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CARIBBEAN EXPORT REFINERIES AND
THE REGIONAL PETROLEUM RESERVE

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I. Introduction

The New York State Energy Office has contracted with the Petroleum Industry Research Foundation, Inc. (PIRINC) to provide it and the FEA technical support for the analysis and planning of a Regional Petroleum Reserve of residual fuel oil. Under this contract, PIRINC was asked to study and analyze the operations of the major export refineries in the Caribbean. As part of the effort, PIRINC obtained proprietary data from four of these export refineries. This memorandum summarizes the information obtained and discusses some of the political/economic factors affecting the utilization of these refineries for the processing of SPR crude oil. Venezuela's future role in supplying U.S. petroleum product import requirements is also discussed.

The four major export refineries examined are located in the Bahamas, Trinidad and the Netherlands Antilles. The operating companies, ownership and capacity of the refineries are outlined on the following page:

<u>Operating Company</u>	<u>Ownership</u>	<u>Location</u>	<u>Crude Capacity As of Year End 1976 (Mb/d)*</u>
.Bahamas Oil Refining Co. (BORCO)	New England Petroleum Corp. (NEPCO): 65% Standard Oil Company of Calif- ornia (SOCAL): 35%	Freeport, Bahamas	500
.Texaco Trinidad, Inc.	Texaco, Inc.: 100%	Pointe-a-Pierre, Trinidad	361
.Lago Oil and Transport Co. Ltd.	Exxon Corp.: 100%	Aruba, Netherlands Antilles	440
. Shell Curacao	Royal Dutch/ Shell Group: 100%	Curacao, Netherlands Antilles	362

*Thousand barrels per day.

Together the crude oil refining capacity of the four export refineries was approximately 1,660 M b/d at the end of 1976. For comparison, total refinery capacity along the U.S. East Coast was only 120 M b/d larger at that time.

These refineries have been, and will continue to be for some time, major suppliers of residual fuel oil to the U.S. East Coast (PAD I). In 1976, for example, they supplied approximately 43% of the East Coast's foreign imports of residual oil or 28% of total demand for this product in the area*. These refineries have

*It is important to note that also included in these percentages are small volumes of residual oil imports from the Trinidad government's 100 Mb/d refinery at Point Fortin.

traditionally (pre-1973) been able to supply residual oil to the U.S. East Coast at a cost lower than both domestically produced fuel oil and alternative energy sources, namely natural gas and coal. This, together with U.S. refiners maximizing motor gasoline production at the expense of heavy fuel oil output while Caribbean refineries pursued the opposite course, led to rapidly expanding imports of Caribbean residual oil into the U.S. East Coast. In addition, the Caribbean's close proximity to this market has played an important part in making its supplies uniquely competitive relative to other foreign supply sources. This same distance factor has permitted the FEA to consider the possibility of processing U.S. crude oil from the SPR in the four export refineries in the event of an embargo.

In order to obtain information about these four export refineries, which would not otherwise be available, PIRINC requested from each of the parent companies data on all phases of their refinery's operations. The submissions from these companies are the basis of the ensuing discussion. Since much of the data is proprietary, we will in most instances use aggregate figures in the discussion. None of the data obtained from the companies is presented in a way which would make individual companies readily identifiable.

II. Summary of Data Collected From The Four Major Caribbean Export Refineries

A. Refinery Capacity and Crude Oil Runs

In 1976 the four refineries had crude oil runs totaling about 1,000 Mb/d, some 12 percent higher than in 1975. With the level of refinery capacity relatively unchanged between the two years, capacity utilization improved markedly although it continued to remain at a low level compared with U.S. refinery utilization. Average capacity utilization in the four major export refineries was 60.2% in 1976 versus a 1975 level of 53.4%. In comparison U.S. refineries operated at about 85.4% utilization rate in 1976.

The relatively low utilization rates in these Caribbean refineries reflected the aftermath of the 1973/74 OPEC price explosion and the world economic recession in 1975. Both events particularly affected the demand for residual fuel oil, the largest volume product produced at these refineries.

U.S. refineries have been insulated from the excess refining capacity in the Caribbean, and also Western Europe, by crude oil price controls and the entitlements program which have effectively placed first call on U.S. refinery capacity, since the higher crude oil costs faced by foreign refineries have presented a formidable barrier to competitive entry into the U.S. market.

Table I shows the Caribbean refineries' crude runs and capacity utilization by quarter in 1975 and 1976. The biggest improvement in runs occurred in the fourth quarter of 1976 versus the year earlier, as extremely cold weather swept through the eastern portion of the United States and the Caribbean refineries increased production to meet expanded U.S. import requirements. This is indicative of the incremental supply

role played by these refineries in the U.S. market. With residual oil demand expected to increase at least to 1980, expanded production from these refineries will represent an important source of increasing supply.

TABLE I

CRUDE RUNS AND CAPACITY UTILIZATION IN THE FOUR
MAJOR CARIBBEAN EXPORT REFINERIES, 1975 AND 1976

	<u>1975</u>		<u>1976</u>	
	<u>Crude Runs (Mb/d)</u>	<u>Capacity Utilization (%)</u>	<u>Crude Runs (Mb/d)</u>	<u>Capacity Utilization (%)</u>
1st Quarter	945.8	56.6	999.8	60.2
2nd Quarter	780.2	46.7	958.8	57.8
3rd Quarter	984.3	58.9	955.4	57.6
4th Quarter	<u>856.2</u>	<u>51.3</u>	<u>1,086.0</u>	<u>65.4</u>
Annual	891.6	53.4	1,000.1	60.2

The lowest level of crude runs during 1975 and 1976 occurred in the 2nd quarter of 1975, when the average capacity utilization rate dropped to 46.7% from 56.6% in the first quarter. This decline was caused in large part by a local labor dispute, together with maintenance difficulties, at one of the refineries. Data collected from the companies on the month of highest crude runs indicate that during the two year period the highest utilization rate achieved in any month by any of the refineries was 93%. The other three refineries had maximum monthly utilization rates ranging from 72% to 84% of capacity.

B. Product Yield Patterns

Product yield data were obtained for some 60% of the total capacity of the four Caribbean refineries. The combined product yield averages calculated from this data are shown in Table II.

TABLE II

REFINERY PRODUCT YIELDS
ANNUAL AVERAGES (%)

	<u>1975</u>	<u>1976</u>
Residual Fuel Oil (1)		
0.0-2.0% Sulfur	28.9	23.3
Over 2.0% Sulfur	28.9	32.1
Distillate Fuel Oil	10.9	11.0
Gasoline	5.2	6.0
Jet Fuel	8.4	7.8
Naphtha	6.0	6.7
Asphalt	2.9	2.6
Other Products	<u>8.7</u>	<u>10.4</u>
Total	100.0	100.0

(1) No. 4, No. 5, and No. 6 Oil.

Residual fuel oil output represented 58% of total output in 1975 and 55% in 1976. One of the reporting companies had a residual oil yield of approximately 70% over the two years; the others were a good deal lower. The data also indicates that there was a shift downward in the output of low sulfur residual oil in 1976. This trend probably began in 1974. While the four refineries under study have desulfurization capacity of 348 Mb/d, these units have not, in general, been fully utilized. For instance, trade information indicates that one refinery's desulfurization unit has never been used. The shift to less low sulfur residual output in these refineries reflects the change in U.S. residual oil demand patterns since 1973. U.S. demand for low sulfur residual oil has declined in recent years, and, in turn, reduced the level of required imports. According to the Bureau of Mines, PAD I imports of residual fuel oil containing 0.5% sulfur or less amounted to only

62% of their 1973 level in 1976, while imports of all sulfur grades of residual oil had fallen to 74% of their 1973 volume. This represents a drop in the share of the low sulfur imports from 35% in 1973 to 30% in 1976.

C. Crude Oil and Petroleum Product Storage

The four refineries maintained approximately 30 million barrels of on-site crude oil storage capacity in 1975 and 31 million barrels in 1976. The ratio of crude storage to refinery capacity varies significantly among the refineries. One refinery's crude oil storage capacity is 10 times its daily refining capacity, while another's is 28 times. In the aggregate, storage capacity is 19 times daily refining capacity. The ratio of crude oil storage capacity to crude runs was, of course, substantially greater in 1975 and 1976 owing to the low operating rates at these refineries.

Figure I charts the volume of crude oil stored by all refineries on the first day of each quarter. At the peak on January 1, 1975, the four refineries had just under 20 million barrels in storage, using 66% of total capacity. Inventories were at their lowest level on April 1, 1976, at 10.5 million barrels or 34% of storage capacity. The volumes stored when inventories were at their highest or lowest level during the period varied enormously. As its low point, one company's inventory was 0 (zero), and at its highest point, one company's volume of stored crude oil exceeded its on-site storage capacity by 23%. While these levels were extreme, at least one other company reported an inventory higher than its storage capacity, and all fell to relatively low levels (under 10 days at average quarterly crude oil runs to stills

Figure I

AGGREGATE INVENTORY OF FOUR CARIBBEAN EXPORT REFINERIES

(CRUDE AND RESIDUAL OIL)

MM Bbls

-8-

20

18

16

14

12

10

74.5% of Storage Capacity

65.8% of Storage Capacity

RESIDUAL OIL

50.5% of Storage Capacity

CRUDE OIL

33.9% of Storage Capacity

Jan 1

Apr 1

Jul 1

Oct 1

Jan 1

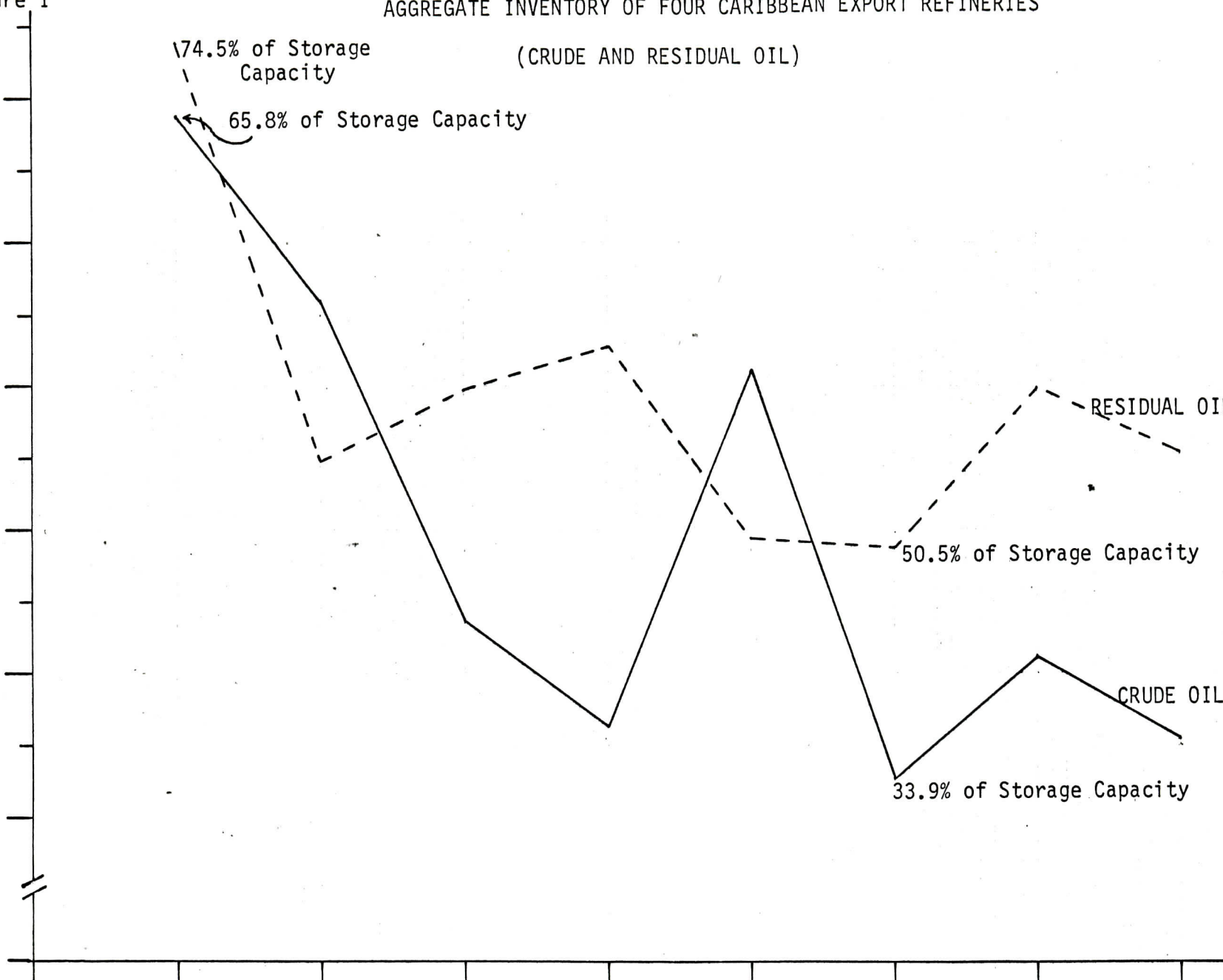
Apr 1

Jul 1

Oct 1

1975

1976



volumes) at their nadir.

Figure I also plots the volume of residual oil stored on the first day of each quarter. Residual (No. 4, No. 5 and No. 6) oil storage capacity for the four refineries was 27.9 million barrels in 1975 and 27.2 million barrels in 1976. On January 1, 1975, the companies were utilizing 74.5% of this capacity (20.8 million barrels) while on April, 1976, 50.5% of the capacity was filled. The dates of the peak and trough in the quarterly inventory series for residual oil coincide with those for crude oil. The swings for residual oil, however, are less pronounced than those for crude oil.

The refineries maintain, in addition, inventories of other products. In general, these volumes, as a total, are larger than residual oil inventories.

D. Shipments to the U.S.

Three refineries provided data on residual oil export volumes. Their figures show that in 1975 the U.S. received 82% of the total residual oil exports, while in 1976 the U.S. share was 71%. For one company, the share going to the U.S. out of its total residual fuel oil exports fell to less than one-half its 1975 share.

For the companies reporting on exports of both residual oil and other products, the following table illustrates percentage distributions.

Table III

DISTRIBUTION OF PRODUCT EXPORTS
FROM CARIBBEAN REFINERIES
1976

	<u>Percent Distribution By Product</u>	<u>Percent of Specific Product Export Going to U.S.</u>
Residual Fuel (1)		
0.0 - 0.50% Sulfur	9	100
0.51 - 1.00% Sulfur	13	98
1.01 - 2.00% Sulfur	1	99
Over 2.00% Sulfur	<u>35</u>	<u>48</u>
Subtotal*	58	68
Distillate Fuel Oil	11	18
Gasoline	6	3
Jet Fuel	10	41
Asphalt	3	54
Other Products	<u>12</u>	<u>3</u>
Subtotal*	42	19
Total*	100	48
*Comparable Shares, 1975:		
Residual Fuel Oil	60	77
All Other Products	40	28
Total	100	57

(1) Includes 4, 5 and 6 fuel oils.

While these figures must be taken as estimates because they are based on partial data, several features stand out. The U.S. represents, for practical purposes, the only market for these refineries' low sulfur residual fuel oil. By contrast, the U.S. receives just under 50% of the their high sulfur oil. The bulk of the remainder is used for bunkering and other Latin American and Caribbean consumption, with a small amount going to Europe.

Large amounts of the jet fuel and asphalt exports from these refineries go to the U.S., but each of these products represents a small share of total product exports.

TABLE IV

DISTRIBUTION OF TOTAL PRODUCT EXPORTS
FROM CARIBBEAN REFINERIES BY DESTINATION
1975 and 1976
(%)

	<u>1975</u>	<u>1976</u>
United States	57	48
Latin America and Caribbean*	30	34
Western Europe	9	10
Other	<u>4</u>	<u>8</u>
Total	100	100

*Includes local consumption and bunkering

As can be seen from the preceding table, the United States received 48% of the refineries' product exports in 1976, down from 57% in 1975. Shipments to local areas increased in relative importance in 1976, rising to 34 percent of total exports from 30 percent in 1975. Other areas also increased their relative share of product exports from these refineries.

E. Crude Oil Supplies

1) Dependence on OAPEC

It has been proposed that SPR crude be sent to the Caribbean to replace crude supplies from the Organization of Arab Petroleum Exporting Countries (OAPEC) during an interruption imposed by those nations. The need for such a program depends, of course, on the degree to which the Caribbean refineries rely on OAPEC supplies. The table below summarizes the four Caribbean refineries' source of crude supplies by area.

Roughly half of the crude supplies to the export refineries came from Western Hemisphere sources in 1975 and 1976, particularly from Venezuela. The 5% increase in the share of Western Hemisphere crude supplies in 1976 over the year earlier reflected an increase in the use of Venezuelan crude. One refinery reported using 31% more Venezuelan crude in 1976; another, 12% more. OAPEC crude represented 26.2 percent of the refineries' crude supplies in 1976, down from 31.7 percent in 1975. The remaining supplies came from other Eastern Hemisphere sources and represented about 20% of supplies in each of the two years.

Table V

SOURCE OF CRUDE OIL SUPPLIES TO CARIBBEAN EXPORT REFINERIES			
BY AREA OF ORIGIN		(%)	(%)
		1975	1976
OAPEC		31.7	26.2
Other Eastern Hemisphere		20.1	20.5
Western Hemisphere		48.2	53.2
Total		100.0	100.0

Sources of crude oil to individual refineries varied significantly. One refinery received as much as 66% of its crude oil from OAPEC sources, while another depended on the Arab countries for only 2% of its crude supplies. (It should be noted that trade information indicates that the latter refinery has utilized more OAPEC crude in 1977). One of the refineries used almost exclusively Venezuelan crude oil, while another ran virtually none of this crude.

Caribbean refiners are expected to increase their use of Eastern Hemisphere crudes over the next few years. It has been reported in the trade press, for example, that the Bahamas refinery has recently contracted with Iran for 100 Mb/d of crude oil. In addition, internal Venezuelan oil demand is expected to grow faster than production so that less Venezuelan crude will be available for export. However, Mexican crude production is expected to reach at least 2 million barrels per day by 1980, an increase of 800,000 b/d above today's level and this crude has of course ready access to the Caribbean refineries. On balance, although the volumes of Eastern Hemisphere crude run in the four major Caribbean refineries will grow, their relative share of crude runs may not.

2) Crude Oil Supplies by Sulfur Content

The Caribbean export refineries, as mentioned previously, have 348 Mb/d desulfurization capacity (both direct and indirect), which is substantially under-utilized in the aggregate. Their only low sulfur residual oil market is the U.S.; and exports of residual fuel oil containing 1.0% sulfur or less were 22% of total product exports.

TABLE VI

CRUDE OIL RECEIPTS AT CARIBBEAN
EXPORT REFINERIES BY SULFUR CONTENT

	% of total receipts	
	<u>1975</u>	<u>1976</u>
Crude Oil Containing:		
0.0 - 0.5% Sulfur	26	17
0.51 - 1.00% Sulfur	1	3
1.01 - 2.00% Sulfur	37	54
Over 2.00% Sulfur	<u>35</u>	<u>26</u>
Total	100	100

While the residual product has a higher sulfur content than its crude oil feedstock, crude oil with less than 0.5% sulfur can usually be refined into heavy fuel oil with less than 1.0% sulfur without desulfurization. Low sulfur crude oils, however, tend to be relatively light, thus decreasing the residual yield and increasing the yield of lighter products. Some of these lighter products, such as gasoil or distillates, which contain less sulfur than the residual oil, can be blended into the heavy fuel oil to reduce its sulfur content. In addition, the gasoil and distillate can be desulfurized with less effort than the residual, and blended after this additional processing.

The share of low sulfur crude oil (0.5% S or less) processed in the Caribbean refineries decreased substantially in 1976 to 17% from 26% in 1975 (see Table VI). This movement, together with industry reports that the refineries' desulfurization units have been significantly under

utilized in the aggregate, is consistent with the reduction in the share of low sulfur residual output at these refineries. It should be noted, however, that there are significant differences among the refineries in their use of low sulfur crude oils.

One refinery, for instance, received virtually all of its crude supplies in the 1.0% S or higher range, and another used crude oil with a sulfur content of 0.5% or less to satisfy 56% of its crude requirements. Despite these differences in low sulfur crude oil processing by the two refineries, both produced a similar share of fuel oil with 1.0% S or less in their total residual output.

III. A Note on Venezuela

The U.S. East Coast imported 39% of its foreign residual oil supplies from Venezuela in 1976. Venezuela is the price leader in the East Coast heavy fuel oil market. A reflection of the interdependence between Venezuela and U.S. residual oil markets is Venezuela's decision of September 1976 to begin monthly, rather than quarterly, pricing of its residual oil. Its monthly pricing policy is strongly influenced by residual fuel oil supply, demand and seasonal trends in the United States, particularly along the U.S. East Coast.

As of the end of 1976, Venezuela had 1445 Mb/d of refinery capacity, including one facility of 695 Mb/d. Crude runs in 1976 were 986 Mb/d, indicating a 68% capacity utilization. In 1975, capacity utilization was 60%.

In 1976, approximately 60% of Venezuela's refinery output was residual oil. Some 25% of this (or 15% of total refinery output) was residual oil containing less than 1.9% sulfur, all of which was produced at the two largest refineries, Amuay and Cardon. (See Table VII).

TABLE VII

VENEZUELAN RESIDUAL OIL (1.9% S OR LESS)
PRODUCED AND EXPORTED*

Produced	<u>1975</u>	<u>1976</u>
	(000b/d)	
0.0 - 0.3% Sulfur	22.3	42.9
0.31 - 0.5% Sulfur	11.7	16.3
0.51 - 1.9% Sulfur	<u>30.9</u>	<u>93.6</u>
Total	65.0	152.8**
Exported		
0.0 - 0.3% Sulfur	21.4	61.5
0.31 - 0.5% Sulfur	11.8	16.4
0.51 - 1.9% Sulfur	<u>30.6</u>	<u>94.4</u>
Total	63.8	172.3**

*The Amuay and Cardon refineries account for 100% of production (i.e. refinery output) and approximately 90% of exports of residual oil containing 1.9%S or less.

**Exports were probably greater than production due to stock changes. The latter was not reported by the source.

Note: Figures may not add due to rounding.

Source: Venezuelan Ministry of Mines and Hydrocarbons

Inland demand for petroleum products in Venezuela was 203 Mb/d in 1976, representing a 9.6% increase over 1975 demand. Bunkers and petroleum industry use accounted for another 50 Mb/d. Inland Venezuelan demand is expected to grow at approximately 7%/year between now and 1980, while its crude production will remain approximately unchanged. The overall effects of these anticipated movements are not expected to have a major impact on Venezuelan oil exports until the early 1980's. It is significant, however, that Venezuela is unlikely to participate in supplying increased oil import requirements to the U.S. over the next few years either directly through increased total crude and product exports or indirectly by increasing crude supplies to the Caribbean refineries.

IV. The Role of the Four Major Caribbean
Export Refineries During Interruption
of OAEPC Oil Supplies to the U.S.

A. U.S. and PAD I Residual Fuel Oil Supply/Demand Trends,
1973 to 1980

U.S. residual fuel oil demand registered a sharp decline in the period from 1973 to 1975, falling some 13% between the two years (see Table VIII). Virtually all of the decline was exhibited in PAD I where residual oil demand declined by 23% from 1,940 Mb/d in 1973 to 1,496 Mb/d in 1975. All regions shared in residual fuel oil demand growth in 1976, but while the regions outside PAD I exceeded their 1973 demand levels, PAD I consumption was some 14% or 277 Mb/d lower. Consequently, residual fuel oil demand in PAD I as a percent of total U.S. demand declined from about 69% in 1973 to 60% in 1976.

Similar trends in regional residual fuel oil demand are expected in the 1976 to 1980 period. All regions are likely to participate in the growth, but those outside PAD I as a group are expected to show substantially larger demand growth. Hence, by 1980 PAD I's residual oil demand is expected to decline to approximately 50 percent of total U.S. demand, and will still be below that registered in 1973.

On the supply side, U.S. domestic residual oil output increased rapidly between 1973 and 1975, rising some 27%, as residual oil yield on crude runs increased from 7.8% in 1973 to 9.9% in 1975. Residual output in PAD I followed a similar trend, supported both by expanded crude runs and increased residual oil yield (see Table VIII). U.S. residual output growth continued into 1976, but at a slower rate, due in part to the introduction of reverse entitlements. Despite higher crude runs last year, residual output on the U.S. East Coast actually

TABLE VIII

U.S. AND PAD I RESIDUAL FUEL OIL SUPPLY/DEMAND 1973 TO 1980
(Thousand Barrels Per Day)

	<u>1973</u>		<u>1975</u>		<u>1976</u>		<u>1980</u>	
	<u>PAD</u> <u>I</u>	<u>U.S.</u>	<u>PAD</u> <u>I</u>	<u>U.S.</u>	<u>PAD</u> <u>I</u>	<u>U.S.</u>	<u>PAD</u> <u>I</u>	<u>U.S.</u>
Residual Demand	1,940	2,822	1,496	2,461	1,663	2,786	1,830	3,590
<u>Supply</u>								
Domestic Production	143	971	187	1,236	185	1,378	220	1,845
Transfers From Other PAD Districts	46	-	162	-	136	-	15	-
Required Imports (1)	<u>1,752</u>	<u>1,853</u>	<u>1,140</u>	<u>1,223</u>	<u>1,344</u>	<u>1,398</u>	<u>1,595</u>	<u>1,745</u>
Total	1,940	2,822	1,496	2,461	1,663	2,786	1,830	3,590
Crude Runs	1,502	12,432	1,407	12,442	1,586	13,416	1,750	15,725
Residual Yield On Crude Runs (%)	9.5	7.8	13.2	9.9	11.7	10.3	12.6	11.7

Note: Total supply may not equal the sum of its individual components due to stock changes and exports.

(1) Includes shipments from the Virgin Islands and Puerto Rico as well as those from other countries.

Sources: Historical data, Bureau of Mines. 1980 estimates was made by PIRINC.

declined slightly because of a reduction in yield from 13.3% in 1975 to 11.7% in 1976, as East Coast refiners reacted to the disincentive for residual output caused by reverse entitlements. The increase in residual oil demand last year therefore was met totally by expanded imports.

Residual oil imports into PAD I peaked in 1973 at a level of 1,752 Mb/d, representing 95% of total U.S. residual oil imports. PAD I imports of residual oil declined to 1,140 Mb/d in 1975 and then increased to 1,344 in 1976. In 1980, we project residual oil imports into PAD I will be 1,595 Mb/d. These volumes include shipments from the Virgin Islands and Puerto Rico.

The four major Caribbean export refineries supplied approximately 690 Mb/d of residual oil to PAD I in 1973, representing about 45% of the region's residual oil imports outside those from Puerto Rico and the Virgin Islands.* At that time, these refineries were running at an average capacity utilization rate well above 90%. Imports from these refineries declined to about 463 Mb/d in 1976 and are estimated to increase to around 600 Mb/d in 1980 when they are expected to represent nearly half of PAD I's residual oil imports, outside those from Puerto Rico and the Virgin Islands (see Table IX). At the projected level of residual exports to the U.S., the four major Caribbean refineries would probably operate at a capacity utilization rate in the range of 75 to 85 percent in 1980.

*The historical volumes quoted for the four major Caribbean export refineries are taken from the Bureau of Mines and include small volumes of residual oil exports from the Trinidad government's 100 Mb/d refinery at Point Fortin.

TABLE IX

RESIDUAL OIL IMPORTS INTO PAD I FROM THE FOUR
MAJOR CARIBBEAN EXPORT REFINERIES, 1973 TO 1980
(Thousand Barrels Per Day)

	<u>1973</u>	<u>1976</u>	<u>1980</u>
Total PAD I Residual Imports	1,752	1,344	1,595
<u>Shipments From:</u>			
Puerto Rico/Virgin Islands	217	262	350
Four Major Caribbean Export Refineries:			
Bahamas	127	99	) 600
Netherland Antilles	426	232	
Trinidad	137 (1)	132 (1)	
	<u>690</u>	<u>463</u>	<u>600</u>
Other (2)	845	619	645

(1) Includes small volumes of residual oil exports from the Trinidad government's 100 Mb/d refinery at Point Fortin.

(2) Includes imports from Venezuela, Western Europe, Africa, Canada and other.

Source: 1973 and 1976 data: U.S. Bureau of Mines. 1980 estimates were made by PIRINC.

B. Caribbean Export Refinery Operations During an Interruption of Oil From OAPEC Sources

In this section, we analyze some of the factors likely to influence the conduct of the four major Caribbean export refineries during an interruption of OAPEC oil supplies to the United States. Two interruption cases are considered. In the first, it is assumed that the four Caribbean export refiners continue to receive all OAPEC crude; in the second, it is assumed they are fully cut off. In both cases two other events are assumed: a) All OAPEC crude shipments to the U.S. are halted; and b) a worldwide shortage of crude oil develops. The shortage could come about either as a result of the cessation of OAPEC crude oil shipments to the U.S., and possibly also to Caribbean export refineries, and a concurrent reduction in total OAPEC exports by the amount of crude oil previously exported to these destinations; or it could result from a general, instantaneous or progressive, reduction in OAPEC exports, volumetrically unrelated to U.S. requirements. The second shortage scenario would be similar to that of the 1973/74 embargo.

In the first shortage scenario the amount of Arab crude oil involved would have been 2.6 million b/d if it had occurred last year and if non-U.S. Caribbean refiners would not have been included in the embargo. Inclusion of the latter would have added another 270,000 b/d to the OAPEC production cutback. This year, the total volume involved would be in excess of 3 million b/d, equal to at least 6% of total free world oil demand.

B. Caribbean Export Refinery Operations During an Interruption of Oil From OAPEC Sources

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In the first shortage scenario the amount of Arab crude oil involved would have been 2.6 million b/d if it had occurred last year and if non-U.S. Caribbean refiners would not have been included in the embargo. Inclusion of the latter would have added another 270,000 b/d to the OAPEC production cutback. This year, the total volume involved would be in excess of 3 million b/d, equal to at least 6% of total free world oil demand.

Part of the OAPEC export reductions could be made up by additional exports from other OPEC numbers. An evaluation of the likelihood and extent of such a development is beyond the scope of this paper. However, we believe, an equally good case could be made for its occurrence as against it.

Case 1: Caribbean Refiners Retain Access
to OAPEC Supplies

In this case, the only crude oil losses experienced by the four major Caribbean export refineries would be those resulting from the general shortage in crude oil availability. It may be assumed that the shortage incurred by these refineries would be in approximate proportion to the worldwide shortage. We assume that these refineries would continue to supply their traditional customers on a pro rata basis in line with the reduction in the volume of crude oil processed. It would be unlikely that new customers would be supplied. Both actions conform to normal business practices during shortage periods.

Any interruption in OAPEC crude supplies (which currently account for nearly 50% of total U.S. crude imports) would bring into operation an allocation and price control program in the U.S. oil market. If such controls should limit the prices which importers and resellers could pay, this could make the U.S. market relatively less attractive to the Caribbean refineries than markets without such controls. In this event, the Caribbean refiners would have to weigh the short term economic gain of shifting supplies to non-U.S. markets against their long term relationship with the U.S. market, both economically, and politically.

It should be pointed out in this connection that any general crude oil shortage would activate the emergency allocation system of the International Energy Agency (IEA). Under this system the 19 member states would not only allocate crude oil supplies but are also committed, individually and through cooperation, to prevent or minimize price increases, particularly those resulting from the bidding up of available supplies. Thus, the opportunities to sell in uncontrolled or less controlled markets during an oil interruption would be quite limited.

Nevertheless, it could exist in some oil importing countries which are not members of the IEA. Furthermore, state oil companies in OPEC and other exporting countries, which are of course beyond the control of the IEA, may wish to obtain prevailing market prices for their crude oil and products exports. These factors could drive the price of some foreign oil supplies up, despite U.S. and IEA efforts to the contrary. This could very well affect the cost of crude supplies to Caribbean refineries and the market pattern of their products exports. The U.S. Government should therefore take a flexible posture regarding the cost of products imports from these refineries in order not to contribute to a reduction of supplies from them during the emergency.

The U.S. Government could obviate or reduce the need for Caribbean export refineries to bid for available crude supplies in the world market by prearranging for their access to SPR crude to make up any shortfalls. (This is discussed in some detail in a later section.) In this way, the U.S. market would continue to be supplied by these

refineries, presumably with volumes equalling or approaching the preinterruption level.

Case 2: Caribbean Refineries Are Embargoed by OAPEC

The survey data, collected from the four major Caribbean export refineries, indicate that 26% of the refineries' one million b/d of crude supplies came from OAPEC countries in 1976. If their utilization rate had been much higher than the 60% reported for that year, the share of OAPEC crudes would probably have been greater, since there was little available spare crude oil producing capacity in Western Hemisphere exporting countries during 1976. But even the 26% level indicated for 1976 is significant, since it represents 266 M b/d and will undoubtedly increase as crude runs expand in these refineries over the next few years.

The Caribbean refiners faced with an interruption of OAPEC crude supplies would probably offset the shortfall to some extent by initially shifting non-OAPEC crudes to their Caribbean refineries while sending OAPEC crudes to refineries in non-embargoed areas. All of the international major oil companies with Caribbean refineries would have some ability to rearrange their available worldwide crude supplies in this fashion, in cooperation with the appropriate U.S. Government agency and/or the IEA, both of which may want to facilitate such moves. The same would probably be true of NEPCO, the only independent refinery in the area. Nonetheless, total crude oil supplies to the four major Caribbean export refineries would undoubtedly be lower than normal, because of the assumed concurrent worldwide crude oil shortage.

It would of course be important for the U.S. Government to accurately assess the degree of the shortage and of the availability of non-OAPEC crude to the Caribbean refineries, in order to determine the full direct and indirect impact on the U.S. market of an OAPEC interruption. The required data for such an assessment are unlikely to be available in the initial crisis period. Thus, in order for the government not to be pressured or panicked into sending SPR crude immediately to Caribbean refineries, it might be very desirable to have access to a Regional Petroleum Reserve designated for the East Coast and consisting of residual fuel oil. Reliance on this reserve could allow the government to postpone a decision on SPR crude exports until more facts were known.

The reason for caution in making the decision is that the U.S. Government should avoid sending (directly or indirectly) any SPR crude to the Caribbean refineries to replace non-OAPEC crude which would have been processed by these refineries in the absence of U.S. SPR crude supplies. In other words, the U.S. SPR program should not in any way inhibit the incentive for Caribbean refineries to increase their use of non-OAPEC crudes during an interruption. It should also be noted that companies with refineries located both in the United States and abroad might have an incentive to divert crude shipments from the U.S. to their foreign refineries, since the shortfall in their U.S. refineries would be made up by SPR crudes. This could possibly increase the oil shortage in the U.S., and the consequent drawdown of the SPR, beyond anticipated levels.

Once the decision to process SPR crude in Caribbean refineries is made, the U.S. Government could arrange for the swapping of foreign crudes for SPR crude, retaining government ownership, so that SPR crude need not be physically shipped to the Caribbean refineries. By diverting foreign crudes in transit to the U.S. to the Caribbean refineries, overall transportation costs would be lowered and time savings would also result.

3. U.S. Government Crude Supply Arrangements with Caribbean Refiners

There are a number of possible crude supply arrangements the U.S. Government could make with the four major Caribbean refineries which could be activated during an oil supply interruption. In general, they fall within two broad types. (1) Crude oil could be sold to the refineries and the finished petroleum products purchased from them by the U.S. Government; or (2) the refineries could perform a processing service for a fee, returning U.S. Government owned crude oil in the form of petroleum products. A number of combinations of these two alternatives are also possible.

A processing agreement has several attractive characteristics. The government would maintain ownership of crude oil and the derived finished petroleum products. It would also have sole control of the pricing of the products. U.S. export laws currently require that the prices paid for product imports produced from U.S. crude oil exported during an embargo be no higher than if the products had been refined domestically. Consequently, barring a change in the law, products

received from Caribbean export refineries would be under U.S. price control, regardless of whether a processing agreement was set up or SPR crude was sold to these refiners and the products subsequently purchased by the U.S. Government.

Whatever type of agreement is made, it is desirable that its principal terms be negotiated prior to an actual interruption and accepted by all parties concerned, including the host countries of the refineries, where applicable. In the case of a processing agreement, the major area of bargaining would be the processing fee. The refiner would seek to recover its costs plus a profit on the portion of refinery capacity that would utilize SPR crude. The cost plus profit could be established for some base year and escalated with published cost indices.

As part of the agreement, the mix of products which will be received from the Caribbean refineries processing SPR crude should be mutually agreed to. Since the principal product, by far, required from the Caribbean refineries is residual fuel oil, the government should negotiate for the maximum obtainable amount of residual per barrel of SPR crude. Since the SPR crude would be run incrementally, it may even be possible for the refineries to return residual fuel oil on a one to one basis by adjusting the yields for their total refinery runs accordingly. The product mix and processing fee agreements should be reviewed periodically so that adjustments can be made if warranted by changing market or other conditions.

A P P E N D I X

Attachments: 1) Letter sent to companies.
2) Survey questionnaire



ATTACHMENT 1

Petroleum Industry Research Foundation, Inc.

122 EAST 42nd STREET

New York, N. Y. 10017

June 29, 1977

Dear

We are participating in a joint effort by the Federal Energy Administration (Strategic Petroleum Reserve Office) and the New York State Energy Office to ascertain the need for Regional Petroleum Reserves. The emphasis, as might be expected, is on residual fuel oil supply in PAD I. Because the Caribbean export refineries are such an important source of residual oil for the U.S. East Coast, we have been asked to gather extensive information on refinery operations in the Netherlands Antilles, Trinidad, and the Bahamas. Inasmuch as not all of the data are publicly available, we hope to secure the necessary information directly from the companies involved.

We have developed the attached questionnaire in an effort to make your task easier in supplying the information and our task easier in tabulating and analyzing the data. The figures we request cover refinery capacity, output, storage, source of crude oil and destination of product output.

We and the FEA are well aware that some of the information requested is proprietary. You may prefer, therefore, to give us the data verbally, rather than in writing. Such an arrangement would certainly be satisfactory. In addition, according to your preference, we can either destroy or return to you any supplied data at the conclusion of our study. Attached is a copy of a letter from Glenn Coplon of the FEA Strategic Petroleum Reserve Office to Gary Ross of our office outlining FEA's stance on protecting the confidentiality of data given to FEA in connection with this study. Please note that any written information supplied should be designated as "proprietary confidential" in accordance with your company's customary adherence to FEA regulations.

We would appreciate your cooperation in this undertaking. If you have any questions or concerns, please do not hesitate to call us.

Sincerely,

John H. Lichtblau

John H. Lichtblau
Executive Director

JHL/jg
Encl.

Petroleum Industry Research Foundation, Inc.
122 East 42nd Street
New York, N.Y. 10017

COMPANY:

REFINER/REFINERY:

CONTACT:

TELEPHONE NO.: ()

Explanatory Notes: This information is being gathered in recognition of the critical importance of Caribbean export refineries as a source of residual fuel oil for the U.S. East Coast. The data will provide essential detail for decisions on a Regional Petroleum Reserve, as authorized by the Energy Policy and Conservation Act of 1975 (PL 94-163).

If confidential handling of the material is desired, please so indicate by appropriate notification on each completed page.

All data is requested in thousands of barrels, unless otherwise indicated. If supplied figures are in other units, please specify.

For the purposes of this questionnaire, residual fuel oil is defined as No. 4, No. 5 and No. 6 oil.

	<u>1 9 7 5</u>	<u>1 9 7 6</u>
1a. Crude Oil Capacity of Refinery as of year-end (000 BPCD)		
1b. Desulfurization* Capacity of Refinery as of year-end (000 BPCD)		
*Residual fuel oil desulfurization, both direct and indirect		
2a. Crude Oil Runs to Stills (000 bbls)		
1st Quarter		
2nd Quarter		
3rd Quarter		
4th Quarter		
Annual Total		
2b. Crude Oil Runs to Stills in Highest Month		
Month:		
Volume (000 bbls)		
2c. Crude Oil Runs to Stills in Lowest Month		
Month		
Volume (000 bbls)		

Please return to:

Petroleum Industry Research Foundation, Inc.
 122 East 42nd Street
 New York, New York 10017

COMPANY:

3. Product Yield Patterns (000 bbls)							
Residual Fuel Oil (No. 4, No. 5 and No. 6) 0.0% to 0.50% Sulfur	1st Q	2nd Q	3rd Q	4th Q	Year	1st Q	2nd Q
0.51% to 1.00% Sulfur							
1.01% to 2.00% Sulfur							
Over 2.00% Sulfur							
Distillate Fuel Oil 0.0% to 0.2% Sulfur							
Over 0.2% Sulfur							
Gasoline							
Jet Fuel (Naphtha and Kero)							
Naphtha							
Asphalt							
Other							
Total							

1 9 7 5

1

[illegible]

COMPANY:

	<u>1 9 7 5</u>	<u>1 9 7 6</u>
4a. On-Site Crude Oil Storage Capacity (000 bbls)		
Inventory (000 bbls), as of:		
<u>January 1</u>		
<u>April 1</u>		
<u>July 1</u>		
<u>October 1</u>		
Occurrence of highest inventory		
<u>Date</u>		
<u>Volume (000 bbls)</u>		
Occurrence of lowest inventory		
<u>Date</u>		
<u>Volume (000 bbls)</u>		
4b. On-Site Residual Fuel Oil* Storage Capacity (000 bbls)		
Inventory (000 bbls), as of:		
<u>January 1</u>		
<u>April 1</u>		
<u>July 1</u>		
<u>October 1</u>		
Occurrence of highest inventory		
<u>Date</u>		
<u>Volume (000 bbls)</u>		
Occurrence of lowest inventory		
<u>Date</u>		
<u>Volume (000 bbls)</u>		
* Include No. 4, No. 5 and No. 6 oil		
4c. On-Site Storage for Other Products Capacity (000 bbls)		
Inventory (000 bbls), as of:		
<u>January 1</u>		
<u>April 1</u>		
<u>July 1</u>		
<u>October 1</u>		
Occurrence of highest inventory		
<u>Date</u>		
<u>Volume (000 bbls)</u>		
Occurrence of lowest inventory		
<u>Date</u>		

COMPANY:

	<u>1 9 7 5</u>	<u>1 9 7 6</u>
5a. Source of Crude Oil Receipts into Caribbean Refinery by Country of Origin (000 bbls)		
Algeria		
Bahrain		
Egypt		
Iraq		
Kuwait		
Libya		
Qatar		
Saudi Arabia		
Syria		
United Arab Emirates		
OAPEC Total		
Iran		
Nigeria		
Gabon		
Other Western Africa		
Indonesia		
Western Europe		
Other Eastern Hemisphere		
Eastern Hemisphere Total		
Venezuela		
Ecuador		
Trinidad		
Mexico		
Other Latin America & Caribbean		
Western Hemisphere Total		
Total		
5b. Crude Oil Receipts by Sulfur Content, Annual Total (000 bbls)		
0.0 - 0.50% Sulfur		
0.51 - 1.00% Sulfur		
1.01 - 2.00% Sulfur		
Over 2.00% Sulfur		
Total		

Petroleum Industry Research Foundation, Inc.
122 East 42nd Street
New York, New York 10017

COMPANY:

	<u>1 9 7 5</u>	<u>1 9 7 6</u>
5c. Crude Oil Receipts into Caribbean Refinery by Month (000 bbls)		
January		
February		
March		
April		
May		
June		
July		
August		
September		
October		
November		
December		
Total		

6a. Residual Fuel Oil (No. 4, No. 5 and No. 6) Exports
by Month (000 bbls)

	<u>1 9 7 5</u>		<u>1 9 7 6</u>	
	<u>U.S.</u>	<u>Other</u>	<u>U.S.</u>	<u>Other</u>
January				
February				
March				
April				
May				
June				
July				
August				
September				
October				
November				
December				
Total				

COMPANY: _____

6b. Destination of Caribbean Refinery's Residual Fuel Oil (No. 4, No. 5 and No. 6)
 Output by Country (including shipments for local consumption, bunkering,
 and refinery fuel) (000 bbls)

Country	1975	1976				Total
	Total	0.0% to 0.50% S	0.51% to 1.00% S	1.01% to 2.00% S	Over 2.00% S	
United States						
Mexico						
Canada						
Bahamas						
Jamaica						
Netherlands Antilles						
Trinidad						
Other Latin America and Caribbean						
France						
Germany						
Italy						
Netherlands						
United Kingdom						
Other Western Europe						
Other Eastern Hemisphere						
Total						

6c. Destination of Products other than No. 4, No. 5 and No. 6 Oil by Country
 (including shipments for local consumption) (000 bbls)

	<u>1 9 7 5</u>	<u>1 9 7 6</u>					Total (incl. "other")
	<u>Total</u>	Distillate 0.0% to <u>0.2% S</u>	Over <u>0.2% S</u>	<u>Gasoline</u>	Jet Fuel (Naphtha and Kero)	<u>Asphalt</u>	
United States							
Local Consumption							
Other Latin America and Caribbean							
Western Europe							
Other							
Total							