandarias Depot. Supposing that all the imports will be carried with a 30 kℓ tank-truck, the annual transportation frequency will be 8,230.

Approximately one day is needed for a tank-truck to travel from Araucaria in Brazil to the Hernandarias Depot, according to PETROPAR. Assuming that a day will be required to unload products at the depot and return to Araucaria, it will take a tank-truck about two days to make such a round-trip.

This translates into about 132 such round-trips per year for a tank-truck, if 264 days are available a year. Therefore, at least 62 tank-trucks with a capacity of 30 kℓ each (or a total capacity of 1,860 kℓ) will be necessary for the transportation of all the annual imports.

In contrast, as indicated in Table 4.2-5, for transportation of petroleum products except for LPG and asphalt, Paraguayan transportation companies presently own tank-trucks with a total loading capacity of 1,271 kℓ (or 42 tank-trucks based on a 30 kℓ capacity). Thus 20 more tank-trucks will be needed.

(iii) Aviation Gasoline

Aviation gasoline will be all received at the Villa Elisa Refinery. Assuming that the total imports of 4,200 kℓ will be transported with a 30 kℓ tank-truck, a transportation frequency of 140 per annum will be required.

If a round-trip between Cubatao (Sao Paulo) and the Villa Elisa Refinery is supposed to require four days, then a tank-truck can make 66 such round-trips per year.

Therefore, two tank-trucks with a capacity of 30 kℓ each will be needed to transport the annual imports of aviation gasoline. As mentioned in (ii) above, the tank-trucks owned by the Paraguayan transportation companies are supposed to be used to transport regular gasoline, premium gasoline, and gas oil to the Hernandarias Depot. Then two 30 kℓ tank-trucks will be additionally required for aviation gasoline.

6.2.4 Domestic Distribution

(1) Distribution Center

A study has been made to judge whether or not a third distribution center is required in addition to the two existing centers - the Villa Elisa Refinery and the Hernandarias Depot - to cover the regional demands for petroleum products in the year 2000.

(a) Study Basis

If the third distribution center is to be set up, the most reasonable location for such a center seems to be somewhere in the south of Itapua Department, which is expected to have a relatively large demand for petroleum products, to be located in a position to form a triangle in relation to the Villa Elisa Refinery and the Hernandarias Depot.

The supply area of the third center is assumed to cover Itapua Department and the neighboring Departments of Misiones and Caazapa in view of its correlative position in relation to the two existing distribution centers and the routes of the national highways in Paraguay.

(b) Study Method and Results

An examination is made to see if the petroleum product demand in Itapua Department will be large enough to justify the installation of the third distribution center, as most of the product demand of the abovementioned supply area is concentrated in the said department.

As shown in Table 6.2-6, the estimated demand in Itapua for the year 2000 indicates that the demand for petroleum products other than regular gasoline and gas oil is too small, if not nil, for the installation of the third distribution center to be viable.

As for regular gasoline, its demand corresponds to only about a half of the shipments from the Hernandarias Depot in 1987, and hence the installation of the center could not be justified.

The demand for gas oil, on the other hand, is comparable to the total shipments from the Hernandarias Depot in 1987, and would seem to be large enough to require the distribution center. However, a distribution center which handles only one single type of petroleum product may not be realistic from an economic viewpoint.

In conclusion, the third distribution center does not appear to be necessary and the distribution centers required for the future petroleum product supply plans in Paraguay will be the Villa Elisa Refinery and the Hernandarias Depot, the same as at present.

(2) Supply Areas of Each Distribution Center

In order to plan the future facilities in the distribution centers at Villa Elisa and Hernandarias, it is necessary to fix the amount of each product to be handled at each of

Table 6.2-6 Itapua Department's Demand in 2000 vs. Hernandarias Depot's Shipments in 1987

(Unit: Kℓ)

Product	Itapua Department's Demand in 2000	Hernandarias Depot's Shipments in 1987
1. LPG	Small	0
2. Regular Gasoline	11,200	23,686
3. Premium Gasoline	3,200	0
4. Aviation Gasoline	0	0
5. Kerosene	1,200	0
6. Jet Fuel	0	0
7. Gas Oil	58,100	71,549
8. Fuel Oil	0	0
9. Asphalt	Small	0

Source: JICA Mission and PETROPAR

the centers. Such amounts are established by assuming the supply area for each distribution center.

It is known that Paraguay is divided into four regions, and this division seems to be a convenient basis for the setting up of the supply areas of the two distribution centers. In consideration of the highway network in the country, it is assumed that the supply area for the Hernandarias Depot would be the Region II (Este or East), while that for the Villa Elisa Refinery would cover the other three regions, i.e., Region I (Centro Sur or Center South), Region III (Norte or North), and Region IV (Occidental or West). Although this division of supply areas for the two distribution centers is only for convenience, it will not be too much different from the present situation, and it should be noted that the division will by no means be rigid and unchangeable.

In the above assumptions, the amounts of the petroleum products to be handled at the Villa Elisa Refinery and the Hernandarias Depot are as shown in Table 6.2-7. The whole amount of aviation gasoline and kerosene are assumed to be handled at the Villa Elisa Refinery since demand for the two products in the Region II is estimated to be very small. LPG and asphalt are assumed to be all handled also at the Villa Elisa Refinery, because the future regional demand for such products is not available. (Incidentally, at present, all the terminals for the import and distribution of LPG are owned by LPG distributors and are concentrated in the capital of Asuncion and its suburbs. On the other hand, imported asphalt is sent directly to construction sites in most cases, and asphalt tanks at the Villa Elisa Refinery are not fully utilized.)

(3) Routes and Means of Transportation for Domestic Distribution

The routes and means of transportation for domestic distribution are supposed to be basically the same as they are at present.

(a) Distribution Routes

As shown in Fig. 4.4-1, the present distribution routes are classified into two: One is through distributors, and the other is the direct channel from PETROPAR to consumers. The former consists of two cases: one where products are sold to consumers via retailers, and the other where products are directly sold to consumers by distributors.

(i) A greater part of regular gasoline, premium gasoline, kerosene, and gas oil will be shipped from PETROPAR to retailer's service stations via distributors, to whom the retailers are under contracts. The rest is to be sold to consumers by PETROPAR directly, or through distributors.

Table 6.2-7 Supplies of Petroleum Products from Villa Elisa Refinery and Hernandarias Depot in 2000

(Unit: Kℓ)

Product	Villa Elisa Refinery	Hernandarias Depot	Total Demand
1. LPG	103,900 1)	0 1)	103,900
2. Regular Gasoline	95,700	47,000	142,700
3. Premium Gasoline	52,200	12,200	64,400
4. Aviation Gasoline	4,200 2)	0 2)	4,200
5. Kerosene	9,400 2)	0 2)	9,400
6. Jet Fuel	58,600	0	58,600
7. Gas Oil	393,800	187,600	581,400
8. Fuel Oil	43,300	0	43,300
9. Asphalt	12,200 1)	0 1)	12,200

Source: JICA Mission

1) As the most of the total demand is expected in Regions I, III and IV, the total demand is assumed to be supplied from Villa Elisa Refinery.

2) Since shipments from Hernandarias Depot to Region II are relatively small, these are supposed to be supplied from Villa Elisa Refinery.

(ii) Most of the aviation gasoline and jet fuel will to be sold from PETROPAR to consumers through distributors, while the rest is sold directly from PETROPAR to consumers.

(iii) LPG is to be shipped from PETROPAR to distributors; LPG for household use is to be filled into cylinders at the distributors' storage terminals and sold to consumers through the retail service stations; LPG for automobile use is to be sold at the distributors' filling stations.

(iv) Fuel oil is to be sold to consumers through distributors or directly by PETROPAR.

(v) Asphalt is to be sold to consumers directly by PETROPAR or via distributors.

(b) Means of Transportation

The transportation of petroleum products at each distribution stage mentioned above is to be undertaken by transportation companies using tank-trucks, under agreements with distributors.

Tank-trucks with an average capacity of 14 kℓ are to be used for transportation of petroleum products, except for LPG which is to be carried mainly with 44 kℓ - capacity tank-trucks.

Fuel oil sold to consumers on the Parana River or the Paraguay River will be shipped directly from the Villa Elisa Refinery by barge.

(4) Number of Tank-trucks for Transportation of Petroleum Products for Domestic Distribution

With regard to Case-2, in which the total shipments of petroleum products from the Villa Elisa Refinery are the largest among all the cases, the required number of tank-trucks to transport such products for domestic distribution in the year 2000 is estimated as follows:

It is herein assumed that, irrespective of distribution routes, a day would be required on the average for products shipped from either the refinery or the Hernandarias Depot to reach service stations (for LPG, storage terminals or filling stations) or PETROPAR's direct customers and also that each tank-truck will be engaged in one round of transportation once a day.

Another assumption is that 264 days per year (22 days per month on the average) will be available for shipping products from the Villa Elisa Refinery and the Hernandarias Depot, respectively, in view of holidays etc.

The annual shipments of products in the year 2000 is as shown in Fig. 6.3-2.

(a) LPG

Assuming that an annual quantity of 103,900 kℓ will be shipped from the Villa Elisa Refinery with a tank-truck having a 44 kℓ capacity, which is equivalent to an average capacity of tank-trucks so far been used, then the required transportation frequency will be about 2,360 per year.

On the other hand, the number of times available for a tank-truck to transport LPG during 264 days will be 264 per year.

Therefore, to transport all of the total annual quantity of LPG, about nine 44 kℓ tank-trucks will be required, with a total loading capacity of about 400 kℓ.

The total capacity of LPG tank-trucks owned at present by the Paraguayan transportation companies is 914 kℓ, as indicated in Table 4.4-3, which is equivalent to approximately 21 tank-trucks in terms of a 44 kℓ capacity. Of these tank-trucks, about 12 trucks will be used for transportation of imported LPG from PETROBRAS, as mentioned in 6.2.3. Therefore, about nine trucks remaining will be sufficient to carry all the annual shipments for domestic distribution.

(b) Petroleum Products except LPG and Asphalt

With respect to petroleum products except LPG and asphalt, the annual shipments for domestic distribution will be 1,397,600 kℓ, comprising the total quantities of products to be shipped from the Villa Elisa Refinery and the Hernandarias Depot plus the quantities of products to be transferred from the refinery to the depot.

Supposing that the above total quantity will be transported with a tank-truck of a 14 kℓ capacity which is the present average, then the required transportation frequency amounts to about 99,830 per year.

On the other hand, a transportation frequency of 264 per year will be required to carry the products with a 14 kℓ tank-truck. About 378 tank-trucks (total loading capacity of about 5,290 kℓ) will hence be necessary to deliver the annual shipments.

The total capacity of tank-trucks owned by Paraguayan transportation companies to transport petroleum products except for LPG and asphalt amounts to about 3,840 kℓ (or about 274 tank-trucks in terms of a 14 kℓ capacity), as indicated in Table 4.4-2. Therefore, about 104 more tank-trucks will be required to deal with the shipments for the year 2000.

(c) Asphalt

In case where the annual asphalt shipments of 12,200 kℓ is to be transported with a five kℓ tank-truck owned by Jose T. Fleitas, a Paraguayan asphalt distributor, as shown in Table 4.4-2, then the transportation frequency required will be 2,440 per year.

On the other hand, since a transportation frequency of 264 per year will be necessary to cover the annual shipments, a total of about nine tank-trucks with a capacity of five kℓ each will be required.

Consequently, about eight more 5 kℓ tank-trucks will be needed in addition to the existing tank-truck.

6.3 Petroleum Product Supply Balance

The future supply balance of petroleum products has been fixed on the basis of the estimated domestic demand for petroleum products up to the year 2000. In Case-1, all of the products required are to be imported. In Case-2 and Case-3, the amounts of products to be imported are calculated by deducting the respective amounts to be produced at the refinery (as indicated in Section 6.2-2) from the estimated demands for those products.

With regard to the products to be imported, their suppliers, the amount of supply, and the receiving facilities have been determined as discussed in Section 6.2.3. Since domestically produced absolute alcohol is blended with regular gasoline, its amount is reflected in the supply balance of regular gasoline. An outline of the future supply balance is discussed below.

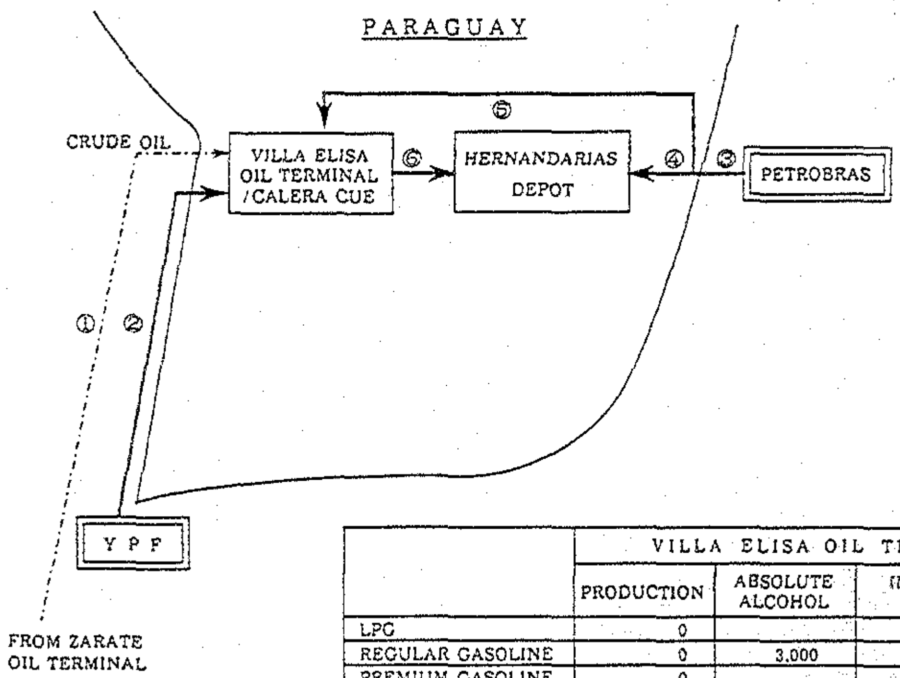
6.3.1 Supply Balance in Case-1

Fig. 6.3-1 shows the supply balance of the petroleum products for Case-1 in the year 2000. The total demand for petroleum products in the year 2000 will be 1,020,100 kℓ, all of which will be imported, except 3,000 kℓ of absolute alcohol produced in Paraguay and blended with regular gasoline.

The products to be imported from YPF of Argentina will amount to 662,200 kℓ and the imports from PETROBRAS of Brazil will be 354,900 kℓ, thus the ratio being 65% / 35%.

The balance for each product is as follows:

(1) LPG demand will be 103,900 kℓ, all of which is to be imported from PETROBRAS and received at the Villa Elisa Oil Terminal and at LPG distributors' storage facilities.



DEMAND & SUPPLY BALANCE

(Unit : Kℓ/Y)

	DEMAND	SUPPLY		
		DOMESTIC REFINING	PRODUCT IMPORT ②+③	ABSOLUTE ALCOHOL
LPG	103,900	0	103,900	
REGULAR GASOLINE	142,700	0	139,700	3,000
PREMIUM GASOLINE	64,400	0	64,400	
AVIATION GASOLINE	4,200	0	4,200	
KEROSENE	9,400	0	9,400	
JET FUEL	58,600	0	58,600	
GAS OIL	581,400	0	581,400	
FUEL OIL	43,300	0	43,300	
ASPHALT	12,200	0	12,200	
TOTAL	1,020,100	0	1,017,100	3,000
CRUDE OIL ①				

OIL HANDLING

(Unit : Kℓ/Y)

	VILLA ELISA OIL TERMINAL / CALERA CUE					HERNANDARIAS DEPOT		
	PRODUCTION	ABSOLUTE ALCOHOL	IMPORT ②	IMPORT ⑤	TOTAL	IMPORT ④	TRANSFER ⑥	TOTAL
LPG	0		0	103,900	103,900	0	0	0
REGULAR GASOLINE	0	3,000	92,700	0	95,700	47,000	0	47,000
PREMIUM GASOLINE	0		52,200	0	52,200	12,200	0	12,200
AVIATION GASOLINE	0		0	4,200	4,200	0	0	0
KEROSENE	0		9,400	0	9,400	0	0	0
JET FUEL	0		58,600	0	58,600	0	0	0
GAS OIL	0		393,800	0	393,800	187,600	0	187,600
FUEL OIL	0		43,300	0	43,300	0	0	0
ASPHALT	0		12,200	0	12,200	0	0	0
TOTAL	0	3,000	662,200	108,100	773,300	246,800	0	246,800
CRUDE OIL ①								

Source : JICA Mission

Fig. 6.3-1 Petroleum Supply Balance in 2000 for Case-1

(2) Regular gasoline demand will be 142,700 kℓ, of which 3,000 kℓ is to be supplied in the form of absolute alcohol and the balance of 139,700 kℓ is to be imported. Imports from YPF will be 92,700 kℓ, being received at the Villa Elisa Oil Terminal. 47,000 kℓ of regular gasoline imported from PETROBRAS will be received at the Hernandarias Depot.

(3) Premium gasoline demand will be 64,400 kℓ, of which 52,200 kℓ is to be imported from YPF being received at the Villa Elisa Oil Terminal, while 12,200 kℓ from PETROBRAS will be received at the Hernandarias Depot.

(4) Aviation gasoline demand will be 4,200 kℓ, all of which is to be imported from PETROBRAS being received at the Villa Elisa Oil Terminal.

(5) Kerosene and jet fuel demands will be 9,400 kℓ and 58,600 kℓ, respectively. All of these products are to be imported from YPF being received at the Villa Elisa Oil Terminal.

(6) Gas Oil demand will be 581,400 kℓ, of which 393,800 kℓ is to be imported from YPF being received at the Villa Elisa Oil Terminal, and 187,600 kℓ from PETROBRAS being received at the Hernandarias Depot.

(7) Fuel oil and asphalt demand will be 43,300 kℓ and 12,200 kℓ, respectively. All are to be imported from YPF being received at the Villa Elisa Oil Terminal.

The supply balance of petroleum products in each year of the study period (1992 - 2000) is calculated in a similar way to the above on the basis of the estimated product demand for each year. The calculated figures are tabulated in Table 6.3-1.

6.3.2 Supply Balance in Case-2

The supply balance of petroleum products in the year 2000 for Case-2 is shown in Fig. 6.3-2. Of the total demand for petroleum products of 1,020,100 kℓ in the year 2000, 949,600 kℓ is to be supplied by the refinery and by absolute alcohol, and the remaining 70,500 kℓ will be imported. The ratio of the domestic refining to the imports will be 93% / 7%.

The crude oil to be used at the refinery is to be the Bonny Light crude, and the amount to be imported and refined in the year 2000 will be 996,800 kℓ.

Imports of refined products from YPF and PETROBRAS will be 12,200 kℓ and 58,300 kℓ, respectively, the ratio hence being 17% / 83%.

The supply balance for each product is as follows:

Table 6.3-1 Future Supply Balance for Case-1 (Continued)

(Unit: Kℓ/Y)

Product	1992				1993				1994			
	Demand	Supply			Demand	Supply			Demand	Supply		
		Domestic Refining	Product Import	Absolute Alcohol		Domestic Refining	Product Import	Absolute Alcohol		Domestic Refining	Product Import	Absolute Alcohol
1. LPG	75,000	0	75,000		78,500	0	78,500		82,000	0	82,000	
House	(64,700)	0			(67,800)	0			(70,900)	0		
Motorcar	(10,300)	0			(10,700)	0			(11,100)	0		
2. Regular Gasoline	113,800	0	111,000	2,800	116,600	0	113,700	2,900	119,500	0	116,600	2,900
3. Premium Gasoline	47,200	0	47,200		49,000	0	49,000		50,800	0	50,800	
4. Aviation Gasoline	4,200	0	4,200		4,200	0	4,200		4,200	0	4,200	
5. Kerosene	14,400	0	14,400		13,800	0	13,800		13,200	0	13,200	
6. Jet Fuel	41,600	0	41,600		43,700	0	43,700		45,800	0	45,800	
7. Gas Oil	433,200	0	433,200		448,100	0	448,100		463,500	0	463,500	
8. Fuel Oil	38,000	0	38,000		38,500	0	38,500		39,100	0	39,100	
9. Asphalt	9,400	0	9,400		9,700	0	9,700		10,000	0	10,000	
10. Crude Oil												
Total	776,800	0	774,000	2,800	802,100	0	799,200	2,900	828,100	0	825,200	2,900

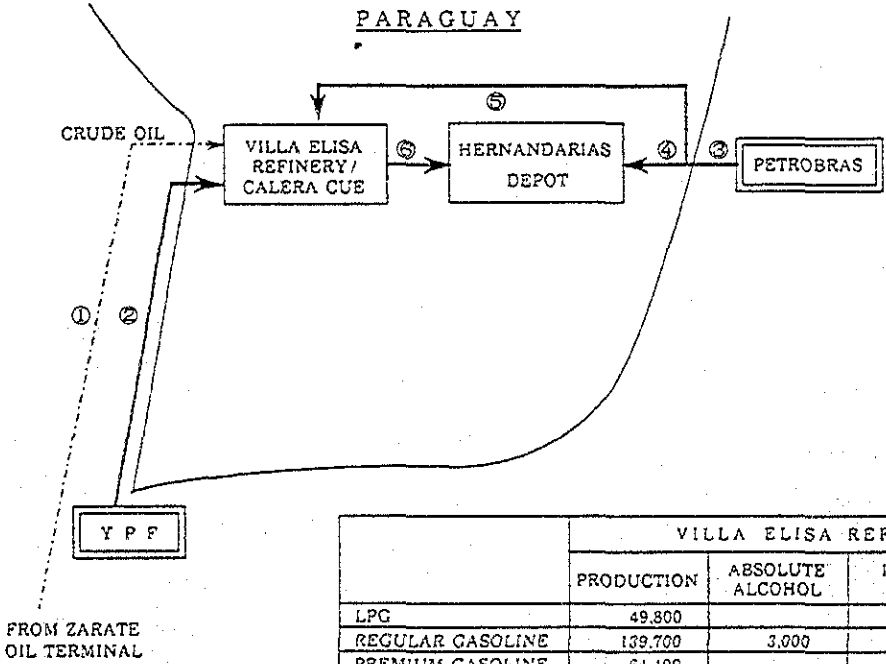
Product	1995				1996				1997			
	Demand	Supply			Demand	Supply			Demand	Supply		
		Domestic Refining	Product Import	Absolute Alcohol		Domestic Refining	Product Import	Absolute Alcohol		Domestic Refining	Product Import	Absolute Alcohol
1. LPG	85,400	0	85,400		88,900	0	88,900		92,500	0	92,500	
House	(73,800)	0			(76,800)	0			(79,900)	0		
Motorcar	(11,600)	0			(12,100)	0			(12,600)	0		
2. Regular Gasoline	122,500	0	119,500	3,000	126,300	0	123,300	3,000	130,200	0	127,200	3,000
3. Premium Gasoline	52,600	0	52,600		54,800	0	54,800		57,100	0	57,100	
4. Aviation Gasoline	4,200	0	4,200		4,200	0	4,200		4,200	0	4,200	
5. Kerosene	12,600	0	12,600		12,000	0	12,000		11,400	0	11,400	
6. Jet Fuel	48,000	0	48,000		50,100	0	50,100		52,200	0	52,200	
7. Gas Oil	479,300	0	479,300		498,400	0	498,400		518,100	0	518,100	
8. Fuel Oil	39,700	0	39,700		40,400	0	40,400		41,100	0	41,100	
9. Asphalt	10,300	0	10,300		10,600	0	10,600		11,000	0	11,000	
10. Crude Oil												
Total	854,600	0	851,600	3,000	885,700	0	882,700	3,000	917,800	0	914,800	3.000

Table 6.3-1 Future Supply Balance for Case-1 (Concluded)

(Unit: Kℓ/Y)

Product	1998				1999				2000			
	Demand	Supply			Demand	Supply			Demand	Supply		
		Domestic Refining	Product Import	Absolute Alcohol		Domestic Refining	Product Import	Absolute Alcohol		Domestic Refining	Product Import	Absolute Alcohol
1. LPG	96,200	0	96,200		100,000	0	100,000		103,900	0	103,900	
House	(83,100)	0			(86,400)	0			(89,700)	0		
Motorcar	(13,100)	0			(13,600)	0			(14,200)	0		
2. Regular Gasoline	134,200	0	131,200	3,000	138,400	0	135,400	3,000	142,700	0	139,700	3,000
3. Premium Gasoline	59,400	0	59,400		61,800	0	61,800		64,400	0	64,400	
4. Aviation Gasoline	4,200	0	4,200		4,200	0	4,200		4,200	0	4,200	
5. Kerosene	10,700	0	10,700		10,100	0	10,100		9,400	0	9,400	
6. Jet Fuel	54,300	0	54,300		56,500	0	56,500		58,600	0	58,600	
7. Gas Oil	538,400	0	538,400		559,500	0	559,500		581,400	0	581,400	
8. Fuel Oil	41,800	0	41,800		42,600	0	42,600		43,300	0	43,300	
9. Asphalt	11,400	0	11,400		11,800	0	11,800		12,200	0	12,200	
10. Crude Oil												
Total	950,600	0	947,600	3,000	984,900	0	981,900	3,000	1,020,100	0	1,017,100	3,000

Source: JICA Mission



DEMAND & SUPPLY BALANCE

(Unit : Kℓ/Y)

	DEMAND	SUPPLY		
		DOMESTIC REFINING	PRODUCT IMPORT ② + ③	ABSOLUTE ALCOHOL
LPG	103,900	49,800	54,100	
REGULAR GASOLINE	142,700	139,700	0	3,000
PREMIUM GASOLINE	64,400	64,400	0	
AVIATION GASOLINE	4,200	0	4,200	
KEROSENE	9,400	9,400	0	
JET FUEL	58,600	58,600	0	
GAS OIL	581,400	581,400	0	
FUEL OIL	43,300	43,300	0	
ASPHALT	12,200	0	12,200	
TOTAL	1,020,100	946,600	70,500	3,000
CRUDE OIL ①		996,800		

OIL HANDLING

(Unit : Kℓ/Y)

	VILLA ELISA REFINERY / CALERA CUE					HERNANDARIAS DEPOT		
	PRODUCTION	ABSOLUTE ALCOHOL	IMPORT ②	IMPORT ⑤	TOTAL	IMPORT ④	TRANSFER ⑥	TOTAL
LPG	49,800		0	54,100	103,900	0	0	0
REGULAR GASOLINE	139,700	3,000	0	0	142,700	0	47,000	47,000
PREMIUM GASOLINE	64,400		0	0	64,400	0	12,200	12,200
AVIATION GASOLINE	0		0	4,200	4,200	0	0	0
KEROSENE	9,400		0	0	9,400	0	0	0
JET FUEL	58,600		0	0	58,600	0	0	0
GAS OIL	581,400		0	0	581,400	0	187,600	187,600
FUEL OIL	43,300		0	0	43,300	0	0	0
ASPHALT	0		12,200	0	12,200	0	0	0
TOTAL	946,600	3,000	12,200	58,300	1,020,100	0	246,800	246,800
CRUDE OIL ①	996,800							

Source : JICA Mission

Fig. 6.3-2 Petroleum Supply Balance in 2000 for Case-2

(1) The LPG demand will be 103,900 kℓ, of which 49,800 kℓ is to be supplied by the refinery and the balance of 54,100 kℓ is to be imported from PETROBRAS. The imported LPG is to be received at the Villa Elisa Refinery and at the storage facilities of LPG distributors.

(2) Regular gasoline and premium gasoline will be all supplied from the domestic sources, i.e., the products of the refinery and absolute alcohol. Of the products from the Villa Elisa Refinery, 47,000 kℓ of regular gasoline (including absolute alcohol) and 12,200 kℓ of premium gasoline will be transferred from the refinery to the Hernandarias Depot.

(3) Aviation gasoline will be all imported from PETROBRAS being received at the Villa Elisa Refinery.

(4) Kerosene, jet fuel, gas oil, and fuel oil will be all supplied by the domestic refining. Of the gas oil produced by the Villa Elisa Refinery, 187,600 kℓ will be transferred from the refinery to the Hernandarias Depot.

(5) Asphalt will be all imported from YPF being received at the Villa Elisa Refinery.

The supply balance in each year of the study period (1992 - 2000) is calculated on the basis of the estimated product demand for each year, on the supposition that the refinery will be operated so as to produce no surplus products, and that products in short supply will be imported. The balance for each year is shown in Table 6.3-2.

6.3.3 Supply Balance in Case-3

The supply balance of petroleum products in the year 2000 for Case-3 is shown in Fig. 6.3-3. Of the total product demand of 1,020,100 kℓ in the year 2000, 424,600 kℓ will be supplied domestically, and the balance of 595,500 kℓ will be imported. The ratio of the domestic refining (including absolute alcohol) to the imports will be 42% / 58%.

Crude oil processed at the refinery is to be the Saharan Blend crude and the annual imports in the year 2000 will amount to 440,700 kℓ.

The product imports from YPF and PETROBRAS will be 270,600 kℓ and 324,900 kℓ, respectively, thus the ratio being 45% / 55%.

The supply balance of each product is as follows:

Table 6.3-2 Future Supply Balance for Case-2 (Continued)

(Unit: Kℓ/Y)

Product	1992				1993				1994			
	Demand	Supply			Demand	Supply			Demand	Supply		
		Domestic Refining	Product Import	Absolute Alcohol		Domestic Refining	Product Import	Absolute Alcohol		Domestic Refining	Product Import	Absolute Alcohol
1. LPG	75,000	35,400	39,600		78,500	37,200	41,300		82,000	39,000	43,000	
House	(64,700)				(67,800)				(70,900)			
Motorcar	(10,300)				(10,700)				(11,100)			
2. Regular Gasoline	113,800	98,500	12,500	2,800	116,600	103,600	10,100	2,900	119,500	108,800	7,800	2,900
3. Premium Gasoline	47,200	45,700	1,50		49,000	48,100	900		50,800	50,400	400	
4. Aviation Gasoline	4,200	0	4,20		4,200	0	4,200		4,200	0	4,200	
5. Kerosene	14,400	6,700	7,70		13,800	7,000	6,800		13,200	7,400	5,800	
6. Jet Fuel	41,600	41,600	0		43,700	43,700	0		45,800	45,800	0	
7. Gas Oil	433,200	412,900	20,300		448,100	434,000	14,100		463,500	455,000	8,500	
8. Fuel Oil	38,000	30,800	7,200		38,500	32,300	6,200		39,100	33,900	5,200	
9. Asphalt	9,400	0	9,400		9,700	0	9,700		10,000	0	10,000	
10. Crude Oil		(707,900)				(744,000)				(780,100)		
Total	776,800	671,600	102,400	2,800	802,100	705,900	93,300	2,900	828,100	740,300	84,900	2,900

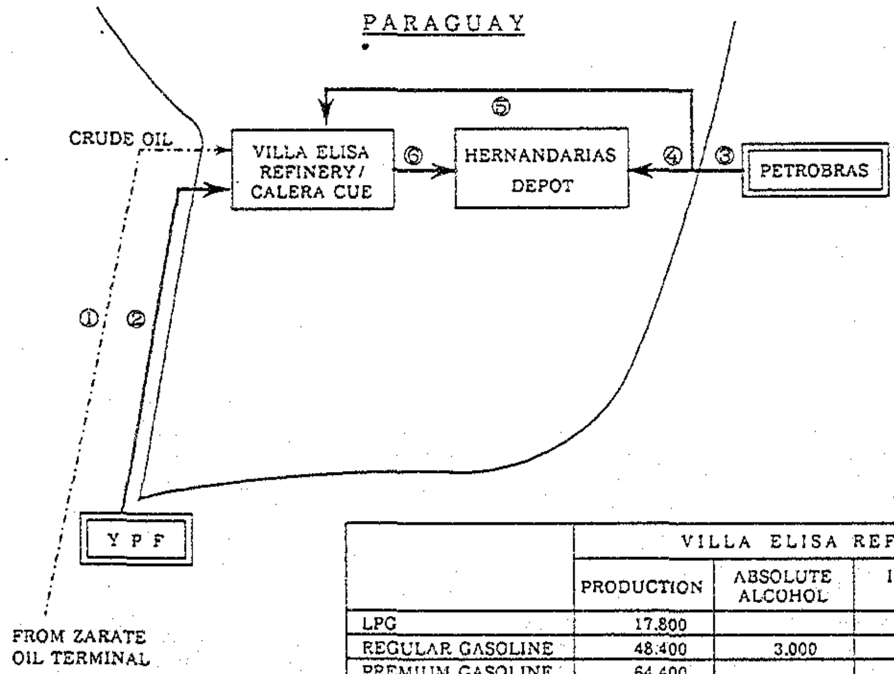
Product	1995				1996				1997			
	Demand	Supply			Demand	Supply			Demand	Supply		
		Domestic Refining	Product Import	Absolute Alcohol		Domestic Refining	Product Import	Absolute Alcohol		Domestic Refining	Product Import	Absolute Alcohol
1. LPG	85,400	40,700	44,700		88,900	42,400	46,500		92,500	44,200	48,300	
House	(73,800)				(76,800)				(79,900)			
Motorcar	(11,600)				(12,100)				(12,600)			
2. Regular Gasoline	122,500	113,700	5,800	3,000	126,300	118,600	4,700	3,000	130,200	123,600	3,600	3,000
3. Premium Gasoline	52,600	52,600	0		54,800	54,800	0		57,100	57,100	0	
4. Aviation Gasoline	4,200	0	4,200		4,200	0	4,200		4,200	0	4,200	
5. Kerosene	12,600	7,700	4,900		12,000	8,000	4,000		11,400	8,300	3,100	
6. Jet Fuel	48,000	47,900	100		50,100	49,900	200		52,200	52,000	200	
7. Gas Oil	479,300	475,600	3,700		498,400	495,500	2,900		518,100	515,800	2,300	
8. Fuel Oil	39,700	35,400	4,300		40,400	36,900	3,500		41,100	38,400	2,700	
9. Asphalt	10,300	0	10,300		10,600	0	10,600		11,000	0	11,000	
10. Crude Oil		(815,400)				(849,500)				(884,300)		
Total	854,600	773,600	78,000	3,000	885,700	806,100	76,600	3,000	917,800	839,400	75,400	3,000

Table 6.3-2 Future Supply Balance for Case-2 (Concluded)

(Unit: Kℓ/Y)

Product	1998				1999				2000			
	Demand	Supply			Demand	Supply			Demand	Supply		
		Domestic Refining	Product Import	Absolute Alcohol		Domestic Refining	Product Import	Absolute Alcohol		Domestic Refining	Product Import	Absolute Alcohol
1. LPG	96,200	46,000	50,200		100,000	47,900	52,100		103,900	49,800	54,100	
House	(83,100)				(86,400)				(89,700)			
Motorcar	(13,100)				(13,600)				(14,200)			
2. Regular Gasoline	134,200	128,800	2,400	3,000	138,400	134,100	1,300	3,000	142,700	139,700	0	3,000
3. Premium Gasoline	59,400	59,400	0		61,800	61,800	0		64,400	64,400	0	
4. Aviation Gasoline	4,200	0	4,200		4,200	0	4,200		4,200	0	4,200	
5. Kerosene	10,700	8,700	2,000		10,100	9,000	1,100		9,400	9,400	0	
6. Jet Fuel	54,300	54,100	200		56,500	56,300	200		58,600	58,600	0	
7. Gas Oil	538,400	537,000	1,400		559,500	558,700	800		581,400	581,400	0	
8. Fuel Oil	41,800	40,000	1,800		42,600	41,600	1,000		43,300	43,300	0	
9. Asphalt	11,400	0	11,400		11,800	0	11,800		12,200	0	12,200	
10. Crude Oil		(920,600)				(957,900)				(996,800)		
Total	950,600	874,000	73,600	3,000	984,900	909,400	72,500	3,000	1,020,100	946,600	70,500	3,000

Source: JICA Mission



DEMAND & SUPPLY BALANCE

(Unit : Kℓ/Y)

	DEMAND	SUPPLY		
		DOMESTIC REFINING	PRODUCT IMPORT ② + ③	ABSOLUTE ALCOHOL
LPG	103,900	17,800	86,100	
REGULAR GASOLINE	142,700	48,400	91,300	3,000
PREMIUM GASOLINE	64,400	64,400	0	
AVIATION GASOLINE	4,200	0	4,200	
KEROSENE	9,400	0	9,400	
JET FUEL	58,600	35,200	23,400	
GAS OIL	581,400	212,500	368,900	
FUEL OIL	43,300	43,300	0	
ASPHALT	12,200	0	12,200	
TOTAL	1,020,100	421,600	595,500	3,000
CRUDE OIL ①		440,700		

OIL HANDLING

(Unit : Kℓ/Y)

	VILLA ELISA REFINERY / CALERA CUE					HERNANDARIAS DEPOT		
	PRODUCTION	ABSOLUTE ALCOHOL	IMPORT ②	IMPORT ⑤	TOTAL	IMPORT ④	TRANSFER ⑥	TOTAL
LPG	17,800		0	86,100	103,900	0	0	0
REGULAR GASOLINE	48,400	3,000	44,300	0	95,700	47,000	0	47,000
PREMIUM GASOLINE	64,400		0	0	64,400	0	12,200	12,200
AVIATION GASOLINE	0		0	4,200	4,200	0	0	0
KEROSENE	0		9,400	0	9,400	0	0	0
JET FUEL	35,200		23,400	0	58,600	0	0	0
GAS OIL	212,500		181,300	0	393,800	187,600	0	187,600
FUEL OIL	43,300		0	0	43,300	0	0	0
ASPHALT	0		12,200	0	12,200	0	0	0
TOTAL	421,600	3,000	270,600	90,300	785,500	234,600	12,200	246,800
CRUDE OIL ①	440,700							

Source : JICA Mission

Fig. 6.3-3 Petroleum Supply Balance in 2000 for Case-3

(1) LPG demand will be 103,900 kℓ, of which 17,800 kℓ will be produced at the refinery and the rest of 86,100 kℓ will be imported from PETROBRAS. The imported LPG is to be received at the refinery and LPG distributors' storage facilities.

(2) Regular gasoline demand will be 142,700 kℓ, of which 51,400 kℓ will be supplied by domestically refined products and absolute alcohol. The balance of 91,300 kℓ will be imported. The imports from YPF will be 44,300 kℓ being received at the refinery, and 47,000 kℓ from PETROBRAS being received at the Hernandarias Depot.

(3) Premium gasoline demand of 64,400 kℓ will be all supplied by the refinery. 12,200 kℓ of premium gasoline is to be transferred from the refinery to the Hernandarias Depot.

(4) Aviation gasoline is to be all imported from PETROBRAS being received at the refinery.

(5) Kerosene will be all imported from YPF being received at the refinery.

(6) Jet fuel demand will be 58,600 kℓ, of which 35,200 kℓ will be supplied by the refinery and the remaining 23,400 kℓ will be imported. The imports will be received at the refinery.

(7) The gas oil demand will be 581,400 kℓ, of which 212,500 kℓ will be covered by the domestically refined product and the balance of 368,900 kℓ will be imported. The imports of 181,300 kℓ from YPF are to be received at the refinery, and 187,600 kℓ from PETROBRAS at the Hernandarias Depot.

(8) Fuel oil demand of 43,300 kℓ is to be supplied by the domestically refined product.

(9) Asphalt will be all imported from YPF being received at the refinery.

The supply balance in each year of the study period (1992 - 2000) is calculated in the same manner as in Case-2, as shown in Table 6.3-3.

Table 6.3-3 Future Supply Balance for Case-3 (Continued)

(Unit: Kℓ/Y)

Product	1992				1993				1994			
	Demand	Supply			Demand	Supply			Demand	Supply		
		Domestic Refining	Product Import	Absolute Alcohol		Domestic Refining	Product Import	Absolute Alcohol		Domestic Refining	Product Import	Absolute Alcohol
1. LPG	75,000	13,100	61,900		78,500	13,500	65,000		82,000	14,000	68,000	
House	(64,700)				(67,800)				(70,900)			
Motorcar	(10,300)				(10,700)				(11,100)			
2. Regular Gasoline	113,800	34,900	76,100	2,800	116,600	36,200	77,500	2,900	119,500	37,700	78,900	2,900
3. Premium Gasoline	47,200	47,200	0		49,000	49,000	0		50,800	50,800	0	
4. Aviation Gasoline	4,200	0	4,200		4,200	0	4,200		4,200	0	4,200	
5. Kerosene	14,400	0	14,400		13,800	0	13,800		13,200	0	13,200	
6. Jet Fuel	41,600	25,800	15,800		43,700	26,800	16,900		45,800	27,800	18,000	
7. Gas Oil	433,200	155,800	277,400		448,100	161,700	286,400		463,500	167,700	295,800	
8. Fuel Oil	38,000	31,800	6,200		38,500	32,900	5,600		39,100	34,200	4,900	
9. Asphalt	9,400	0	9,400		9,700	0	9,700		10,000	0	10,000	
10. Crude Oil		(323,200)				(335,300)				(347,800)		
Total	776,800	308,600	465,400	2,800	802,100	320,100	479,100	2,900	828,100	332,200	493,000	2,900

Product	1995				1996				1997			
	Demand	Supply			Demand	Supply			Demand	Supply		
		Domestic Refining	Product Import	Absolute Alcohol		Domestic Refining	Product Import	Absolute Alcohol		Domestic Refining	Product Import	Absolute Alcohol
1. LPG	85,400	14,600	70,800		88,900	15,200	73,700		92,500	15,800	76,700	
House	(73,800)				(76,800)				(79,900)			
Motorcar	(11,600)				(12,100)				(12,600)			
2. Regular Gasoline	122,500	39,000	80,500	3,000	126,300	40,800	82,500	3,000	130,200	42,600	84,600	3,000
3. Premium Gasoline	52,600	52,600	0		54,800	54,800	0		57,100	57,100	0	
4. Aviation Gasoline	4,200	0	4,200		4,200	0	4,200		4,200	0	4,200	
5. Kerosene	12,600	0	12,600		12,000	0	12,000		11,400	0	11,400	
6. Jet Fuel	48,000	28,800	19,200		50,100	30,000	20,100		52,200	31,200	21,000	
7. Gas Oil	479,300	173,800	305,500		498,400	181,100	317,300		518,100	188,500	329,600	
8. Fuel Oil	39,700	35,400	4,300		40,400	36,900	3,500		41,100	38,400	2,700	
9. Asphalt	10,300	0	10,300		10,600	0	10,600		11,000	0	11,000	
10. Crude Oil		(360,500)				(375,600)				(390,900)		
Total	854,600	344,200	507,400	3,000	885,700	358,800	523,900	3,000	917,800	373,600	541,200	3,000

Table 6.3-3 Future Supply Balance for Case-3 (Concluded)

(Unit: Kℓ/Y)

Product	1998				1999				2000			
	Demand	Supply			Demand	Supply			Demand	Supply		
		Domestic Refining	Product Import	Absolute Alcohol		Domestic Refining	Product Import	Absolute Alcohol		Domestic Refining	Product Import	Absolute Alcohol
1. LPG	96,200	16,400	79,800		100,000	17,100	82,900		103,900	17,800	86,100	
House	(83,100)				(86,400)				(89,700)			
Motorcar	(13,100)				(13,600)				(14,200)			
2. Regular Gasoline	134,200	44,500	86,700	3,000	138,400	46,400	89,000	3,000	142,700	48,400	91,300	3,000
3. Premium Gasoline	59,400	59,400	0		61,800	61,800	0		64,400	64,400	0	
4. Aviation Gasoline	4,200	0	4,200		4,200	0	4,200		4,200	0	4,200	
5. Kerosene	10,700	0	10,700		10,100	0	10,100		9,400	0	9,400	
6. Jet Fuel	54,300	32,500	21,800		56,500	33,800	22,700		58,600	35,200	23,400	
7. Gas Oil	538,400	196,300	342,100		559,500	204,200	355,300		581,400	212,500	368,900	
8. Fuel Oil	41,800	40,000	1,800		42,600	41,600	1,000		43,300	43,300	0	
9. Asphalt	11,400	0	11,400		11,800	0	11,800		12,200	0	12,200	
10. Crude Oil		(407,000)				(423,500)				(440,700)		
Total	950,600	389,100	558,500	3,000	984,900	404,900	577,000	3,000	1,020,100	421,600	595,500	3,000

Source: JICA Mission

CHAPTER 7 DESCRIPTION OF SUPPLY FACILITIES

7.1 Design Basis and Conditions

(1) Demand for Petroleum Products

Petroleum product supply facilities will be planned according to demand for the petroleum products in the year 2000 as per Section 3.3.

(2) Product Specifications

The specifications of imported and domestically refined products are given in Appendix 3 and 4. Also, the major specifications of each domestically refined product are given in Table 7.1-1.

(3) Crude Oil

The crude oil to be processed in the refinery will be as follows:

Case-2: Bonny Light crude oil

Case-3: Saharan Blend crude oil

(4) Utilities

Utilities, other than electricity required in the Villa Elisa Refinery and electricity and fuel oil required in the Villa Elisa Oil Terminal, will be provided in these sites to meet the respective requirements. Electricity will be purchased and supplied from ANDE, and river water will be used as raw water for cooling water, etc.

(5) Storage Facilities

(a) Present Petroleum Product Storage Capacity

The present capacity of the petroleum storage facilities in Paraguay is about 188,200 kℓ, as a total of the capacity of the crude oil and product tanks at the Villa Elisa Refinery and Calera Cue, the product tanks at the Hernandarias Depot, and the LPG tanks possessed by the LPG distributors. The gross demand for petroleum products based on actual records in 1987, is about 698,300 kℓ (1,913 kℓ/day). Therefore, the present storage capacity (the capacity of the storage facilities divided by the average product demand/day) covers a 98-day demand, an approximately 33-day demand for crude oil and an approximately 65-day demand for products.

Table 7.1-1 Product Specification

Product	Properties	Specification
1. Regular Gasoline	Research Octane No.	Min. 81
	Lead Content, grPb/ℓ	Max. 1
	Reid Vapor Pressure, psia	7.5 – 10
	End Point, °C (ASTM D86)	Max. 225
2. Premium Gasoline	Research Octane No.	Min. 93
	Lead Content, grPb/ℓ	Max. 1
	Reid Vapor Pressure, psia	Max. 10
	End Point, °C (ASTM D86)	Max. 225
3. Kerosene	Specific Gravity, 15/15°C	0.775 – 0.840
	Sulfur, wt%	Max. 0.3
	Smoke Point, mm	Min. 20
	Flash Point, °C	Min. 38
	Freezing Point, °C	Max. –30
	End Point, °C (ASTM D86)	Max. 300
4. Jet Fuel	Density @15°C, Kg/ℓ	0.7753 – 0.8398
	Sulfur, wt%	Max. 0.3
	Smoke Point, mm	Min. 25
	Flash Point, °C	Min. 37.8
	Freezing Point, °C	Max. –47
	End Point, °C (ASTM D86)	Max. 300
	Aroma Content, vol%	Max. 20
5. Gas Oil	Specific Gravity, 15/15°C	0.815 – 0.862
	Sulfur, wt%	Max. 0.5
	Cetane Index	Min. 50
	Flash Point, °C	Min. 55
	Pour Point, °C (summer)	Max. 0
	(winter)	Max. –5
	Viscosity @37.8°C, ssu	33 – 46
6. Fuel Oil	Specific Gravity, 15/15°C	0.920 – 0.965
	Sulfur, wt%	Max. 0.9
	Flash Point, °C	Min. 55
	Pour Point, °C	Max. 20
	Viscosity @50°C, ssf	150 – 300
	High Heating Value, Kcal/kg	Min. 10,300

Source: PETROPAR

(b) Future Petroleum Product Storage Capacity

The storage capacity of the petroleum (crude oil plus products) throughout Paraguay is to meet a 100-day demand in the year 2000. However, the LPG storage capacity is to meet a 30-day demand, because of a high storage cost. The storage capacity of the crude oil and petroleum products for each case will be as follows.

However, when all the amount of a product is imported in Case-2 and Case-3, the storage capacity of the product is to cover a 100-day demand.

Case	Crude Oil	Product
Case–1	–	100 days
Case–2	60 days	40 days
Case–3	40 days	60 days

(c) Storage Capacity Required in the Year 2000

The storage capacity of petroleum products and crude oil throughout Paraguay in the year 2000, obtained from the foregoing item (b), are shown in Table 7.1-2. In calculating such storage capacity, it is assumed that LPG distributors would not increase the capacity of the LPG tanks to maintain the present capacity, and the required storage capacity at the Hernandarias Depot would correspond to a 30-day demand for petroleum products in Region II. The storage capacity required in the refinery (or the oil terminal) at Villa Elisa has been determined by deducting the storage capacity of the LPG tanks possessed by the LPG distributors and also that at the Hernandarias Depot, from the required storage capacity throughout Paraguay. Also, the product tanks at Calera Cue is assumed as a part of the refinery (or the oil terminal).

(6) Receiving and Shipping Facilities

The basis and conditions common to determining the capacity of the receiving and shipping facilities for each case of the future product supply plans are as follows:

(a) Receiving and Shipping Volume

The basis is the volume for the year 2000, as shown in Fig. 6.3-1 through 6.3-3.

Table 7.1-2 Required Storage Capacity in 2000

(Unit: Kℓ)

Crude/Product	Case-1				Case-2				Case-3			
	Required Storage Capacity	Villa Elisa Oil Terminal/ Calera Cue	Hernandarias Depot	LPG Distributor	Required Storage Capacity	Villa Elisa Refinery/ Calera Cue	Hernandarias Depot	LPG Distributor	Required Storage Capacity	Villa Elisa Refinery/ Calera Cue	Hernandarias Depot	LPG Distributor
1. LPG	8,600	7,000		1,600	8,600	7,000		1,600	8,600	7,000		1,600
2. Regular Gasoline	39,100	35,200	3,900		15,600	11,700	3,900		23,500	19,600	3,900	
3. Premium Gasoline	17,600	16,600	1,000		7,000	6,000	1,000		10,600	9,600	1,000	
4. Aviation Gasoline	1,200	1,200			1,200	1,200			1,200	1,200		
5. Kerosene	2,600	2,600			1,000	1,000			2,600	2,600		
6. Jet Fuel	16,000	16,000			6,400	6,400			9,600	9,600		
7. Gas Oil	159,200	143,800	15,400		63,800	48,400	15,400		95,600	80,200	15,400	
8. Fuel Oil	11,900	11,900			4,800	4,800			7,100	7,100		
9. Asphalt	3,400	3,400			3,400	3,400			3,400	3,400		
Subtotal	259,600	237,700	20,300	1,600	111,800	89,900	20,300	1,600	162,200	140,300	20,300	1,600
10. Crude Oil	–				167,700	167,700			111,800	111,800		
Total	259,600	237,700	20,300	1,600	279,500	257,600	20,300	1,600	274,000	252,100	20,300	1,600

Source: JICA Mission

(b) Method of Determining Capacity

Receiving or shipping facilities are generally designed to allow the proportion of the actually received or shipped volume to the receiving or shipping capacity (namely, "occupancy rate" or "operating rate") to be kept at a maximum of about 60%. This design philosophy will be herein followed.

7.2 Supply Facilities for Case-1

7.2.1 Villa Elisa Oil Terminal

This Section gives a summary of the facility plans and project implementation plans at the Villa Elisa Oil Terminal for Case-1.

(1) Process Units

The existing crude distillation and jet fuel treating units will be shut down.

(2) Utility Facilities

The utilities required at the oil terminal will be supplied from the existing utility facilities. However, a facility will be newly installed to make nitrogen to be used as sealing gas for tanks to avoid such situation to lead to explosion.

Electricity (3.2 x 10^6 kWh/yr) and boiler fuel oil (3,200 kℓ/yr) will be supplied from outside of the oil terminal.

(3) Storage Facilities

The required storage capacity of each product tank will be as per Section 7.1 (5). The number of new tanks will be determined on the basis of the capacity of the existing tanks and their diversion, as per Table 7.2-1.

(4) Wharfs

For Case-1, wharfs will be used not only for receiving petroleum products imported from YPF, but also for shipping a part of fuel oil. In the case where the existing two wharfs are used for such purposes, wharf occupancy rate is estimated as follows, to see whether or not their capacity is enough:

(a) Receipt of Products to be Imported from YPF

The following conditions are assumed:

(i) Monthly imported products from YPF will be 55,200 kℓ, based on the annual import volume (662,200 kℓ) as per Fig. 6.3-1.

Table 7.2-1 Tank List for Case-1

Crude/Product	Existing Tanks Item No. (D9-)	Existing Tanks Capacity (Kℓ)	Total Requirement (Kℓ)	Additional Requirement (Kℓ)	New Tanks Capacity (Kℓ)	New Tanks Type
(1) LPG	916, 919, 920, 924, 925	300	7,000	6,700	2,000 x3 1,000 x1	SPH SPH
(2) Regular Gasoline	907, 921, 922, 917	36,300	35,200	–	–	
(3) Premium Gasoline	904, 905, 908, 915, 902	20,565	16,600	–	–	
(4) Aviation Gasoline	903, 918	1,380	1,200	–	–	
(5) Kerosene	909, 913	3,050	2,600	–	–	
(6) Jet Fuel	906, 910	2,780	16,000	13,200	13,000 x1	CR
(7) Gas Oil	923, 926, 927 928, 929, ES-2 901	99,200	143,800	44,600	25,000 x2	CR
(8) Fuel Oil	911, 912, ES-1	15,760	11,900	–	–	
(9) Asphalt	935, 936, 937	1,230	3,400	2,170	2,000 x1	CRH
(10) Alcohol	914	1,680	800	–	–	

Source: JICA Mission
Note SHP: Spherical Tank
CR: Cone Roof Tank
CRH: Cone Roof Tank with heating

(ii) The loading capacity of the barge to be used for transporting imported products will be 2,000 kℓ, which is equivalent to the average capacity of the existing barges.

(iii) The capacity of the pump for unloading products will be 150 kℓ/hr, which is equivalent to the average capacity of the pumps provided for 2,000 kℓ barges.

(iv) The working time will be 24 hours per day which is probably the same as the present situation.

Under the above conditions, the wharf occupancy rate is calculated as follows:

Number of barges required for transporting the monthly volume of products imported:

(55,200 kℓ)/(2,000 kℓ) = 28 barges

Time required to unload one barge:
(2,000 kℓ)/(150 kℓ/hr) = 13 hours

Time for one barge to occupy one of the existing wharfs: 19 hours (it is assumed that 6 hours would be required in addition to the above 13 hours for unloading.)

Monthly occupancy time of one wharf:
(19 hours/barge) x (28 barges)/2 = 266 hours
= 11.1 days

Wharf occupancy rate:
[(11.1 days)/(30 days)] x 100 = 37%

(b) Delivery of Fuel Oil

Even when it is assumed that all the volume of fuel oil corresponding to the total demand in Paraguay in the year 2000 would be shipped from the wharfs, the delivery volume is only 7% of the total product imports from YPF, being very small, as shown in Fig. 6.3-1.

Accordingly, the total wharf occupancy rate, when the shipping volume of fuel oil is handled together with products imported from YPF, is far below 60%, because the estimated occupancy rate for the latter is 37%.

(c) Conclusion

As the estimated wharf occupancy rate is below 60%, the existing two wharfs can be used as they are.

(5) Land Shipping Facilities

The operating rate of the existing land shipping facilities is estimated as follows, in order to judge whether or not their capacity is sufficient.

(a) Basis

(i) Except for LPG, the daily shipping volume is calculatd based on the annual shipping volume in the year 2000 as per Fig. 6.3-1, on the assumption that products will be shipped for 22 days per month.

On the other hand, the LPG shipping volume is supposed to be the net delivery volume from Villa Elisa, on the assumption that the LPG imported to the LPG distributors directly from PETROBRAS in 1987 will continue to be delivered directly to the LPG terminals of the distributors even in the year 2000 at an unchanged volume of 52,113 kℓ.

(ii) The average capacity of tank-trucks to be used for delivering LPG and the other products will be 44 kℓ and 14 kℓ, respectively, same as at present.

(iii) Loading time for petroleum products (except LPG) into one 14 kℓ tank-truck is assumed to be 25 minutes on the average. As for LPG, the net time of filling it into one 44 kℓ tank-truck is supposed to be 132 minutes, the waiting time 8 minutes, and thus the total loading time, 140 minutes.

(iv) The daily delivery time will be 8 hours.

(b) Estimation of Operating Rate

As an example, the operating rate of the land shipping facilities for gas oil is estimated as follows:

The daily shipping capacity is calculated on the assumption that the existing six loading arms would be available:

(14 kℓ) x [(480 minutes)/(25 minutes)] x 6 = 1,613 kℓ

Daily shipping volume:

[(393,800 kℓ)/12] x (1/22) = 1,492 kℓ

Operating rate:

[(1,492 kℓ)/(1,613 kℓ)] x 100 = 92%

The operating rate of the land shipping facilities for other products, calculated in a similar way, is given in Table 7.2-2.

(c) Conclusion

As shown in Table 7.2-2, the operating rate of the land shipping facilities for the products other than gas oil and LPG is less than 61%. Therefore, the capacity of the existing facilities is deemed enough.

As for gas oil and LPG, however, the operating rate is 92% and 130%, respec-

Table 7.2-2 Land Shipping Facilities (Case-1)

Product	Shipping Amount (Kℓ/yr)	Shipping Amount (Kℓ/day)	Shipping Capacity (Kℓ/day)	Operating Rate (%)	Existing Facilities		Total Required Facilities		Additional Required Facilities	
					No. of Loading Arm	Capacity per Arm (Kℓ/hr)	No. of Loading Arm	Capacity per Arm (Kℓ/hr)	No. of Loading Arm	Capacity per Arm (Kℓ/hr)
LPG	51,800	196	151	130	1	20	2	20	1	20
Regular Gasoline	95,700	362	1,344	27	5	51	5	51	0	–
Premium Gasoline	52,200	198	806	25	3	51	3	51	0	–
Aviation Gasoline	4,200	16	269	6	1	51	1	51	0	–
Kerosene	9,400	36	806	4	3	39	3	39	0	–
Jet Fuel	58,600	222	538	41	2	51	2	51	0	–
Gas Oil	393,800	1,492	1,613	92	6	60	9	60	3	60
Fuel Oil	43,300	164	269	61	1	48	1	48	0	–

Source: JICA Mission

tively, thus exceeding 60%.

For gas oil, a total of 9 loading arms with a shipping capacity of 60 kℓ/hr each will be required to make the operating rate less than about 60%.

This means that, as the existing six loading arms with a capacity of 60 kℓ/hr each are available, three more loading arms with the same capacity each will be needed.

Likewise, for LPG, a total of two loading arms with a capacity of 20 kℓ/hr each will be required to reduce the operating rate to around 60%. As one existing loading arm with a capacity of 20 kℓ/hr is available, another loading arm with the same capacity will be necessary.

With regard to asphalt, shipping facilities is supposed to be installed to be capable of meeting the shipping volume for the year 2000.

(6) Summary of Project Implementation Plan

(a) Required Area

The required area for the major facilities added is as follows:

- Storage facilities/land shipping facilities: 35,000 m^2

It is believed that these facilities can be constructed within the site of the existing refinery.

(b) Construction Period

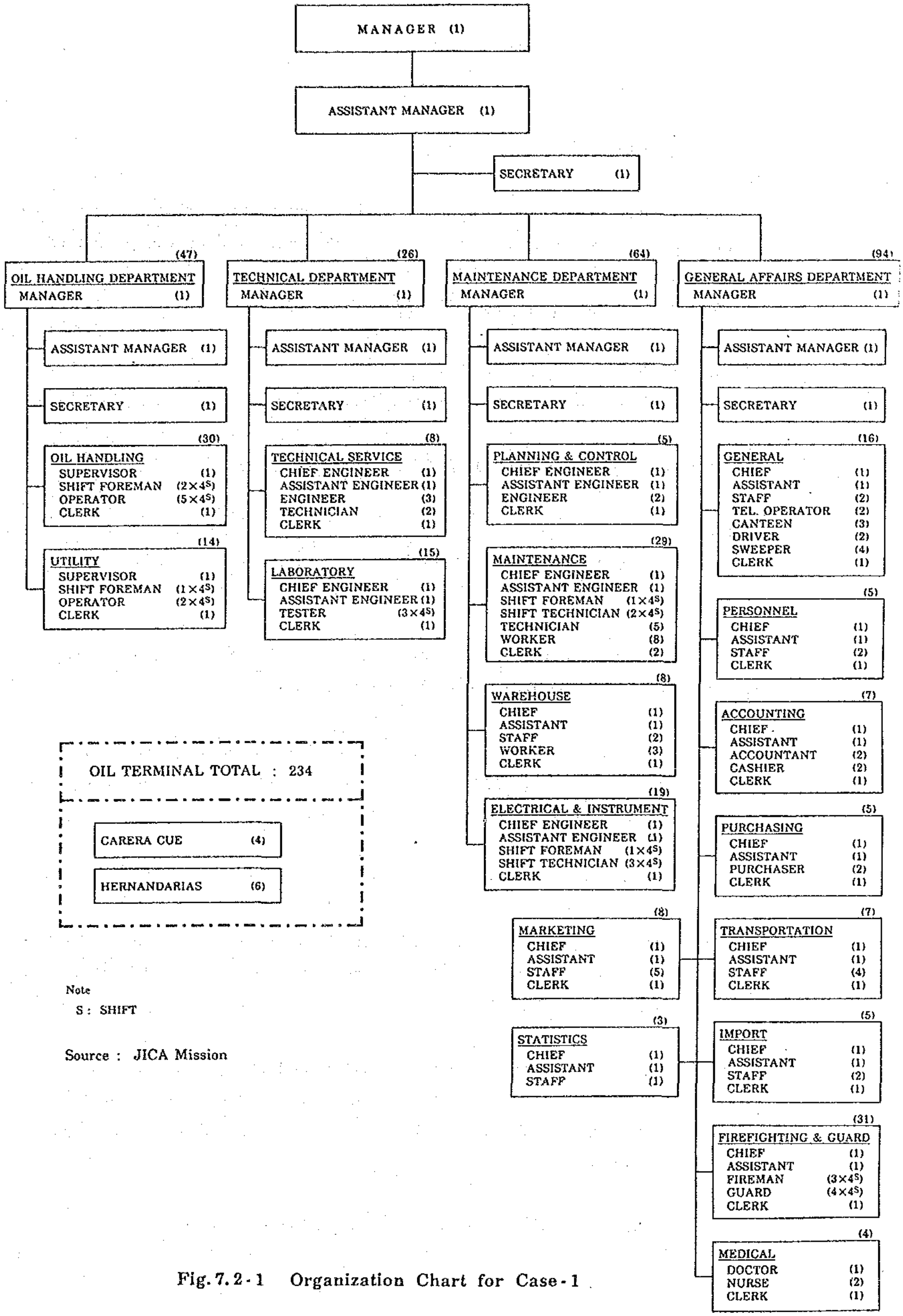
The construction period for the oil terminal is estimated at 18 months, to be executed between July 1990 and December 1991.

(c) Manning Plan

The organization and the number of personnel required for the oil terminal are shown in Fig. 7.2-1. The organization consists of an oil handling department, technical department, maintenance department and general affairs department, and the number of personnel required is 234. The required number at the Calera Cue Product Storage Terminal will be 4, equivalent to that at present.

(d) Personnel Training

It is assumed that the oil terminal will be operated by the present PETROPAR's personnel. Accordingly, no particular training of personnel will be required.



Note
S : SHIFT

Source : JICA Mission

Fig. 7.2-1 Organization Chart for Case-1

7.2.2 Hernandarias Depot

(1) Land Receiving Facilities

The existing receiving facilities are for regular gasoline and gas oil alone. Therefore, facilities for receiving premium gasoline as well as the above products will be required in the year 2000.

An outline of the existing receiving facilities is as follows:

- Regular gasoline

  One receiving pump being used for receiving gas oil as well (capacity: 45 kℓ/hr)

  One receiving line being used for receiving gas oil as well

- Gas oil

  One receiving pump (capacity: 45 kℓ/hr)

  One receiving line

In order to estimate the operating rates of the above existing facilities when they are used in the year 2000, the following conditions are supposed:

(i) The daily receiving volume is estimated, on the basis of the annual shipping volume in the year 2000 as per Fig. 6.3-1, and on the assumption that products will be received for 22 days per month.

(ii) The daily shipping time will be 8 hours.

(iii) The capacity of tank-trucks to be used for product transportation will be 31 kℓ, which is equivalent to that of tank-trucks presently used for importing products from PETROBRAS.

(iv) Time required for unloading one 31 kℓ tank-truck is estimated to be 50 minutes, by adding the waiting and other required time of 9 minutes to 41 minutes for transferring products into the tank, as calculated based on the capacity of the existing pump.

(v) The receiving volume of each petroleum product is as follows:

– Regular gasoline:	47,000 kℓ/year
	178 kℓ/day
– Premium gasoline:	12,200 kℓ/year
	46 kℓ/day
– Gas oil:	187,600 kℓ/year
	711 kℓ/day

All of these products will be imported from PETROBRAS.

The receiving capacity of the existing facility for regular gasoline is calculated as follows: Since the receiving pump is used for regular gasoline and gas oil, its utilization rate is assumed to be 0.5.

(31 kℓ) x [(480 minutes)/(50 minutes)] x 0.5 = 149 kℓ/day

The operating rate is:

[(178 kℓ/day)/(149 kℓ/day)] x 100 = 119%

The rate considerably exceeds the considered adequate rate of 60%. In order to reduce the operating rate to around 60%, the receiving capacity must be about double that of the existing facility. Accordingly, the existing receiving pump used currently for receiving gas oil as well needs to be used exclusively for receiving regular gasoline.

As for gas oil, the receiving capacity of the existing facility is:

(31 kℓ) x [(480 minutes)/(50 minutes)] x 1.0 = 298 kℓ/day

The operating rate of the facilities is:

[(711 kℓ/day)/(298 kℓ/day)] x 100 = 239%

Thus, the operating rate considerably exceeds 60%. In order to reduce the operating rate to 60%, the receiving capacity must be about 4 times that of the existing facility. This means that three more receiving facilities with a capacity of 45 kℓ/hr each will be required, thereby making a total of four facilities.

As for premium gasoline, a newly installed receiving facility with a capacity of 45 kℓ/hr will be enough, as its operating rate becomes less than 60%.

(2) Land Shipping Facilities

The shipping volume of petroleum products being equivalent to the receiving volume is as follows, on the assumption that they will be shipped 22 days per month and 8 hours per day:

- Regular gasoline: 178 kℓ/day
- Premium gasoline: 46 kℓ/day
- Gas oil: 711 kℓ/day

The capacity of one tank-truck to be used for shipping products is supposed to be 14 kℓ, as in the present situation.

An outline of the existing shipping facilities is as follows:

- Regular gasoline:
  One shipping pump (capacity: 45 kℓ/hr)
  One loading arm
- Gas oil
  One shipping pump (capacity: 45 kℓ/hr)
  Two loading arms

Time required for loading one 14 kℓ tank-truck is assumed to be a total of 27 minutes (19 minutes calculated on the basis of the shipping pump capacity plus the waiting time of 8 minutes).

The daily shipping capacity for both regular gasoline and gas oil will be as follows:

(14 kℓ) x (480 minutes)/(27 minutes) = 249 kℓ

The operating rate of the existing facility for shipping regular gasoline is as follows, if it is used in the year 2000:

[(178 kℓ/day)/(249 kℓ/day)] x 100 = 71%

As the rate is over 60%, the capacity of the existing facility will be sufficient.

The operating rate of the existing facility for shipping gas oil is:

[(711 kℓ/day)/(249 kℓ/day)] x 100 = 286%

In order to reduce this rate to 60% or less, the shipping capacity must be about 5 times that of the existing facility. Accordingly, four shipping pumps and three loading arms with a capacity of 45 kℓ/hr each will need to be added to the existing facilities.

With regard to premium gasoline, one new 45 kℓ/hr pump and one new loading arm will be enough.

(3) Storage Tank

As shown in Table 7.2-3, one 2,500 kℓ tank for regular gasoline and one 11,000 kℓ tank for gas oil will be necessary in addition to the existing tanks, in order to meet the increased receiving and shipping volumes. One 1,000 kℓ tank for premium gasoline will be newly installed, because there are no tanks for this use presently.

Table 7.2-3 Storage Tank List for Hernandarias Depot

Product	Existing Tanks			Total Required Capacity (Kℓ)	Required Capacity of Additional Tanks (Kℓ)	Additional/Required Tanks		
	Item No.	Capacity (Kℓ)	Type			Capacity (Kℓ)	No.	Type
Regular Gasoline	No. 1	1,500	CR	3,900	2,400	2,500	1	CR
Premium Gasoline	—	—	—	1,000	1,000	1,000	1	CR
Gas Oil	No. 2	4,500	CR	15,400	10,900	11,000	1	CR

Source: JICA Mission

(4) Others

(a) Number of Personnel

The number of personnel now available is five. However, as the work volume is expected to increase with increments in the receiving and shipping volumes in the year 2000, one more person will be required.

(b) Utility Consumption

Electricity to be used for the receiving and shipping pumps will account for the most part of the utility consumption in the Hernandarias Depot. The electricity consumption for the year 2000 is estimated at 100,000 kWh/year.

7.3 Supply Facilities for Case-2

7.3.1 Villa Elisa Refinery

This Section gives a summary of the facility plan for the Villa Elisa Refinery and also the project implementation plan for Case-2.

(1) Process Units

As outlined in Section 6.2.2, the refinery for Case-2 features an increased yield of gas oil and a reduced yield of fuel oil by the adoption of a vacuum gas oil hydrocracking unit. Table 7.3-1 and Table 7.3-2 show the crude oil throughput with the production volume of products, and the product properties, respectively.

The existing crude distillation and jet fuel treating units will be shut down and process units with their respective capacities as per Table 7.3-3 will be newly installed.

Table 7.3-1 Crude and Product for Case-2

Crude/Product	BPSD 1)	Kℓ/Y
1. Bonny Light Crude Oil	19,000	996,800
2. Product		
(1) LPG	950	49,800
(2) Regular Gasoline	2,720	142,700
– Gasoline	(2,660)	(139,700)
– Absolute Alcohol	(60)	(3,000)
(3) Premium Gasoline	1,230	64,400
(4) Aviation Gasoline	0	0
(5) Kerosene	180	9,400
(6) Jet Fuel	1,120	58,600
(7) Gas Oil	11,080	581,400
(8) Fuel Oil	830	43,300
(9) Asphalt	0	0

Source: JICA Mission
1) Annual operation days are assumed to be 330 days.

(2) Utility Facilities

(a) Steam Generators

Two package boilers will be newly installed to supply steam, whereby the operation of the two existing boilers will be stopped. The capacity of the new boilers is as follows:

Capacity: 10t/hr x 15 kg/cm^2 G x 2
(one set: stand-by boiler)

(b) Power Receiving Facility

Electricity (about 23.8 x 10^6 kWh/Y) required in the refinery will be received from ANDE. The operation of the existing power receiving facility will be continued and a new power receiving facility with the following capacity will be added.

Capacity of the added power receiving facility: 2,600 kW

Two existing diesel generators will be used in emergency.

(c) Water Supply Facilities

(i) Cooling Water Supply Facilities

The volume of cooling water required for the refinery is estimated at about 2,000 kℓ/h, which will be supplied from the existing two cooling towers.

(ii) Water Intake Facilities

Water for making up boiler feedwater and cooling water will be supplied from the existing water intake and associated facilities.

(d) Other Utility Facilities

- Instrument and plant air will be provided from the existing air supply facilities.
- A nitrogen supply facility will be newly installed.
- Fuel gas and fuel oil supply facilities will be expanded.

(3) Storage Facilities

The required storage capacity of crude oil and product tanks will be as per Section 7.1(5), and the total capacity of semi-product and final product storage tanks will meet the required product tank storage capacity. The capacity of the semi-product storage tanks will cover 7-day production of semi-products.

The capacity and number of new tanks as per Table 7.3-4 are determined to meet the required storage capacity, on the basis of the capacity and a diverted use of the existing tanks.

(4) Wharfs

For Case-2, wharfs will be used for receiving imported crude oil from Nigeria and asphalt imported from YPF, and also for shipping fuel oil. Wharf occupancy rate is estimated as follows, to know whether or not the capacity of the existing two wharfs is sufficient, if they are used for the above purposes.

Table 7.3-2 Estimated Product Properties

Product	Properties	Estimated Value
1. Regular Gasoline	Specific Gravity, 15/15°C	0.74
	Research Octane No., Clear	81 1)
	Reid Vapor Pressure, psia	7.5
2. Premium Gasoline	Specific Gravity, 15/15°C	0.79
	Research Octane No., Clear	93
	Reid Vapor Pressure, psia	5.0
3. Kerosene/Jet Fuel	Specific Gravity, 15/15°C	0.80
	Sulfur	< 5 ppm
	Smoke Point, mm	25
	Flash Point, °C	41
	Freezing Point, °C	−56
	End Point, °C (ASTM D86)	250
	Aroma Content, vol%	8
4. Gas Oil	Specific Gravity, 15/15°C	0.84
	Sulfur, wt%	0.1
	Cetane Index	50
	Flash Point, °C	90
	Pour Point, °C	−18
	Viscosity @37.8°C, ssu	35
5. Fuel Oil	Specific Gravity, 15/15°C	0.96
	Sulfur, wt%	0.25
	Flash Point, °C	225
	Pour Point, °C	20
	Viscosity @50°C, ssf	150
	High Heating Value Kcal/kg	10,400

Source: JICA Mission
1) Octane No. without absolute alcohol

Table 7.3-3 Capacity of Process Unit for Case-2

Process Unit	Capacity (BPSD)
1. Crude Distillation Unit	19,000
2. Vacuum Distillation Unit	5,900
3. Naphtha Hydrotreating Unit	2,200
4. Catalytic Reforming Unit	2,200
5. Hydrocracking Unit	4,900
6. Hydrogen Plant	4.5 MMSCFD
7. Gas Recovery Unit	1,100
8. Sour Water Stripper	10 Ton/hr

Source: JICA Mission

Table 7.3-4 Tank List for Case-2

Crude/Product	Existing Tanks		Total Requirement (Kℓ)	Additional Requirement (Kℓ)	New Tanks	
	Item No. (D9-)	Capacity (Kℓ)			Capacity (Kℓ)	Type
1. Crude Tank	901, 902, 917	62,900	167,700	104,800	50,000 x2	FR
2. Product Tank						
(1) LPG	916, 919, 920, 924, 925	300	7,000	6,700	2,000 x3 1,000 x1	SPH SPH
(2) Regular Gasoline	907, 922	8,900	8,700	–	–	
(3) Premium Gasoline	904, 905	2,750	3,000	–	–	
(4) Aviation Gasoline	903, 918	1,380	1,200	–	–	
(5) Kerosene	913	1,400	1,000	–	–	
(6) Jet Fuel	906, 909, 910	4,430	6,400	1,970	2,000 x1	CR
(7) Gas Oil	928, 929, ES-2	40,400	35,600	–	–	
(8) Fuel Oil	912, ES-1	1,680 12,400	3,700	2,020	2,000 x1	CRH
(9) Asphalt	935, 936, 937	1,230	3,400	2,170	2,000 x1	CRH
(10) Alcohol	914	1,680	800	–	–	
3. Intermediate Tank						
(1) SR Light Naphtha	915	815	800	–	–	
(2) SR Heavy Naphtha	921	2,400	2,400	–	–	
(3) Reformate	908	2,500	1,900	–	–	
(4) HCR Light Naphtha	–	–	400	400	1,000 x1	FR
(5) HCR Heavy Naphtha	–	–	500	500	1,000 x1	FR
(6) SR Kerosene	923	6,400	3,400	–	–	
(7) SR Gas Oil	926	14,500	6,300	–	–	
(8) HCR Gas Oil	927	14,500	3,100	–	–	
(9) Vacuum Residue	911	1,680	1,100	–	–	

Source: JICA Mission
Note SPH: Spherical Tank
CR: Cone Roof Tank
CRH: Cone Roof Tank with heating
FR: Floating Roof Tank

(a) Receipt of Crude Oil Imported from Nigeria

The following conditions are assumed:

(i) The volume of crude oil to be imported from Nigeria per month is supposed to be 83,100 kℓ, on the basis of the annual import volume of 996,800 kℓ in the year 2000 as per Fig. 6.3-2.

(ii) The loading capacity of each barge to be used for transporting the crude oil imported will be 4,000 kℓ, being equivalent to the capacity of COPEX's barge.

(iii) The capacity of the pump for unloading crude oil will be 400 kℓ/hr, as it is.

(iv) The daily working hours will be 24.

The wharf occupancy rate is estimated as follows, on the basis of the above conditions:

The number of barges required for transporting the volume of crude oil imported per month:

(83,100 kℓ)/(4,000 kℓ) = 21

Time required for unloading one barge:

(4,000 kℓ)/(400 kℓ) = 10 hours

Time for one barge to occupy one of the existing wharfs is supposed to be 16 hours, on the assumption that 6 hours will be required in addition to the above unloading hours.

The occupancy time of one wharf per month:

(16 hours/barge) x (21 barges)/2 = 168 hours

= 7.0 days

(v) Therefore, the wharf occupancy rate:

[(7.0 days)/(30 days)] x 100 = 23%

(b) Receipt of Imported Asphalt and Shipping of Fuel Oil

As clearly seen in Fig. 6.3-2, the total of the volume of imported asphalt and fuel oil shipped in the year 2000 accounts for only 6% of the crude oil imports, which is a very small figure. Accordingly, it is estimated that the total wharf occupancy rate in the case where the volumes of the asphalt received and fuel oil shipped are combined with the volume of the crude oil imported will definitely be below 60%, because the wharf occupancy rate for imported crude oil is only 23%. Therefore, the capacity of the existing two wharfs will be sufficient.

(5) Land Shipping Facilities

The operating rate of the land shipping facilities for the year 2000 is estimated as follows, to judge whether or not their capacity will be enough for the year 2000.

The following conditions are assumed:

The daily product shipping volume will be calculated on the basis of the annual shipping volume in the year 2000 as per Fig. 6.3-2, on the assumption that products will be shipped for 22 days/month.

The other conditions will be the same as in Section 7.2.1-(5).

Table 7.3-5 shows the operating rate of the shipping facilities which is estimated in the same calculation procedure as in Section 7.2.1-(5).

As the capacity of the shipping facilities for products other than gas oil and LPG is below 61%, the existing shipping facilities can be used in the year 2000.

On the other hand, the estimated operating rates for gas oil and LPG are 137% and 130%, respectively, both considerably exceeding 60%.

In the case of gas oil, in order to reduce the operating rate to around 60%, a total of 13 loading arms with a shipping capacity of 60 kℓ/hr each will be required. This means that as the existing six loading arms with such a capacity each are available, seven more loading arms with 60 kℓ/hr each will be needed.

With regard to LPG, in order to reduce the operating rate to about 60%, a total of two loading arms with a capacity of 20 kℓ/hr each will be necessary. As the existing one loading arm with such a capacity is available, one more loading arm at 20 kℓ/hr must be added.

As for asphalt, the refinery is to be equipped with a shipping facility with enough capacity to meet the shipping volume of asphalt for the year 2000.

(6) Waste Water Treating Facilities

Waste water from the refinery is treated being separated as process, oily and clean

Table 7.3-5 Land Shipping Facilities (Case-2)

Product	Shipping Amount (Kℓ/yr)	Shipping Amount (Kℓ/day)	Shipping Capacity (Kℓ/day)	Operating Rate (%)	Existing Facilities		Total Required Facilities		Additional Required Facilities	
					No. of Loading Arm	Capacity per Arm (Kℓ/hr)	No. of Loading Arm	Capacity per Arm (Kℓ/hr)	No. of Loading Arm	Capacity per Arm (Kℓ/hr)
LPG	51,800	196	151	130	1	20	2	20	1	20
Regular Gasoline	142,700	541	1,344	40	5	51	5	51	0	–
Premium Gasoline	64,400	244	806	30	3	51	3	51	0	–
Aviation Gasoline	4,200	16	269	6	1	51	1	51	0	–
Kerosene	9,400	36	806	4	3	39	3	39	0	–
Jet Fuel	58,600	222	538	41	2	51	2	51	0	–
Gas Oil	581,400	2,202	1,613	137	6	60	13	60	7	60
Fuel Oil	43,300	164	269	61	1	48	1	48	0	–

Source: JICA Mission

waste water. The process waste water is treated by a sour water stripper, and then treated together with oily waste water in a new oil separator.

Blow-down from cooling water and clean drain such as rain water not including oil, etc., are discharged along with the above treated waste water.

(7) Other Auxiliary Facilities

The following auxiliary facilities will be additionally installed:

- Flare System
- Firefighting Facility
- Control Room
- Building

(8) Summary of Project Implementation Plan

(a) Required area

The required area for the major facilities added is as follows:

- Process units/utility facilities: 20,000 m^2
- Storage facilities/land shipping facilities: 50,000 m^2

It is believed that these facilities can be constructed within the site of the existing refinery.

(b) Construction Period

The refinery is supposed to be constructed in 30 months between July 1989 and December 1991.

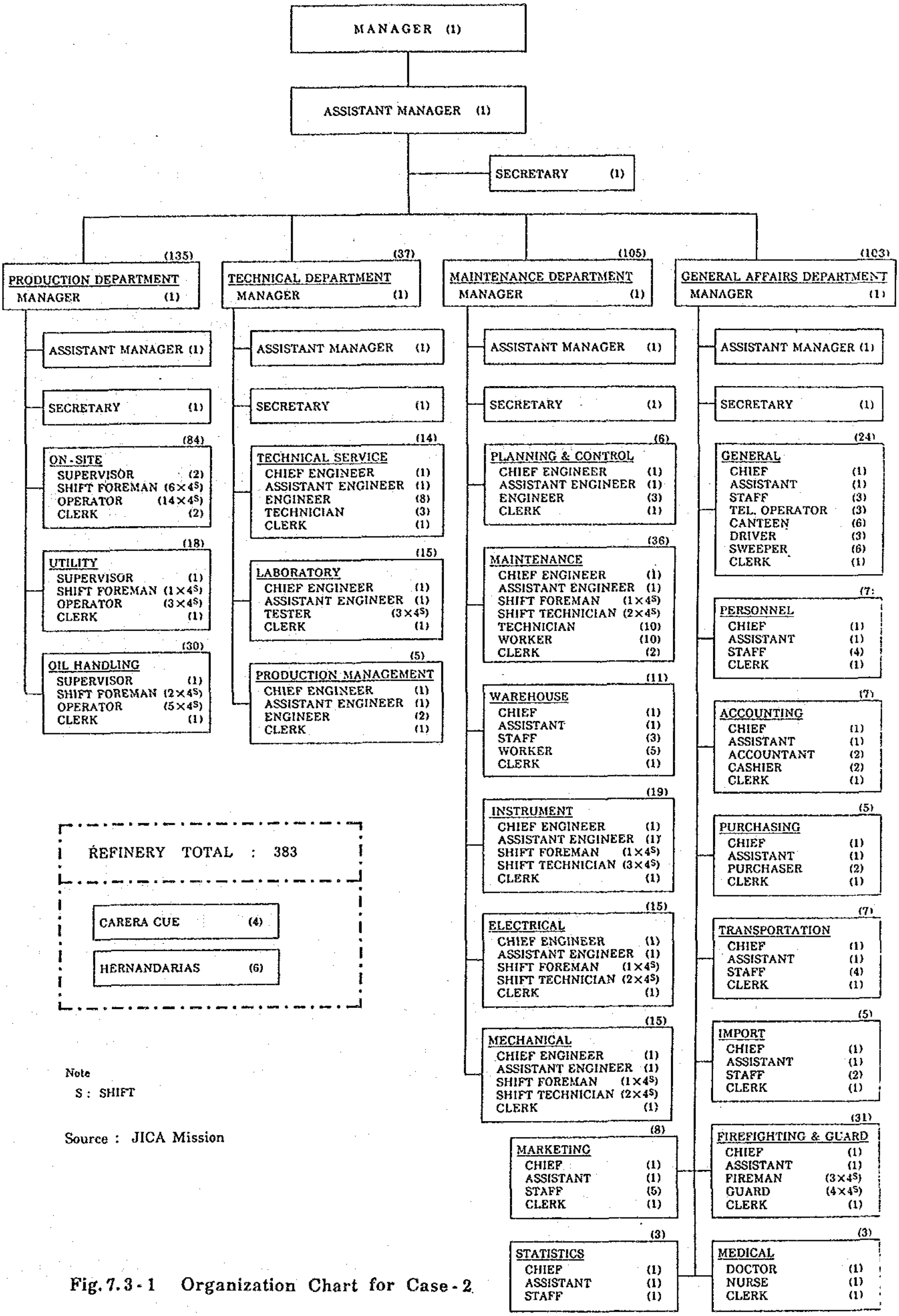
(c) Manning Plan

Fig. 7.3-1 shows the organization and the number of personnel required for the operation of the refinery.

The organization of the refinery consists of a production department, technical department, maintenance department and general affairs department. The total number of personnel required at the refinery will be 383. The number of the personnel required in the Calera Cue Product Storage Terminal will be four, being equivalent to that now available.

(d) Personnel Training Program

As the secondary processing units not provided in the existing refinery will be installed in the new refinery, pertinent personnel must be trained to ensure the



Note
S : SHIFT

Source : JICA Mission

Fig. 7.3-1 Organization Chart for Case-2 smooth operation of the refinery after start-up. Table 7.3-6 shows the number of trainees and the training period required prior to the operation of the refinery.

Table 7.3-6 Trainees for Case-2

Class of Trainee	Number of Trainee	Training Month	Training Place
1. Production Department			
(1) Foreman of Process Section	24	6 6	Foreign Refinery Plant Site
(2) Foreman of Utility and Oil Handling Section	12	6	Plant Site
(3) Chief Operator	22	12	Foreign Refinery
(4) Operator	76	6	Plant Site
2. Technical Department			
(1) Chief Tester of Laboratory Section	4	6	Foreign Refinery
3. Maintenance Department			
(1) Foreman	16	6	Foreign Refinery
(2) Technician	36	6	Plant Site
Total	190		

Source: JICA Mission

7.3.2 Zarate Oil Terminal

For Case-2, the Zarate Oil Terminal is supposed to be used for transshipping crude oil imported from Nigeria. In other words, such crude oil will be received into the crude oil tanks in the terminal from ocean tankers (and also from small tankers of light draft concurrently used), and loaded into barges for river transportation.

The capacity of the existing tanks at the Zarate Oil Terminal will be sufficient, if ocean tankers to be used have the same capacity as that of the tankers used at present.

The occupancy rate of the existing jetties is estimated in order to see whether or not their capacity will be sufficient.

(1) Receipt of Imported Crude Oil

The following conditions are assumed:

(i) The monthly estimated volume of crude oil imported from Nigeria is 83,100 kℓ.

(ii) The loading capacity of each ocean tanker to be used for transporting imported crude oil will be 60,000 kℓ, same as at present.

(iii) The existing pump (capacity: 1,000 kℓ/hr) will be used to unload crude oil, same as at present.

(iv) Daily working hours will be 24 hours, on the basis of the supposed present situation.

The occupancy rate of the jetties is calculated as follows:

The number of 60,000 kℓ tankers required to transport the monthly volume of crude oil imported:

(83,100 kℓ)/(60,000 kℓ) = 1.4

Time for unloading the volume of crude oil imported once (60,000 kℓ): (60,000 kℓ)/(1,000 kℓ/hr) = 60 hours

The occupancy time of the jetties required to unload one crude oil import consignment is estimated at 70 hours on the assumption that ten hours will be required in addition to the above 60 hours required for unloading.

The occupancy time of the jetties required to receive the monthly volume of imported crude oil:

(70 hours) x 1.4 = 98 hours
= 4.1 days

The occupancy rate of the jetties:

[(4.1 days)/(30 days)] x 100 = 14%

(2) Loading of Imported Crude Oil

The following conditions are assumed:

(i) The monthly volume of the crude oil imported will be 83,100 kℓ.

(ii) The loading capacity of each barge to be used to transport the imported crude oil will be 4,000 kℓ, which is equivalent to that of the respective existing barges owned by COPEX.

(iii) The existing pump with a capacity of 1,000 kℓ/hr will be used to load crude oil, same as at present.

(iv) Daily working hours will be 24 horus.

The occupancy rate of the jetties is estimated as follows:

The number of barges required to transport the monthly volume of imported crude oil:

(83,100 kℓ)/(4,000 kℓ) = 21 barges

Required time for loading crude oil into one barge:

(4,000 kℓ)/(1,000 kℓ/hr) = 4 hours

Jetty occupancy time for one barge is supposed to be 10 hours, on the assumption that six hours will be required in addition to the above 4 hours for loading crude oil.

The occupancy time of jetties per month:

(10 hours/barge) x (21 barges) = 210 hours

= 8.8 days

The occupancy rate of the jetties:

[(8.8 days)/(30 days)] x 100 = 29%

(3) Conclusion

The estimated occupancy rate of the jetties to be used to receive and load imported crude oil totals 43%, which is below 60%.

Accordingly, it is estimated that the capacity of the two exisiting jetties is enough, and the existing Zarate Oil Terminal will be usable for the year 2000.

7.3.3 Hernandarias Oil Depot

(1) Land Receiving Facilities

The operating rate of the existing land receiving facilities is estimated as follows, assuming that they will be used under the present conditions.

The following conditions are assumed:

(i) The daily volume of refined petroleum products received into the Hernandarias Depot is calculated, on the basis of the annual shipping volume of petroleum products in the year 2000 as per Fig. 6.3-2, and on the assumption that they will be shipped for 22 days per month. As a result, the receiving and shipping volume per day is the same as Case-1.

(ii) All amounts of the products will be transferred from the Villa Elisa Refinery, and each capacity of the tank-trucks to be used will be 14 kℓ.

(iii) An outline of the existing shipping facilities are as per foregoing 7.2.2.

(iv) Time for unloading petroleum produts using one 14 kℓ tank-truck is assumed to be 27 minutes (transfer time of 19 minutes into the storage tanks plus other required time of 8 minutes).

The operating rate of the land receiving facilities is calculated as follows:

The daily capacity of the land receiving facilities is expressed in the following equation:

(14 kℓ) x (480 minutes/27 minutes) x (number of loading pumps with a capacity of 45 kℓ/hr)

Therefore, regarding regular gasoline, the daily capacity of the land receiving facility:

(14 kℓ) x (480 minutes/27 minutes) x 0.5 = 125 kℓ/day

Accordingly, the operating rate of the above receiving facilities is:
[(178 kℓ/day)/(125 kℓ/day)] x 100 = 142%

As for gas oil, on the other hand, the daily capacity of the land receiving facility:

(14 kℓ) x (480 minutes/27 minutes) x 1.5 = 374 kℓ/day

Therefore, the operating rate of the receiving facilities is as follows, based on the daily shipping volume of 711 kℓ/day:

[(711 kℓ/day)/(374 kℓ/day)] x 100 = 190%

Thus, it is estimated that the operating rate of the receiving facilities for both types of products will considerably exceed 60%.

As a measure, in the case of regular gasoline, one existing receiving facility (capacity: 45 kℓ/hr) used concurrently for both regular gasoline and gas oil should be used only for regular gasoline. With such a change, the operating rate will fall to a tolerable value of 71%.

Concerning gas oil, on the other hand, in order to reduce the operating rate, a total of five receiving facilities with a capacity of 45 kℓ/day each will be required. This means that four more receiving facilities each with the same capacity as the above will be needed.

As for premium gasoline, one receiving facility with a capacity of 45 kℓ/day will be newly installed.

(2) Other Facilities

The land shipping facilities, storage tanks and other necessary facilities will be the same as for Case-1.

7.4 Supply Facilities for Case-3

7.4.1 Villa Elisa Refinery

This Section summarizes the facility plans at the Villa Elisa Refinery and also the associated project implementation plan for Case-3.

(1) Process Units

As mentioned in Section 6.2.2, the flow scheme of the refinery for Case-3 features the introduction of a naphtha reformer, which allows premium gasoline to be produced. Also, the capacity of the existing crude distillation unit will be expanded to 10,000 BPSD, and the operation of the existing jet fuel treating unit will be continued. Table 7.4-1 shows the throughput rate of crude oil and the production rates of products, and Table 7.4-2 shows the capacity of the process units.

The octane number of regular gasoline will be 81 before being blended with alcohol and before leaded, and that of premium gasoline will be 93 before being leaded. The properties of the other products are the same as at present.

The overhead section of the main distillation column and the trays in the naphtha distillation section of this column will be revamped and a gas oil stripper newly installed, in order to increase the capacity of the existing crude distillation unit to 10,000 BPSD.

(a) Revamping of Overhead Section of Main Distillation Column

The following two measures can be taken to cope with the increase in the heat duties in the overhead section of the main distillation column.

(i) A large-capacity heat exchanger instead of the existing overhead exchanger will be installed.

(ii) A new external reflux system will be adopted.

In this seciton, an external reflux system is adopted.

In the external reflux system, trays for heat exchange will be required. It is difficult to install such trays in the overhead section of the existing main distillation column, however. It is realistic to install a new column equipped with these trays, and to introduce overhead vapor into this column (Refer to Fig. 7.4-1).

The size of the above column is as follows:

Column diameter:	3,000 mm
Number of trays:	4 (sieve tray)
Column material:	Monel clad
Tray material:	Monel

Table 7.4-1 Crude and Product for Case-3

	BPSD 1)	Kℓ/Y
1. Saharan Blend Crude Oil	8,400	440,700
2. Product		
(1) LPG	340	17,800
(2) Regular Gasoline	980	51,400
– Gasoline	(920)	(48,400)
– Absolute Alcohol	(60)	(3,000)
(3) Premium Gasoline	1,230	64,400
(4) Aviation Gasoline	0	0
(5) Kerosene	0	0
(6) Jet Fuel	670	35,200
(7) Gas Oil	4,050	212,500
(8) Fuel Oil	830	43,300
(9) Asphalt	0	0

Source: JICA Mission

1) Annual operation days are assumed to be 330 days.

Table 7.4-2 Capacity of Process Unit for Case-3

Process Unit	Capacity (BPSD)
1. Existing Crude Distillation Unit	Revamp to 10,000
2. Naphtha Hydrotreating Unit	1,600
3. Catalytic Reforming Unit	1,600

Source: JICA Mission

An associated pump and heat exchanger will be required to constitute the external reflux system.

(b) Tray in Naphtha Distillation Section (#8 - #13) of Main Distillation Column

If 10,000 BPSD crude oil is run in the existing main distillation column, the capacity of the existing trays in the naphtha distillaiton section will exceed the maximum allowable throughput. Accordingly, these trays must be replaced by new valve type 3-pass trays.

(c) New Installation of Gas Oil Stripper

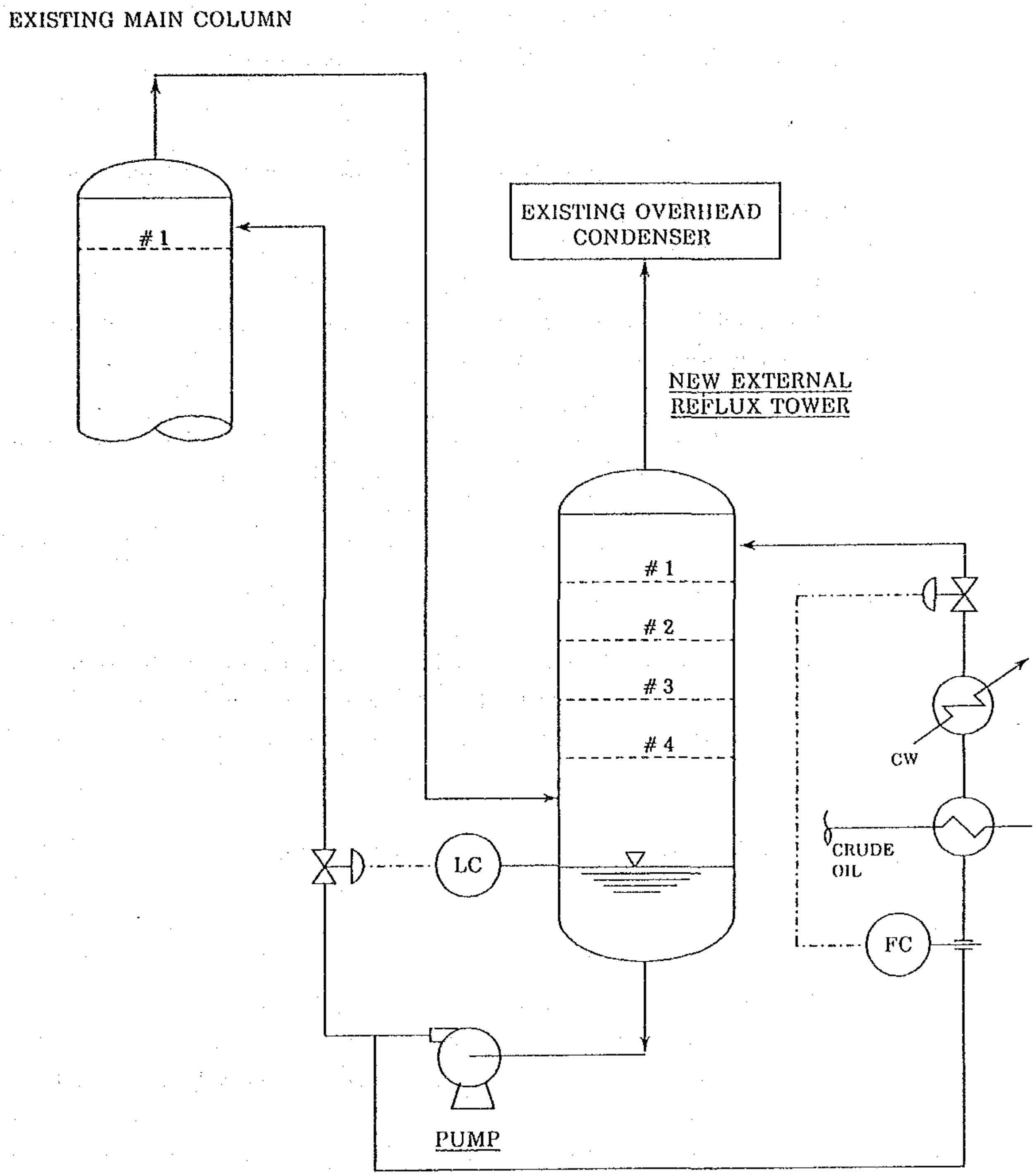
As described in Chapter 5, Section 5.1.3(2), the existing gas oil stripper will not be capable of fully stripping gas oil, because the capacity of the trays in the stripper has exceeded their upper operating limit under the present crude throughput conditions.

Accordingly, the new installation of a gas oil stripper will be required to run 10,000 BPSD crude oil, and the diameter of the pipeline around the above stripper will also be changed. The size of the new stripper is as follows:

Column diameter:	1,000 mm
Number of trays:	6
Column length:	9,550 mm
Column material:	Carbon steel
Tray material:	Stainless steel

(2) Utility Supply Facilities

Steam, cooling water, and instrument and plant air will be supplied from the existing facilities. Electricity required in the refinery is about 5.2×10^6 kWh/Y, and a 250 kW



Source : JICA Mission

Fig. 7. 4 - 1 External Reflux System

power receiving facility will be added. Also, a nitrogen supply facility will be newly installed, and fuel gas and fuel oil supply facilities will be expanded.

(3) Storage Facilities

The number of new tanks required is determined by the same method as for Case-2, per Table 7.4-3.

(4) Wharfs

Wharfs will be used to receive crude oil imported from Algeria, petroleum products imported from YPF, and to ship out fuel oil.

The occupancy rate of the existing two wharfs is estimated as follows, to know whether or not their capacity is enough, if they are used for the above purposes.

(a) Reception of Crude Oil Imported

The following conditions are supposed:

(i) The monthly volume of crude oil imported from Algeria will be 36,700 kℓ, on the basis of the annual import volume (440,700 kℓ) as per Fig. 6.3-3.

(ii) The other conditions will be the same as in the case of crude oil imported from Nigeria as per 7.3.1.

If the wharf occupancy rate is estimated by the same method as in 7.3.1, it becomes 10%.

(b) Reception of Products Imported

The following conditions are assumed.

The monthly volume of petroleum products to be imported from YPF is estimated at 22,600 kℓ, on the basis of the annual import volume (270,600 kℓ) as per Fig. 6.3-3.

The other conditions will be the same as in the case of products imported from YPF as per 7.2.1.

If the wharf occupancy rate is estimated by the same method as in 7.2.1, it becomes 15%.

(c) Conclusion

The wharf occupancy rate for receiving the crude oil imported from Algeria and the products imported from YPF becomes a total of 25%. Accordingly, it is estimated that the total wharf occupnacy rate will be much smaller than 60%, even if the shipping volume of fuel oil is added to the above receiving volume. Thus, the existing two wharfs can be used for the year 2000.

Table 7.4-3 Tank List for Case-3

Crude/Product	Existing Tanks		Total Requirement (Kℓ)	Additional Requirement (Kℓ)	New Tanks	
	Item No. (D9-)	Capacity (Kℓ)			Capacity (Kℓ)	Type
1. Crude Tank	901, 902, 917	62,900	111,800	48,900	50,000 x 1	FR
2. Product Tank						
(1) LPG	916, 919, 920, 924, 925	300	7,000	6,700	2,000 x3 1,000 x 1	SPH SPH
(2) Regular Gasoline	907, 921, 922	11,300	17,500	6,200	6,500 x 1	FR
(3) Premium Gasoline	904, 905, 908, 915	6,065	7,500	1,435	1,500 x 1	FR
(4) Aviation Gasoline	903, 918	1,380	1,200	—	—	
(5) Kerosene	909, 913	3,050	2,600	—	—	
(6) Jet Fuel	906, 910	2,780	9,600	6,820	7,000 x 1	CR
(7) Gas Oil	923, 926, 927, 928, 929, ES-2	75,800	80,200	4,400	5,000 x 1	CR
(8) Fuel Oil	911, 912, ES-1	15,760	7,100	—	—	
(9) Asphalt	935, 936, 937	1,230	3,400	2,170	2,000 x 1	CRH
(10) Alcohol	914	1,680	800	—	—	
3. Intermediate Tank						
(1) SR Light Naphtha	—	—	600	600	1,000 x 1	FR
(2) SR Heavy Naphtha	—	—	2,100	2,100	2,000 x 1	FR
(3) Reformate	—	—	1,400	1,400	1,500 x 1	FR

Source: JICA Mission

Note SPH: Spherical Tank

CR: Cone Roof Tank

CRH: Cone Roof Tank with heating

FR: Floating Roof Tank

(5) Land Shipping Facilities

The operating rate of the existing land shipping facilities is estimated as follows, to see whether or not their capacity is sufficient, if they are used for the year 2000.

The following conditions are assumed:

(i) The daily shipping volume of products is calculated on the basis of the annual shipping volume in the year 2000 per Fig. 6.3-3, and assuming that they will be shipped for 22 days per month.

(ii) The other conditions are the same as per foregoing 7.2.1.

The operating rate of the land shipping facilities is estimated using the same calculation procedure as in the case of foregoing 7.2.1 (Refer to Table 7.4-1).

As shown in Table 7.4-4, the operating rate of the land shipping facilities for products other than gas oil and LPG is below 61%. Accordingly, the existing land shipping facilities can be used for the year 2000.

The operating rate of the land shipping facilities for gas oil and LPG is 92% and 130% respectively, thus considerably exceeding the adequate operating rate of 60%. In order to reduce the operating rate to around 60%, nine loading arms with a shipping capacity of 60 kℓ/hr each will be required to ship gas oil. Since six loading arms with the same capacity are now available, three loading arms will be added.

Also, in order to reduce the operating rate of the LPG shipping facility to around 60%, two loading arms with a shipping capacity of 20 kℓ/hr will be required. As one loading arm with the same capacity now exists, one loading arm will be added.

Furthermore, the shipping facility which are capable of meeting the shipping volume of asphalt for the year 2000 will be installed.

(6) Waste Water Treating Facilities

Process waste water is treated along with oily waste water using a new oil separator, and diluted with clean waste water, to be discharged subsequently.

(7) Other Auxiliary Facilities

The auxiliary facilities will be added as in the case of Case-2.

Table 7.4-4 Land Shipping Facilities (Case-3)

Product	Shipping Amount (Kℓ/yr)	Shipping Amount (Kℓ/day)	Shipping Capacity (Kℓ/day)	Operating Rate (%)	Existing Facilities		Total Required Facilities		Additional Required Facilities	
					No. of Loading Arm	Capacity per Arm (Kℓ/hr)	No. of Loading Arm	Capacity per Arm (Kℓ/hr)	No. of Loading Arm	Capacity per Arm (Kℓ/hr)
LPG	51,800	196	151	130	1	20	2	20	1	20
Regular Gasoline	95,700	362	1,344	27	5	51	5	51	0	–
Premium Gasoline	64,400	244	806	30	3	51	3	51	0	–
Aviation Gasoline	4,200	16	269	6	1	51	1	51	0	–
Kerosene	9,400	36	806	4	3	39	3	39	0	–
Jet Fuel	58,600	222	538	41	2	51	2	51	0	–
Gas Oil	393,800	1,492	1,613	92	6	60	9	60	3	60
Fuel Oil	43,300	164	269	61	1	48	1	48	0	–

Source: JICA Mission

(8) Summary of Project Implementation Plan

(a) Required Area

The area required for the major additional facilities is as follows:

- Process units/utility facilities: 8,000 m^2
- Storage facilities/land shipping facilities: 55,000 m^2

It is considered that these facilities could be constructed in the existing refinery site.

(b) Construction Period

The refinery will be constructed in 24 months, between January, 1990 and December, 1991.

(c) Manning Plan

Fig. 7.4-2 shows the organization and the number of personnel required for the operation of the refinery.

The organization at the refinery will be the same as for Case-2, and the personnel required number 314. The required number of personnel at the Calera Cue Product Storage Terminal will be four, which is equivalent to that at present.

(d) Personnel Training Program

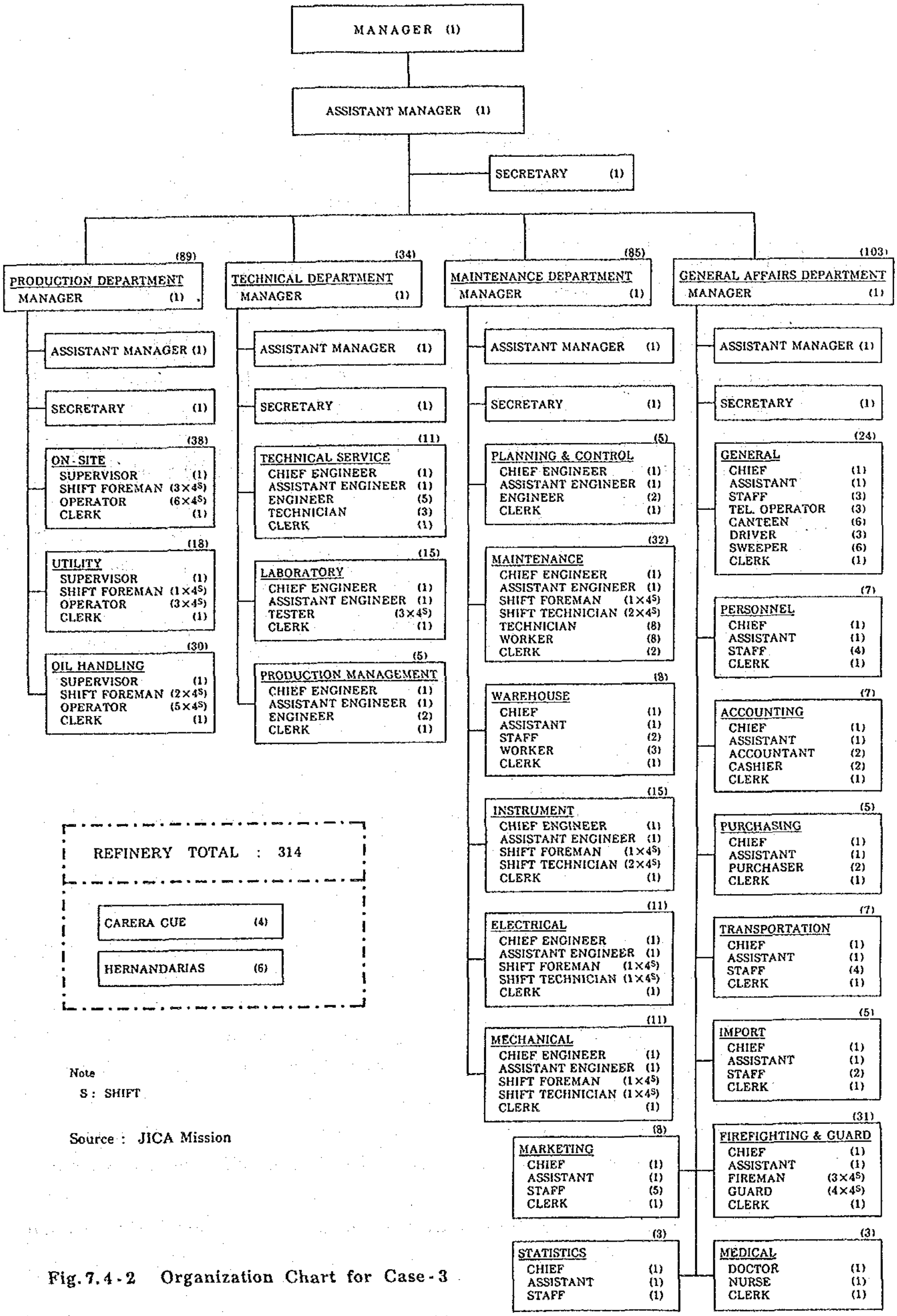
As the training of the personnel engaged in the operation of the facilities is required as in Case-2, Table 7.4-5 shows the number of trainees and also the training period prior to the operation of the facilities.

7.4.2 Zarate Oil Terminal

Imported crude oil will be received from the tankers and loaded into barges at the Zarate Oil Terminal, as in Case-2.

For Case-2, it is estimated that the occupancy rate of the existing jetties will be below 60%.

Accordingly, for Case-3 where the volume of the crude oil imported is much smaller than that for Case-2, the occupancy rate of the existing jetties will be below 60%, if the other conditions are the same as for Case-2. Thus, the existing Zarate Oil Terminal including the existing two jetties will be used for the year 2000.



Note
S : SHIFT

Source : JICA Mission

Fig. 7.4-2 Organization Chart for Case-3

Table 7.4-5 Trainees for Case-3

Class of Trainee	Number of Trainee	Training Month	Training Place
1. Production Department			
(1) Foreman of Process Section	8	6 6	Foreign Refinery Plant Site
(2) Foreman of Utility and Oil Handling Section	8	6	Plant Site
(3) Chief Operator	16	12	Foreign Refinery
(4) Operator	28	6	Plant Site
2. Technical Department			
(1) Chief Tester of Laboratory Section	4	6	Foreign Refinery
3. Maintenance Department			
(1) Foreman	16	6	Foreign Refinery
(2) Technician	24	6	Plant Site
Total	104		

Source: JICA Mission

7.4.3 Hernandarias Depot

(1) Land Receiving Facilities

The operating rate of the existing land receiving facilities is estimated as shown below, when they are to be used as they are.

The following conditions are assumed:

(i) The daily volume of petroleum products is estimated on the basis of the annual receiving volume in the year 2000 as shown in Fig. 6.3-3, assuming that such products will be received for 22 days per month. Both regular gasoline and gas oil will be imported from PETROBRAS, and premium gasoline transferred from the Villa Elisa Refinery. Therefore, the results of the receiving facilities are the same as per 7.2.2. In other words, the existing pump (45 kℓ/hr) used currently for regular gasoline and gas oil will be used exclusively for receiving regular gasoline. Also three receiving facilities with a receiving capacity of 45 kℓ/hr each will be added to receive gas oil.

One receiving facility with a receiving capacity of 45 kℓ/hr will be newly installed to receive premium gasoline.

(2) Other Facilities

The operating rates and required number of land shipping facilities, storage tanks and other facilities are the same as Case-1.

CHAPTER 8 EVALUATION

8.1 Study Method

8.1.1 Scope of the Study

Evaluations are made on the following three alternative future supply plans presented in Chapter 6 and Chapter 7 from both financial and economic viewpoints.

Case-1: Operation of the existing refinery will be shut-down and all the petroleum products required will be imported.

Case-2: The existing refinery will be fully modernized to cover the demands for petroleum products as far as possible, with the aim of minimizing products import.

Case-3: The existing refinery will be kept in operation with some modification. The products in short supply will be all imported to satisfy the demands.

The supply of petroleum products consists of two phases, that is, primary supply (domestic refining and products import) and domestic distribution. The major differences among the alternative supply plans above lie in the phase of primary supply and there is no substantial difference in the domestic distribution.
As described in Chapter 6, PETROPAR is exclusively responsible for the primary supply of petroleum products in Paraguay, i.e., it owns and operates the Villa Elisa Refinery and the Hernandarias Depot to undertake such business activities as import and storage of crude oil and petroleum products, petroleum refining, and shipping (including transportation of some products between Villa Elisa and Hernandarias) of refined and imported products. Accordingly, the differences among the alternative supply plans are basically within the range of the current business of PETROPAR.

Consequently, the following analysis of capital requirements, running costs, and revenues will be done in line with the current business activity of PETROPAR.

8.1.2 Viewpoints of the Study

The evaluation study is made from the following two viewpoints:

(1) Supply Cost

Which case is capable of supplying petroleum products at the lowest cost over the study period?

What is the difference in the supply costs among three cases of supply plans?

How does the supply cost of each case respond to the changes in the values of major cost components?

(2) Profitability

How is the profitability achieved in each case of the supply plans?

How does the profitability of each case respond to the changes in the values of revenue components?

Prior to evaluations, values are estimated for every component which is involved in the investment costs, running costs and revenues in each case of the supply plans. The estimation is made on the current price basis based on the actual record. Then, indicators for the evaluation are calculated by use of the data estimated as above.

8.1.3 Procedure of the Study

In the first place, the financial cost of the primary supply of petroleum products in each case of the supply plans is examined by use of the average supply cost (ASC) over the study period.

Then sensitivity analysis is made to know how the ASC value responds to the changes in major cost components.

In order to examine the profitability of each case, the financial internal rate of return (FIRR) is calculated. For this purpose, a Profit & Loss Table and a Funds Outlook are developed based on the data on cost components as aforementioned as well as on the ex-PETROPAR price of petroleum products under the current supply system.

The sensitivity of the FIRR to changes in ex-PETROPAR price of petroleum products is also analyzed.

As the last step of the evaluations, an economic evaluation is made in which necessary adjustments are made on the values of some cost components used in the financial evaluation.

The adjustments made are as follows:

- transfer items such as tax are excluded from the cost components.
- shadow exchange rate is applied to the foreign currency portion of the cost components.

Average supply cost (ASC) and economic internal rate of return (EIRR) are calculated and their sensitivity is analyzed in the same way as in the financial analysis.

Further, the net present value (NPV) is calculated for each case of the supply plans and examined by the "With and Without Principle".

In addition, foreign currency requirements and employment effect of the supply plans are examined.

The formulas used in the calculation of various indicators for financial and economic evaluations, as well as the mathematical symbols in the formulas, are presented in the following:

Mathematical Symbols

ASC:	Average Supply Cost
IRR:	Internal Rate of Return; FIRR (Financial Internal Rate of Return) and EIRR (Economic Internal Rate of Return) are explained in respective sections.
NPV:	Net Present Value
i:	i-th year of the study period
n:	Study period in years
r:	Discount rate
Ii:	Investment in i-th year (excluding interest during construction)
RCi:	Running Cost in i-th year (excluding depreciation cost and interest paid)
Qi:	Sales quantity of petroleum products in i-th year
CIFi:	Cash inflow in i-th year
COFi:	Cash outflow in i-th year (Cash inflow and cash outflow are explained in respective sections.)

Evaluation Formulas

(1) ASC (Average Supply Cost)

ASC is the average supply cost per one unit quantity of petroleum products to be supplied over the study period, and defined by the following formula:

$$\sum_{i=0}^{n} \frac{ASC \times Q_i}{(1+r)^i} = \sum_{i=0}^{n} \frac{I_i + RC_i}{(1+r)^i}$$

therefore,

$$ASC = \sum_{i=0}^{n} \frac{I_i + RC_i}{(1+r)^i} \Big/ \sum_{i=0}^{n} \frac{Q_i}{(1+r)^i}$$

(2) IRR (Internal Rate of Return)

IRR is the discount rate which makes the total sum of the present value of the net cash flow equal to zero (0), and is given by the following formula:

$$\sum_{i=0}^{n} \frac{CIF_i - COF_i}{(1+r)^i} = 0$$

In the financial and economic evaluations, FIRR and EIRR are used, respectively. Whereas the formula used is the same in both evaluations, definitions of CIFi and COFi differ.

In Financial Evaluation (FIRR)

CIFi = Profit after tax but before depreciation and interest paid

COFi = Investment (excluding interest during construction) - Salvage Value

In Economic Evaluation (EIRR)

Modifications are made on cost components related to the transfer items and exchange rate.

CIFi = Profit before tax and before depreciation and interest paid

COFi = Investment (excluding interest during construction) - Salvage Value

(3) NPV (Net Present Value)

NPV is the total sum of the present value of the net cash flow over the entire study period when a specific discount rate is applied, and is given by the following formula:

$$NPV = \sum_{i=0}^{n} \frac{CIF_i - COF_i}{(1+r)^i}$$

8.1.4 Sensitivity Analysis

In the sensitivity analysis, the effect on each evaluation indicator of changes in cost and revenue factors within the respective ranges is examined. These factors are listed below with respective ranges of changes.

Financial Evaluation

Evaluation Indicator	Factor	Range
ASC	– discount rate	10% ~ 20%
	– plant construction cost	±30%
	– import price of crude oil	±20%
	– import price of crude oil and petroleum products (assumed to change at the same rate simultaneously)	±20%
FIRR	– sales price of petroleum products	±30%

Economic Evaluation

Evaluation Indicator	Factor	Range
ASC	– discount rate	10% ~ 20%
	– plant construction cost	±30%
	– import price of crude oil	±20%
	– import price of crude oil and petroleum products (assumed to change at the same rate simultaneously)	±20%
EIRR	– sales price of petroleum products	±30%
NPV	– discount rate	10% ~ 20%

8.2 Study Basis

8.2.1 Total Capital Requirements

Total capital requirements mean the total sum of the capital costs invested up to the time when the facilities start commercial operation, and are divided into fixed capital and working capital.

The total capital requirements for the facilities for the future supply of petroleum products in Paraguay, as described in Chapter 7, include the following capital costs:

Fixed Capital

- Plant construction costs
- Licensor's costs
- Initial costs of catalysts and chemicals
- Pre-operation expenses
- Interest during construction period

Working Capital

- Inventories of crude oil and products
- Inventories of spare parts
- Inventories of catalysts and chemicals

The total capital requirements for each case of the future supply plans are shown in Table 8.2-1 in terms of the Paraguayan currency, guaranis. The exchange rates used in the conversion of foreign currency payments for estimating the total capital requirements are 400 Gs/US$ for the FOB prices of the equipment and materials and 900 Gs/US$ for the costs of other services.

Table 8.2-1 Total Capital Requirement

(Unit: MMGs)

Item	Case-1	Case-2	Case-3
1. Fixed Capital	15,283	95,033	31,436
2. Working Capital	12,250	15,660	14,180
Total	27,533	110,693	45,616

Source: JICA Mission

The portion of the fixed capital to be paid in foreign currency is given below in terms of US$, with a separation of the FOB prices and the costs of other services.

(Unit: MMUS$)

Case	Foreign Portion		
	FOB Price	Other Service	Total
Case–1	9.4	7.7	17.1
Case–2	56.6	67.8	124.4
Case–3	17.3	20.1	37.4

Explanation of each item in the total capital requirements is given below.

(1) Fixed Capital

(a) Plant Construction Costs

The plant construction costs are estimated on the following bases:

- The costs include the construction costs of the facilities in the Product Import Terminal or Refinery at Villa Elisa and the Hernandarias Depot.
- The costs are as of early 1988 and future escalations are not taken into consideration.
- The costs include the equipment and material costs, freight costs, labor costs and contractor's expenses for engineering, project management and other services, but site preparation costs are excluded. It is assumed that the costs of the equipments and materials would be entirely included in the foreign portion and the costs of civil work and construction of tanks and buildings would be included in the local portion.

(b) Licensor's Costs

The basic design fee and royalties are estimated as the licensor's costs.

(c) Initial Costs of Catalysts and Chemicals

The initial costs of catalysts and chemicals, required at the start-up of the facilities, are estimated and included in the fixed capital.

(d) Pre-operation Expenses

The pre-operation expenses include the training fee, administration costs and start-up expenses. The personnel training costs consist of the salaries to be paid to the trainees and the direct expenses required for training during the training period. The administration costs include the salaries to be paid to the managers and staffs employed prior to the start of commercial operation and the accompanying indirect costs. The start-up expenses include the costs for test run instructors sent by process licensor and the contractor and the costs of chemical and utilities consumed during the test-run period.

(e) Interest during Construction Period

The interest paid during the construction period, which is incorporated into the fixed capital, is estimated according to the fund arrangement plan described in Section 8.2.2 and to the following yearly capital expenditures, which are determined based on the construction schedule for each case described in Chapter 7:

- Yearly disbursements of the plant construction costs and licensor's costs are to be paid based on the standard disbursement schedule.
- Initial costs of catalysts and chemicals are assumed to be paid just prior to the start of commercial operation.
- Pre-operation expenses are assumed to be paid in the year preceding the start of commercial operation.

(2) Working Capital

(a) Inventories of Crude Oil and Products

The average stock quantities of crude oil and products are calculated on an assumption that crude oil and products would be in stock at 50% of the total tank storage capacities. The working capital for the oil inventories is estimated by multiplying the stock quantities by the unit cost of the imported crude oil and products.

(b) Inventory of Spare Parts

As inventory of spare parts, 3% of the equipment and material costs is added to the working capital.

(c) Inventory of Catalysts and Chemicals

As an inventory of catalysts and chemicals, the expenses required for one year's operation are added to the working capital.

8.2.2 Revenues and Expenses

Explanations are given below on the method of estimating the revenue and expense items which serve as the basis for financial and economic evaluations. And the estimated values of these items are tabulated in a series of tables at the end of this section.

It is assumed in this study that the new facilities for all three cases of supply plans would be put into commercial operation in January, 1992, despite the expected difference in the construction period of the facilities. And the study period is set forth as nine (9) years from January 1992, to 31 December, 2000.

Further, it is also assumed that existing facilities in the refinery and depot would be maintained in such a way that they can be operated throughout the study period.

(1) Running Cost

The following cost items which constitute the running cost are calculated on the basis of actual records of PETROPAR in 1987 and early 1988.

- Crude oil cost
- Petroleum products import cost
- Alcohol cost
- Utilities cost (including catalysts & chemicals cost)
- Operating labor cost
- Administrative expenses
- Insurance cost
- Maintenance cost
- Local transportation cost

(a) Crude Oil Cost

For Case-2 and Case-3 where imported crude oil is refined, the crude oil cost for each year of the study period is calculated by multiplying the annual crude oil throughput by unit CIF price of the crude oil at the Villa Elisa Refinery. The CIF price of the Bonny Light and Saharan Blend Crudes, which are assumed to be used in Case-2 and Case-3, respectively, are set on the basis of the government sales prices of respective crudes.

(b) Petroleum Products Import Cost

Petroleum products import cost for each year of the study period is calculated as a total sum of the import value of each product imported in the year. The import value of each product is calculated by multiplying the unit CIF price of the product imported from either YPF or PETROBRAS by annual import volume from either of the two suppliers determined by the supply plan described in Chapter 6. Unit CIF prices of imported products are based on the actual import records from the two suppliers.

(c) Alcohol Cost

The alcohol cost is the price paid for the absolute alcohol to be purchased from APAL and mixed in the regular gasoline.

(d) Utilities Cost (Including Catalysts and Chemicals Cost)

Costs for electricity, fuel, catalysts and chemicals are regarded as constituting the utilities cost. However, no fuel cost is included in Case-2 and Case-3, because the fuel oil is to be self-supplied in these two cases. And no catalysts and chemicals cost is included in Case-1, where all petroleum products required are to be imported.

(e) Operating Labor Cost

Operating labor cost is calculated on the basis of the number of employees required. For this calculation, a labor cost of 445,000 Gs/man-month is adopted as a unit cost. The number of employees required for each case is as determined by the manning plan described in Chapter 7.

(f) Administrative Cost

Administrative cost is assumed, on the basis of the actual record in 1987, to be Gs 1,000 million per year, to which 1.7% of PETROPAR's annual sales revenues is added as stamp tax.

(g) Insurance Cost and Maintenance Cost

Insurance cost and maintenance cost for newly installed facilities are assumed to be 1% and 3%, respectively, of the plant construction costs. For existing facilities, actual records of these two costs in 1987 are adopted.

(h) Local Transportation Cost

Local transportation cost is the cost for transporting petroleum products from the Villa Elisa Refinery to the Hernandarias Depot, and is calculated on the basis of the results of the study described in Chapter 6.

(2) Depreciation Cost

Depreciation cost for the new facilities is calculated by the straight line method at 6% annually of the fixed capital. For existing facilities, depreciation cost is set on the basis of actual records in 1987.

(3) Sales Revenues

PETROPAR's shipping prices for petroleum products in 1987 are used to calculate the sales revenues. Sales volume of each product in each year of the study period is as described in Chapter 6.

(4) Fund Arrangement Plan

All funds required during the study period are assumed to be covered by loan in all three cases. Accordingly, foreign and local currencies to meet the expenditures for the fixed capital are to be covered by long-term loans under the conditions below.

Foreign Currency

Interest rate:	9% annually
Principal repayment:	8 annual fixed installments after the start of commercial operation

Local Currency

Interest rate:	17% annually
Principal repayment:	8 annual fixed installments after the start of commercial operation.

And, funds required in case of a cash shortfall are to be covered by short-term loans under the conditions below:

Interest rate:	8.25% annually
Principal repayment:	When funds are in excess

(5) Tax

Transfer to the national treasury and the income tax are regarded as tax, and the total tax rate is assumed to be 51% of the profit.

All detailed data concerning revenues, expenses and related items calculated on the above basis are tabulated in the following tables.

All monetary figures are shown in terms of guaranis, the Paraguayan currency. And in converting foreign currency into guaranis, a rate of Gs 400 per US dollar is applied to the FOB price portion, and Gs 900 per US dollar to other portion.

List of Tables

Table 8.2-2 Payment Schedule in Case-1

(Unit: MMGs)

Item	1989	1990	1991	Total
Fixed Capital [1]	0	4,125	11,158	15,283
(Foreign)	0	3,099	7,600	10,699
(Local)	0	1,026	3,558	4,584
Working Capital [2]	0	0	12,250	12,250
(Foreign)	0	0	12,100	12,100
(Local)	0	0	150	150
Total	0	4,125	23,408	27,533
(Foreign)	0	3,099	19,700	22,799
(Local)	0	1,026	3,708	4,734

Source: JICA Mission

1) Fixed Capital includes following items.
- Plant Construction Cost
- Licensor's Cost
- Initial Catalists & Chemicals
- Pre-Operational Expense
- Interest during Construction Period

2) Working Capital includes following items.
- Oil Inventory
- Spare Parts
- Catalists & Chemicals

Table 8.2-3 Payment Schedule in Case-2

(Unit: MMGs)

Item	1989	1990	1991	Total
Fixed Capital [1]	8,221	33,700	53,112	95,033
(Foreign)	7,267	29,722	46,694	83,683
(Local)	954	3,978	6,418	11,350
Working Capital [2]	0	0	15,660	16,660
(Foreign)	0	0	14,340	14,340
(Local)	0	0	1,320	1,320
Total	8,221	33,700	68,772	110,693
(Foreign)	7,267	29,722	61,034	98,023
(Local)	954	3,978	7,738	12,670

Source: JICA Mission

1) Fixed Capital includes following items.
- Plant Construction Cost
- Licensor's Cost
- Initial Catalists & Chemicals
- Pre-Operational Expense
- Interest during Construction Period

2) Working Capital includes following items.
- Oil Inventory
- Spare Parts
- Catalists & Chemicals

Table 8.2-4 Payment Schedule in Case-3

(Unit: MMGs)

Item	1989	1990	1991	Total
Fixed Capital 1)	0	10,516	20,920	31,436
(Foreign)	0	8,392	16,653	25,045
(Local)	0	2,124	4,267	6,391
Working Capital 2)	0	0	14,180	14,180
(Foreign)	0	0	13,080	13,080
(Local)	0	0	1,100	1,100
Total	0	10,516	35,100	45,616
(Foreign)	0	8,392	29,733	38,125
(Local)	0	2,124	5,367	7,491

Source: JICA Mission

1) Fixed Capital includes following items.
   - Plant Construction Cost
   - Licensor's Cost
   - Initial Catalists & Chemicals
   - Pre-Operational Expense
   - Interest during Construction Period

2) Working Capital includes following items.
   - Oil Inventory
   - Spare Parts
   - Catalists & Chemicals

Table 8.2-5 Depreciation

Item	Method	Salvage Value	Start Year
New Facility	6% of Investment straight-line	20%	1992
Existing Facility	30 MMGs of Straight-line	20%	1992

Source: RESOLUCION G-No.34

JICA Mission

Table 8.2-6 Import Price of Crude Oil

(Unit: Gs/Kℓ)

Item	Case-1	Case-2	Case-3
Import Price of Crude Oil	—	110,200 (17,500 Gs/BBL)	110,800 (17,600 Gs/BBL)

Source: PETROPAR
JICA Mission

Table 8.2-7 Throughput of Crude Oil

(Unit: Kℓ/Y)

Year	Case-1	Case-2	Case-3
1992	—	707,900	323,200
1993	—	744,000	335,300
1994	—	780,100	347,800
1995	—	815,400	360,500
1996	—	849,500	375,600
1997	—	884,300	390,900
1998	—	920,600	407,000
1999	—	957,900	423,500
2000	—	996,800	440,700

Source: JICA Mission

Table 8.2-8 Import Price of Petroleum Products

(Unit: Gs/Kℓ)

Petroleum Products	Import Price
LPG	70,100
Regular Gasoline	92,700
Premium Gasoline	97,100
Aviation Gasoline	213,200
Kerosene	98,000
Jet Fuel	98,000
Gas Oil	95,500
Fuel Oil	86,200
Asphalt	111,600

Source: PETROPAR
JICA Mission

Table 8.2-9 Import Quantity of Petroleum Products in Case-1

(Unit: Kℓ/Y)

Year	LPG	Regular Gasoline	Premium Gasoline	Aviation Gasoline	Kerosene	Jet Fuel	Gas Oil	Fuel Oil	Asphalt
1992	75,000	111,000	47,200	4,200	14,400	41,600	433,200	38,000	9,400
1993,	78,500	113,700	49,000	4,200	13,800	43,700	448,100	38,500	9,700
1994	82,000	116,600	50,800	4,200	13,200	45,800	463,500	39,100	10,000
1995	85,400	119,500	52,600	4,200	12,600	48,000	479,300	39,700	10,300
1996	88,900	123,300	54,800	4,200	12,000	50,100	498,400	40,400	10,600
1997	92,500	127,200	57,100	4,200	11,400	52,200	518,100	41,100	11,000
1998	96,200	131,200	59,400	4,200	10,700	54,300	538,400	41,800	11,400
1999	100,000	135,400	61,800	4,200	10,100	56,500	559,500	42,600	11,800
2000	103,900	139,700	64,400	4,200	9,400	58,600	581,400	43,300	12,200

Source: JICA Mission

Table 8.2-10 Import Quantity of Petroleum Products in Case-2

(Unit: Kℓ/Y)

Year	LPG	Regular Gasoline	Premium Gasoline	Aviation Gasoline	Kerosene	Jet Fuel	Gas Oil	Fuel Oil	Asphalt
1992	39,600	12,500	1,500	4,200	7,700	0	20,300	7,200	9,400
1993	41,300	10,100	900	4,200	6,800	0	14,100	6,200	9,700
1994	43,000	7,800	400	4,200	5,800	0	8,500	5,200	10,000
1995	44,700	5,800	0	4,200	4,900	100	3,700	4,300	10,300
1996	46,500	4,700	0	4,200	4,000	200	2,900	3,500	10,600
1997	48,300	3,600	0	4,200	3,100	200	2,300	2,700	11,000
1998	50,200	2,400	0	4,200	2,000	200	1,400	1,800	11,400
1999	52,100	1,300	0	4,200	1,100	200	800	1,000	11,800
2000	54,100	0	0	4,200	0	0	0	0	12,200

Source: JICA Mission

Table 8.2-11 Import Quantity of Petroleum Products in Case-3

(Unit: Kℓ/Y)

Year	LPG	Regular Gasoline	Premium Gasoline	Aviation Gasoline	Kerosene	Jet Fuel	Gas Oil	Fuel Oil	Asphalt
1992	61,900	76,100	0	4,200	14,400	15,800	277,400	6,200	9,400
1993	65,000	77,500	0	4,200	13,800	16,900	286,400	5,600	9,700
1994	68,000	78,900	0	4,200	13,200	18,000	295,800	4,900	10,000
1995	70,800	80,500	0	4,200	12,600	19,200	305,500	4,300	10,300
1996	73,700	82,500	0	4,200	12,000	20,100	317,300	3,500	10,600
1997	76,700	84,600	0	4,200	11,400	21,000	329,600	2,700	11,000
1998	79,800	86,700	0	4,200	10,700	21,800	342,100	1,800	11,400
1999	82,900	89,000	0	4,200	10,100	22,700	355,300	1,000	11,800
2000	86,100	91,300	0	4,200	9,400	23,400	368,900	0	12,200

Source: JICA Mission

Table 8.2-12 Alcohol Cost

Year	Price (Unit: Gs/Kℓ)	Quantity (Unit: Kℓ/Y)
1992	222,000	2,800
1993	222,000	2,900
1994	222,000	2,900
1995	222,000	3,000
1996	222,000	3,000
1997	222,000	3,000
1998	222,000	3,000
1999	222,000	3,000
2000	222,000	3,000

Source: PETROPAR
JICA Mission

Table 8.2-13 Electricity Cost

Item		Case-1	Case-2	Case-3
Potential reserve Kw	(Unit: Kw)	550	3,150	800
Consumption Kw	(Unit: Kw/Y)	3.3×10^6	23.9×10^6	5.3×10^6

Source: JICA Mission

1) Operating Rate = 100%
2) Electricity cost = 2,504 Gs/Kw/Y x (Potential reserve Kw) + 6.42 Gs/Kw x (Consumption Kw)

Table 8.2-14 Fuel Oil Cost

Item	Price (Unit: Gs/Kℓ)	Quantity (Unit: Kℓ/Y)		
		Case-1	Case-2	Case-3
Fuel Oil	86,200	3,200	—	—

Source: PETROPAR
JICA Mission

1) Operating rate = 100%

Table 8.2-15 Catalists & Chemicals Cost

(Unit: MMGs/Y)

Item	Case-1	Case-2	Case-3
Catalists & Chemicals	——	1,080	250

Source: JICA Mission
1) Operating rate = 100%

Table 8.2-16 Operating Labor Cost

Item	Average Wage Rate (Unit: Gs/Person·Month)	Quantity (person)		
		Case-1	Case-2	Case-3
Labor	445,000	244	393	324

Source: JICA Mission
1) Average Wage Rate includes social welfare cost.

Table 8.2-17 Administrative Expense

(Unit: MMGs/Y)

Item	Case-1	Case-2	Case-3
Administrative expense	1,000	1,000	1,000
Stamp Tax	Revenue x 0.017		

Source: PETROPAR
JICA Mission

Table 8.2-18 Insurance Cost

(Unit: MMGs/Y)

Item	Case-1	Case-2	Case-3
New Facility	Plant Construction Cost x 0.01		
Existing Facility	74	74	74

Source: JICA Mission

Table 8.2-19 Maintenance Cost

(Unit: MMGs/Y)

Item	Case-1	Case-2	Case-3
New Facility	Plant Construction Cost x 0.03		
Existing Facility	40	40	40

Source: JICA Mission

Table 8.2-20 Local Transportation Cost

Year	Price (Unit: Gs/Kℓ)	Quantity (Unit: Kℓ/Y)		
		Case-1	Case-2	Case-3
1992	12,000	0	143,800	7,900
1993	12,000	0	159,400	8,300
1994	12,000	0	174,200	8,700
1995	12,000	0	188,200	9,100
1996	12,000	0	199,200	9,700
1997	12,000	0	210,400	10,300
1998	12,000	0	222,400	10,900
1999	12,000	0	234,000	11,500
2000	12,000	0	246,800	12,200

Source: PETROPAR
JICA Mission

Table 8.2-21 Sales Price of Petroleum Products

(Unit: Gs/Kℓ)

Item	Sales Price
LPG	86,900
Regular Gasoline	133,100
Premium Gasoline	159,600
Aviation Gasoline	273,500
Kerosene	162,300
Jet Fuel	170,100
Gas Oil	124,900
Fuel Oil	87,700
Asphalt	116,700

Source: PETROPAR
JICA Mission

Table 8.2-22 Sales Quantity of Petroleum Products

(Unit: Kℓ/Y)

Year	LPG	Regular Gasoline	Premium Gasoline	Aviation Gasoline	Kerosene	Jet Fuel	Gas Oil	Fuel Oil	Asphalt
1992	75,000	113,800	47,200	4,200	14,400	41,600	433,200	38,000	9,400
1993	78,500	116,600	49,000	4,200	13,800	43,700	448,100	38,500	9,700
1994	82,000	119,500	50,800	4,200	13,200	45,800	463,500	39,100	10,000
1995	85,400	122,500	52,600	4,200	12,600	48,000	479,300	39,700	10,300
1996	88,900	126,300	54,800	4,200	12,000	50,100	498,400	40,400	10,600
1997	92,500	130,200	57,100	4,200	11,400	52,200	518,100	41,100	11,000
1998	96,200	134,200	59,400	4,200	10,700	54,300	538,400	41,800	11,400
1999	100,000	138,400	61,800	4,200	10,100	56,500	559,500	42,600	11,800
2000	103,900	142,700	64,400	4,200	9,400	58,600	581,400	43,300	12,200

Source: JICA Mission

Table 8.2-23 Loans and Repayments

Item	Long-Term Loan		Short-Term Loan
	Foreign Portion	Local Portion	
Interest rate	9% per annum 1)	17% per annum	8.25% per annum
Loan	During construction	During construction	After ope. start
Refund	8 annum fixed installements after ope. start	8 annum fixed installements after ope. start.	When funds are in excess
Debt loan time	The end of the year	The end of the year	The end of the year
Debt refund time	The end of the year	The end of the year	The end of the year

Source: JICA Mission

1) Averaged LIBOR at around the end of 1987 + 1%

Table 8.2-24 TAX

Item	Taxation System
Transfer to the National Treasury	Profit x 0.3
Income Tax	Taxable Income x 0.3
Total	Profit x 0.51

Source: Ley No. 1182 Art. 43

1) Taxable Income = Profit – Transfer to the National Treasury

8.3 Financial Evaluation

8.3.1 Supply Cost

Supply costs of petroleum products in each of the three alternative cases of future supply plans are compared in terms of average supply cost (ASC). ASC is an indicator which shows the supply cost averaged over a number of years of the study period by use of a discount rate, and is expressed as the cost per unit quantity of petroleum products.

ASC values in three alternative cases, with a discount rate of 15% applied, are shown as base cases in Table 8.3-1. Also shown are the results of a sensitivity analysis in which the effects of changes in various factors on ASC values are examined.

Table 8.3-1 The Results of ASC (Financial)

(Unit: Gs/ℓ)

Case		Case-1	Case-2	Case-3
Base Case (Discount Rate = 15%)		105	151	119
Sensitivity Analysis				
– Discount Rate	10%	104	144	117
	20%	107	158	122
– Plant Construction Cost	30% Down	104	145	117
	30% Up	106	156	121
– Import Price of Crude Oil	20% Down	105	130	110
	20% Up	105	172	128
– Import Price of Crude Oil and Petroleum Products	20% Down	87	128	99
	20% Up	124	173	140

Source: JICA Mission

(1) Comparison of Alternative Cases (Base Case)

Among the three alternative cases, Case-1 gives the lowest ASC value of 105 Gs/ℓ. The next lowest is 119 Gs/ℓ of Case-3, and the ASC value of Case-2 is the highest, 151 Gs/ℓ. Differences between the ASC value of Case-1 and the values of Cases-2 and -3 are 46 Gs/ℓ and 14 Gs/ℓ, respectively, indicating that the higher the dependence on product imports (dependence on domestic refining is lower), the lower the ASC value. This is caused by the fact that import price of crude oil (refer to Table 8.2-6) is higher than that of almost all kinds of imported products (refer to Table 8.2-8).

The portions of major cost components which constitute the ASC value of each case are shown in Fig. 8.3-1. As clearly shown in these figures, 88% of ASC in Case-1 is the cost of imported products and the rate of investment-related cost is only 5%. In Case-2, on the other hand, the rate of crude oil cost is as low as 69% and that of investment-related cost is 16%. And this case has a cost element of local transportation which accounts for 2% of the ASC value. In Case-3, cost of imported products and that of crude oil captures 46% and 39%, respectively; totaling at 85% of the ASC value. The rate of investment-related cost is about 8%. It can be said that Case-2 requires, in addition to the local transportation cost, a higher investment cost than other two cases do, in order to satisfy the domestic demand for petroleum products by the domestically refined products as far as possible. This is a cause of the higher ASC value in this case compared with other cases.

(2) Sensitivity Analysis

The sensitivity analysis has examined effects of independent changes in discount rate, plant construction costs, and crude oil price, and simultaneous changes in prices of crude oil and imported products at the same rate, on the ASC values of the alternative cases, as shown in Table 8.3-1. The results of the sensitivity analysis are given below.

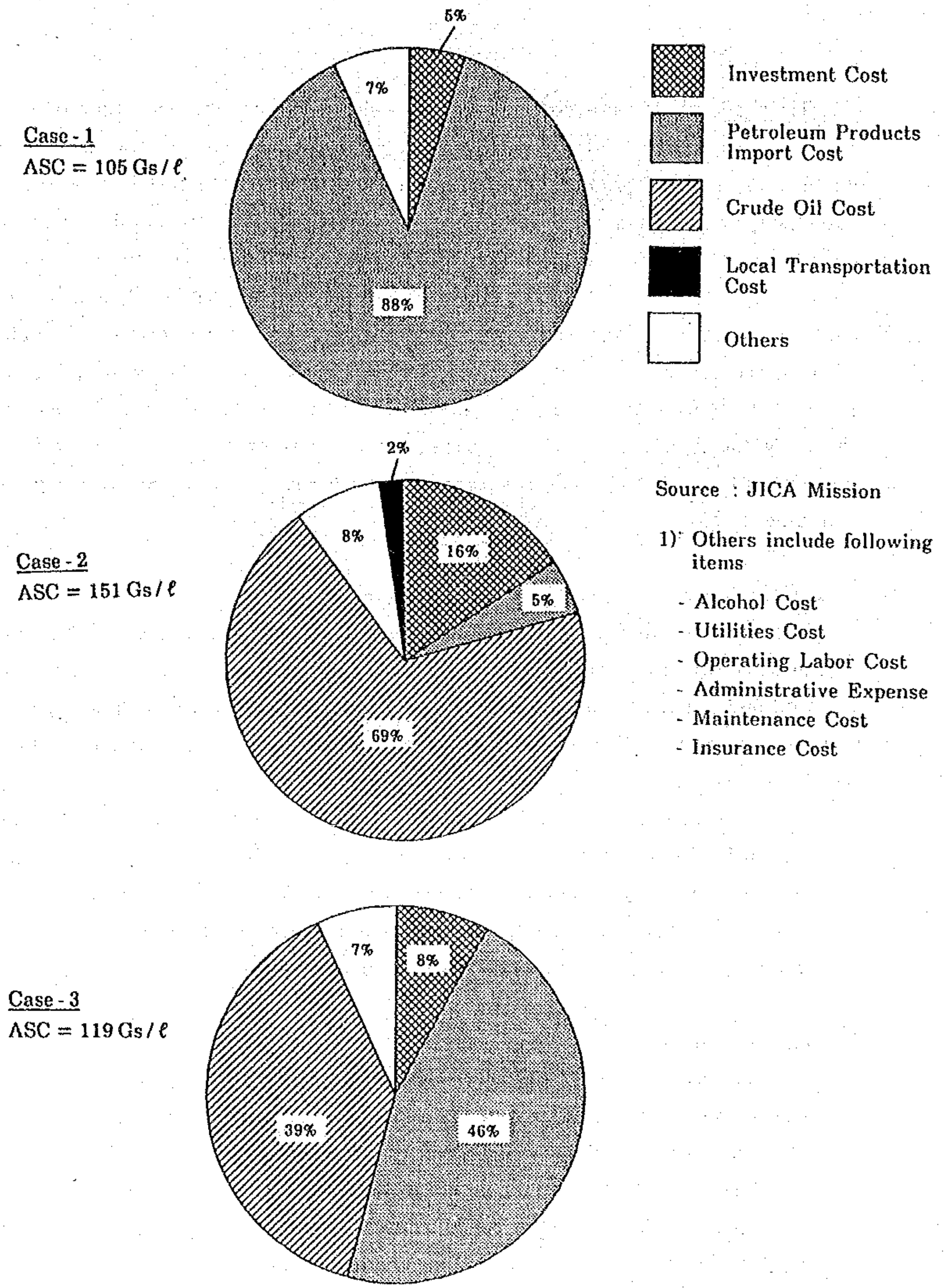
(a) Discount Rate

As shown in Fig. 8.3-2, a higher discount rate gives a higher ASC value. Especially, Case-2 is more sensitive to the change in the discount rate than two other cases. A change of discount rate by 1% cause a change in ASC value at a rate of more than 1 Gs/ℓ. This is because the amount of capital investments in the early years of the study period is larger in Case-2 than two other cases.

(b) Plant Construction Cost

As shown in Fig. 8.3-3, the effects of change in the plant construction cost are also most noticeable in Case-2. If the plant construction cost declines by 30%, the ASC value decreases from 151 Gs/ℓ in the base case to 145 Gs/ℓ. In contrast, in Case-1 and Case-3, ASC values are not so sensitive. This is caused by the fact that cost items related to the plant construction cost (depreciation and interest) cover a larger portion of ASC value in Case-2 than two other cases.

Nevertheless, even if the plant construction cost should decline by 30%, the ASC value of Case-2 would not be lower than the other two cases.



Source : JICA Mission

1) Others include following items

- Alcohol Cost
- Utilities Cost
- Operating Labor Cost
- Administrative Expense
- Maintenance Cost
- Insurance Cost

Fig. 8.3-1 Constitution of ASC

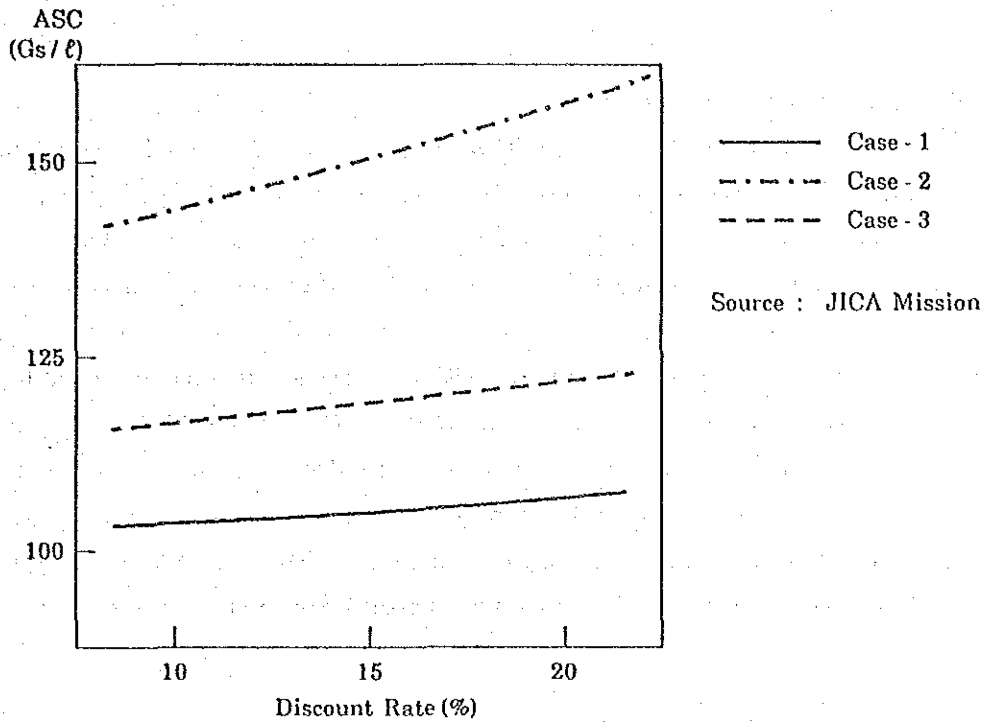


Fig. 8.3-2 ASC vs Discount Rate (Financial)

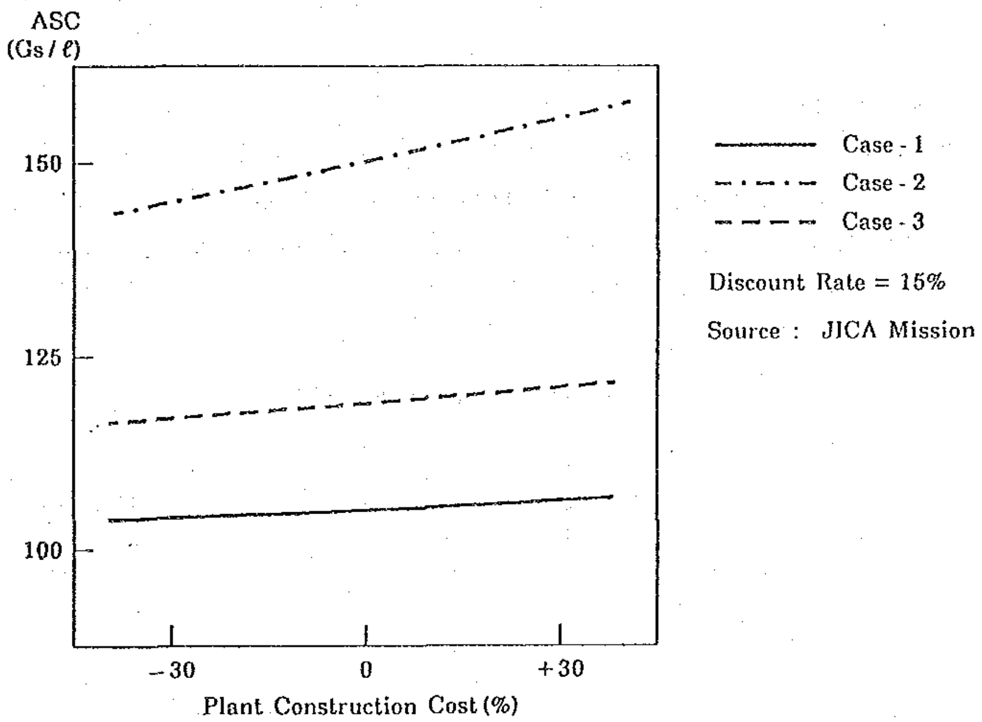


Fig. 8.3-3 ASC vs Plant Construction Cost (Financial)

(c) Import Price of Crude Oil

As shown in Fig. 8.3-4, ASC values in Case-2 and Case-3 decrease remarkably if the import price of crude oil declines. The effect is particularly strong in Case-2 in which a 20% decrease in the crude oil price results in a decline of ASC value by more than 20 Gs/ℓ from that of the base case. This is because the proportion of crude oil price in the ASC value in Case-2 is as high as 69%. Case-1 is not affected by the crude oil price, naturally, since its ASC value has no component related to the crude oil price. The rate of crude oil price in the ASC value of Case-3 is 39%, and the 20% decrease in the crude oil results in a 9 Gs/ℓ decline in the ASC value in this case.

It is supposed from the above observations that the crude oil prices in Case-2 and Case-3 need to be decreased by more than 40% and about 30%, respectively, in order for these two cases to supply petroleum products at about the same ASC value as Case-1.

(d) Import Price of Crude Oil and Petroleum Products

ASC values in all three cases change drastically with the simultaneous changes of the same rate in import prices of crude oil and petroleum products, as shown in Fig. 8.3-5. Change by 1% in crude oil and product prices results in a 1 Gs/ℓ change in ASC value.

8.3.2 Profitability

Profit & Loss and Funds Outlook tables are prepared (refer to Appendix 8) based on the sales prices of petroleum products by PETROPAR in 1987, and the financial internal rate of return (FIRR) is calculated in order to examine the profitability of each of the three alternative cases. The results are shown in Table 8.3-2.

Table 8.3-2 The Results of FIRR

(Unit: %)

Item	Case-1	Case-2	Case-3
FIRR	42	−7	18

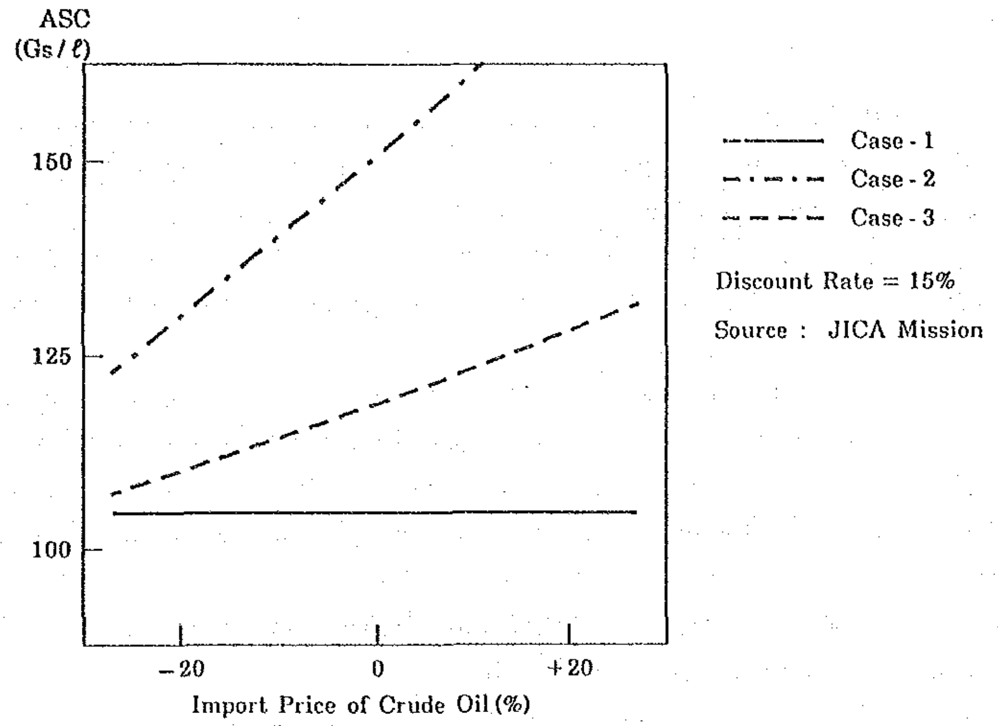


Fig. 8.3-4 A S C vs Import Price of Crude Oil (Financial)

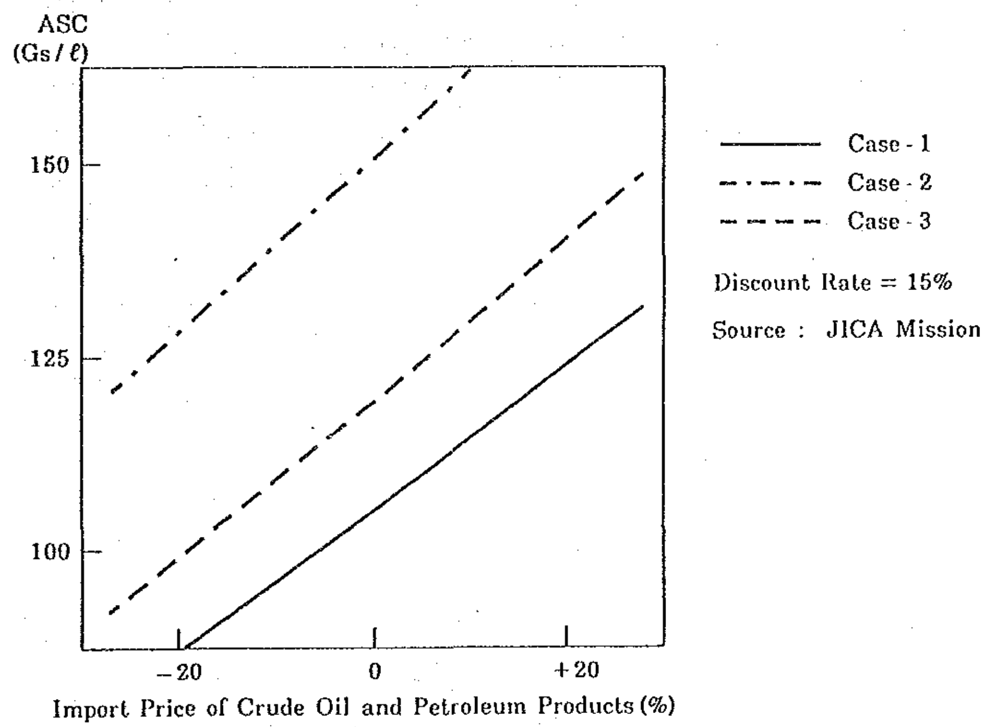


Fig. 8.3-5 A S C vs Import Price of Crude Oil and Petroleum Products (Financial)

While FIRR value is 42% in Case-1 and 18% in Case-3, Case-2 gives a negative FIRR value of minus 7%. This result is as expected from the examination of ASC values. That is, the lower the degree of dependence on domestic refining, the higher the profitability.

Of the three alternative cases, FIRR value in Case-3, 18%, is close to 15% which is generally regarded as an acceptable FIRR value for projects related to petroleum refining. This could be interpreted to mean as follows: The supply system of petroleum products in Case-3 is similar to the current supply system and the import costs and shipping prices of petroleum products used in the calculation of FIRR are set approximately at the current level. On the other hand, FIRR values for Case-1 and Case-3 reflect the fact that cost/price structures used in the calculation of FIRR for the respective cases are quite different from the current cost/price system.

Next, the effects of changes in the sales price of petroleum products on the profitability is examined in a sensitivity analysis. The result is shown in Fig. 8.3-6.

As seen from the figure, while FIRR values are quite sensitive to sales price in all three cases, the effects are especially remarkable in Case-1 and Case-3. A 1% rise in sales price increases the FIRR value in both Case-1 and Case-3 by about 1.5%, but in Case-2 by only about 1%. This is because in Case-2, the large amount of cash outflow for investment in the early project stage offsets the effects on the profitability caused by the rise in the sales price, although the increased cash inflow is equal in all three cases.

If an FIRR value of around 18% is to be attained, as is in Case-3 which is regarded as similar to the current supply system as discussed earlier, the product sales price in Case-1 would be reduced by around 15% from the base case, whereas the product sales price in Case-2 should be raised by about 30%.

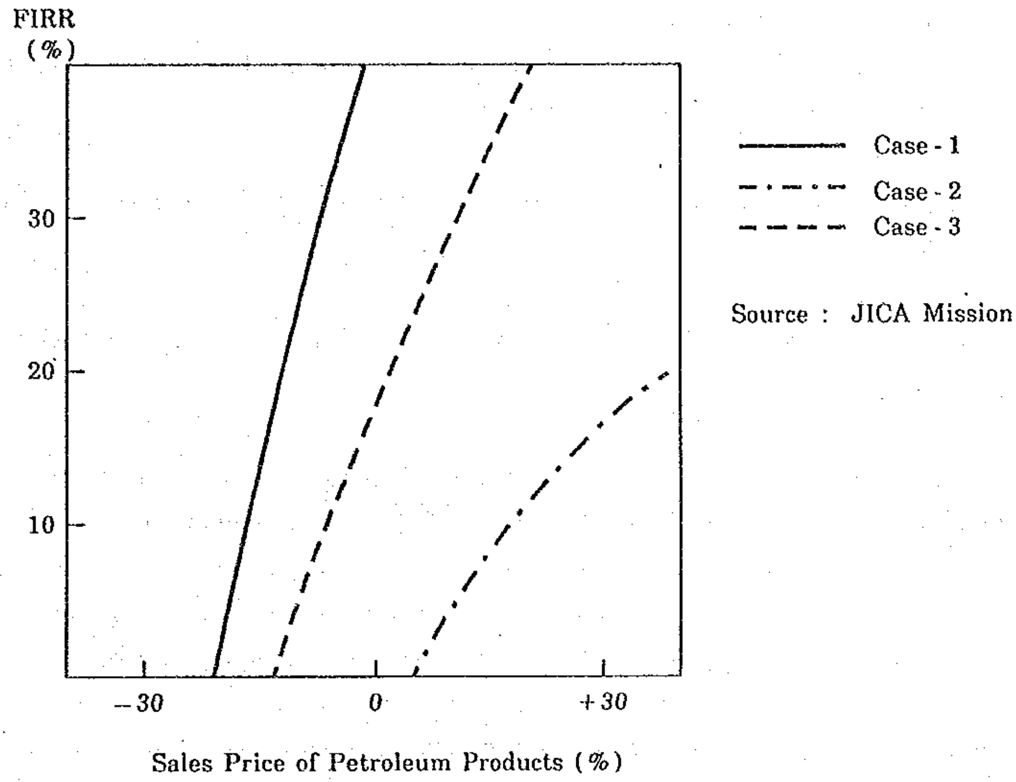


Fig. 8. 3 - 6 FIRR vs Sales Price of Petroleum Products

8.4 Economic Evaluation

In order to make an economic evaluation, the following adjustments are applied to the cost components defined in the financial evaluation.

(1) Application of a shadow exchange rate to convert costs generated in US dollars into guaranis.

(2) Exclusion of taxes paid from costs, since taxes are regarded as a transfer payments in the national economy.

The shadow exchange rate applied here is Gs 550 per US dollar. This rate is recommended by the IMF memorandum in August 1987 as a unified exchange rate in Paraguay.

The main method of economic evaluation is almost similar to that of the financial evaluation, that is, comparisons on ASC (Average Supply Cost, but in the case of economic evaluation, "Economic Supply Cost") between the three cases of supplying petroleum products. Also conducted are studies of the effects on the foreign-exchange balance, and comparisons between with and without cases using NPV (Net Present Value) and sensitivity analysis.

8.4.1 Comparison of Average Economic Supply Cost

The average economic supply costs of the petroleum products for each case are calculated by applying a discount rate of 15%. The results are as follows:

Case-1	109 Gs/ℓ
Case-2	141 Gs/ℓ
Case-3	117 Gs/ℓ

The economic supply cost of Case-1 is the lowest, followed by Case-3, and then by Case-2. The result is the same as for the financial evaluation (see Table 8.3-1). However, the economic supply cost of Case-1 is higher than its financial supply cost. On the other hand, the economic supply costs of Case-2 and Case-3 are lower than their financial supply costs.

The reason for this discrepancy between the results of the economic evaluation and financial evaluation is that the shadow exchange rate of Gs 550 per US dollar is applied in the economic evaluation, while, in the financial evaluation, import price of crude oil, petroleum products and plant equipment are divided into an FOB portion and other foreign currency portions, and different exchange rates of Gs 400 and Gs 900 are applied to them, respectively. This results in the different composite exchange rates in the financial evaluation as follows:

- composite exchange rate for the import of crude oil at CIF prices > 550 Gs/US$
- composite exchange rate for the import of petroleum products at CIF prices < 550 Gs/US$
- composite exchange rate for the import of plant equipment > 550 Gs/US$

The financial supply cost of Case-1, which is mainly the cost of imported petroleum products, is lower than the economic supply cost, while the financial supply costs of Case-2 and Case-3, which include the imports of crude oil and equipment, show reversed results.

8.4.2 Sensitivity Analysis

The sensitivity analysis of average economic supply costs is conducted in the same manner as for the financial evaluation. The results are shown in Figures 8.4-1 through 8.4-4. There is no substantial difference between results of the financial evaluation and economic evaluation.

However, the sensitivity analysis shows that the economic supply cost is more substantially affected by changes in crude oil prices than in the financial evaluation: If crude oil price should decline by about 20%, Case-3 suggests the possibility of supplying products at nearly the same economic supply cost as that of Case-1.

A sensitivity analysis is carried out to examine the effects of changes in the sales prices of petroleum products on profitability using the EIRR (Economic Internal Rate of Return) as an indicator, similarly to the financial analysis. As shown in Figure 8.4-5, changes in the sales prices greatly influence the EIRR. If the acceptable EIRR from the national economic point of view should be more than 15%, then a more than 15% EIRR is expectable in Case-1 and Case-3, even if sales prices of petroleum products fall from the present level, whereas, in Case-2, sales prices may have to be raised by more than 10% in order to achieve a 15% EIRR.

8.4.3 Comparison between With Case and Without Case

Among the three cases analyzed here, Case-3 is judged to be the most probable case for adapting the present system of supplying petroleum products to future increases in demand, because Case-3 is intended to utilize the existing refinery with minor modifications. Therefore, Case-3 may be regarded as the "without" case and the other two cases as "with" cases. The results of the analysis are shown in Fig. 8.4-6.

Indifferent to changes in the discount rate, the NPV in Case-1 is always on the positive side, while that of Case-2 is always on the negative side. This means that a benefit of 2 to 3 billion guaranis in NPV is expected in Case-1, while in Case-2, the cost in terms of NPV may be over 5 billion guaranis, as compared with the Case-3, which is regarded as an extention of the present supply system into the future.

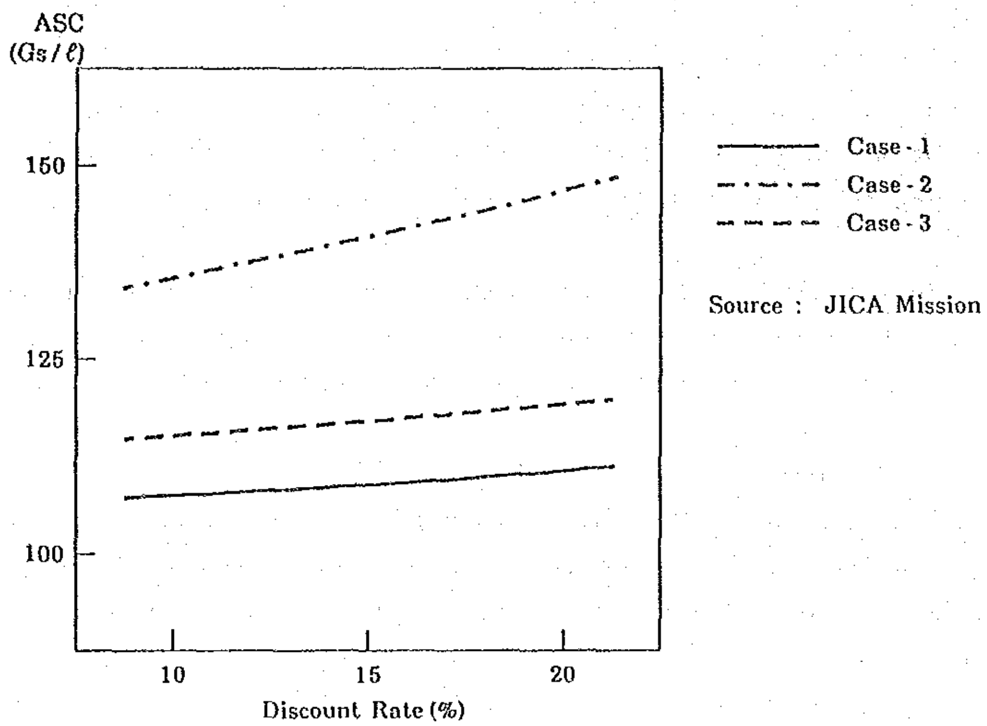


Fig. 8.4-1 ASC vs Discount Rate (Economic)

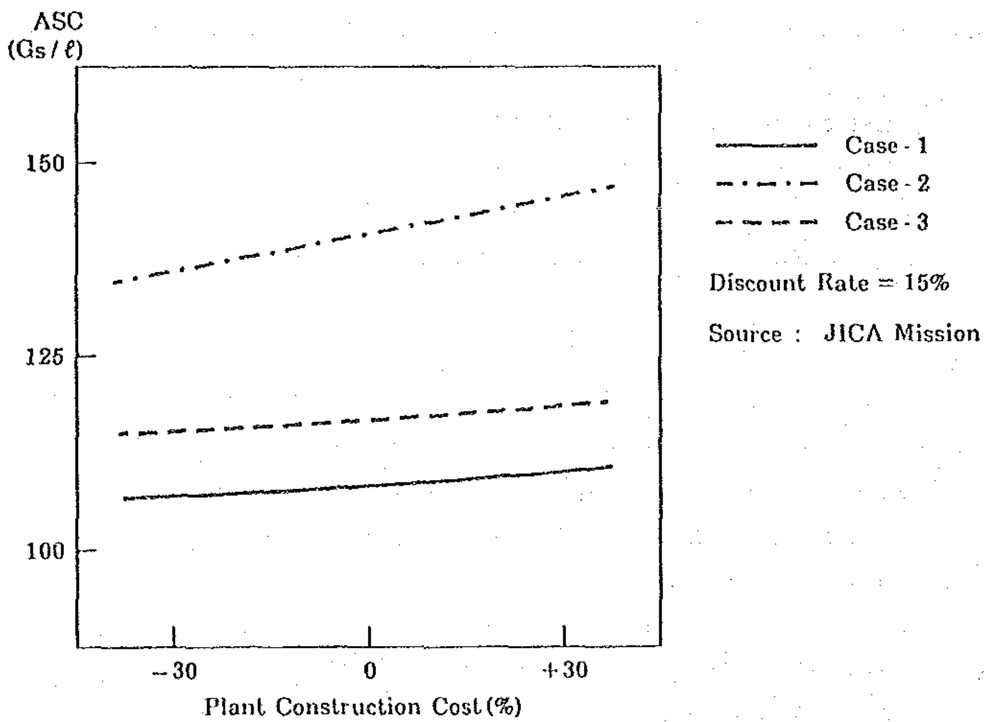


Fig. 8.4-2 ASC vs Plant Construction Cost (Economic)

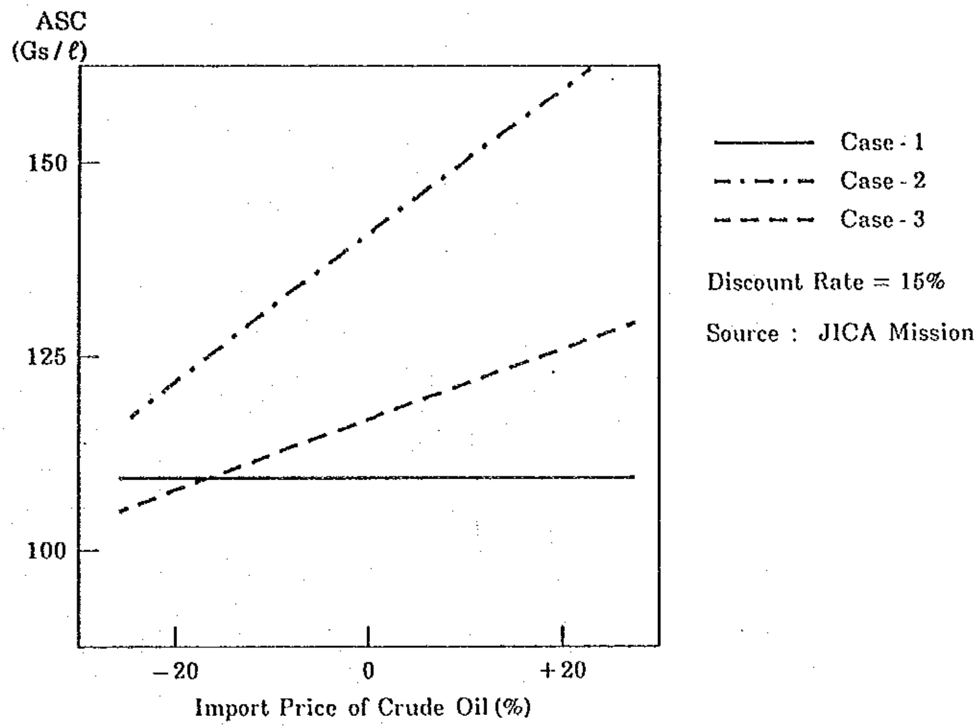


Fig. 8.4-3 ASC vs Import Price of Crude Oil (Economic)

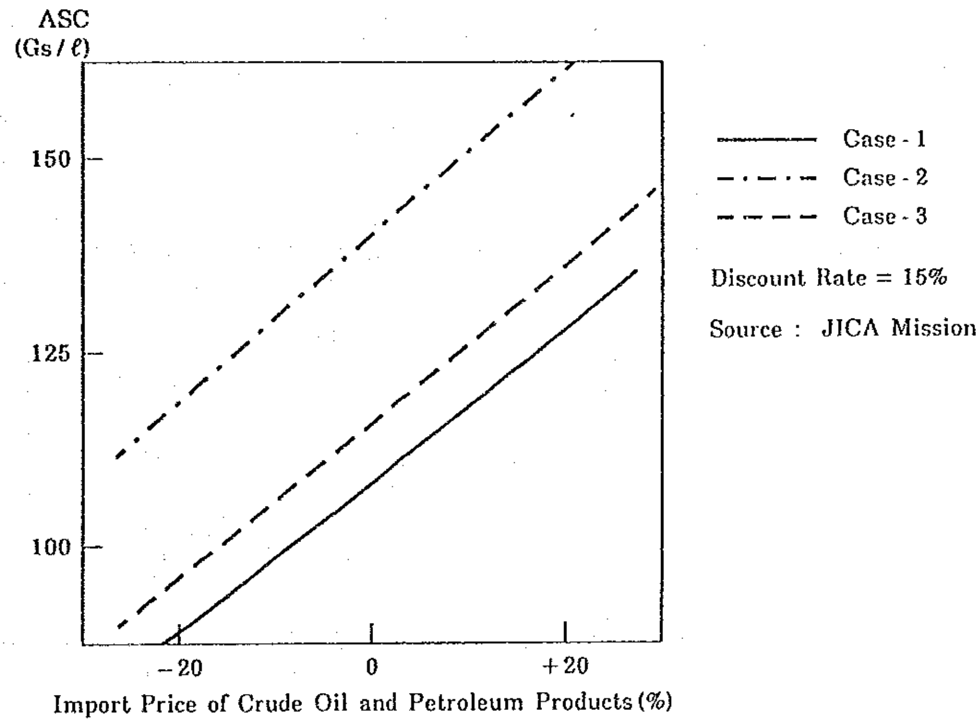


Fig. 8.4-4 ASC vs Import Price of Crude Oil and Petroleum Products (Economic)

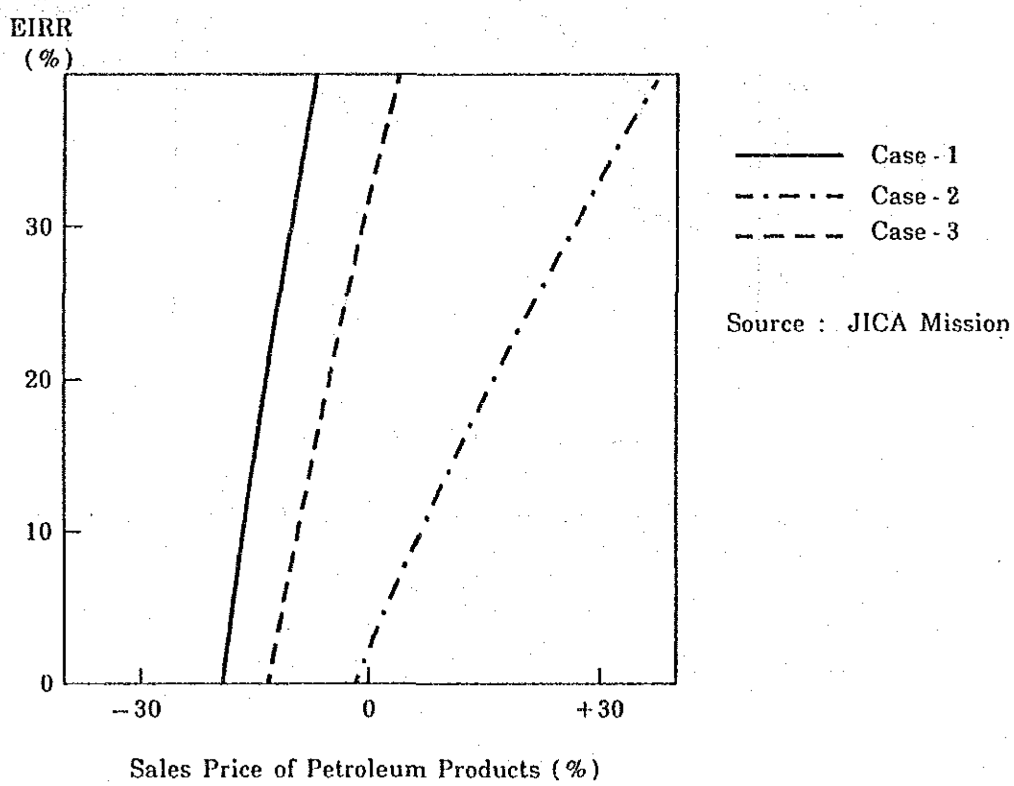


Fig. 8.4-5 EIRR vs Sales Price of Petroleum Products

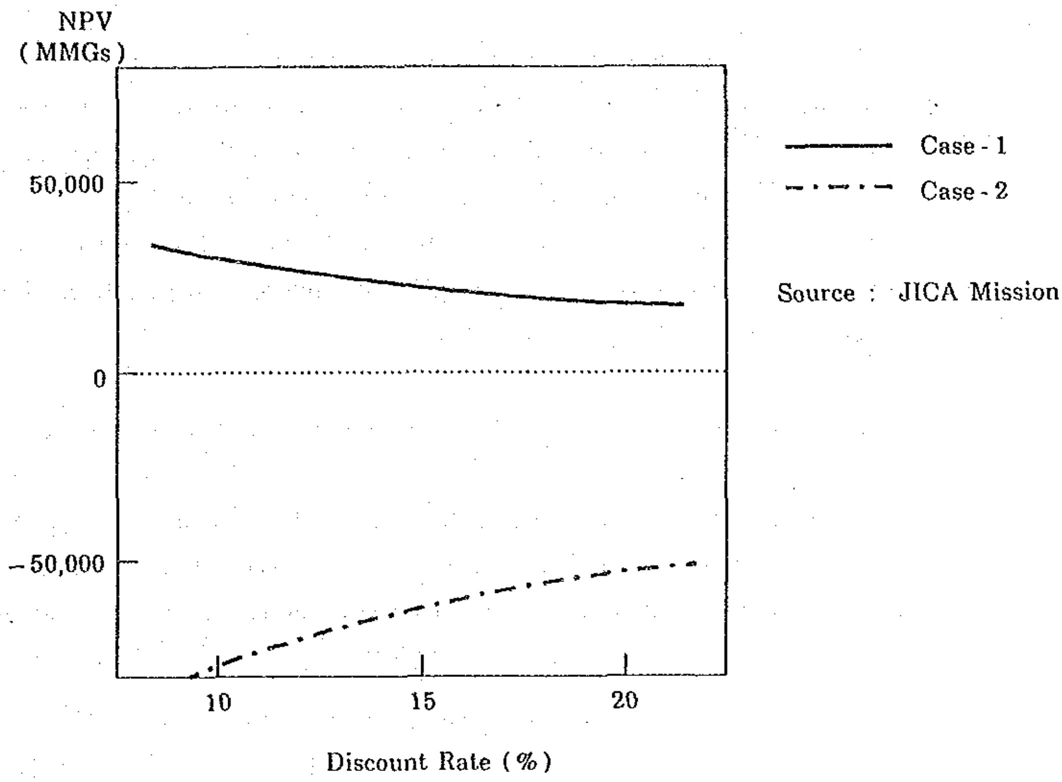


Fig. 8. 4 - 6 NPV vs Discount Rate by 「With and Without Principle」

8.4.4 The Effects of Foreign Currency Balance and Employment

(1) The Effects of Foreign Currency Balance on the National Economy

The required amount of foreign currency in each case from 1992 to 2000 is shown in Table 8.4-1.

Case-1 requires the least amount of foreign currency among the three cases - about US$1.5 billion at the 1987 price. Ninety-seven percent of the foreign currency for Case-1 is for importing petroleum products, by the nature of the case. The medium case is Case-3 - its transactions involve about US$1.6 billion, of which 94% is for importing crude oil and petroleum products. In case-2, US$1.8 billion is necessary, the largest total of the three. Eighty-eight percent, or US$1,583 million is for importing crude oil and petroleum products.

The required foreign currency for importing plant equipment in each case is balanced at closing, because as soon as it flows in as a foreign loan, it flows out as payment for the plant equipment. However, item "Other" in Table 8.4-1 includes repayments of the principal and interest on foreign loans used for purchasing plant equipment. The differences in the required amount of foreign currency among the three cases almost originate in the differences in these investment funds used for purchasing new plant equipment.

Table 8.4-1 Foreign Currency Requirement

(Unit: MM US$)

	Case-1			Case-2			Case-3		
	Imp. of oil & Products	Other 1)	Total	Imp. of oil & products	Other 1)	Total	Imp. of oil & products	Other 1)	Total
1992	140	9	149	153	33	186	146	14	160
1993	144	8	152	158	31	189	150	13	163
1994	149	8	157	163	29	192	155	12	167
1995	153	8	161	169	28	197	160	12	172
1996	159	7	166	175	26	201	166	11	177
1997	165	6	171	181	24	205	172	10	182
1998	171	6	177	188	22	210	178	9	187
1999	177	5	182	195	21	216	184	9	193
2000	183	0	183	201	0	201	191	0	191
Total	1,441	57	1,498	1,583	214	1,797	1,502	90	1,592

Source: JICA Mission

1) Including refund and interest payment.

(2) The Effects on Employment

As mentioned in Chapter 7, employment outside the headquarters in each case is as follows:

Case-1	244 persons
Case-2	393 persons
Case-3	324 persons

When compared with the present employment of PETROPAR, 224 persons, employment will be increased in each case: 20 persons in Case-1, about 170 persons in Case-2, and 100 persons in Case-3.

Most of the work requires skilled workers; this is why the shadow wage rate is not applied in this analysis.

CHAPTER 9 DISCUSSION AND RECOMMENDATION

9.1 Target of Petroleum Policy

A stable supply of energy is an important factor in the economic security of a country. "Stable" means not only to provide the nation with the required amounts and kinds of energy without any shortfalls and at the lowest possible cost, but to provide such energy without cost fluctuations which may have a harmful effect on the national economy.

In regard to petroleum, which plays a central role among various energy sources in a modern society, a fundamental task of a country's petroleum policy is to secure a stable supply of petroleum products at low cost. However, as is the case for other kinds of energy, it is not always easy to achieve the two targets of stability and low cost simultaneously.

Nowadays, the world petroleum market is in a very fluid condition. The supply capacity of crude oil is by far larger than the world demand, and aggravated by the need of oil producing countries for money, there is a chronic oversupply of crude oil on the world market. As for refined petroleum products, a surplus in refining capacity compared to demand for products still remains. Consequently, spot markets for both crude oil and refined products are very active, and speculative oil trading proliferates, causing fluidity in the world petroleum market.

In response to such a situation, most oil comsuming countries are taking measures to diversify their supply sources of petroleum and to expand their oil stockpiling. To diversify petroleum supply sources, they procure crude oil from more suppliers than before, import refined products to some extent even if the countries have their own domestic refineries, and purchase crude oil and refined products from spot markets in addition to making purchases from traditional suppliers under long-term agreements.

The energy economy of Paraguay has a peculiar characteristic in that about three fourths of all the energy consumed in the country is supplied by such non-commercial energy as firewood and vegitable residues. However, even in such a situation, petroleum is the energy source that is indispensable for the day-to-day lives of the people as fuel for transportation vehicles and for agricultural machinery. Further, there are no other alternative energy sources for such uses. In planning a future petroleum products supply system, basic consideration will have to be given to the stability of supply from the viewpoints of both quantity and cost.

9.2 Present Status of, and Problems with, the Petroleum Supply in Paraguay

In Paraguay, the state-owned company, PETROPAR, holds an exclusive position in the exploration and development of petroleum resources, imports of crude oil and refined products, petroleum refining, and the primary wholesale of petroleum products.

Generally speaking, nationalization of the petroleum industry is a policy taken by many of the oil producing countries, and is aimed at strengthening the sovereignty over their own petroleum resources, rather than at the stable supply of petroleum to the domestic market. And, while there are not many national petroleum companies in non-oil producing countries in the market economies, there are a few examples whose aims are to secure a stable supply of petroleum to the domestic market, to stabilize prices and other domestic market conditions, and to contribute to the government revenue.

There were presumably historical reasons specific to Paraguay for the nationalization of her petroleum industry which led to the formation of PETROPAR, but the basic aims were supposedly the same as national oil companies in other oil consuming countries. And, as the records of PETROPAR indicate, nationalization has achieved the aim of stabilizing the supply of petroleum products and the domestic petroleum products market, and has made certain contributions to the government revenue.

PETROPAR took over the Villa Elisa Refinery from its predecessor, REPSA, and continued the latter's operations of processing imported crude oil to satisfy a part of the domestic demand for refined petroleum products, and of importing refined products to fill the gap between domestic demand and supplies from the refinery. This operation eventually resulted in the diversification of supply sources of petroleum products.

A calculation based on actual records in 1987 indicates, however, the average production cost of all products produced by the Villa Elisa Refinery was 101.8 guaranis per liter, whereas the average import cost of imported petroleum products was, on an assumption that the same kinds and same amounts of products as the Villa Elisa Refinery produced were imported, 89.9 guaranis per liter. More exactly, the difference in cost of domestically refined and imported products could be narrowed, if the fact that the imported products were stored and handled at the Villa Elisa Refinery was taken into account. However, there still lies a difference of about 10 guaranis per liter between the average cost of imported petroleum products and that of the refinery's products, since 96.7% of the production cost was the cost of imported crude oil and the refining costs at the refinery accounted for only 3.3 guaranis per liter.

However, the value for a country to have her own domestic refinery cannot be judged by the costs of the refined products. In the case of Paraguay, the refinery of PETROPAR has been making contributions, both explicitly and implicitly, to the stable supply of petroleum products, and to the company's bargaining power in the import of petroleum products, not mentioning the contributions to government revenue. The cost difference between the imported products and domestically refined products should be regarded as the price to be paid for such benefits. Whether the price of 10 guaranis per liter is expensive or not is a matter of policy of the country itself.

Another value of a refinery which must not be overlooked is the value as an industrial and technological asset of the country. In Paraguay whose modern industries were still under-developed, the Villa Elisa Refinery represented the sole large-scale process industry of the country, and a valuable industrial and technological asset of the country forerunning INC (cement), APAL (ethanol), and ACEPAR (iron and steel).

The crude distillation unit of the Villa Elisa Refinery which was commissioned more than 20 years ago is still maintained in a good condition, testifying to the quality and high morale of the personnel of the refinery. The refinery also has a plant for treatment of jet fuel oil designed by its technical staff. This is a rare example for a developing country and it indicates the technical capabilities of the staff.

The primary reason for the high cost of Paraguay's domestic petroleum products is the high cost of imported crude oil. The crude oil cost consists of its FOB price at the shipping port and transportation cost to the refinery. The Villa Elisa Refinery uses the Saharan Blend crude from Algeria, which is expensive compared to other kinds of crude oil and whose market price is rather rigid. However, in order to meet the structure of Paraguay's petroleum products market where the demand for heavy fuel oil is extremely small, the super-light (and therefore expensive) Saharan Blend seems to be the only possible choice. This could be proved by the fact that once in the past a crude oil other than the Saharan Blend was used by the refinery, which subsequently led to an over-production of heavy fuel oil that could only be sold off with extreme difficulty.

Another reason for the high cost of crude oil in Paraguay is the high transportation cost to the Villa Elisa Refinery, which accounts for more than 35% of the CIF price of crude oil at Villa Elisa.

The transportation cost of crude oil consists of three elements: the ocean tanker freight from the shipping port in Algeria to the mouth of the La Plata River, costs for transshipping at the river mouth and for unloading and loading at the Zarate Oil Terminal, and costs relating to the river transportation from the Zarate Terminal to the Villa Elisa Refinery.

In regard to ocean tanker freight, Paraguay cannot hire large capacity tankers because of the small amount of crude oil she imports. Accordingly she must hire small capacity tankers on a spot basis for each shipment, and therefore cost reductions are presumably not easily obtainable. As for transshipment and unloading-loading costs, such also seems unavoidable since they are directly caused by the insufficient depth of the Parana River. In regard to river transportation costs, a lack of sufficient information for the present study makes it impossible to judge if there is any room for rationalization. However, it seems that immediate cost reductions will be difficult in consideration of the fact that the present transportation cost structure was inherited by PETROPAR from its predecessor, REPSA.

In consideration of the abovementioned situation, the high procurement cost of crude oil for Paraguay is due basically to her geographic position as an inland country, the characteristics of her domestic petroleum products market, and the historical factors. Moreover, despite the high cost of the crude oil used, the retail prices of petroleum products to the end consumers in Paraguay are set at a level which is not very high compared to the international level and those in the neighboring countries. Therefore, there could be good reason for the acceptance of rather high costs for domestically refined petroleum products compared with that of imported products.

However, this does not mean that no efforts are required for PETROPAR or the Government of Paraguay to reduce the costs of petroleum products refined domestically. Already at present, PETROPAR has switched the method of purchasing crude oil to direct contract with SONATRACH, the national oil company of Algeria, excluding the use of a trading house as a traditional intermediary. PETROPAR has also taken measures to introduce the principle of competition in the hiring of ocean tankers to transport the imported crude oil. This kind of efforts will have to be further strengthened in the future.

Characteristics similar to those given above can also be applied to the import of the refined petroleum products. Paraguay at present imports petroleum products from YPF of Argentina and PETROBRAS of Brazil, national oil companies of respective countries bordering Paraguay. This can be said to be a rational choice from the viewpoint of Paraguay's position as well as that of diversifying supply sources of petroleum. Though both Argentina and Brazil are crude oil importers, more than half of their requirements for petroleum are met by their domestic crude oil production, and their oil refining capacities are 690 thousand BPCD and 1,410 thousand BPCD for Argentina and Brazil, respectively, thus easily being sufficient enough to supply petroleum products to Paraguay in terms of quantity.

PETROPAR concludes basic supply contracts with the two suppliers every year, has both companies submit offered prices every month, and determines the kinds and quantities of petroleum products to be purchased from each of the suppliers for the subsequent month, thus, seemingly, introducing the principle of competition. Even if the price offered for a certain product by one supplier is lower than that of the other, PETROPAR is said to have never purchased all of such petroleum product from that supplier. This is understandable as a measure to secure a stable supply of petroleum products over the long-term despite the lower cost of making a single purchase. Moreover, supposedly, a politico-diplomatic consideration is being made to maintain good relationships with the two neighboring big powers in the South America. According to actual record in 1987, products imported from Argentina were mainly received at the Villa Elisa Refinery, and those from Brazil at the Hernandarias Depot. Due to the cost of transportation between the two locations, however, the above choice of supplier results, eventually, in an economical one from the viewpoint of costs of imports.

With regard to gas oil, the product which is imported in largest volume, about 23% and 25% for the imports from Argentina and from Brazil, respectively, of PETROPAR's CIF prices were transportation and related costs. Import prices from Brazil are based on CIF at the receiving terminal of PETROPAR, and the selection of transportation company is in the hands of the supplier, PETROBRAS, and hence there seems to be no room for PETROPAR to move towards cutting such costs. Import prices from Argentina, on the other hand, are based on FOB at the YPF's refinery from where the products are shipped. And the products are transported by river barge in the same way as crude oil is. The fees for transporting the products are set at almost the same level as that for crude oil. Accordingly, similar problems regarding fees as in the transportation of crude oil are assumed to exist.

The ultimate aim of any petroleum products supply policy is to supply petroleum products on a stable and low cost basis to end consumers. In Paraguay the present distribution of petroleum products following shipment from the Villa Elisa Refinery or the Hernandarias Depot are undertaken by such distributors as Shell, Esso, COPETROL, etc., and out of the hands of PETROPAR.

However, the maximum retail prices of petroleum products are set by a government decree. And PETROPAR decides sales margins of distributors and retailers as well as ex-PETROPAR prices of petroleum products. The distributors are subsidized for their transportation costs in order to maintain the official sales prices within a 20 km sphere from Villa Elisa and Hernandarias. Further, the addition of transportation costs to the official prices is an accepted practice for those products sold in remote districts of the country. Under such a retail price system, it seems, there is very little motivation, if any at all, to reduce the distribution costs on the part of distributors and retailers. Such matters as distribution margins for distributors and retailers, or the addition of distribution costs to retail prices should desirably be left to the business efforts of distributors and retailers in a market economy. Additionally, any intervention by the government should preferably be kept to the minimum as long as the market stability is maintained. It is hoped that the pricing mechanism for petroleum products in Paraguay will shift to one in which the forces of the market work more effectively as the petroleum products market matures in the country.

And, if the present pricing mechanism is to be maintained, it is desirable that PETROPAR strengthen its ability to examine the operating costs of distributors and retailers, thus enabling the distribution costs of petroleum products to decrease through business efforts on the part of distributors and retailers.

9.3 Discussion on the Plans for the Future Supply System

In this report, three alternative cases are presented with regard to the future supply system for petroleum products in Paraguay. It must be noted in the first place, however, that it is not the main purpose of the present study to compare advantages and disadvantages of these alternative cases and recommend one particular case as the most preferable plan.

Therefore, in the present study, Case-1 is presented as an extreme in which all petroleum products required in Paraguay in the future will be supplied by imports of refined products; Case-2 is in the opposite extreme in which the future demand for petroleum products will be satisfied as far as possible by products from the domestic refinery and imports of refined products minimized; and Case-3 is in between Case-1 and Case-2. The ratios of petroleum product supply from domestic refining to that from product imports are: 0 : 100 for Case-1, 93 : 7 for Case-2, and 42 : 58 for Case-3.

Average Supply Cost (ASC) throughout the study period is calculated for each of these cases. When a discount rate of 15% is applied, Case-1 has the lowest ASC value of 105 guaranis, and the ASC value of Case-2 is the highest at 151 guaranis, while that of Case-3 is intermediate at 119 guaranis. These ASC values are those calculated by the financial evaluation method. Under an economic evaluation method, the ASC values for Cases-1, -2, and -3 are 109, 141, and 117 guaranis, respectively. Whereas the difference in ASC values between Case-1 and Cases-2 and -3 are narrowed to some extent, there seems to be no substantial change. Therefore, the results of the financial analysis are used in the following discussion unless otherwise mentioned.

These ASC values are calculated using the values of various cost elements in 1987, when the actual costs of imported petroleum products were lower than those of the domestically refined products. Therefore, it can be said that Case-1 could be expected to offer the lowest ASC value.

In addition, the differences in ASC values between the three alternative cases of future petroleum products supply reflect, as already discussed, differences in the amount of capital investment for these alternative cases. In Case-1, the facilities to be newly installed comprise only product tanks to meet the increased demands for petroleum products. Further, these tank facilities are also needed in Cases-2 and -3. On the other hand, in Cases-2 and -3, new investments in refining plants within the existing refinery are required to increase the supply of domestically refined products. Whereas the new investments required for Case-3 comprise those for the revamp of the existing crude distillation unit and for the installation of a few relatively simple secondary processing units of small scale, Case-2 requires the new installation of a crude distillation unit itself and a number of additional secondary processing units. To absorb these higher investment costs, the ASC value for Case-3 has to be higher than that for Case-1, and the ASC value for Case-2 has to be the highest of the three cases.

Now, what will be the judgement that can be deduced from these results of the financial evaluation?

If "Minimum Cost" is considered as the only criterion with no room for compromise, Case-1 is the only choice possible, i.e., if the "Minimum Cost" is to be respected, the importation of all petroleum products required should be implemented immediately as actual records in 1987 clearly justify.

The cost differences in the 1987 records and the differences in the ASC values calculated by the financial evaluation differ in nature and therefore these two sets of figures cannot be compared on the same level. However, as discussed in relation to the cost comparison for 1987, the advantages of supplying at least a part of the required petroleum products from the domestic refinery should be taken into consideration when a policy decision is made in relation to the result of this financial evaluation. The rationale is that the cost difference between the imported products and the domestically refined products is to be regarded as the price paid for the stable supply of petroleum products, for the enhancement of bargaining power concerning petroleum product imports, and for the industrial and technological asset which a country's own refinery affords.

Case-2 gives an ASC value that is about 44% higher than that of Case-1 by 46 guaranis per liter, and the ASC value of Case-2 is about 27% higher that of Case-3 by 32 guaranis per liter. Further, to attain the FIRR value of 18%, which is attained by Case-3 under the product shipping price system in 1987 and is thought to be reasonable in the evaluation of this kind of capital project, the product shipping price in Case-2 will have to be raised by around 30%. It seems to be difficult to find any logic to justify such a high cost. Moreover, the possibility cannot be neglected that such a high petroleum product price as this would certainly result in an increase in illegal inflow of petroleum products in addition to promoting other kinds of confusion in the domestic market. Further, to supply almost all required petroleum products from the domestic refinery may conflict with the principle of the diversification of supply sources for the stable supply of petroleum products.

Consequently, the most realistic choice would be either Case-1 or Case-3. If the "Minimum Cost" criteria is to be pursued, Case-1 should be selected. If the higher cost of petroleum products is to be accepted as the cost paid to guarantee the stable supply of petroleum products by diversifying supply sources, to stabilize the domestic petroleum products market, and to maintain such industrial and technological asset as the refinery, then Case-3 would have to be selected. It should be added that Case-3 would enable Paraguay to achieve self-sufficiency in premium gasoline which is priced higher than other petroleum products and for which the future demand is expected to increase in Paraguay.

In regard to the comparison between Case-1 and Case-3, it is noted in the results of the sensitivity analysis that if the cost of crude oil decreases, the ASC value for Case-3 falls to a level near that of Case-1, and if the crude cost decreases by about 30%, the difference in ASC values of the two cases almost disappears. In reality, however, a 30% reduction in crude cost is inconceivable unless crude prices worldwide drop drastically. Also, if such is the case, the cost of imported petroleum products will also drop simultaneously, thereby maintaining the ASC of Case-3 at a higher level than that of Case-1. Therefore, to make Case-3 a truly effective choice, a key question for Paraguay would be to reduce the procurement cost of crude oil under her own efforts.

As mentioned before, the procurement cost (CIF price) of crude oil is composed of FOB price and transportation costs. The latter further consists of three elements, that is, ocean tanker freight, transshipment and other oil handling expenses at the mouth of the La Plata River and at the Zarate Terminal, and the river transportation costs.

Firstly, the market price of the Saharan Blend crude which is assumed as being used in Case-3 is rather rigid, as mentioned earlier. This is because this crude oil holds an advantageous position in the world crude oil market because of its super light and low sulphur qualities as well as the relatively small amount produced. Furthermore, its producer, Algeria, is strict in maintaining the policy of keeping the crude oil price at a high level rather than increasing production, among the OPEC member countries. Nevertheless, there could be some ways to reduce the FOB price of the crude oil to some extent by devising certain purchase arrangements.

As for transportation costs, there is also room for cost reduction in each of the three elements if PETROPAR could become accustomed to the transportation industry practices and reinforce its bargaining capabilities.

Further, it should be added that the crude oil pipeline described in Appendix 7 of this report as an alternative means of crude oil transportation has a possibility of reducing the transportation cost of crude oil and therefore its feasibility is worth further detailed study.

Lastly, the reduction in transportation costs is not a question related to crude oil import only. The discussion above could be applied almost equally to the transportation of imported petroleum products. In this field also, therefore, it is desired that PETROPAR intensify its researches and efforts.

The foregoing discussions are mainly based on the results of the financial analysis. Hereafter, some interesting findings related to the comparison between Case-1 and Case-3 from the results of the analyses by other methods will be elaborated.

Internal Rate of Return

When the shipping prices of petroleum products in 1987 are applied, Case-3 gives a financial internal rate of return (FIRR) of 18%, which is regarded as reasonable for this kind of petroleum related capital project. This means, supposedly, a balanced relationship is achieved in this Case between the supply costs and the shipping prices of petroleum products, and this Case can be regarded as a natural extension into the future of the existing supply system.

On the other hand, if the product shipping prices in 1987 are applied to Case-1, it gives an extraordinary high value of FIRR. This means that the supply costs of the products are low (because all products are imported), and they do not balance with the product prices in 1987, and thus there is room to reduce product prices.

Capital Investment Required

Case-1 : Gs 15,300 million

Case-3 : Gs 31,400 million

Case-3 requires about two times as much investment as in Case-1.

Foreign Currency Requirements in the Capital Investment

Case-1 : US$ 17.1 million

Case-3 : US$ 37.4 million

Also Case-3 requires more than two times as much foreign currency as in Case-1.

Initial Investment Required Including Working Capital

Case-1 : Gs 27,500 million
(of which Gs 22,800 million is in foreign currency)

Case-3 : Gs 45,600 million
(of which Gs 38,100 million is in foreign currency)

Foreign Currency Requirements Throughout the Study Period

Case-1 : US$ 1,500 million

Case-3 : US$ 1,600 million

Most of the foreign currency is to be paid as the import price of crude oil and/or refined petroleum products in both cases.

Employment by PETROPAR

Employment by PETROPAR excluding the headquarters is estimated at:

Case-1 : 244

Case-3 : 324

Compared with the present number of employees at the refinery and the depot of

PETROPAR, the increase in employment would be 20 in Case-1 and 100 in Case-3. The higher ASC value for Case-3 in comparison to that for Case-1 could be regarded as including the costs for the creation of this new employment and the costs related to the training of these new employees.