SCOMM

#14:16

CHEM SYSTEMS INC.

PACIFIC RIM MARKET FOR PETROCHEMICALS

A Study For

Royalty Oil & Gas Advisory Board
Department of Natural Resources
State of Alaska

Chem Systems Inc.
747 Third Avenue
New York, NY 10017

October, 1979

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont'd)

TABLE OF CONTENTS (Cont'd)

TABLE OF CONTENTS (Cont'd)

TABLE OF CONTENTS (Cont'd)

I. SUMMARY

A. Introduction

There has been considerable interest in determining the feasibility of a petrochemical complex in Alaska due to the availability of large amounts of natural gas liquids (ethane, propane, and butanes) in the natural gas at Prudhoe. As part of their efforts, the Royalty Oil and Gas Development Advisory Board, Department of Natural Resources, State of Alaska, commissioned Chem Systems Inc. to prepare an analysis of the Pacific Rim markets for petrochemicals which could be produced from natural gas liquids. This area encompasses the western parts of the United States and Canada and the Far Eastern and Southeast Asian countries. The study entailed analyzing the market situations for those large volume basic petrochemicals, chemical intermediates, and plastic resins which are natural gas liquids derived and, based upon anticipated supply and demand relationships, market structure, etc., determining those products which could be produced in Alaska in world-scale facilities.

B. Market Characteristics

1. U.S. West Coast

The U.S. West Coast market encompasses the states of Alaska, California, Oregon, Washington, and Hawaii with a population of 29 million. Although these states account for 13 percent of U.S. population and 12 percent of value added by manufacture, they only account for about 2 percent of U.S. production of the major petrochemicals and 6 percent of overall U.S. chemical value added by manufacture. Most of the petrochemicals consumed within the region are supplied from facilities on the Gulf Coast.

The level of manufacturing activiites on the West Coast by SIC group is summarized in Table I-B-1. Although the percentage of value added within the region is roughly comparable to the West Coast's share of population, the distribution of manufacturing activities within the region

is substantially different than that for the U.S. The region is relatively important in food processing, lumber and wood, petroleum, and transporatation equipment (aircraft), while its activities in tobacco, textile mill products, fibers, chemicals, rubber, leather, automotive equipment and primary metals are substantially less than the U.S. average.

TABLE I-B-1

U.S. WEST COAST VALUE ADDED BY MANUFACTURE, 1975*
(Billion Dollars)

SIC Group		Total U.S.	U.S. West Coast	Percent of Total U.S.
20	Food & Kindred Products	48	7.5	16
21	Tobacco	4	-	-
22	Textile Mills Products	12	small	2
23	Apparel	15	2	12
24	Lumber & Wood	10	4	37
25	Furniture & Fixtures	6	1	13
26	Paper & Allied Products	18	2	13
27	Printing & Publishing	24	3	10
28	Chemicals	45	3	6
29	Petroleum & Coal	10	1.5	16
30	Rubber & Misc. Plastics	14	1	9
31	Leather & Leather Products	3	small	2
32	Stone, Clay & Glass	16	2	11
33	Primary Metal Industry	30	2	7
34	Fabricated Metal Products	35	3.5	11
35	Machinery Except Electrical	46	4	10
36	Electric & Electronic Equipment	35	5	14
37	Transportation Equipment	45	9.5	21
38	Instruments	14	2	12
39	Misc. Manufacturing Industries & Other	15	small	9
	Total	445	53	12

Source: Bureau of the Census, Annual Survey of Manufactures, 1975.

* Latest year for which information is available.

The West Coast is also an important agricultural center. The region is a major producer of fruits and vegetables, accounting for over half of U.S. production of a number of crops. However, it is a much less significant factor in grains.

Petrochemical consumption is related to both population and the nature and size of industrial and agricultural activities. Lack of major automobile, fiber, and synthetic rubber industries within the region means that the region is not significant in industries which account for about 20 percent of petrochemical consumption. This seriously affects products serving those industries such as polypropylene, and the major fiber and elastomer raw materials.

The important industries within the region are agriculture and related food processing applications, lumber and wood, transportation equipment (aircraft), and the electronics industry. Since agriculture and food processing are packaging-related industries, consumption of products such as low density polyethylene tends to be high. The large lumber, aircraft, boat building and electronics industries, unfortunately, are not large petrochemical consumers, although specific products, such as phenolic and unsaturated polyester resins, are used in sizeable quantities.

Lastly, there are some markets where the consumption is population related. This is true for large segments of the packaging industry, which is related to the demand for commodity resins, and certain other industries, such as coatings and inks, which are important consumers of materials such as solvents.

2. Other U.S. and Canadian Markets

In addition to supplying regional markets, a West Coast petrochemical facility is well located to supply adjacent regions in the U.S. and Canada. This encompasses those states and provinces west of the Rockies

and includes all or part of Arizona, Colorado, Idaho, Montana, Nevada, Utah, Wyoming and the Canadian province of British Columbia. These areas have a population of about 5 million, but, unfortunately, these areas are not significant consumers of petrochemicals.

3. Pacific Basin Markets

The Pacific Basin market, which encompasses Japan, Korea, Taiwan, Hong Kong and ASEAN countries of Philippines, Singapore, Malaysia, Thailand, and Indonesia, has a population of about 400 million.

Japan is the free world's second largest petrochemical producer, with a current basic petrochemical production of about 30 billion pounds per year, and other countries in the Pacific Basin consume over 2 billion pounds per year of petrochemicals. Key economic factors for these countries are summarized in Table I-B-2.

TABLE I-B-2

PACIFIC BASIN COUNTRY ECONOMIC GROWTH FACTORS

Country	1978 Population MM	1978 GNP MMM$	GNP Growth 1965-75	GNP Growth 1978-85	1978 Crude Oil Reserves MM Bbl	1978 Natural Gas Reserves MMM Ft^3
Japan	113	1,012	8.6	5	60	500
Korea	39	46	10.6	8	-	-
Taiwan	16	25	8.5	6-7	12	700
Hong Kong	5	14	6.7	5-6	-	-
ASEAN Countries						
Philippines	44	23	5.1	4-5	100	-
Singapore	2	8	10.4	7-8	-	-
Malaysia	12	16	6.5	5-6	2,800	17,000
Thailand	43	22	7.0	5-6	0.3	5,000
Indonesia	140	53	6.8	5-6	10,200	24,000

Japan is anticipated to have future growth approaching that of the U.S. and Europe due to loss of low oil costs, loss of cost competitiveness in labor-intensive industries, and major export market saturation. Overcapacity exists in petrochemicals, but domestic prices are relatively high due to high naphtha costs and the structure of the market. Although it traditionally has been difficult to export products to Japan for which ample domestic capacity exists, their high cost position can make it attractive to import products instead of producing them domestically.

Korea and Taiwan have experienced high economic growth and, in spite of current difficulties, good growth will continue since these countries are replacing Japan as low cost textile producers and they are building up their heavy industries. Both countries are in the process of building petrochemical industries which are justified on the basis of import substitution economics. These industries are protected by high duties and other trade barriers and thus imports are only possible for products for which local production is insufficient or under duty drawback situations.

Hong Kong is heavily oriented to textiles, electronics, and plastics fabrication. Dow's polystyrene plant is the only petrochemical plant in the Colony, and it is unlikely that any others will be built. No restriction or duties on petrochemical imports exist.

ASEAN Countries

The Association of Southeast Asian Nations (ASEAN) is attempting to promote an apportionment of facilities within the region coupled with a preferential duty structure. With respect to petrochemicals, the individual countries are promoting their projects, and rationalization of the situation within the next several years is unlikely. However, ultimately the basic goals of ASEAN are expected to be realized. Every country within the group, except Singapore, has significant protection for domestic industry such that petrochemical imports are limited to

those products whose local production is insufficient to meet demand and duty drawback situations.

The Philippines has a relatively poor growth outlook due to a continuing need for oil imports, the commodity nature of their exports, and the political situation. A petrochemical complex is planned, but it is unlikely to reach fruition for several years.

Singapore is a free port and has no duties and restrictions on petrochemical imports, essentially all of which are re-exported in the form of fabricated products. A large petrochemical complex consisting of an olefins unit and downstream units is planned by the Government in conjunction with Sumitomo and other Japanese firms, and it will be on stream in the early 1980s.

Malaysia has crude oil and gas reserves and could be the site of an export-oriented petrochemical complex in the future. Petrochemical consumption is relatively low, but steady growth is anticipated. The economy is dependent upon minerals and agricultural products, but the country benefits from a relatively stable political climate.

Thailand is primarily an agricultural country. Petrochemical consumption is modest, and the future growth outlook could be clouded by a potentially unstable political situation.

Indonesia has substantial crude oil and gas reserves, which may ultimately form the basis of a petrochemical industry. Petrochemical consumption is relatively modest but is capable of growing rapidly. Indonesia has the potential of replacing Korea and Taiwan as a center of low-cost labor in about a decade.

The Peoples' Republic of China was not analyzed in detail. The country has a population of about 900 million and has significant oil and natural gas reserves. A petrochemical industry, based on imported technology, is being developed. Petrochemical imports are anticipated to be modest since priority is being given to importation of plants and equipment.

C. Pacific Rim Petrochemical Markets

Those major petrochemicals which can be produced from natural gas liquids were examined. Materials whose production from natural gas liquids or whose markets are small were ignored. The products examined are as follows:

1. Basic petrochemicals (made directly from natural gas liquids).
   - ethylene
   - propylene

2. Major ethylene and propylene derivatives.
   - low density polyethylene
   - high density polyethylene
   - ethylbenzene/styrene
   - ethylene dichloride/vinyl chloride
   - ethlyene glycol
   - polypropylene
   - cumene/phenol
   - acrylonitrile
   - isopropyl alcohol

3. Other large-volume plastics.
   - polystyrene
   - polyvinyl chloride

1. Low Density Polyethylene

Low density polyethylene (LDPE) is the largest volume plastic resin. Most is made into film and bags, such as agricultural mulch film and trash bags. It is also used as the coating on milk cartons and as wire insulation. The current West Coast demand for this material is nearly 1 billion pounds while markets in the Pacific Basin are about 3 billion pounds, as shown in Table I-C-1. By 1985, Pacific Rim demand will approach 7 billion pounds.

TABLE I-C-1

LOW DENSITY POLYETHYLENE

	Demand				Capacity, per year	
	1978	1980	1990	AAGR, %*	1978	Future
		(Million Pounds)				
West Coast	935	1,660	2,320	7.9	140	0
		(Thousand Metric Tons)				
Japan	960	1,420	1,770	5.2	1,520	1,620
Korea	160	305	420	8.4	70	320
Taiwan	75	115	150	6.0	90	215
Hong Kong	90	115	135	3.4	0	0
ASEAN Countries	172	308	421	7.7	0	100**

* Average annual growth rate.
** Other projects possible.

At present Union Carbide, which has a small plant, is the only West Coast LDPE producer, while most resin used is brought into the region from the Gulf Coast. Due to the established position of existing suppliers and some captive consumption, an Alaskan producer could only reasonably expect to capture about 15-20 percent of the merchant market which would equate to about 250 and 350 million pounds in 1985 and 1990, respectively. Hong Kong and the ASEAN countries will be major importers of LDPE during the 1980s, and Japan could become an importer due to its poor petrochemical cost postion.

World-scale LDPE plants during the 1980s will be at least 500 million pounds per year in size. Based upon market opportunities on the West Coast and substantial export opportunities to the Pacific Basin, an LDPE plant in Alaska is viable from a market standpoint.

2. High Density Polyethylene

High density polyethylene (HDPE) is used in the manufacture of bleach and other bottles. A rapidly developing use is in the production of thin film, where it is replacing LDPE and paper. The current West Coast demand is about 500 million pounds while markets in the Pacific Basin area are about 1.5 billion pounds, as shown in Table I-C-2. By 1985, Pacific Rim demand will approach 4 billion pounds.

TABLE I-C-2

HIGH DENSITY POLYETHYLENE

	Demand				Capacity, per year	
	1978	1985	1990	AAGR, %	1978	Future
		(Million Pounds)				
West Coast	500	1,065	1,610	10.3	0	0
		(Thousand Metric Tons)				
Japan	438	780	970	7.0	882	982*
Korea	60	140	205	10.1	35	105
Taiwan	45	80	115	8.1	50	170
Hong Kong	30	48	63	6.4	0	0
ASEAN Countries	115	208	297	8.2	0	80**

* Future projects not certain.
** Additional facilities possible.

The competitive factors in the West Coast market are similar to those for LDPE. As a result, an Alaskan producer could only reasonably expect to capture about 20 percent of the merchant market, or about 200 and 300 million pounds in 1985 and 1990, respectively.

Hong Kong, the ASEAN countries and Korea will be major HDPE importers during the 1980s and Japan also could become a significant importer due to its poor cost position.

World-scale HDPE plants during the 1980s will be at least 250 million pounds per year in size. Based upon market opportunities on the West Coast and in the Pacific Basin, an HDPE facility is viable from a market standpoint.

3. Polystyrene

Polystyrene is used in the manufacture of foamed plastic cups, refrigerator door liners, and toys. The current West Cost demand is nearly 600 million pounds while markets in the Pacific Basin are about 3 times as large, as shown in Table I-C-3. By 1985, Pacific Rim demand will be about 3.5 billion pounds.

TABLE I-C-3

POLYSTYRENE

	Demand				Capacity, per year	
	1978	1985	1990	AAGR, %	1978	Future
		(Million Pounds)				
West Coast	555	830	1,060	5.5	480	550*
		(Thousand Metric Tons)				
Japan	570	825	1,030	5.1	739	739*
Korea	70	125	165	7.4	50	118*
Taiwan	58	110	135	7.3	70	70*
Hong Kong	100	170	220	6.8	65	125
ASEAN Countries	54	110	212	10.6	39	47*

* Additional expansions likely.

At present most polystyrene consumed on the West Coast is produced locally. The same situation exists in the Pacific Basin since polystyrene resins are relatively easy to manufacture and it is easier to ship the styrene monomer than the resin itself. As a result, polystyrene manufacture in Alaska does not appear very attractive.

4. Polyvinyl Chloride

Polyvinyl chloride (PVC) is used to produce plastic pipe for agricultural and telecommunications use. It is also used to make vinyl floor tiles, shower curtains, upholstery, etc. The current West Coast demand for PVC is about 700 million pounds while the Pacific Basin market is over 4 billion pounds. By 1985, Pacific Rim demand will approach 8 billion pounds, as shown in Table I-C-4.

TABLE I-C-4

POLYVINYL CHLORIDE

	Demand				Capacity, per year	
	1978	1985	1990	AAGR, %	1978	Future
		(Million Pounds)				
West Coast	695	1,330	1,890	8.7	370	370
		(Thousand Metric Tons)				
Japan	1,180	1,660	2,060	4.8	1,921	1,921*
Korea	185	350	460	7.9	200	200*
Taiwan	330	535	695	6.4	428	452*
Hong Kong	50	73	89	4.9	0	0
ASEAN Countries	135	275	415	8.8	151	221*

* Additional expansions likely.

At present about half of the PVC used on the West Coast is produced locally while the remainder is shipped from the Gulf Coast. Countries within the Pacific Basin are anticipated to be virtually self-sufficient in PVC, which provides little opportunity for exportation from an Alaska plant. During the 1980s, new polyvinyl chloride facilities will have to be at least 200 million pounds per year in size in order to be competitive. The output of such a facility could be sold in West Coast markets, but it is generally preferable for a firm to locate the facility closer to the markets and ship vinyl chloride monomer.

5. Styrene

Styrene is a chemical intermediate which is used for the production of polystyrene, ABS, and unsaturated polyester resins. It is also used for the production of SBR rubber. The current West Coast and Pacific Basin demand for styrene is about 650 million and 3 billion pounds, respectively. By 1985, the overall Pacific Rim market will reach 7 billion pounds, as shown in Table I-C-5.

TABLE I-C-5

STYRENE

	Demand				Capacity, per year	
	1978	1985	1990	AAGR, %	1978	Future
		(Million Pounds)				
West Coast	639	1,003	1,340	6.4	0	0
		(Thousand Metric Tons)				
Japan	1,112	1,540	1,920	4.8	1,550	1,780*
Korea	75	167	235	10.0	60	185
Taiwan	81	162	201	7.9	100	200
Hong Kong	74	125	125	4.5	0	0
ASEAN Countries	25	75	125	14.3	0	0

* Additional expansions likely.

About half of the West Coast market is captive while the remainder of the market is primarily represented by unsaturated polyester resin producers who purchase primarily on price. In the Pacific Basin, Korea and Taiwan will be basically self-sufficient in styrene while the remainder of the market is largely in the hands of Dow Chemical and Japanese firms.

During the 1980s, it is expected that a styrene plant will have to be at least 600-800 million pounds per year in size in order to be competitive. Production of styrene or its precursor, ethylbenzene, is

viable in Alaska, but most likely only by those firms which have a strong captive position in styrene derivatives within the Pacific Rim area. Production of styrene also would require a source of benzene, which could become available from the proposed Alpetco facilities or the large complex envisioned in Alberta.

6. Vinyl Chloride Monomer

Essentially all vinyl chloride monomer is used in the production of PVC resins. In 1978 West Coast demand was 335 million pounds while the Pacific Basin demand approached 5 billion pounds. By 1985 Pacific Rim demand will reach 7.5 billion pounds, as shown in Table I-C-6.

TABLE I-C-6

VINYL CHLORIDE MONOMER

	Demand*				Capacity, per year	
	1978	1985	1990	AAGR, %	1978	Future
		(Million Pounds)				
West Coast	335	500-600	500-600	-	175	175**
		(Thousand Metric Tons)				
Japan	1,370	1,970	2,410	4.8	2,191	2,666
Korea	200	360	470	7.4	78	430
Taiwan	400	615	785	5.8	360	700
Hong Kong	0	0	0	0	0	0
ASEAN Countries	120	235	365	9.7	0	0

* In part dependent upon new PVC facilities.
** Plant may shut down.

Vinyl chloride is manufactured from ethylene and chlorine. Chlorine is an energy-intensive product and its production also entails the marketing of large quantities of coproduct caustic soda. Due to the high energy consumption and the chlorine/caustic soda imbalance in Japan and Taiwan, firms in these countries are anticipated to import significant quantities of vinyl chloride and its precursor, ethylene dichloride. This imbalance

does not exist on the West Coast, where large quantities of caustic soda are required by the paper industry. In addition to market opportunities in the Pacific Basin, a large part of the West Coast vinyl chloride market should be available to an Alaskan producer. Basically, there are markets in the Pacific Rim Area for the output of an 500 million-1 billion pound per year world-scale facility.

7. Ethylene Glycol

Ethylene glycol is used as an antifreeze on the West Coast while the product's other major end-use, the manufacture of polyester fiber, is the predominate market for the product in the Pacific Basin countries. The 200 million pound per year West Coast market is small, and it consists primarily of branded antifreeze products. The Pacific Basin market is currently 1.5 billion pounds, and it is forecast to reach nearly 2.4 billion pounds by 1985, as shown in Table I-C-7.

TABLE I-C-7

ETHYLENE GLYCOL

	Demand				Capacity, per year	
	1978	1985	1990	AAGR, %	1978	Future
	(Million Pounds)					
West Coast	200	232	248	1.8	0	0
	(Thousand Metric Tons)					
Japan	410	575	675	4.2	575	675
Korea	80	158	220	8.8	0	80
Taiwan	120	240	300	8.0	175	225
Hong Kong	neg.	neg.	neg.	-	0	0
ASEAN Countries	69	98	126	5.3	0	120

In the mid-1980s, most Pacific Basin countries will be significant importers of ethylene glycol, and it may be advantageous for Japanese firms to import the material due to their relatively poor cost position. Production of ethylene glycol in a world-scale 400-500 million pound per year plant would be viable for a firm or group of firms which had a strong position in the product within the Pacific Basin area.

8. Ethylene

The primary use for ethylene is for the production of derivatives in adjacent facilities. However, modest quantities are currently shipped in cryogenic tankers in Japan and Europe (the product boils at -119°F). The only market sufficient to take the output from a 1 to 1.5 billion pound per year world-scale plant would be Japan. However, the Japanese would prefer to import derivatives. Petrochemical complexes are being planned for the Phillipines and Thailand, which would utilize liquid ethylene as the feedstock. Potential requirements would be about 500 million pounds per year. This demand could be met from Alaska, but actual completion of the projects is highly uncertain, and over the longer term replacement of imports with local production is likely.

9. Polypropylene

Polypropylene is used in the manufacture of plastic straws, automobile interior door panels, fiber and film. Demand on the West Coast was only 130 million pounds in 1978 since many major uses for the product do not exist in the area. Pacific Basin demand was about 2 billion pounds, as shown in Table I-C-8. By 1985, demand is expected to reach 3.5 billion pounds.

TABLE I-C-8

POLYPROPYLENE

	Demand				Capacity, per year	
	1978	1985	1990	AAGR, %	1978	Future
	(Million Pounds)					
West Coast	130	260	375	9.1	0	0
	(Thousand Metric Tons)					
Japan	577	855	1,045	5.1	1,131	1,331
Korea	131	245	330	8.0	70	150
Taiwan	74	155	225	9.7	50	180
Hong Kong	18	33	41	7.1	0	0
ASEAN Countries	105	209	303	9.2	20	100-200*

* Future projects not certain.

The significant polypropylene markets are in the Pacific Basin, where an Alaskan plant would face strong competition from the large Japanese producers. Polypropylene production does not look attractive, except possibly for selected Japanese firms with a strong position in the Pacific Basin.

10. Phenol

Phenol is primarily used for the production of phenolic adhesives for plywood and other forest products. In the Pacific Basin countries, phenolic resins are not generally used in plywood manufacture. The West Coast market for phenol is currently about 300 million pounds while the Pacific Basin market is only 500 million pounds, as shown in Table I-C-9. By 1985, the overall market will reach 1.2 billion pounds.

TABLE I-C-9

PHENOL

	Demand				Capacity, per year	
	1978	1985	1990	AAGR, %	1978	Future
		(Million Pounds)				
West Coast	305	430	520	4.5	140	165
		(Thousand Metric Tons)				
Japan	202	295	405	6.0	316	416
Korea	10	24	35	11.0	0	0
Taiwan	8	18	24	9.6	0	0
Hong Kong	neg.	neg.	neg.	-	0	0
ASEAN Countries	12	18	23	5.5	0	0

The West Coast market is largely captive and the Pacific Basin market is relatively small; thus, marketing the output from a world-scale 400-500 million pound per year unit is not feasible.

11. Acrylonitrile

Acrylonitrile is primarily used for the production of acrylic fibers and ABS resins. The West Coast acrylonitrile market is negligible while the Pacific Basin market was about 1.6 billion pounds in 1978. It should increase to 2.3 billion pounds by 1985, as shown in Table I-C-10.

TABLE I-C-10

ACRYLONITRILE

	Demand				Capacity, per year	
	1978	1985	1990	AAGR, %	1978	Future
	(Million Pounds)					
West Coast	8	10	13	4.2	0	0
	(Thousand Metric Tons)					
Japan	515	700	860	4.4	744	744
Korea	124	190	240	5.7	77	177
Taiwan	84	154	198	7.4	132	132*
Hong Kong	neg.	neg.	neg.	-	0	0
ASEAN Countries	neg.	neg.	neg.	-	0	0

* Additional facilities expected.

There is a large excess of acrylonitrile capacity on the Gulf Coast, and the Pacific Basin countries are adequately supplied with regional production. As a result, an Alaskan facility would not be attractive.

12. Isopropyl Alcohol

Isopropyl alcohol is used as a solvent and for the production of acetone. The West Coast isopropyl alcohol demand was 165 million pounds in 1978 while the Pacific Basin market was of comparable size. By 1985, the overall market should reach 500 million pounds, as shown in Table I-C-11.

TABLE I-C-11

ISOPROPYL ALCOHOL

	Demand				Capacity, per year	
	1978	1985	1990	AAGR, %	1978	Future
	(Million Pounds)					
West Coast	165	198	220	2.4	215	215
	(Thousand Metric Tons)					
Japan	65	83	95	3.2	105	105
Korea	2	3	3	-	0	0
Taiwan	1	32	32	-	0	30
Hong Kong	2	3	4	-	0	0
ASEAN Countries	7	11	15	6.6	0	0

Since demand for the product is relatively small and adequate capacity exists, isopropyl alcohol production in Alaska is not viable.

13. Propylene

Propylene is primarily used for the production of derivatives at adjacent or nearby sites. Although the product is easier to ship than ethylene, large-scale exportation is generally not practiced, although Korea is a significant importer at present and a project based on imported propylene is envisioned for the Philippines. It is anticipated that adequate supply will exist in the Pacific Rim area and thus large shipments from Alaska would not be viable from a market standpoint.

D. Feasibility of an Alaskan Petrochemical Complex

The core of a natural gas liquids based petrochemical complex is an olefins plant which produces ethylene as the prime product. The simplest and lowest cost olefin units are based on ethane feed. If propane and/or butane are used as the feedstock instead of ethane, significant quantities of propylene are also produced.

In order for a petrochemical complex to be viable, a sufficient volume of derivatives must be produced to utilize the production from a world-scale

olefins unit. The economic size is at least 1 billion pounds per year of ethylene capacity.

The manufacture of low and high density polyethylene, styrene, vinyl chloride, and ethylene glycol in world-scale units were found to be viable. Table I-D-1 summarizes the potential ethylene consumption by derivative.

TABLE I-D-1

POTENTIAL ETHYLENE CONSUMPTION BY DERIVATIVE
(Million Pounds Per Year)

Derivative	Derivative Plant Size	Ethylene Consumption at Capacity
Low Density Polyethylene	500	525
High Density Polyethylene	250-400	260-420
Styrene	600-800	200-270
Vinyl Chloride	500-1,000	250-500
Ethylene Glycol	400-500	320-400
		1,555-2,115

Based on the market situations, an Alaskan petrochemical complex would most likely consist of low and high density polyethylene facilities plus a styrene, vinyl chloride, or ethylene glycol plant. The actual units considered would primarily be dictated by the nature of the specific firms involved in the project.

The market for propylene derivatives does not look very good. However, if it is necessary to use propane and/or butanes as part of the feed, a 200 million pound per year polypropylene plant probably would be viable.

Basically, the petrochemical markets in the Pacific Rim area are sufficient to support a major complex in Alaska at present and probably a second complex in the late 1980s.

II. INTRODUCTION

The natural gas at Prudhoe contains large amounts of natural gas liquids (ethane, propane and butanes). These materials are desirable feedstocks for the production of a range of petrochemicals. As a result, there has been considerable interest in determining the feasibility of a petrochemical complex in Alaska based upon utilization of these materials. Such a complex would provide steady long-term employment and help diversify the Alaskan economy.

As part of their efforts, the Royalty Oil and Gas Development Advisory Board, Department of Natural Resources, State of Alaska, commissioned Chem Systems Inc. to prepare an analysis of the Pacific Rim markets for petrochemicals which could be produced from natural gas liquids. This area encompasses the western parts of the United States and Canada and the Far Eastern and Southeast Asian countries. The study entailed analyzing the market situations for those large volume basic petrochemicals, chemical intermediates, and plastic resins which are natural gas liquids derived and, based upon anticipated supply and demand relationships, market structure, etc., determining those products which could be produced in Alaska in world-scale facilities.

III. MARKET CHARACTERISTICS

A. North American West Coast

1. U.S. West Coast

a. Background

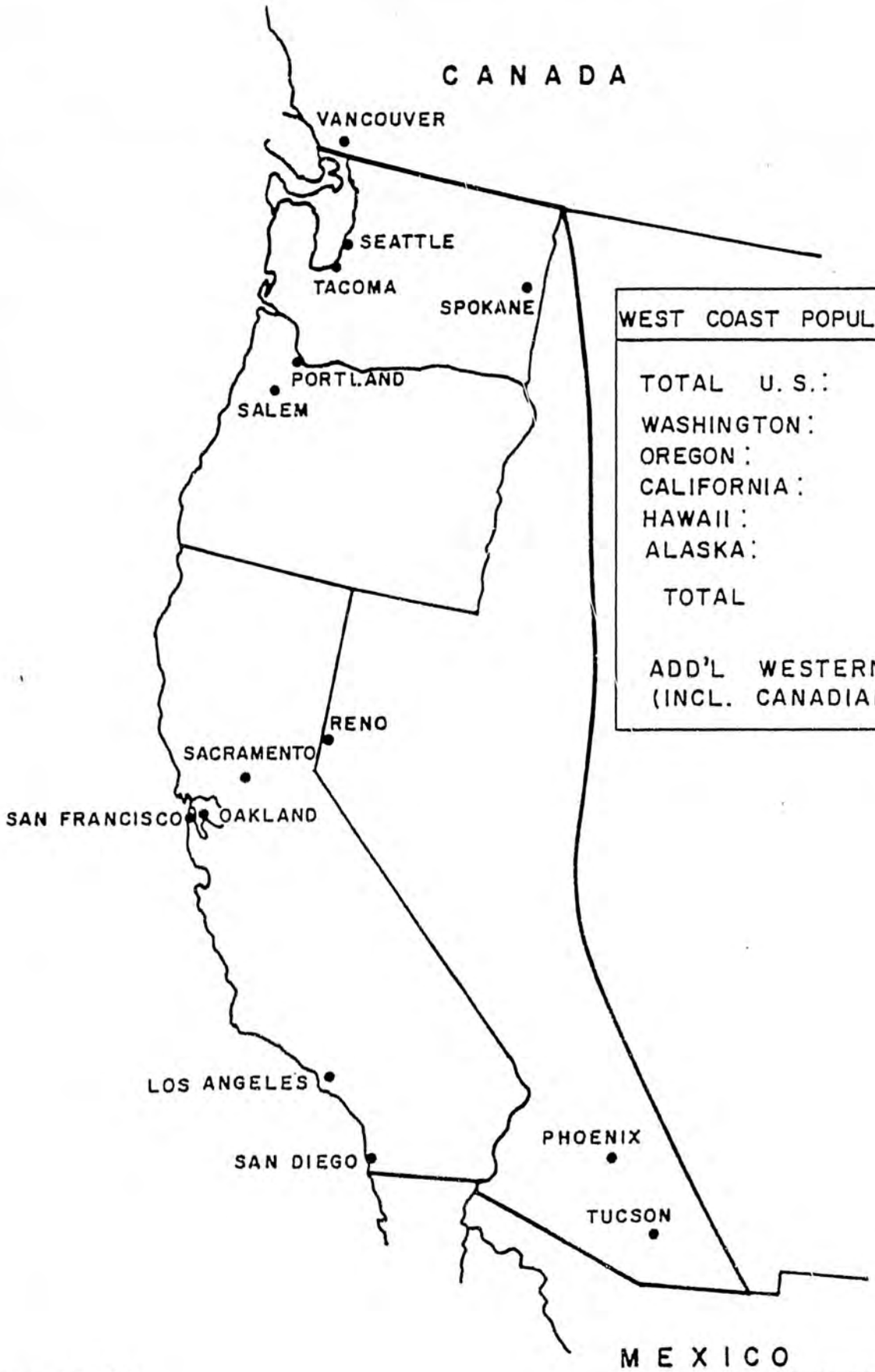
The U.S. West Coast has always had the distinction of being part of, yet somewhat separate from, the overall U.S. market, which is concentrated east of the Rockies. This is due to the mountains and to considerable distances separating the region from other major population and industrial centers. The Pacific or West Coast Region is considered that area to the West of the Sierra Nevada mountains and the Cascade Range. Within the Pacific region is California, the largest state, with Oregon and Washington to the north. Also included for purposes of this report, but of relatively small impact, are Hawaii and Alaska. The area adjacent to the Pacific region, between the Rockies and the Pacific region, is the so-called Mountain Region. The two most populated states in this region are Colorado and Arizona, and they can be considered adjunct markets to the West Coast Pacific Region. A map showing the region is presented in Figure III-A-1.

Population

The population of the West Coast Region in 1977 was about 29.3 million, of which 28.0 live in California, Oregon and Washington. The regional total equals about 13.5 percent of the U.S. population of 217 million. The population breakdown by state in the West Coast Region is also indicated in Figure III-A-1. California is by far the largest market with 75 percent of West Coast population.

By 1980 and 1985, if the 1960-1970 migration patterns within the United States continue, the percentage of population in the West Coast region will rise from 12.5 percent of the U.S. total in 1977 to 14.0 percent in 1980 and 14.4 percent in 1985, as shown in Table III-A-1.

FIGURE III – A – 1



WEST COAST POPULATION BREAKDOWN	
TOTAL U. S.:	213 MM
WASHINGTON:	3.5 MM
OREGON:	2.3 MM
CALIFORNIA:	21.2 MM
HAWAII:	0.9 MM
ALASKA:	0.4 MM
TOTAL	28.3
ADD'L WESTERN MARKETS (INCL. CANADIAN):	5 MM

AGO 559552

CHEM SYSTEMS INC.
PROJECT NO. 527 DATE

In 1985, West Coast population is anticipated to reach 34.5 million, a growth of 22 percent over the decade in contrast to a U.S. growth of only 12 percent.

TABLE III-A-1

U.S. WEST COAST POPULATION PROJECTIONS

	1977	1980	1985	AAGR, %*
Total U.S.	216.8	226.9	239.3	1.2
U.S. West Coast	29.3	31.8	34.5	2.0
West Coat, % of U.S.	13.5	14.0	14.4	

* Average annual growth rate.

Although the population of the West Coast is larger than that of many countries with fair-sized petrochemical industries, such as Canada, Australia and the Benelux countries, it still is relatively small and spread out by U.S. standards. For instance, the East Coast market, which is shown in Figure III-A-2, is roughly comparable in size, but has nearly three times the population.

Manufacturing and Agricultural Activities

In 1975, the latest year for which statistics are available, value added by manufacture on the West Coast totaled about $53 billion, or 12 percent of the overall U.S. figure of $445 billion. This percentage is roughly comparable to the West Coast's share of population. However, the distribution of manufacturing activities within the region is substantially different than that for the U.S., as is shown in Table III-A-2. The region is relatively important in food processing, lumber and wood, petroleum and transportation equipment, while its activities in tobacco, textile mill products, chemicals, leather and primary metals are substantially less than the U.S. average. In addition, in most industrial segments, the distribution of activities within a segment is considerably different from that in the country as a whole. For instance, the West Coast's share of electrical and electronic equipment

FIGURE III – A – 2

DEMOGRAPHIC STATISTICS

TOTAL U.S. POPULATION:	213 MM
NEW ENGLAND MARKET:	12 MM
MIDDLE ATLANTIC MARKET:	48 MM
SOUTHEAST U.S. MARKET:	29 MM
WEST COAST MARKET:	28 MM

AGO 559554

CHEM SYSTEMS INC.
PROJECT NO. 527 DATE

manufacture is in line with its share of the population, but in the West Coast this market consists almost entirely of the electronics segment of this market. The situations for the major manufacturing industries are briefly described below.

TABLE III-A-2

U.S. WEST COAST VALUE ADDED BY MANUFACTURE, 1975*
(Billion Dollars)

SIC Group		Total U.S.	U.S. West Coast	Percent of Total U.S.
20	Food and Kindred Products	48	7.5	16
21	Tobacco	4	-	-
22	Textile Mill Products	12	small	2
23	Apparel	15	2	12
24	Lumber and Wood	10	4	37
25	Furniture and Fixtures	6	1	13
26	Paper and Allied Products	18	2	13
27	Printing and Publishing	24	3	10
28	Chemicals	45	3	6
29	Petroleum and Coal	10	1.5	16
30	Rubber and Misc. Plastics	14	1	9
31	Leather and Leather Products	3	small	2
32	Stone, Clay and Glass	16	2	11
33	Primary Metal Industry	30	2	7
34	Fabricated Metal Products	35	3.5	11
35	Machinery, except Electrical	46	4	10
36	Electric and Electronic Equipmnt	35	5	14
37	Transportation Equipment	45	9.5	21
38	Instruments	14	2	12
39	Misc. Manufacturing Industries and Others	15	small	9
	Total	445	53	12

Source: Bureau of the Census, Annual Survey of Manufactures, 1975.

* Lastest year for which information is available.

Food and Kindred Products (SIC 20) is the second largest industry within the region, with a value added of $7.5 billion. It consists of the large canned, frozen and dehydrated food industries throughout the region which serve both regional and national markets. Also included is the California wine industry, which represents about 7 percent of the total.

Tobacco (SIC 21) and Textile Mill Products (SIC 22) industries are relatively small in the region, with the tobacco industry being virtually non-existent and the California textile industry accounting for less than 2 percent of the U.S. total.

The Apparel (SIC 23) industry of the region is about in line with its population percentage. The industry is primarily concentrated in California, although there are small operations in Oregon, Washington and Hawaii.

The $4 billion Lumber and Wood (SIC 24) industry on the West Coast represents over one-third of the U.S. total. California, Oregon and Washington each represent over $1 billion in value added in their plywood, saw mill and related operations.

The Furniture and Fixtures (SIC 25) industry of the West Coast represents its share of the U.S. total. It is concentrated in California, which represents 85-90 percent of the regional total of about $800 million. The Paper and Allied Products (SIC 26) and Printing and Publishing (SIC 27) industries also represent the West Coast share of the population.

The Chemical (SIC 28) industry is also concentrated in California. The soaps and detergents, toilet goods, pharmaceutical and inorganic chemical segments are relatively important, while the basic and intermediate petrochemical segments are relatively small.

The $1.5 billion Petroleum and Coal (SIC 29) activity is due to the West Coast refinery industry. Rubber and Miscellaneous Plastics (SIC 30) is primarily accounted for by the California plastics fabrication industry, although there is some tire manufacture within the region.

The Leather (SIC 31) industry is insignificant within the region, but the Stone, Clay and Glass (SIC 32) industry is in line with the region's population percentage. This segment includes gypsum, cement and concrete.

The Primary Metal Industry (SIC 33) is relatively small within the region, representing only 7 percent of the U.S. total. A significant part of this segment is aluminum smelting in Washington and Oregon. Fabricated Metal Products (SIC 34), on the other hand, is more in line with population share due to the aircraft and construction activities within the region.

Machinery, except Electrical (SIC 35) consists of industrial machinery and computers, which account for about a third of the regional total of $4 billion. Electric and Electronic Equipment (SIC 36) consists of essentially all other electrical and electronic equipment. As a result, these classifications tend to understate the importance of the region's electrical and electronics industry, which is about 16-17 percent of the nation's total. This industry is centered in California.

Transportation Equipment (SIC 37) is the largest industry on the West Coast with value added of $9.5 billion, over 21 percent of the U.S. total. Most of this total is accounted for by the aircraft industry in California and Washington.

The regional total for Instruments (SIC 38) and Miscellaneous Manufacturing Industries (SIC 39), which includes toys and jewelry, tend to be in line with population share.

In addition to manufacturing activities, the West Coast is an important agricultural center. Commercial vegetable production is over half the U.S. total, with the region supplying most of the country for the winter months. Fruits are also important, with the regional production of some important products such as apples and peaches representing over 40 percent of U.S. production. The region is much less a factor in grain production, although wheat, barley and rice production are significant.

Markets for Petrochemicals

Due to the differences between the composition of the industrial and agricultural activities of the West Coast relative to the overall U.S.,

petrochemical demand estimates based strictly upon per capita consumption are very misleading. Among the most important markets for petrochemicals are the automobile, fiber, synthetic rubber and the chemical industry itself. Figure III-A-3 shows the historical location of these industries and indicates that the West Coast is not an important location for them. There is no indication that the existing situation will change in the next several years, if ever. This means that regional demand for certain plastic resins, such as acrylonitrile-butadiene-styrene and polypropylene, which are oriented to the automobile and appliance industries, will be small. Likewise, the lack of fiber and synthetic rubber industries means that there is essentially no demand for key raw materials for these industries, such as acrylonitrile and butadiene. The chemical industry has historically been its own best customer. The lack of a large chemical industry means that demand for chemical intermediates tends to be rather low.

The important industries within the region are agriculture and related food processing applications, lumber and wood, transportation equipment and the electronics industry. Since agriculture and food processing involve packaging, consumption of materials such as low density polyethylene would tend to be higher. The large lumber, aircraft, boat building and electronics industries, unfortunately, are not large petrochemical consumers, although consumption of specific products such as phenolic, unsaturated polyester and epoxy resins would tend to be relatively high.

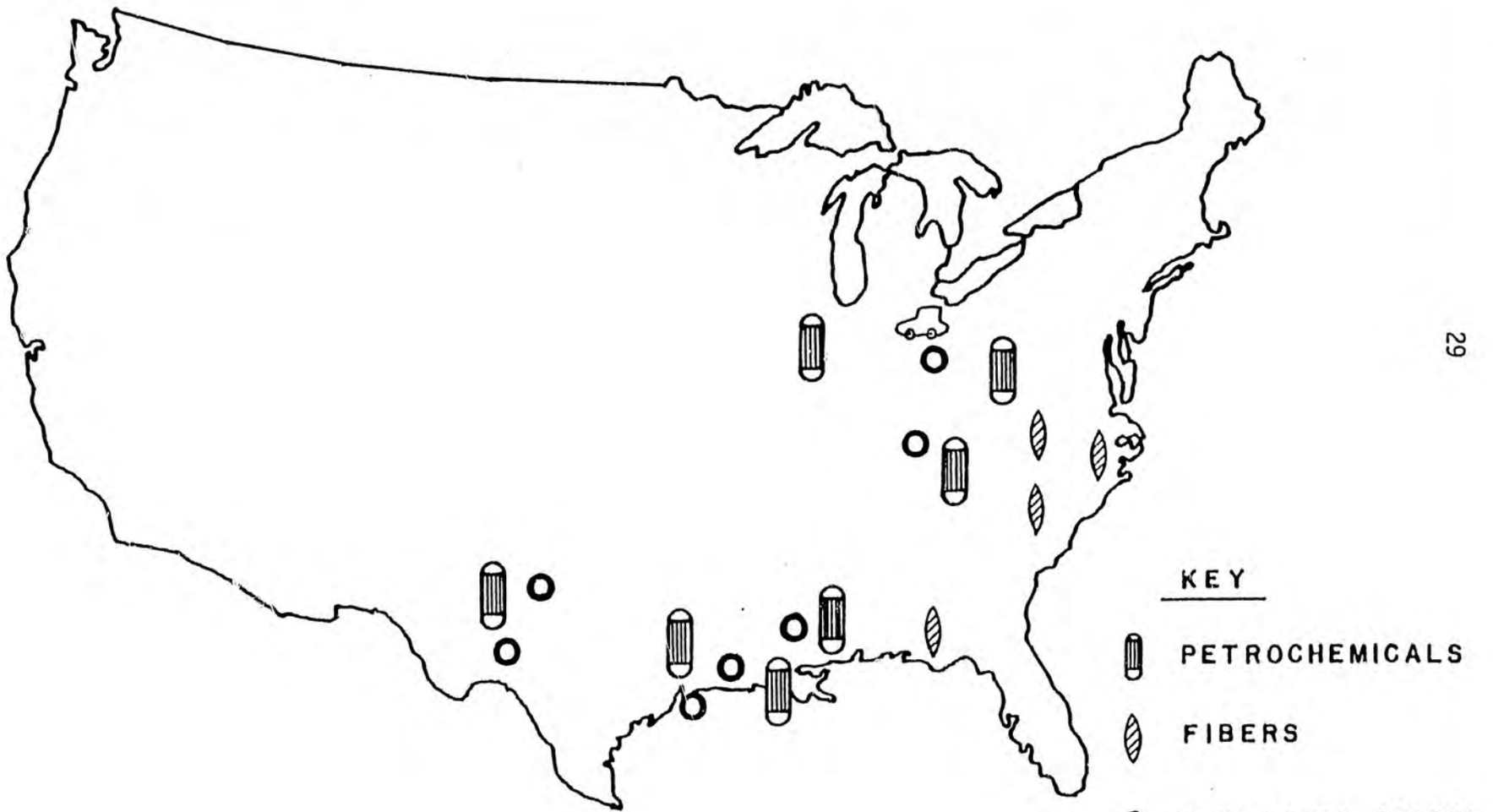
Lastly, there are some markets where the consumption is population related. This is true for large segments of the packaging industry, which is related to the demand for commodity resins and certain other industries, such as coatings and inks, which are important consumers of materials such as solvents.

b. Petrochemical Overview

This section presents an overview of the existing West Coast petrochemical industry. Detailed information on specific products is presented in Section IV of this report.

FIGURE III – A – 3

IMPORTANT GEOGRAPHICAL MARKETS FOR PRIMARY PETROCHEMICALS & INTERMEDIATES



CHEM SYSTEMS INC.
PROJECT NO. 5 2 7 DATE

AGO 559559

The existing petrochemical industry on the West Coast is quite small. A number of important petrochemicals, such as butadiene, the elastomers and many resins, are not produced within the region. For those products which are produced, regional capacity generally averages less than 5 percent of the U.S. total.

At present, most of the petrochemical industry is centered around Los Angeles. In addition, Chevron has some derivative facilities at its Richmond (San Francisco Bay) site. There are also carbon black plants in the desert and there is one petrochemical plant in Washington. A list of the petrochemical plants within the region is shown in Table III-A-4, and the locations for these facilities are shown in Figure III-A-1.

Basic petrochemical production is very small. Ethylene is obtained from refinery gas by Union Carbide and Arco. In addition, Shell and Chevron utilize refinery propylene in derivative production. Regional capacity for these olefins is only about 1 percent of the U.S. total. Both Arco and Chevron have reformer benzene facilities to meet regional needs. In addition, Chevron has ortho and para-xylene facilities designed to serve regional, U.S. and export markets. Carbon black is produced by three firms in facilities designed to meet regional needs.

Only seven intermediate petrochemicals are produced within the region (vinyl chloride, ethyl chloride, isopropyl alcohol, acetone, phthalic anhydride, cumene and phenol). This is a small percentage of the approximately 30 intermediates which are produced in significant volume. These intermediates are consumed within the region, with the region being self-sufficient in ethyl chloride, isopropyl alcohol, acetone, phthalic anhydride and cumene.

Low density polyethylene is the only polyolefin resin produced on the West Coast. The output from the Union Carbide facility satisfies less than 20 percent of regional demand. On the other hand, most of the West Coast polyvinyl chloride and polystyrene resin demand is met with production from within the region.

TABLE III-A-4

EXISTING U.S. WEST COAST PETROCHEMICAL FACILITIES
(Million Pounds per Year)

Product	Company	Location	Capacity	% of U.S. Capacity
Basic Petrochemicals				
Ethylene (from refinery gas)	Arco	Wilmington, CA	100	
	Union Carbide	Torrance, CA	170	
			270	1
Propylene (from refinery gas)	Shell	Dominquez, CA	100	
	Chevron	Richmond, CA	200	
		El Segundo, CA	100	
			400	2
Benzene (reformer)	Arco	Wilmington, CA	14*	
	Chevron	El Segundo, CA	15	
			29*	1
o-Xylene	Chevron	Richmond, CA	150	10
p-Xylene	Chevron	Richmond, CA	110	2
Carbon black (furnace)	Ashland	Mojave, CA	60	
	Cities Service	Mojave, CA	53	
	Continental Carbon	Bakersfield, CA	77	
			190	5
Intermediates & Solvents				
Vinyl chloride monomer	Stauffer Chemical	Watson, CA	175	2
Cumene	Chevron	El Segundo, CA	100	2
Phenol	Chevron	Richmond, CA	50	
	Ferro	Santa Fe Springs, CA	2	
	Kalama	Kalama, WA	75	
			127	4

* Million gallons.

TABLE III-A-4 (Cont'd)

Product	Company	Location	Capacity	% of U.S. Capacity
Intermediates & Solvents				
Phthalic anhydride	Allied Chemical	El Segundo, CA	36	
	Chevron	Richmond, CA	50	
			86	7
Isopropyl alcohol	Shell Chemical	Dominquez, CA	210	8
Acetone	Shell Chemical	Dominquez, CA	100	
	Chevron	Richmond, CA	33	
			133	4
Ethyl chloride	Stauffer Chemical	Long Beach, CA	100	14
Plastic Resins				
Low density polyethylene	Union Carbide	Torrance, CA	140	2
Polyvinyl chloride	B.F. Goodrich	Long Beach, CA	150	
	Keysor Century	Saugus, CA	50	
	Stauffer Chemical	Carson, CA	140	
			340	5
Polystyrene	A&E Plastik	City of Industry, CA	45	
	Dow Chemical	Torrance, CA	200	
	Monsanto	Long Beach, CA	50	
	Amoco Chemical	Torrance, CA	35	
	Sterling Plastics	Los Angeles, CA	60	
	Mobil Chemical	Santa Ana, CA	30	
			420	8

2. Canadian West Coast

a. Background

British Columbia is the most Westerly province of Canada. It has an area of 366,255 square miles, including 6,976 square miles of freshwater lakes. It ranks third in size among the ten provinces. Its length from north to south is 760 miles; its average width from west to east is over 400 miles. The Yukon Territory and the Northwest Territories lie to the north of the province, while the states of Washington, Idaho and Montana are to the south. Alberta is to the east. On the west, B.C. is bounded by the Pacific Ocean as far north as 50° 40"; between that point and 60°N lies the "panhandle" of Alaska.

The warm Japanese current gives the coastal region of B.C. a very moderate climate. Weather conditions on Vancouver Island and in the heavily populated southwest corner of the mainland are frequently compared with those in England; but the summers are longer, warmer and brighter. The winters are damp, but extremes of temperature are unusual. These conditions have made the region a popular resort area and have also attracted many retired people.

The capital of B.C. is at Victoria on Vancouver Island. The province currently has a population of 2.5 million, growing at an average of 24 percent per decade. British Columbia represents 10.77 percent of the total Canadian population. About 77 percent of the population is urbanized, with 1.1 million living in the Greater Vancouver area. The population is overwhelmingly of British origin. The 1971 census indicated that 58 percent of the population was of British origin.

The province is a significant market for many goods. In 1978, retail sales totaled $8.1 billion (Canadian), which represents 12.03 percent of the total retail sales in Canada and which was 12 percent above the national average. Personal disposable income totaled $18.3 billion (Canadian) in the same year, which was 11.75 percent of the total for

Canada. This translates into a per capita disposable income of $7,220 (Canadian), which was 9 percent above the national average. Real economic growth for the province is forecast at 4-5 percent annually for the foreseeable future.

Industrial Development and Infrastructure

A major influence in the development of the province was the 1915 completion of the Panama Canal, which opened European markets to B.C. products and made Vancouver a major port. The Second World War started spectacular growth in the forest industries, hydro-electric power and manufacturing.

Nearly three quarters of the province is forest covered. There are large mineral-rich areas, and B.C. ranks second only to Quebec in potential water resources. The forest industry has been the backbone of the economy, although mining recently challenged it for supremacy when annual production topped one billion dollars. Most of the production of both industries is exported. Because it depends so heavily on exports, B.C. favors free trade. Export sales exceeded $8 billion in 1978, or 18 percent of the total for Canada. The United Kingdom and European Economic Community each take above 10 percent of B.C. exports, Japan 20 percent and the U.S. over 50 percent. Manufacturing related to forest resources (wood products, pulp and paper) normally accounts for nearly half of all factory employment.

British Columbia ranks fourth among the provinces in total mining production. The volume and value of its products varies considerably from year to year, reflecting the state of world markets and other factors. In 1977, mineral production reached $1.9 billion, representing 10.4 percent of the total for all of Canada. The province is the third largest producer of metals, the most important of which are lead, zinc, copper and molybdenum. Most of the lead, zinc and silver produced in the province comes from the famous Sullivan mine at Kimberly, owned by Cominco Ltd.

Petrochemical Overview

British Columbia has only one petrochemical plant, the 70 million pound per year phenol plant at Ladner. This facility primarily supplies material for the Borden and Reichhold phenolic resin plants which serve the forest products industry within the province. Consideration has been given to upgrading petrochemical raw materials from Alberta in British Columbia to serve Pacific Rim markets, but no firm plans currently exist.

B. Pacific Basin Market

In this report, Japan, Korea, Taiwan, Hong Kong and the ASEAN countries (the Philippines, Singapore, Malaysia, Thailand and Indonesia) were studied. A map showing the locations of these countries is presented as Figure III-B-1. In addition, consideration was given to the import situation in the People's Republic of China.

1. Japan

a. Background

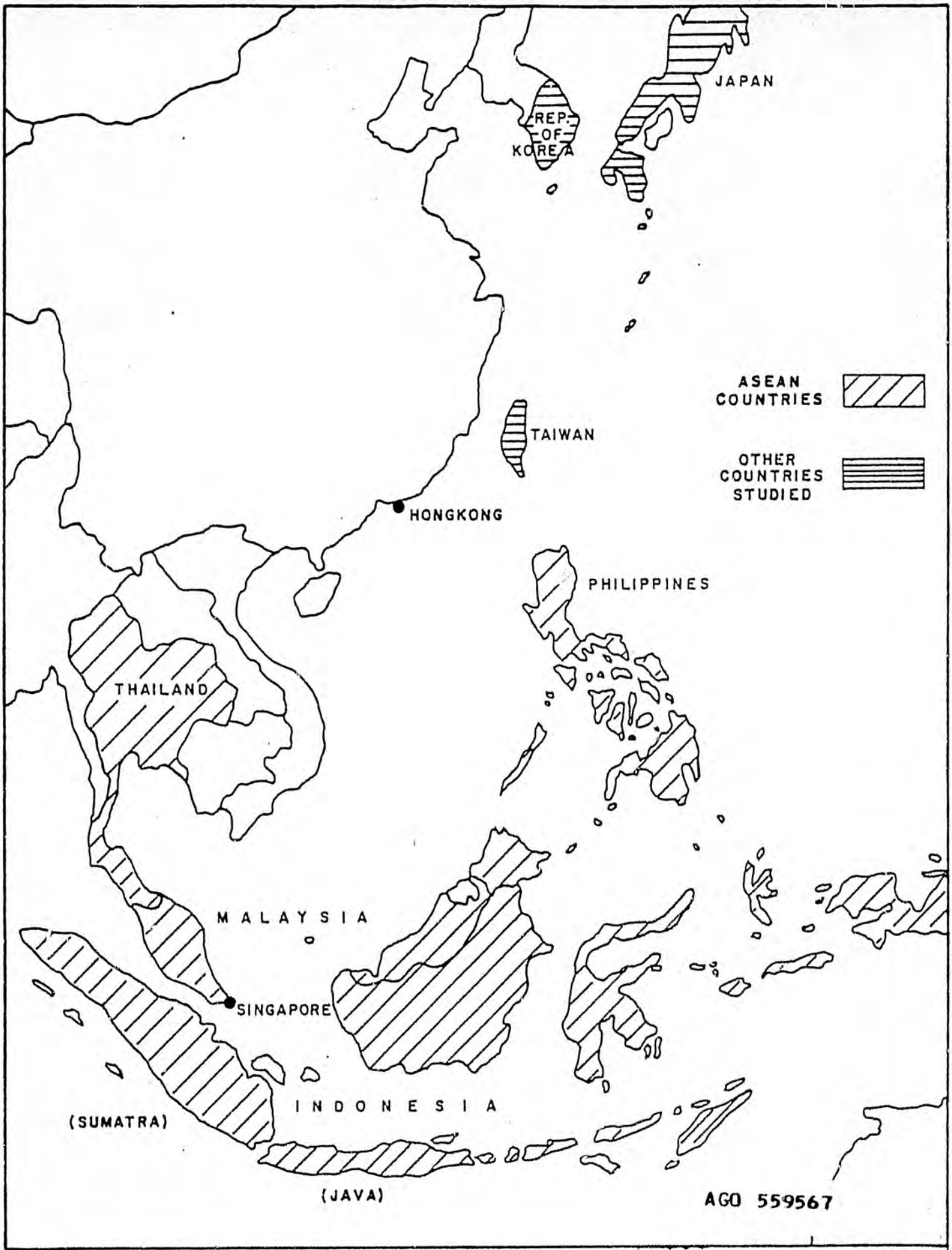
Japan has a land area of approximately 140,000 square miles on four main islands. The country is mostly mountainous, with only about 16 percent of the land area arable. Population was estimated at 113.0 million in 1978, growing at 1.2 percent per year. About 70 percent of this population is urbanized. The very high population density has become a constraint on the overall industrial growth of the country.

The capital and chief commercial center, Tokyo, has a population of 8.7 million. Other principal cities are Osaka (2.8 million), Yokohama (2.6 million) and Nagoya (2.5 million). The total labor force is estimated at nearly 55 million.

Gross national product increased at a compound annual rate of 10.5 percent in real terms during the 10-year period of 1964-1973. In 1974, however, the effects of the OPEC price rises and world recession produced the first GNP decline (1.2 percent) in decades. This was followed by a modest 2.1 percent rise during 1975; the recovery was well under way by the end of 1975, real growth of around 6 percent was achieved during 1976, and moderate growth has continued. Most of the Japanese goverment, industry and public now appear to have accepted that the era of very high growth rates is gone forever, and the government is taking steps to face a new phase of lower growth, which is anticipated to be in the 5 percent per annum range over the period through 1985. The rapid growth of the

FIGURE III-B-1

PACIFIC BASIN COUNTRIES



CHEM SYSTEMS INC.

PROJECT NO. 527 DATE

1960s was based upon transfer of labor into new, fast growing industries, upon imported technology, upon aggressive exporting in a favorable market climate and upon cheap imported energy. Even this new lower level of growth is proving difficult to achieve. The export drive has been highly successful, but the major developed markets of Western Europe and the U.S. are reaching the limits of Japanese penetration in many industries.

Since these existing major markets are reaching their limits, attention is being given to exporting products and complete plants to "third world" markets, particularly in Southeast Asia and the Middle East. Government planning is very consensus-oriented. Public pressure and opinion, with regard to pollution, "quality of life" and similar factors, are a major input to future economic and social planning. This was largely responsible for the Japanese drive to invest in heavy industry and petrochemicals in Southeast Asia, the Middle East and elsewhere, importing products or supplying export markets from these offshore plants as required and thus avoiding further overcrowding and pollution in Japan itself. However, due to slowing growth rates and overcapacity in many industries, including petrochemicals, this trend has been greatly curtailed.

Japan has a unique "lifetime employment system." This system involves extremely high fixed overhead costs to manufacturers because of generous social provisions plus the inability to reduce the labor force in times of reduced demand. Coupled with the traditionally highly leveraged financial structure (only 10-20 percent equity) of Japanese industry, this provides a tremendous incentive to keep operating levels high to cover fixed costs, even if no return on equity capital is generated; hence, the Japanese are determined to achieve high production and export volumes, often at the expense of price levels.

b. Petrochemical Overview

Japan has the second largest refining capacity in the free world, with crude capacity of 5,480,000 barrels per day in 1978. However, the country is forced to import essentially all of its crude since crude

reserves are only 60,000,000 barrels and production is only about 10,000 barrels per day. The country is also deficient in natural gas, with reserves being only 500 billion cubic feet.

The Japanese petrochemical industry grew rapidly during the 1960s and early 1970s to the point where the country is the second largest producer in the world when measured in terms of basic olefins production. The Japanese industry flourished due to the importation of technology from the U.S. and Europe and a favorable feedstock situation based upon low cost crude oil from the Middle East. A substantial home market, plus substantial petrochemical exports, both directly and in the form of manufactured goods, allowed for the erection of world-scale processing units.

The increase in crude oil prices and the recent worldwide recession greatly changed the outlook for the Japanese petrochemical industry from one of extreme optimism to one of considerable pessimism because Japan is now a relatively high cost producer and is facing sharply increased competition in traditional export markets. Ethylene production is a good barometer of petrochemical industry activity. The production levels for the past few years are listed in Table III-B-1. Production fell sharply due to the worldwide recession, and 1978 was the first year in which production exceeded the pre-recession level.

TABLE III-B-1

JAPANESE ETHYLENE PRODUCTION
(Thousand Metric Tons)

1971	3,486
1972	3,816
1973	4,112
1974	4,177
1975	3,358
1976	3,767
1977	3,974
1978	4,387

A list of current Japanese ethylene capacities is shown in Table III-B-2. These capacities tend to reflect the relative size of each firm in the production of large-volume petrochemicals, since petrochemical

complexes in Japan tend to be free standing rather than tied together, as in the U.S. Gulf Coast "spaghetti bowl". After considerable delay, expansions to capacity are being made due to specific company needs for derivative manufacture.

TABLE III-B-2

JAPANESE ETHYLENE PRODUCERS, 1978
(Thousand Metric Tons per Year)

Company	Capacity
Mitsubishi Petrochemical	640
Sumitomo Chemical	570
Mitsubishi Chemical	528
Tonen Petrochemical	501
Maruzen Petrochemical	480
Mitsui Petrochemical	717
Sanyo Petrochemical	390
Idemitsu Petrochemical	362
Nippon Petrochemical	484
Osaka Petrochemical	330
Shindaikyowa Petrochemical	320
Showa Petrochemical	520
Total	5,842

Since there are environmental problems with broad expansion at existing petrochemical sites, much of the expansion at these locations will be of the "scrap and build" approach. In addition, approval has been granted for the development of new petrochemical complex sites on Hokkaido and the northern part of Honshu. This should alleviate, to a degree, the environmental concerns. Full development of these northern sites in the near future is questionable, however, due to business climate concerns. During most of the study period, petrochemical development will occur at or near existing plant locations. Figure III-B-2 is a map showing existing and possible future petrochemical sites in Japan.

While the Japanese petrochemical industry should expand at a rate which is lower than traditional, there has been a re-evaluation of the Japanese producer's role in overseas petrochemical projects. The rapid development of the overseas projects was based on a number of factors which included:

FIGURE I B-2

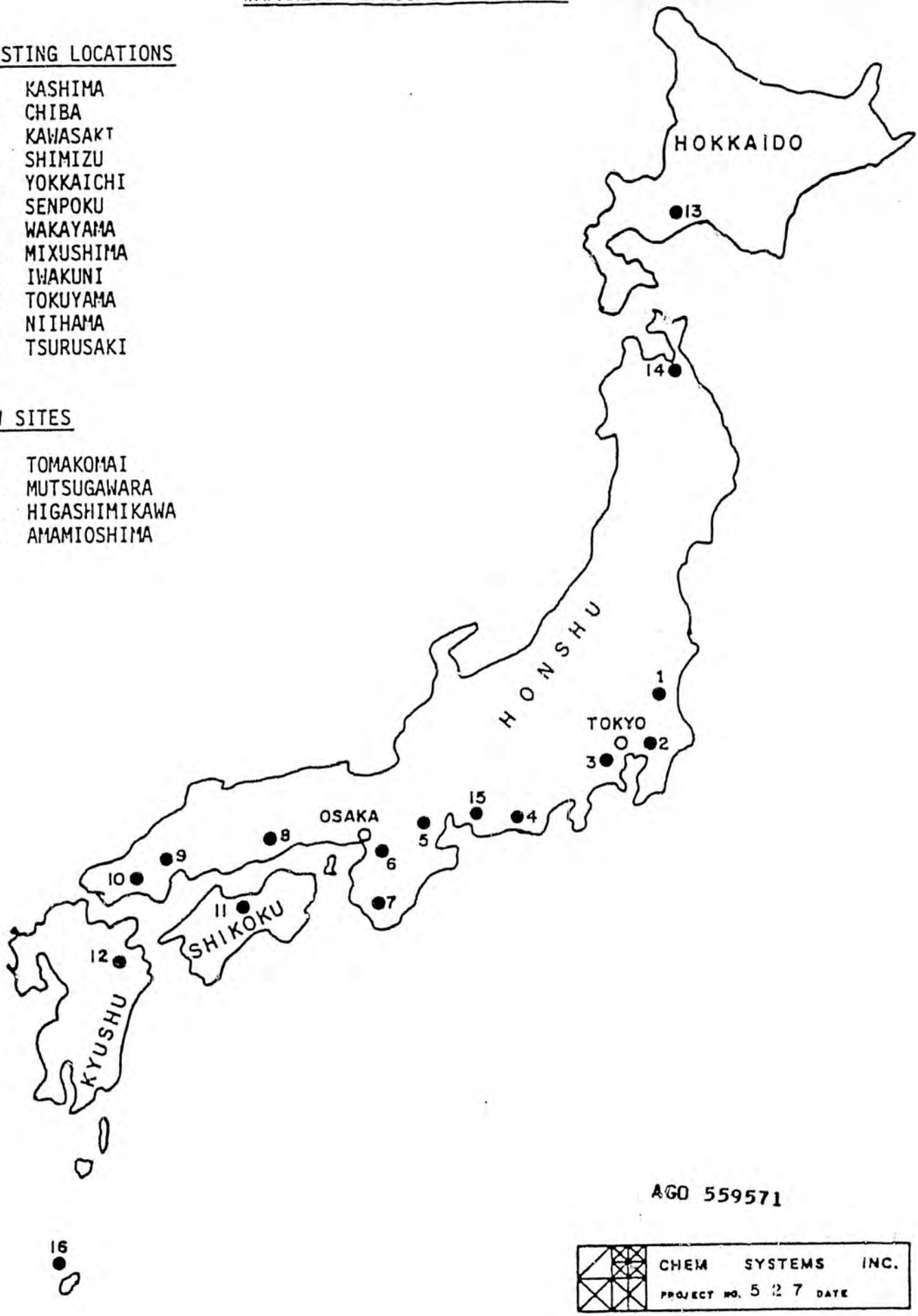
JAPANESE PETROCHEMICAL SITES

EXISTING LOCATIONS

1. KASHIMA
2. CHIBA
3. KAWASAKI
4. SHIMIZU
5. YOKKAICHI
6. SENPOKU
7. WAKAYAMA
8. MIXUSHIMA
9. IWAKUNI
10. TOKUYAMA
11. NIIHAMA
12. TSURUSAKI

NEW SITES

13. TOMAKOMAI
14. MUTSUGAWARA
15. HIGASHIMIKAWA
16. AMAMIOSHIMA



AGO 559571

CHEM SYSTEMS INC.
PROJECT NO. 5 2 7 DATE

- Yen re-evaluation, which reduced the competitiveness of Japanese exports.

- High foreign currency levels and a drive to invest money out of Japan.

- Reaction to pollution problems made it difficult to locate new sites for expansion in Japan.

- The high cost and questionable supply of energy has supported the implementation of petrochemical projects in oil-producing countries.

Since the oil crisis, a re-evaluation of the commitment to overseas projects has occurred, and a number of projects have been dropped. The Mitsui project in Iran, while about 80 percent complete, is just getting restarted after about a year's delay, due to the upheavel in that country. The Sumitomo project in Singapore is proceeding, but at a slow pace. The Mitsubishi group is planning a project in Saudi Arabia, but completion before the late 1980s is not foreseen.

While most of the overseas project development has been by private companies, there is now an effort underway to involve the government in programs to assist the economic development of the less developed countries and secure a dependable oil supply. These projects are taking on a socio-economic overtone, which will necessitate the assistance of the government.

2. Republic of Korea

a. Background

The Republic of Korea (South Korea), with a land area of 37,000 square miles, occupies the southern half of the Korea Peninsula. The whole peninsula is mountainous, particularly the northern and eastern areas.

Good harbors are found only on the western and southern coasts. The largest port and second city is Pusan. Population is approximately 39 million, growing at an average of 2.0 percent per annum. About 55 percent of the population is urbanized, with 6.5 million in the capital, Seoul. The labor force is estimated at 13 million. The population is completely homogeneous, with almost no foreign or minority groups.

Korea is poor in natural resources, densely populated, supports a large military establishment and suffers from shortages of proficient managers and technicians. The great asset of an industrious and able work force, however, has supported rapid industrialization since the early 1960s. GNP rose at over 10 percent per annum through the decade to 1975, based upon exports of light industries such as textiles, clothing, electronics and plywood.

Over the next several years, GNP growth is anticipated to average about 8 percent. However, at present, the country is facing high inflation and economic problems brought about by sharply higher oil and basic commodity costs. This has resulted in trade deficits and lack of hard currency with which to pursue rapid expansion.

Industrial Development and Infrastructure

Korea's past and future growth is based upon added-value processing of imported raw materials for subsequent export. Internal infrastructure is being expanded to sustain this industrial growth.

There is an extensive internal transportation network in Korea. While much is the result of development associated with the military activity of the Korean War, significant additions were made in the past 5-7 years. In 1970, a multi-lane expressway between Seoul and Pusan was completed. By 1980, the government plans to have a total of 1,500 miles of expressway connecting every district in the country. This will support regional development through rapid internal movement of product.

Intercoastal shipping is important for moving products, and the government is embarking on a program of expanding and improving port facilities. Power and water supplies to the industrial areas are geneally adequate.

Government Programs

Korea has a free market economy based upon private ownership of production and distribution. The government maintains some control over the economy through the economic development program, price controls and industrial expansion schemes. Also, the government does own part or all of a number of companies, including the petrochemical and oil industries, which are organized and operated as private entities with independent management. The government has an excellent record of guiding the economy and achieving growth targets.

Korea's Foreign Capital Inducement Law offers liberal tax and related incentives to foreign investment and will favor industries which contribute to balance of payments, introduce advanced technology, utilize domestic resources and increase employment opportunities for Korean labor. Profit remittance is guaranteed by the government.

The government is now becoming more selective, however, regarding the sectors in which it wishes both domestic and foreign investment. Maximum investment incentives will be accorded to the iron and steel, machinery and electronics industries. The large ship building industry will also be supported and developed. Generally, a maximum of 50 percent foreign participation is permitted in new joint ventures.

Regional Associations

South Korea is not a member of any regional association. The proximity of the country to Japan has supported close economic ties between the two countries. Because of the lower labor rate in Korea, Japan utilized Korea as a manufacturing base when labor rates in Japan reduced the competitiveness of Japanese products in world markets.

Japan is the major source of Korean imports and the most important market for Korean exports. The United States ranks second in both categories.

b. Petrochemical Overview

Korea has existing refineries, a fertilizer plant and a petrochemical complex. At present, there are three refineries in operation: Korea Oil Co. (265,000 bbl/day) at Ulsan; Honam Oil Refinery Co. (215,000 bbl/day) at Yeosu; and Kyung In Energy (60,000 bbl/day) at Inchon. In addition, a new refinery and expansions to existing facilities are in progress. The sole olefins complex is Korea Oil's 150,000 metric ton per year ethylene plant at Ulsan. Korea Oil is a 50 percent Gulf Oil, 25 percent government bank, 25 percent Korean public company. This core complex includes a number of downstream facilities, including low density polyethylene, vinyl chloride monomer, acrylonitrile, SBR, alkylbenzene, ethanol, polypropylene, phthalic anhydride and caprolactam manufacture. A second complex at Yeosu is presently nearing completion. This facility will produce 350,000 metric tons per year of ethylene. A third complex had been planned, but the project is being held in abeyance due to present economic situation. However, eventual completion is anticipated. Figure III-B-3 is a map showing the locations of the petrochemical complexes in Korea.

The petrochemical industry is supported by government policies with respect to feedstock pricing and maintenance of product prices for material used domestically at levels such that material destined for export markets can be priced competitively. Unlike countries such as Taiwan, Korea has tended to build up downstream industries before building petrochemical facilities to supply raw material. As a result, most product is used domestically. Korea is replacing Japan as the center for export-oriented labor-intensive industries such as textiles and, as a result, petrochemical consumption is rising rapidly.

FIGURE III-B-3

LOCATION OF KOREAN PETROCHEMICAL COMPLEXES

CHEM SYSTEMS INC.
PROJECT NO. 527 DATE

AGO 559576

3. Taiwan (Republic of China)

a. Background

Although it continues to claim legal soverignty over all of China, the Republic of China exercises control only over the Island of Taiwan, the Penghu Islands (Pescadores) and the "offshore islands" (the two principal island groups are Quemoy and Matsu). Taiwan lies about 90 miles off the southeastern coast of mainland China. It and the Penghu Islands to the west are administered as the Province of Taiwan.

A north-south mountain range forms the backbone of the island. The eastern slope of this range is very steep and craggy, but the western half of the island is generally flat, fertile and well-cultivated. About one-fourth of the island's 13,700 square miles is arable, and some 64 percent of the island may be termed forest land.

Taiwan has a total population of over 16 million, nearly 99 percent of whom live on the Island of Taiwan. The Republic has one of the highest population densities in the world, with about 1200 persons per square mile. The annual population growth rate has averaged 1.9 percent per year until recently, but is declining. The labor force is around 6 million.

The Taiwanese, with the exception of about 225,000 aborigines, are descendants of Chinese who migrated from the coastal mainland areas of Fukien and Kwangtung Provinces during the last 300 years. The two million mainlanders who migrated to Taiwan in 1949 and 1950 come from all parts of China and are referred to as "Overseas Chinese".

Prior to the 1974 worldwide recession, the Taiwanese economy grew rapidly at over 10 percent per annum average, but due to the high export orientation, slowed to under 1 percent real growth in 1974. In 1975, growth was 2.4 percent, but strong recovery occurred in 1976, with about

12 percent real growth. The economic outlook is good, with 6-7 percent per annum growth likely over the next few years, in spite of U.S. recognition of the People's Republic of China.

The government is proceeding with major industrial and infrastructure projects over the next few years (these will cost several billion dollars). The priorities include a major shipyard, a vastly expanded petrochemical production capability, an integrated steel mill complex, port and rail development, completion of the West Coast Freeway, and expansion of power generation facilities.

In general, the economy is highly structured and planned. Extensive use is made of various incentive programs including loans, tax incentives and technical advice to private enterprise. The government has attempted to foster private enterprise by turning over government-owned ventures and not directly competing with private firms. Private industrial production now accounts for nearly 80 percent of the national industrial output versus just over 40 percent in 1952. Since that time, the structure of industry has also changed significantly, with heavy industry now accounting for about 50 percent of output (versus 30 percent in 1960).

The petroleum and chemical industries represent a major sector of Taiwan's economy. The growth of industry made it feasible to establish a petrochemical industry in the early 1960s. Taiwan is supplying many raw and intermediate materials for its important plastic, synthetic fiber and synthetic rubber industries, and the range of its petrochemical products is constantly being expanded.

Taiwan has an unusual complement of supporting industries for a developing country. Its substantial machine tool industry supplies machinery of conventional and special design at prices which are 50 percent or less than equivalent European or United States machine prices.

Taiwan has well-developed highway and rail systems. These are concentrated along the West Coast, connecting the northern and southern ports of Keelung and Kaohsiung and the three major cities of Taipei, Taichung and Kaohsiung.

Taiwan's major ports are in Kaohsiung and Keelung. Although both ports are currently handling containers, Kaohsiung, with much more space in which to expand, will have the country's greatest capacity to handle and store containers in the future. In addition, a new port is under construction at Taichung for the purpose of handling the rapid increase in industrial growth already taking place around the Taichung Export Processing Zone.

In an effort to make Taiwan particularly attractive to export-oriented manufacturing investors, the government embarked in the early 1960s on a vigorous program to develop strategically located Export Processing Zones. Enterprises located in these zones receive the favorable tax treatment provided by the Statute for Encouragement of Investment.

Power and water supplies are constantly being expanded and will not be a constraint to growth.

Government Programs

The government recognizes that continued foreign and domestic investment is essential to sustained economic growth in Taiwan. There is little interference with most of the activities of the private sector, although there is government ownership in certain industries such as petroleum refining. Foreign investment is welcome and is not discriminated against, though the future emphasis will be upon high-technology and capital-intensive industries, rather than on the labor-intensive industries which have been allocated for most investment in the past. Although joint ventures are frequent, local participation is not required by law or policy.

Incentives are provided for investment in a wide range of industries, with special attention currently being given to petrochemicals, metal, machinery, glass and man-made fibers.

The government has a successful history of economic development planning. The plans are indicative in nature, leaving the private sector with much of the responsibility for achieving the targets. However, they set forth a wide range of policy measures to improve the industrial environment so that the targets can be met. In addition to economic plans, the government is also formulating separate long-range plans for transportation, electric power and manpower development.

Taiwan's tariff rates range from free to 120 percent ad valorem. The following is a general breakdown of duty rates:

Tariff Duty	Applies to (generally)
0 - 20%	Essential raw materials, machinery and fuels
35 - 80%	Most manufactured articles
80%+	Most luxuries

In no case are preferential rates granted. There are also some non-tariff import controls, which may be restrictive in certain cases.

The government endorses free trade as an ultimate objective, but does practice protectionism at present. This policy is regarded as necessary to stimulate industrial development and balance international payments.

Regional Association

Taiwan is not a member of any regional association and has only limited bilateral trade agreements with other countries.

b. Petrochemical Overview

Taiwan's hydrocarbon industry is controlled by the Government-owned Chinese Petroleum Corporation. Refining capacity is 425,000 barrels per day. Essentially all of the country's crude is imported, but there are gas reserves of 700 billion cubic feet and condensate reserves of about 12,000,000 barrels.

The petrochemical industry in Taiwan is important to that country's economy as it supplies the bulk of the raw material requirements for its synthetic fiber and plastics fabrication industries, plus material for export. The largest single industrial enterprise in Taiwan (Formosa Plastics Group) is based primarily on the production of plastics and synthetic fibers. In terms of value added, the petrochemical industry in Taiwan accounts for nearly 10 percent of the total value added by all manufacturing industries.

The petrochemical industry in Taiwan is owned by both the public and private sectors. In general, the public sector concentrates on production of basic petrochemicals (e.g., olefins and aromatics) while the private sector concentrates on intermediates and final products (e.g., vinyl chloride monomer and polyvinyl chloride resins). In recent years, production of petrochemical products in Taiwan has risen at rapid rates and there are plans for continued significant expansions. Although some petrochemicals are exported directly, the Taiwanese petrochemical industry is very dependent upon the indirect export of petrochemicals as fabricated products, plastics and synthetic fibers.

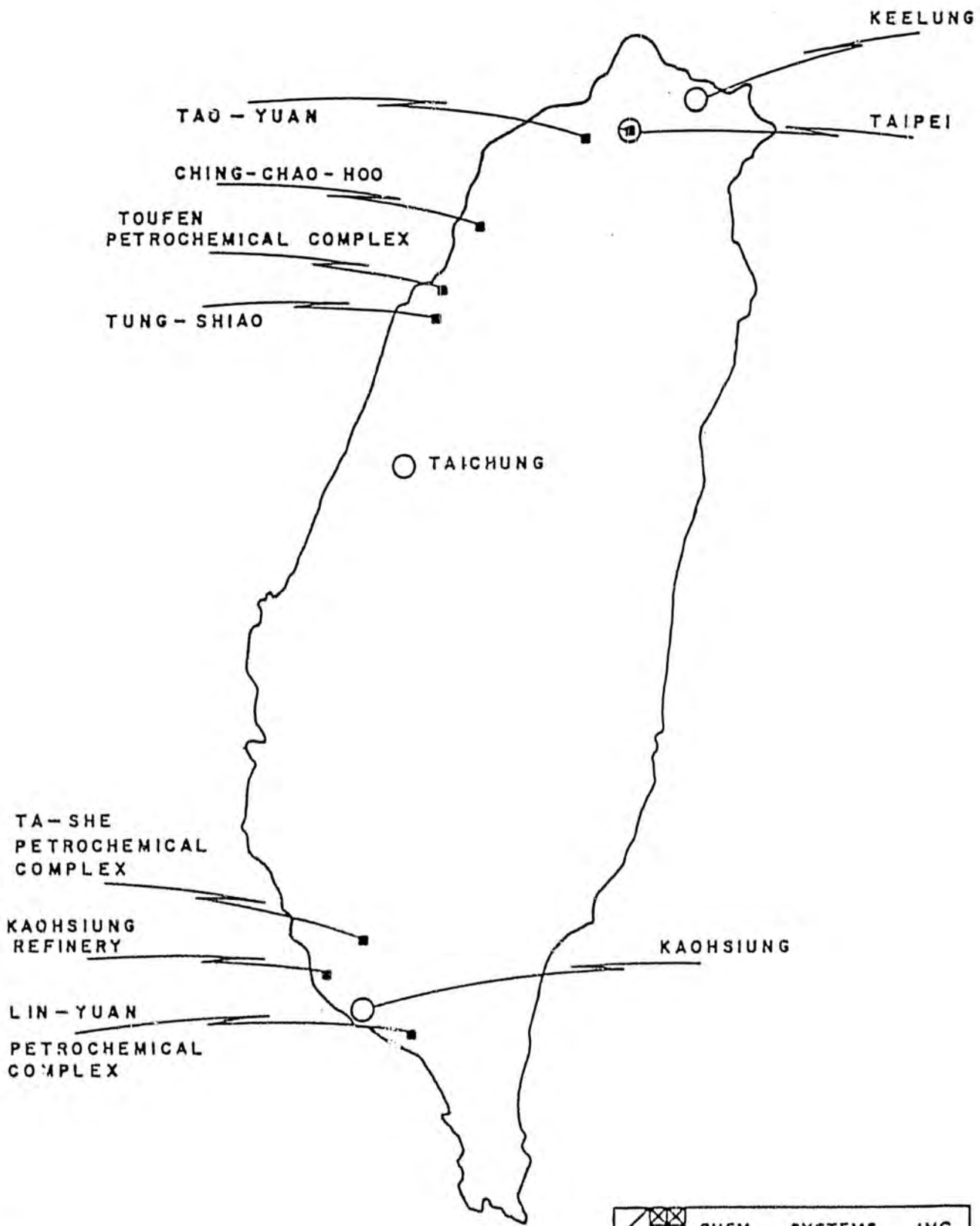
The Taiwanese petrochemical industry is based upon the basic petrochemicals supplied by the Chinese Petroleum Corp. Ethylene is produced in a 55,000 metric ton per year ethane cracker, a naphtha cracker of similar size and two 230,000 metric ton per year naphtha crackers.

In addition, Chinese Petroleum has just approved erection of a new olefin plant which would increase ethylene capacity by 350,000 metric tons per year. These basic petrochemicals are used in the production of a wide range of derivatives, including low and high density polyethylene, polypropylene, vinyl chloride, styrene, SBR elastomer, dimethyl terephthalate, caprolactam and acrylonitrile. A number of other units are under construction.

A map showing the major petrochemical sites in Taiwan is presented as Figure III-B-4.

FIGURE III - B - 4

TAIWAN



CHEM SYSTEMS INC.
PROJECT NO. 527 DATE

AGO 559582

4. Hong Kong

a. Background

Hong Kong is a British crown colony located off the Kwangtung coast of southern China, comprising the island of Hong Kong and adjacent islets, Kowloon peninsula and the leased New Territories on the mainland with surrounding islands. Hong Kong Island takes up only 28 square miles of the total 380 square mile area of the Colony.

Population is estimated to be over 5 million, nearly 99 percent of which is Chinese. The balance is mainly British. Due to its almost total dependence upon exports, the Hong Kong economy came to an abrupt halt in 1974 and 1975, with real GNP growth of 4 percent and 3 percent, respectively. After the double-digit growth of the previous decade, this was a serious reversal. Recovery began during 1975, however, and 1976 was a boom year with a 50 percent export increase and well over 10 percent real GNP growth. Confidence in Hong Kong's economic future remains high, and medium-term real growth rates of at least 5-6 percent per annum may be expected, provided the major Hong Kong markets of the United States and Western Europe avoid serious recessions.

Industrial Development and Infrastructure

Industry was introduced to Hong Kong on a small scale in the early 1930s under the stimulus of the Commonwealth Preference System. During that period and through the 1940s, Hong Kong's main role was as an entrepot, a center of trade and trans-shipment between China and the rest of the world. This activity was responsible for the development of excellent facilities for banking, shipping, warehousing and insurance.

The most significant changes in Hong Kong occurred in 1949 and 1950, and the events that took place were largely responsible for the industrial development which resulted. In 1949, the government of China changed and

over 1 million immigrants came to Hong Kong from Communist China. In 1950, the Korean War resulted in a United Nations embargo on trade with China. This severely reduced Hong Kong's entrepot trade, and it became necessary to quickly find an alternative source of income to survive.

This led to Hong Kong's industrial revolution. Local business people and the immigrants, who brought machinery, technical knowledge and capital, took advantage of a large pool of skilled and semi-skilled workers to establish a manufacturing base. Hong Kong has virtually no natural resources and depends for its survival upon the energy, skill and intelligence of its people, its deepwater harbor and its strategic geographical position.

Textiles was Hong Kong's first major industry, and it was based mainly on cotton. In the late 1960s, synthetics became significant. Even with the development of other industries, textiles and clothing in 1976 accounted for 56 percent of exports in dollar value. The second largest export industry is electronics, with plastic products (principally toys, dolls and flowers) the third most important business category.

As far as Hong Kong's future is concerned, changes are taking place within the Southeast Asia region which are shaping its long range structure. The developing nations, including South Korea, Taiwan, Thailand, Malaysia, etc., are emulating Hong Kong by developing textile and plastics operations of their own. They are able to compete with Hong Kong on the basis of lower cost labor. As a result, Hong Kong business has concluded that it is to its advantage to retain manufacturing facilities requiring more sophisticated techniques. Hong Kong's manufacturing base will thus be oriented more strongly to more sophisticated products with a higher unit value, made from combinations of materials requiring more complex assembly and processing.

There has been some speculation about the fact that the United Kingdom's lease on Hong Kong expires in 1998 and that the People's Republic of China (PRC) might not renew it, thus clouding Hong Kong's future. This is not considered a signficant factor for a number of reasons:

- The PRC has never really recognized any agreements made by Nationalist China and could have taken it over any time it chose to.

- The U.K. does not dispute PRC's claim that Hong Kong is Chinese.

- Hong Kong serves a very useful purpose to the PRC. Over 50 percent of Hong Kong's food is obtained from the PRC and almost 20 percent of its total imports are from that source. Aside from its value as a source of foreign exchange, Hong Kong serves the PRC by providing an excellent channel for the flow of goods into and out of the country without any "cultural pollution".

It is anticipated that this relationship will continue to exist for the foreseeable future.

Government Programs

The Hong Kong government maintains a classic laissez-faire posture towards economic activity in the Colony. There is a minimum of regulation, and taxation of personal and corporate income is limited to 15 percent. The government also adheres to a philosophy of free trade. Duties are levied on tobacco, alcoholic beverages and automotive fuels for revenue purposes only. Most imports and exports are subject to a trade declaration charge at a nominal rate. Import and export licensing is kept to the minimum required for the fulfillment of the U.K.'s and Hong Kong's international obligations, monitoring of essential commodities and the protection of health and safety. Hong Kong has a constant trade deficit due to its dependence upon imports for all raw materials. This deficit is compensated for through the Colony's considerable invisible earnings (particularly from tourism and commerce) and a sizeable annual inflow of capital.

Regional Associations

Hong Kong is a free trade area with no association or commitments to other countries in the region.

b. Petrochemical Overview

There is no oil or gas production nor any refining industry in Hong Kong.

At present, Dow's polystyrene plant is the only petrochemical venture in Hong Kong. No additional facilities are planned, nor are any likely in the foreseeable future. A map showing the location of Dow's facility is presented as Figure III-B-5.

5. Philippines

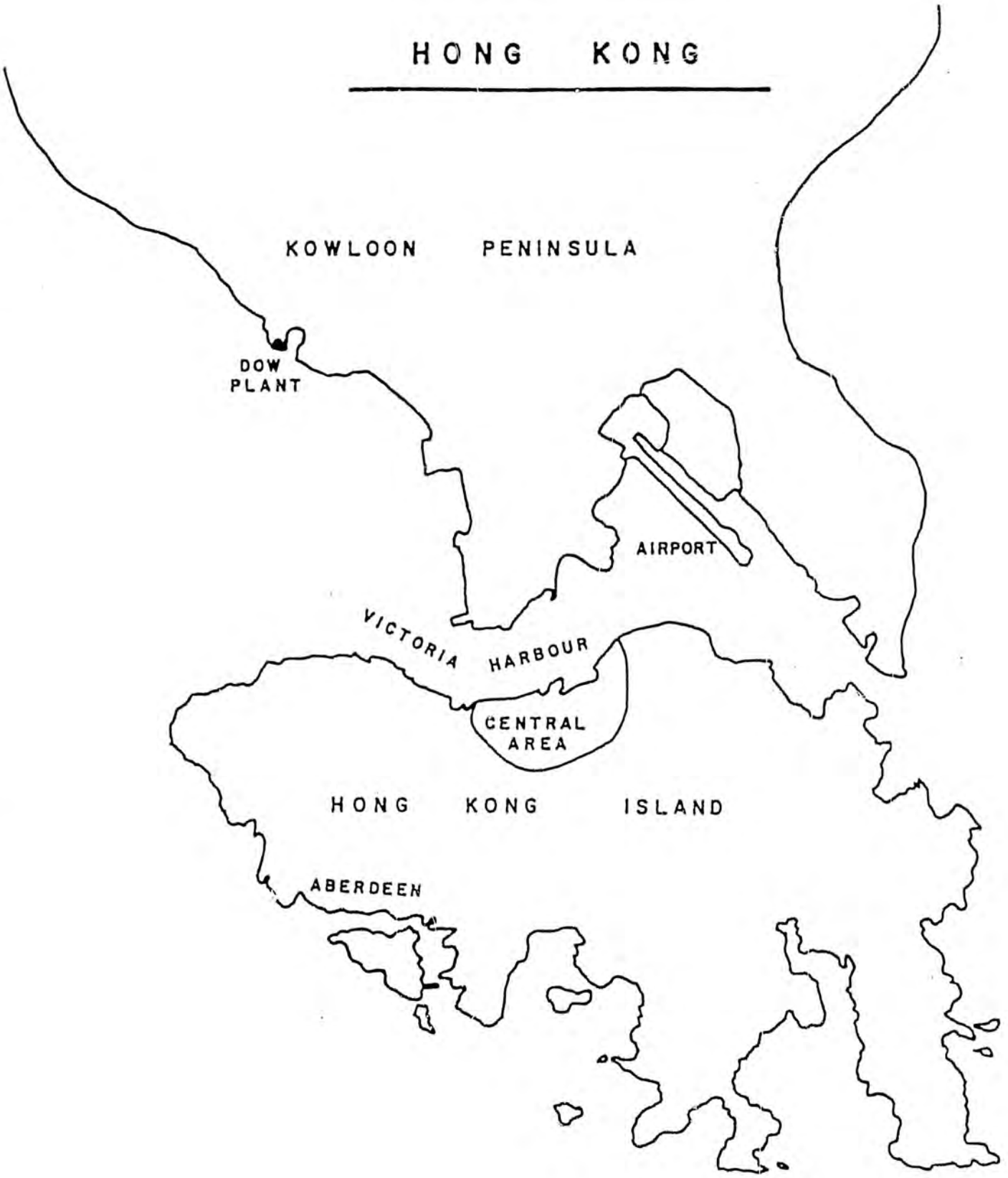
a. Background

The Philippines is an archipelago country of over 7,000 islands with a total land area of almost 114,000 square miles. Of this area, about 41 percent is cultivated, 40 percent is forested and the balance is unusable mountainous country. The principle economic and population center is the greater Manila area, where there are 4 to 5 million people. The total population is about 44 million, growing at 3 percent per annum. Efforts at planned population control have had very limited success. The labor force is around 14 million. A map of the Philippines is shown in Figure III-B-6.

Although large areas of the country are very fertile, the country is in the middle of the Pacific typhoon belt and natural disasters can have major effects upon food production. The government is investing large sums in flood control dams, properly laid out irrigation systems and the removal of illegally built fish ponds, which impede the progress of flood water. The development of a viable agricultural sector is essential so that the government can reduce expenditures of foreign exchange for

FIGURE III - B - 5

HONG KONG

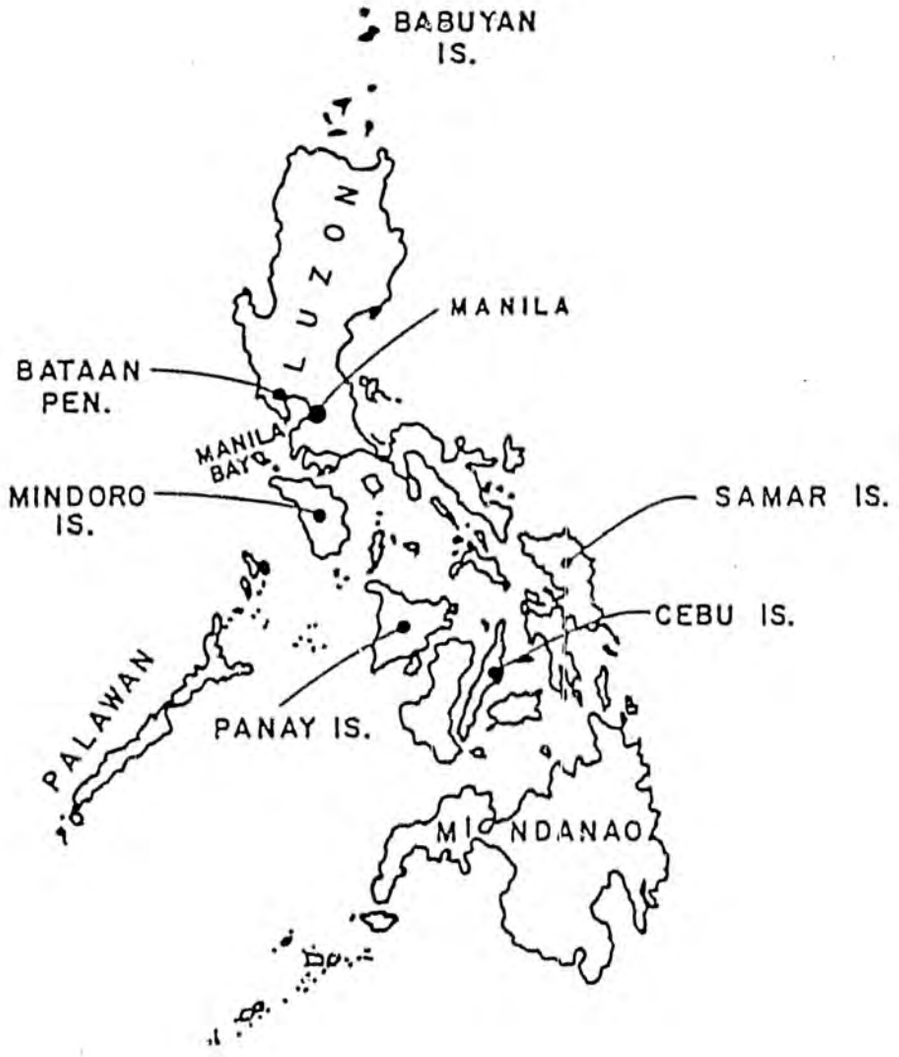


AGD 559587

CHEM SYSTEMS INC.
PROJECT NO. 527 DATE

FIGURE III-B-6

PHILIPPINES



AGO 559588

CHEM SYSTEMS INC.
PROJECT NO. 527 DATE

food. In addition, some of the Philippines' principal foreign exchange earners are agricultural products, including coconut products, sugar and timber.

The islands are also well endowed with minerals. The Philippines is the world's sixth largest producer of copper, and exploration activity for petroleum is now becoming an important activity. Some discoveries have already been made.

GNP growth was around 6 percent per annum in 1975 and 1976. Balance of payments problems are restricting long-term growth prospects, with only a 4-5 percent per annum growth anticipated.

Industrial Development and Infrastructure

The economy of the Philippines is still basically underdeveloped and agricultural. Industrial production has steadily expanded and diversified, but its growth has been relatively slow in recent years. The Government has now established a set of policies geared to the creation of a climate conducive to industrial growth, and prospects for continued industrial growth over the next years are good.

The government's industrial strategy places special emphasis on the processing of local raw materials, the growth of manufactured exports, employment generation, and regional dispersement and development of small and medium scale industries.

The government is spending large sums on road construction and rural electrification. There is a substantial program for rehabilitation of railroads, which are fairly well developed on Luzon and Panay Islands with about 750 miles of track. The total length of roads is nearly 40,000 miles. The Pan-Philippine highway, which is to span the length of the country from north to south, is more than 50 percent complete, and many feeder roads are being built to rural areas which will open new areas for markets and industry.

For many years, the electric generating capacity in the Philippines did not keep pace with the rest of the economy and blackouts are still commonplace. There is now a firm program developed for rural electrification and a number of fairly large-scale projects for hydro, geothermal, nuclear and coal power plants to supplement imported fuel oil. These facilities should be able to support the many new industries that the Bureau of Investment (BOI) is trying to attract into the country.

To relieve the port congestion problem, there is a large expansion under way in Manila which includes facilities for full container ships. In addition, there are plans to build a complete new deep-water port at Batanyas, south of Manila, where two of the country's oil refineries are located. Also under way are projects to increase the port facilities at Cebu City, which is the principal port and distribution center for the Visayas or central part of the country.

On Mindanao in the south, the port at Illigan is also being expanded, as this is the location of the integrated steel works, ferro-chemicals and the new investment by Kawasaki Steel of Japan in a sintering plant.

Government Programs

Due to its long association with the United States, the Philippines was once very much private enterprise-oriented. Since the advent of martial law in September 1972, however, the government has adopted a much more active role in the economy. The state is now involved in fertilizer production, all aspects of the petroleum industry and utilities. Also, the government has used the Bureau of Investment (BOI) as a vehicle to promote industrial development plans.

There is a wide range of incentives for new companies registered with and given BOI approval. These include tax relief, accelerated depreciation, tax-loss carry-forward, tax credits for import duties on machinery and equipment, the right to use expatriate management, protection from competitive imports, etc.

Basically, the BOI tries to promote "pioneer" industries. These are industries which do not exist in the country at present and which have local and/or export market potential. These would include many activities in the petrochemical and plastics fields.

Tariff protection is given where necessary to support local industries. In general, raw materials imported for processing and subsequent re-export are eligible for refund of tariffs when the finished products are exported. Current duties on basic petrochemical imports are in the 10 to 30 percent range.

Regional Associations

The Philippines is a member of ASEAN and, in common with the other members, has made nominal efforts towards regional cooperation. Early in 1977, tariff reductions between the Philippines and Singapore were agreed upon. In the long term, the Philippines could become a leading promoter of regional cooperation in ASEAN.

b. Petrochemical Overview

At present, there is only limited petrochemical production in the Philippines and petrochemical consumption is quite low. A major complex was planned by Herdis at Limay on the Bataan Peninsula with a government-owned core complex and with major participation by foreign companies in the downstream operations. The output from the facilities would have been sold locally and exported primarily to other ASEAN countries. This project has been changed and significantly reduced in scope. At present, a 90,000 metric ton per year low density polyethylene plant (with USI-Far East participation) and a 50,000 metric ton per year polypropylene plant (with Hercules participation) are planned. Both of these facilities would utilize imported feedstocks and primarily serve the local market.

6. Singapore

a. Background

Singapore is situated at the southern tip of the Malay Peninsula, with one main island and over 50 smaller islets comprising a total of 220 square miles. Major land reclamation schemes continue.

Just under 20 percent of the land area is cultivated, but food imports remain significant. Urban development covers over 35 percent of the total land area and continues to expand. Population is currently 2.3 million, growing at around 1.5 percent per annum. Zero population growth is the government objective, but this is proving difficult to achieve. About 75 percent of the population is Chinese, 15 percent Malays, 7 percent Indian and Pakistani and 3 percent European and others. The labor force is around 850,000. Singapore came through the 1974-1975 worldwide recession relatively well. Real GNP increased by 6.0 percent in 1974, 5.7 percent in 1975 and around 7 percent in 1976. This current growth is relatively poor compared to the 12-13 percent per annum rates achieved prior to 1973, and readjustment to this more modest growth has been slow to develop. Key factors responsible for double digit growth in the early 1970s are probably changed forever. Highly competitive labor-intensive production has been undermined by rapid labor cost increases; imported energy will no longer be cheap; the Southeast Asian oil boom, with Singapore as the regional headquarters, has collapsed - at least temporarily; and finally, the economy is now relatively mature, making rapid growth increasingly difficult. In the short/medium term, worldwide overcapacity and reduced demand expectations have badly hit the important oil refinery and shipbuilding industries. Shortage of suitable land will be a long-term constraint on major industrial development.

Projections are now for 7-8 percent per annum growth of the economy, to continue through the early 1980s. Singapore is generally regarded as

having a highly efficient, well-run economy and is likely to become the financial, industrial and services center for the ASEAN region.

Industrial Development and Infrastructure

Since its separation from Malaysia in 1965, Singapore has made maximum effort to attract and develop export-oriented industries. This campaign has been highly successful, and it prevented major disruption of the economy in 1971, when the British forces withdrew from their Singapore bases, which had previously contributed 20 percent of the gross domestic product and employed over 40,000 people.

Government bodies provided infrastructure, sites and buildings for new industries. There is a relatively skilled and experienced work force and constant efforts by the government to upgrade skills and training at all levels. Extensive investment incentive programs have been implemented. Most new companies and industries have been successful, and Singapore is now firmly established as the industrial center of the ASEAN region. The port of Singapore is one of the world's largest and the communications network is good.

The only real long-term infrastructure problem stems from the lack of available land for continued development. Although the government has become more selective regarding the type of industry to be encouraged in Singapore, petrochemicals has been selected as a favored industry for development.

Government Programs

Singapore was a pioneer in developing an organized program of incentives for attracting new industries. These include all forms of tax exemptions and accelerated depreciation provisions, plus complete freedom in remittance of foreign exchange. Singapore is basically a free port, with no tariffs or duties on most raw materials and fabricated products. Protective tariffs are imposed where necessary to support new local industries, and this would probably apply to any new petrochemical and plastics production.

The government is closely involved in industry, but the objective has been to assist and promote rather than to regulate. It has invested both on a wholly-owned and a joint venture basis in most basic industries, and government equity involvement in all petrochemical ventures is likely.

Regional Associations

Singapore is a member of ASEAN; it differs, however, from all other members of the group in being a producer of finished products rather than of raw materials.

As the fourth largest port in the world, Singapore trades and trans-ships a great deal of commerce for its ASEAN neighbors. Despite development of port and export facilities in other ASEAN countries, Singapore will undoubtedly remain the dominant port and trading center for the region.

The ASEAN group is still a very loose association. No common tariff policy has yet been promulgated. In the long term, attempts to divide up projects and industries between the member states will probably succeed. At present, however, each state tends to develop its own plans and projects. This is particularly true of Singapore, and the promotion of its petrochemical project has upset its ASEAN partners due to the lack of consultation and consensus. Since Singapore has so much to gain from the development of a strong, cohesive ASEAN group, with Singapore as the trading and manufacturing center, it is to be expected that strong long-term support will be given by Singapore to joint economic and industrial policies.

b. Petrochemical Overview

At the present time, Singapore's involvement in petrochemicals is limited to a 15,000 metric ton per year polyvinyl chloride plant based upon imported monomer and various resin converters. The imports of resins are largely for the converting industry, which, in turn, exports the bulk of its products.

Singapore has no oil or gas reserves. However, with 918,000 barrels per day of crude oil refining capacity in existence, Singapore has the potential to produce adequate naphtha for a world-scale ethylene facility. At the present time, the majority of this naptha is exported - to Japan, Taiwan, the United States and Europe. A map of Singapore is presented as Figure III-B-7.

The Economic Development Board had been studying the feasibility of an integrated petrochemical project for many years and had developed a proposed joint-venture between Sumitomo and the Development Bank of Singapore. With the lessening of petrochemical growth rates, brought about by rising crude oil prices, Sumitomo delayed with proceeding. Since then, however, the Singapore project was made a Japanese national project with the involvement of over 20 firms which would take over part of Sumitomo's interest. Site preparation for the complex has been completed, but implementation continues to be slow.

The cracker will have a capacity of 300,000 metric tons per year of ethylene, and low density polyethylene, high density polyethylene, ethylene oxide/glycol and polypropylene facilities will be built to utilize the output of the core complex.

7. Malaysia

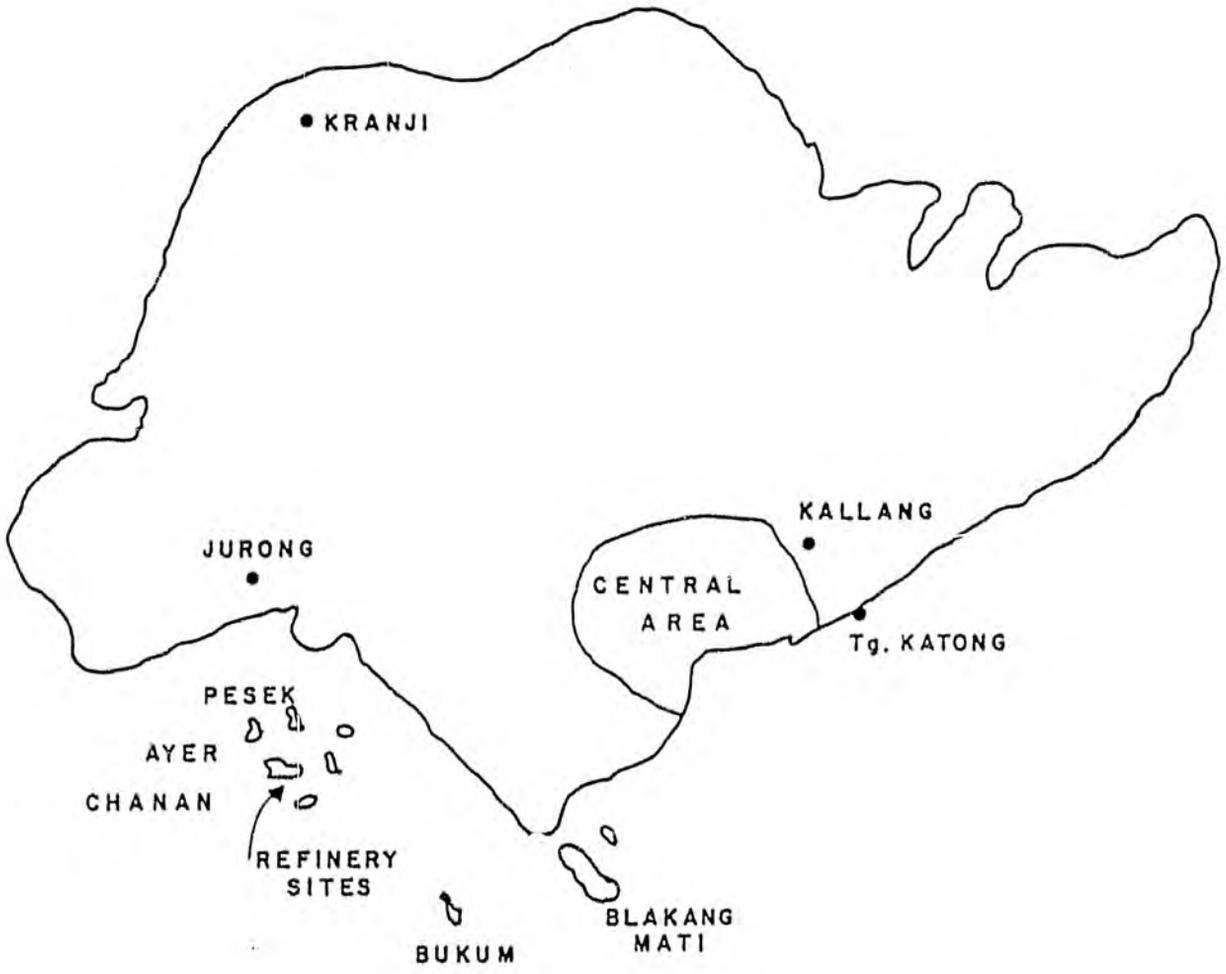
a. Background

The Federation of Malaysia has a total area of 125,780 square miles, of which Peninsular or West Malaysia takes up 51,450 square miles. The East Malaysian States of Sabah and Sarawak take up 28,880 and 46,740 square miles, respectively. A map of Malaysia is presented as Figure III-B-8.

The population, which is estimated at about 12.5 million and is increasing at a rate of about 3 percent per annum, is concentrated mainly along the lowlands of the western side of the peninsula. The large land areas east of the mountains on the peninsula and the two East Malaysian states are sparsely populated.

FIGURE III-B-7

SINGAPORE



AGID 559596

CHEM SYSTEMS INC.
PROJECT NO. 527 DATE

FIGURE III-B-8

MALAYSIA

AGO 559597

67

CHEM SYSTEMS INC.
PROJECT NO. 527 DATE

The racial make-up of Malaysia is roughly 50 percent Malay, 35 percent Chinese and 15 percent Indian, Pakistani and others. There has been friction in the past between the Chinese and the Malays because the Chinese dominate the commercial sector of the economy.

There have been substantial efforts at upgrading and projecting the racial Malays into the industrial and commercial sectors of the economy. This is succeeding to some extent as educational facilities are made available to a greater portion of the population. The labor force is around 4.4 million, with unemployment about 7 percent.

The more developed areas on the western side of the peninsula provide the main agricultural products, including rubber, palm oil, pineapples and food crops such as rice. The tin mines, which have been the source of much of Malaysia's wealth in the past, are also located mainly on the western side of the peninsula. With the population concentration and center on the western side, this area has also been the principal area of industrialization.

The oil and gas discoveries have largely been off-shore Sabah, Sarawak and the east coast states of Pinang and Trengannu. In the future, as oil and gas production reach commercial operation, it is likely that new industrial centers, based on petroleum and petrochemicals, will be located on the east coast of the peninsula and possibly in the East Malaysian states.

The economy survived the 1974-1975 recession fairly well. Recovery was largely due to improved export markets for rubber, tin and other commodities which form the mainstay of the economy. Over the next few years, growth is anticipated to average about 5-6 percent per annum. Manufacturing industry accounted for 11.9 percent of GNP in 1971, 17 percent in 1975 and is projected in the 20-year Perspective Plan to reach 35 percent by 1990.

Industrial Development and Infrastructure

The government is making efforts to improve land communications and develop the underpopulated areas. The East-West highway crossing the northern part of the peninsula provides access to large agricultural and timber areas. There has also been investment in the modernization and expansion of railroads. In East Malaysia, the road system has been gradually improved. However, much of these vast areas is remote and accessible only by air or river travel.

Most of the industrial development has occurred around the major population centers. The largest area is the 30 mile strip between the capital of Kuala Lumpur and the principal port, Port Klang. This area is rapidly filling in with planned industrial sites, which comprise electronic and textile industries for export and other import substitution industries. Other industrial sites are located on the outskirts of principal towns, including Johore Bahru in the south and Malacca, Ipoh and Penang in the north.

There are about 100,000 miles of roads in peninsular Malaysia, but only about 1,000 in Sarawak and less than 2,000 in Sabah. There are 1,200 miles of railways in the peninsula; these connect with Singapore in the south and Thailand in the north. Now that the new East-West highway is completed across the north of the peninsula, all the habitable areas have good access to the manufacturing and trading centers and ports. This allows manufacturers to move farther afield to tap sources of low-cost labor and at the same time allows more trade to develop in the rural areas. As income for manufacturing increases, it will help to smooth out the sharp peaks and dips in the Malaysian GNP which have occurred in the past due to reliance on export prices of commodities.

The National Electricity Board supplies most of the power to the country. About two-thirds of the 1,200 MW capacity is thermal and one-third is hydropower. There are other large new hydro projects under construction, and nuclear power is being considered as an alternative to

oil in the future. The NEB has been able to keep up with demand thus far and seems to be capable of meeting future requirements. Water is generally handled by the individual states and has not been a problem for developing industries.

When large new facilities are planned for the east coast of the peninsula to utilize the off-shore hydrocarbons, considerable preplanning and infrastructural development will be required.

Government Programs

The Malaysian government has well-developed agencies and programs to plan and assist in the development of the country. Statutory bodies will participate in joint ventures with foreign companies, and MIDF (Malaysian Industrial Development Finance) will assist in medium- and long-term loans.

The prime objective of the above organizations is to assist the indigenous racial Malays to penetrate the commercial and industrial sectors of the economy. Since the Malays generally do not have the equity capital required to participate in various proposed joint ventures, there may in the future be a trend whereby the government in one form or another may take up equity in new manufacturing enterprises in order to ensure that a majority of the venture is available to Malays.

The government has taken steps to become more directly involved in commodity trading, including successful price stabilization schemes for the important rubber industry.

Petronas, the national petroleum company, was created in 1974 and is responsible for anything to do with the petroleum industry, from exploration to the final consumer and including products such as petrochemicals and fertilizers. Agreements are gradually being renegotiated between Petronas and the foreign oil companies, and production and exploration have restarted after the nationalization scares.

The government agency for assisting a potential new investor in Malaysia is the Federal Industrial Development Authority (FIDA). Since the creation of Petronas in October 1974, FIDA no longer has the authority over activities involving the petroleum or petroleum-derived chemical industry, as this responsibility now belongs to Petronas. Petronas will develop its own guidelines and incentives for potential investors in the petroleum-related industries.

The incentives FIDA offers other manufacturers are numerous. They include:

- Pioneer status, which grants an approved company exemption from income and development taxes for a period of 5 years.
- Investment tax credits are granted if the proposed industry will produce a "priority product", locate in a "development area" and utilize 50 percent or more of local raw materials.
- Export-oriented industries which export 90 percent or more of their production have extended tax holidays.
- Imported machinery and raw materials are exempt from duty, and additional export allowances are made for local content products.
- Deserving industries are given anti-dumping tariff protection.
- There is a bilateral Foreign Investment Guarantee agreement with the United States.
- Investors are freely permitted to remit capital and income from investments in Malaysia.
- Tariff protection is granted to a wide range of manufactured items.

It is the government's declared policy that tariff protection should be used as a tool to encourage local industries. Where protection from foreign dumping is required, each case is decided on its own merits, with efficiency and cost of production of the local item the main criterion.

Regional Associations

Malaysia is a member of ASEAN, and its balance of payments is very much governed by its exports of primary commodities: rubber, tin, palm oil, timber and, increasingly, oil and gas. Malaysia has been very vocal in pushing for regional producers of these commodities to act in a concerted effort to maintain levels.

As far as intra-ASEAN trade is concerned, Malaysia has not been active in promoting complementary industries or trade. The prime emphasis has been upon developing industries beneficial to Malaysia, without any great enthusiasm for joint ASEAN objectives.

Malaysia has 140,000 barrels per day of refining capacity in contrast to crude oil production of 160,000 barrels per day in 1978 and reserves estimated at 2.8 billion barrels. In addition, there are gas reserves estimated at 17 trillion cubic feet.

b. Petrochemical Overview

Malaysia's petrochemical industry can technically be said to date from 1967, when a 50,000 metric ton per year refinery hydrogen-based ammonia plant was built adjacent to the Esso refinery at Port Dickson. Effective October 1974, all future development was put in the hands of Petronas, the national petroleum company, as part of the law establishing the company as the Malaysian vehicle for controlling all activities in the petroleum and petroleum-derived industries. Although the principal interest has been to develop crude oil production, it is believed that there are substantial gas reserves off-shore Sabah, the other East Malaysian State.

At one time, it was assumed that a State Development Corporation would set up a 250,000 metric ton per year ethylene cracker. This project has never passed beyond the conceptual stage and is very unlikely to be built.

8. Thailand

a. Background

Thailand has an area of 195,000 square miles, of which nearly 40 percent is cultivated and another 55 percent is forested. The economy is mainly agricultural: agriculture employs over 75 percent of the population and produces nearly 30 percent of GDP and the dominant proportion of export revenue.

The population is about 43 million, increasing at 3 percent per annum. The population is mainly Thai, but there is also a 15 percent Chinese minority. The work force is estimated at 19 million, mostly outside the cash economy and involved in agriculture. Most industrial activity is in the Bangkok area, with its population of 4 million.

The Thai economy was not severely affected by the worldwide slump of 1974-1975, since its basically agricultural exports continued to be in demand. Real GNP has increased at about 6 percent per year since then, and over the next few years, GNP growth of around 5-6 percent is anticipated.

Thailand's international credit rating is excellent, based upon good economic conditions. However, the political climate is still a concern because of the threat of aggression by the Communists and actions by the Moslems in the south.

Industrial Development and Infrastructure

Thailand may be divided into the Greater Bangkok region and "up-country". The port of Bangkok, 30 miles up the Chao Phraya River, handles 90 percent of Thailand imports and 75 percent of its

exports. Congestion is a major problem and maximum vessel size is 10,000 DWT. Plans have been discussed for a new commercial port on the Gulf of Thailand at Sattahip, currently a military base. Development is in the future, however. There are two oil refineries located on the coast and the site allocated for the formerly planned petrochemical project is nearby. A map of Thailand is presented in Figure III-B-9.

The road network is fairly well developed, including 12,000 miles of national highways. There are nearly 2,500 miles of single-track railways, and the rivers are also used extensively for inland transportation.

Government Programs

In addition to owning the utilities, transport systems and communications, the Thai government has been heavily involved in manufacturing operations. There appears to be little enthusiasm for government joint ventures with foreign companies.

The government has taken steps to improve the investment climate after the recent political and labor troubles, and business confidence is likely to improve. There are no requirements concerning Thai ownership of any project. The economy is basically a free one.

The Thai Board of Investment appears to be a well-organized body whose role is to assist foreign investors interested in coming into Thailand. They claim their incentives are more attractive than those of other Southeast Asian countries. Their investment incentives cover all the standard points such as tax holiday, full remittance of foreign capital invested, royalties, interest on foreign loans, and guarantees against nationalization and competition from new state enterprises.

Tariff protection, subject to justification of needs, can include import bans on competitive products or the raising of import duties on foreign competitive products. If the project is export-oriented, there is exemption from import duties and business tax on raw materials and re-export items; exemption from business tax for domestic raw materials;

FIGURE III-B-9

THAILAND

AGO 559605

CHEM SYSTEMS INC.
PROJECT NO. 527 DATE

and exemption from duty and/or business tax for all imported and locally produced machinery and equipment. Imports duties on most petrochemicals are currently in the 10 to 30 percent range.

Regional Associations

Thailand belongs to ASEAN, and Bangkok is the seat of the UN Economic and Social Commission for Asia and the Pacific (ESCAP), SEATO and other regional organizations. As in the other ASEAN countries, there has been a lot of planning and conversation on regional cooperation for industrialization. In the case of petrochemical development, Thailand has operated on the principle that an adequate inland market exists for economically viable plants for most of the basic petrochemicals. However, no developments in this area are likely for several years. Thailand is evaluating the feasibility of a $200 million soda ash project proposed by ASEAN to meet regional requirements. This would utilize high purity rock salt found in northeastern Thailand.

b. Petrochemical Overview

Thailand has 160,000 barrels per day of refining capacity. At present, the country has small oil reserves, estimated at 270,000 barrels, but has substantial gas reserves, estimated at 5 trillion cubic feet.

Major petrochemical complexes had been planned for Thailand in the early 1970s, but they died as a result of the oil crisis. At present, activities are primarily limited to polystyrene, PVC and fiber production. At present, a 90,000 metric ton per year low density polyethylene plant and a 50,000 metric ton per year high density polyethylene plant are planned, based upon imported ethylene. In addition, Exxon is reportedly evaluating a natural gas liquids based complex, which would ultimately provide feedstocks for these facilities.

9. Indonesia

a. Background

The archipelago Republic of Indonesia has over 13,000 islands spreading over nearly 3,000 miles. The total land area covers 750,000 square miles. The population is currently estimated to be around 140 million, growing at 2.5 percent per annum. A map of Indonesia is shown as Figure III-B-10.

The labor force is around 45 million, with a very high percentage unemployed or underemployed. The islands of Java and Madura occupy about 9 percent of the total land area, but contain 65 percent of the total population. The population density on these two islands is over 250 persons per square mile.

Although many of the islands are very mountainous, large areas of the country are suitable for agricultural development. These could support a much larger population than at present. Government efforts to relocate people have had very limited success due to the close family relationships of Malay society. About 10 percent of the land area is devoted to agriculture. The food crops are rice, corn, sugar and sweet potatoes, and the principal plantation crops are rubber, palm oil, coffee, tea and spices. Large areas of the country are covered with tropical hardwood forests; timber (as logs, but more increasingly as cut timber and plywood) constitutes the country's second largest export commodity.

Oil is the dominant factor in the Indonesian economy, generating over 50 percent of government revenues and over 70 percent of total export earnings.

During 1976, new agreements were negotiated with the foreign oil companies active in Indonesia, resulting in terms far more favorable to the government. This, coupled with uncertainties about the effects of

FIGURE III - B - 10

INDONESIA

CHEM SYSTEMS INC.
PROJECT NO. 527 DATE

recent U.S. government tax rulings on the oil companies, has resulted in the lowest level of oil exploration activity in over three years.

Because Jakarta, the capital and largest city, and several other major cities are located on Java, the main market potential is on Java. However, the majority of the energy-related raw materials (oil, natural gas, hydro power and coal) are located on other islands or off-shore. As industrial development projects proceed, there will be a continuing struggle to shift the labor supply to the energy/feedstock source and political pressure to locate manufacturing operations in overpopulated, underemployed, land-scarce Java. The imbalance in location of population and raw materials for employment opportunities is one of the principal factors inhibiting the positive expansion of the Indonesian economy.

It is estimated that only about 15 percent of the population is in the money economy on a full-time basis, so the "have nots" represent a sizeable portion of the economy. The easy-going nature of the average Indonesian, his lack of education and training, lack of management ability and susceptibility to corruption at all levels, together with the high rate of population increase, have worked against positive economic growth.

During 1976, Indonesia made a significant recovery from the 1975 financial crisis in Pertamina, the state oil company. International reserves, nearly depleted as an immediate consequence of that crisis, have improved considerably. In the future, the government's ability to service its large debt and still maintain momentum in its development program depends largely upon whether Indonesia can maintain current oil production levels. Over the next several years, GNP growth in the 5-6 percent per year range is anticipated.

Industrial Development and Infrastructure

Infrastructure development and support facilities for industrial development in Indonesia are quite limited. The demands are so great and the capacity in funds, manpower and expertise so restricted that it is

unlikely the country will have a developed infrastructure by Western standards by the end of this century. In the greater Jakarta area and in some of the other cities in Java, an effort has been made to plan industrial sites and provide them with infrastructure such as road and/or rail access, water and power. Availability of unskilled labor is never a problem. As a result, most of the light to medium labor-intensive industries have clustered around Jakarta and other cities in Java. This has added to the already overcrowded situation in Tanjong Priok, the port for Jakarta. Priok handles about 60 percent of the total value of imports, but only about 4.5 percent of the exports. The difference is caused by the fact that most of Indonesia's exports are raw materials which are exported directly from the source.

If manufacturing growth in the Jakarta area continues to the point where exports become of sizeable volume, congestion will become worse. There is some talk about building a complete new port for Jakarta. Before this can ever be realized, however, the need for these additional facilities will be increased severalfold. To a greater or lesser extent, other ports in Indonesia are suffering from the same overload problems.

In remote areas, where mining and petroleum projects are located, the foreign companies are making their own investments in infrastructure and turning it over to the government or, as in the case of oil companies, infrastructure may be provided by Pertamina as part of the production sharing agreement.

Government Programs

The Indonesian government has state investments in many industries. The most prominent of these is through Pertamina, the national oil and gas company. Other state investments include mining, manufacturing and services. The Government also participates in joint ventures with private foreign companies.

The factor inhibiting private petrochemical investment is the limited amount of capital available from private sources for world-scale or even Indonesian-scale ventures.

It is government policy to encourage foreign capital and technology investment, and the following basic assurances and tax incensives are provided:

- Repatriation of current profits; expenses of foreign employees; depreciation of capital assets; compensation in case of nationalization.

- Exemption from corporate and dividend taxes for 6 years.

- Exemption of reinvested profits from corporate tax and dividend tax up to 5 years after date of reinvestment.

- Permission for accelerated depreciation of fixed assets.

b. Petrochemical Overview

Indonesia is a petroleum and natural gas exporting nation. In 1978, crude oil reserves were 10 billion barrels and production was 1.7 million barrels per day. In contrast, the country's refining capacity was 528,000 barrels per day. The country also has natural gas reserves estimated at 24 trillion cubic feet and is currently shipping LNG to Japan.

In addition to ammonia facilities, the only Indonesian petrochemical activity is the 20,000 metric ton per year polypropylene plant at Pladja, South Sumatra. Initial production began in early 1974. Two major petrochemical projects, an aromatics plant and an ethylene complex, were also planned, but the Pertamina collapse delayed their implementation by several years. At present, these projects are again being evaluated.

The collapse of Pertamina brought a change in government agencies responsible for petrochemical projects. As part of the program to rid Pertamina of ancillary activities, petrochemicals were assigned to the

Ministry of Industry. However, since the Ministry of Gas has responsibility of the disposition of natural gas liquids and the Ministry of Finance has responsibility for obtaining loans for all government agencies and corporations, these agencies must be in total agreement with a project before it can proceed.

10. People's Republic of China

a. Background

The People's Republic of China, frequently referred to as China, contains a quarter of the world's population. It is the world's third largest country in size. The People's Republic was proclaimed on October 1, 1949, by the Chinese Communist Party, which set for itself the awesome task of uniting and mobilizing a population impoverished and exhausted by 37 years of domestic chaos, war and foreign invasion in the construction of a modern industrial socialist society.

The territory governed by the Chinese People's Republic includes China Proper (the 18 historic provinces of imperial China), Inner Mongolia, Sinkiang, the Northeast (Manchuria) and Tibet. The country's vast area of 3.69 million square miles (excluding Taiwan) is slightly larger than that of the United States. China's immense land mass forms the greater part of central and eastern Asia.

China's demographic statistics are terribly inadequate. It has been estimated that in 1978 the population of China reached 863 million. It is also estimated that 40 percent of the population is under 15 years of age. This means that there is a much larger dependent population in China than in the economically advanced nations, presenting serious problems in education and employment. Because climate and soil limit agriculture to only one tenth of the land area, some 90 percent of people live on 40 percent of the land area.

Government Programs

After coming to power, the Communists placed overall long-range planning in the hands of the state planning commission, under the national people's congress of the state council. Short-range planning was given to the state economic commission. Other commissions were also formed. The general bureau for the supply of raw materials was formed in 1956 to control resources. Together with the state construction commission and the state technological commission, it helped the state planning commission to formulate five-year plans. Many changes in the commissions have taken place since then, but the general pattern has been the same. Although the central government makes plans, they are implemented by provincial authorities.

Trade

The United States officially recognized the People's Republic of China (PRC) on January 1, 1979. Although trade in 1978 exceeded $1 billion, unresolved trade and commercial issues continue to hamper its growth. Neither country enjoys most-favored nation (MFN) tariff treatment and China does not have access to Export-Import Bank loans and guarantees or other financial programs of the U.S. Government, except for CCC (Commodity Credit Corporation) agricultural credits. The unresolved claims and assets issue inhibits or precludes direct banking relationships, direct shipping or airline connections in flag carriers and the exchange of trade exhibitions. It is the policy of the U.S. government to seek resolution of these and other barriers to the full development of trade and commercial relations.

China's leaders view international trade as an important factor in transforming China into a modern industrial state, as well as an instrument to foster the overall political and economic goals of making China a strong, unified nation capable of exercising leadership in Asia and the world. Import policy is directed at the acquisition of capital

goods that embody the modern technology needed to develop China's industry. Trade also is used to overcome serious shortcomings and bottlenecks in domestic production.

A prevailing theme in PRC foreign trade policy has been economic independence. Until recently, China has avoided long-term foreign credit, preferring to scale imports to the amount of foreign exchange available from export earnings. However, the goal to thoroughly modernize China by the year 2000 and the objectives of the Ten-Year Plan (1976-1985) are so ambitious that China has found it necessary to rely on some foreign financing. Until recently, the PRC had attempted to become self-sufficient through development of its own productive capacity; now it realizes that the industrialization program cannot be successfully completed in the desired time period without a major infusion of foreign plant, equipment and technology. Generally, the PRC seeks to avoid becoming too dependent on any one country as a source of trade.

Development of foreign trade and economic relations with most nations of the world is an important part of China's present policy to maximize the potential contribution of foreign trade to its economic development. China now has trading relations with more than 150 countries. To date, China has joined very few international economic or financial organizations, but Beijing's interest in arrangements that promote trade should increase as the country becomes more involved in international commerce.

b. Petrochemical Overview

Until recently, petrochemical production in the PRC was virtually nonexistent. At present, however, petrochemical production is growing rapidly through the importation of plants and technology. Fertilizer production increased sharply through the erection of a series of ammonia plants, which were given first priority. In addition, facilities for ethylene and derivatives manufacture, synthetic fibers and intermediates and plastics have been completed or under construction. In the petrochemical area, the strategy in the PRC is to import plants and

technology instead of products. As a result, product imports are anticipated to be relatively modest, and the PRC, despite large current local demand, has become a modest exporter in order to earn foreign exchange.

C. Factors Influencing Petrochemical Exports into the Pacific Basin Region

The export of petrochemicals from a U.S. plant to the Pacific Basin regions will depend upon a number of factors such as local supply/demand considerations, pricing for products imported, governmental regulations, regional associations and local business practices. The situation which will influence petrochemical imports in each of the Pacific Basin countries is presented below.

Japan

Japan, as the free world's second largest petrochemical producer, is anticipated to have ample supply of virtually every petrochemical made in essentially world-scale facilities. However, for most petrochemicals, demand is very high in relationship to the output from a single plant, so that large imports from a West Coast plant would only amount to a small percentage of overall demand. Since domestic prices are relatively high and duties are nominal, the country could theoretically be a good export market.

Heretofore, Japanese business practices have precluded the potential for significant imports, except under special circumstances. The trading companies have strong ties to the domestic producers; thus they would not import material which would adversely affect domestic industry. In addition, the interrelationship between the Japanese manufacturers, the trading companies and the banks makes it difficult for a consumer to import materials outside established channels.

As a result of sharp crude oil and naphtha price increases since the 1973-1974 oil embargo, Japan has become a high-cost petrochemical producer. This has changed the long-term strategy for Japanese firms to one of emphasizing specialty instead of commodity chemicals for future growth and to importing those products in which Japanese firms are not

cost competitive from assured, low-cost sources of supply. As a result, Japan could be a significant market for chemicals for Alaska, and Japanese firms are potential investors in an Alaskan petrochemical project.

Korea and Taiwan

Korea and Taiwan both have developing petrochemical industries. A dual pricing structure for the products generally exists, such that material exported or processed into goods for export is valued at world market prices, while material intended for domestic consumption is generally valued at that price required for the producer to obtain a satisfactory return on his investment. Both countries have duties and other taxes which result in effective duties of about 30-50 percent for the commodity petrochemicals. This effectively precludes importation of material, except in duty drawback situations and situations when local supply is nonexistent or is insufficient to meet demand. In both countries, consumers have tended to use locally produced material whenever possible; as a result, significant petrochemical import opportunities exist only for those products where domestic supply is insufficient to meet demand.

Hong Kong

Hong Kong has no duties on imports and there is no protection for domestic industry. As a result, there are no impediments to exports from a U.S. facility.

ASEAN Countries

The ASEAN countries are attempting to develop (1) a trade zone coupled with preferential internal duties and (2) an apportionment of facilities among the countries. With respect to petrochemicals, the individual countries are promoting their projects, and rationalization of the situation on a logical basis appears unlikely within the next several years.

The Philippines, Indonesia, Thailand and Malaysia have significant protection for domestic industry. Petrochemical imports will thus be limited to products where local production is insufficient to meet demand and to duty drawback situations. However, it is anticipated that other countries within the ASEAN group will eventually have a preferable duty position. This will place a U.S. producer at a competitive disadvantage vis-a-vis an ASEAN country producer in those markets. As a result, over the longer term, the potential for imports will tend to be governed more by the supply shortfall within the group rather than on a country-by-country basis.

Singapore is a free port and, like Hong Kong, has no duties or restrictions on petrochemical importation. Since most petrochemical consumption is related to product exports, local production or production in other ASEAN countries would not affect the ability to export from the U.S. to Singapore.

People's Republic of China

The PRC purchases petrochemicals on a spot or short-term contract basis. The quantities purchased are relatively modest and can be quite variable depending upon price and the country's hard currency situation. As a result, the PRC cannot be considered a significant long-term market for petrochemicals from Alaska.

IV. PRODUCT ANALYSES

This section of the report presents market analyses for ethylene, propylene and their major derivatives in the Pacific Rim market.

A. Low Density Polyethylene

1. West Coast Market

a. Demand

The 1978 market for LDPE resin in the West Coast areas of the United States and Canada was estimated at over 900 million pounds. An anticipated overall growth of 7.9 percent per year over the next 12 years will result in a market of over two billion pounds by 1990. Film will account for about 65 percent of the total demand for LDPE resin throughout the study period of 1978-1990, as shown in Table IV-A-1. The Canadian market constitutes about 5 percent of the total.

TABLE IV-A-1

WEST COAST LOW DENSITY POLYETHYLENE DEMAND, 1978-1990
(Million Pounds)

Western U.S.	1978	1980	1985	1990	AAGR, %* (1978-1990)
Film and sheet	580	700	1,060	1,500	8.2
Injection molding	125	145	200	260	6.3
Wire and cable	85	100	145	210	7.8
Extrusion coating	50	55	75	95	5.5
Other uses (including blow molding and pipe)	55	70	115	165	9.6
Total Western U.S.	895	1,070	1,595	2,230	7.9
Western Canada	40	45	65	90	7.0
Total	935	1,115	1,660	2,320	7.9

* Average annual growth rate.

Western U.S.

Film and Sheet

Film is by far the largest market for LDPE on the West Coast, with 1978 consumption of about 580 million pounds. This market is anticipated to more than double by 1990.

Film is used in many forms of packaging and wrap, ranging from food to garbage bags. Shrink and stretch films are also used in packaging. Substantial quantities of film are also used in agricultural applications. Film thickness varies from 0.5 mil for dry cleaning and garment bag applications to 10 mils and higher for construction uses. Ethylene-vinyl acetate copolymer films containing low percentages of the comonomer to achieve improved impact strength and clarity are used for produce bags, shipping sacks and liquid packaging. Growth in film demand on the West Coast is expected to parallel that of the U.S. market. Considerable market potential is anticipated within the region for injected-in film for unitizing containers.

From time to time, the West Coast has felt the pressure of film and bag imports from the Far East. Currently, imports represent a relatively low percentage of overall demand. Increased imports are not anticipated to materially influence the growth of the West Coast industry.

About half of the resin market for film is in southern California. Northern California, Washington, Oregon and Idaho are other significant consuming areas. Major consuming firms are listed in Table IV-A-2.

Injection Molding

There are numerous molders of polyethylene; the major categories are lids for convenience and other foods, toys, housewares and food containers. Housewares account for about 40 percent of the total injection molding

TABLE IV-A-2

MAJOR U.S. WEST COAST USERS OF LDPE RESIN FOR FILM PRODUCTION, 1978
(Million Pounds)

Company	Location
Arco	Long Beach, CA
Crown Zellerbach	San Leandro, CA
	Los Angeles, CA
	Portland, OR
Mobil	Woodland, CA
Shields Bag	Yakima, WA
Weyerhaeuser	two locations - WA
Potlatch	Lewiston, ID
Bemis Bag	Richmond, CA
CT Film (Dart)	Santa Ana, CA
Monsanto	Santa Ana, CA
Dow	Torrance, CA
Golden West	Tustin, CA
Ethyl Corporation	Glendora, CA
St. Regis	Union City, CA

market of 125 million pounds, with lids and toys accounting for another 40 percent. The West Coast injection molding market is anticipated to more than double by 1990.

Housewares are dominated by Fesco (Cities Service) of Tustin, California, and Dart Industries (Tupperware) with its Idaho plant. Processors of lid resins include Amoco, Triplas, Molded Container and Continental Can.

Wire and Cable

The wire and cable market for LDPE was about 85 million pounds in 1978 and is expected to reach 210 million pounds by 1990. The product finds use in telephone and coaxial cables. It is used as both an insulator and a dielectric. High-voltage cables also utilize polyethylene for insulation. The major user of polyethylene was Western Electric in Phoenix, AZ. The major LDPE consumers for wire and cable extrusion are shown in Table IV-A-3.

TABLE IV-A-3

MAJOR U.S. WEST COAST USERS OF LDPE RESIN FOR WIRE AND CABLE

Company	Location
Western Electric	Phoenix, AZ
Kaiser Aluminum	Rockland, CA
Alcan Cable West	Rockland, CA
Reynolds	Longview, WA
Anaconda	Orange, CA
Pirelli	-
Arizona Wire	Phoenix, AZ
ITT Cable Hydrospace	San Diego, CA
Hatfield Wire	Phoenix, AZ

Extrusion Coating

The extrusion coating market for LDPE was about 50 million pounds in 1978 and is expected to almost double by 1990. The major application is in the coating of paperboard and other substrates. Ethylene-vinyl acetate copolymers are used by some converters to improve heat sealability. Companies such as Crown Zellerbach (San Francisco, CA), Guardian Packaging (Newark, CA) and Georgia Pacific (Portland, OR) are large producers of polyethylene-coated paperboard.

Other Uses

This category, including pipe, blow molding, and other uses, amounted to 55 million pounds in 1978. Growth is forecast at 9.6 percent per year, for a 1990 market of 165 million pounds.

Western Canada

The LDPE market in Western Canada was about 40 million pounds in 1978. Demand is forecast to increase at about 7 percent per year and reach 90 million pounds by 1990. Film is the major market within the area, but pipe and extrusion coated materials are also produced. Significant LDPE

consumers include Capital Plastics, Surrey, BC (film), Pacific Plastics, Vancouver (pipe), Seaforth Plastics, Vancouver (film) and Western Concord, Vancouver (film). There is no captive LDPE consumption in the West Canadian market.

b. Supply

There is only one producer of low pressure polyethylene on the U.S. West Coast, namely Union Carbide, with a capacity of 140 million pounds per year at Torrance, CA. This compares with a total U.S. capacity of about 8.5 billion pounds. The major part of the West Coast market is supplied from plants in Texas and Louisiana. The output from the Union Carbide facility is primarily consumed on the West Coast, but some is also shipped to other areas. This unit is small and relatively old, having been built in the 1950s.

Several of the U.S. producers of resin are significant suppliers to the West Coast. Union Carbide, Dow, USI, Exxon and Arco are the five largest suppliers, and they supply about two-thirds of the market.

There are no LDPE producers in British Columbia, but CIL has a 70 million pound per year unit at Edmonton, which supplies consumers in British Columbia. Other suppliers include Dow of Canada, DuPont Canada, Union Carbide Canada, Mitsubishi and some of the U.S. suppliers.

c. Captive Market

About 20 percent of the 895 million pound U.S. West Coast market for LDPE is captive. However, there are no captive consumers in Western Canada. Arco, Mobil, Dart and Cities Service (Fesco) are the major captive users. No significant changes in this percentage are foreseen over the study period.

d. Pricing

Low density polyethylene is sold on a delivered price basis in the U.S., with West Coast prices equivalent to those for the remainder of the U.S. In July 1979, LDPE prices were increased to 35.5 cents per pound for the liner grade. General-purpose grades are 36.5 cents per pound, while injection-molding grades are 38.5 cents per pound. Prices have increased by over one-third in the past year, due primarily to higher prices elsewhere in the world and increased domestic and export demand. Future prices will tend to reflect only increases in costs, since the supply/demand situation is anticipated to remain relatively good.

Liner-grade polyethylene in Canada sold for $0.41 (Canadian) per pound delivered in hopper cars in September 1979. Bagged material is priced 6 cents per pound higher, while the general-purpose resin sells for 2.5 cents per pound more than the liner grade. Prices are anticipated to remain slightly above U.S. levels. The duty on LDPE is 10 percent ad valorem.

2. Pacific Basin Market

a. Japan

Demand

The domestic demand for low density polyethylene homopolymer and ethylene-vinyl acetate copolymer in Japan is forecast to increase from 894,000 metric tons in 1977 and 960,000 metric tons in 1978 to 1,770,000 metric tons in 1990, as is shown in Table IV-A-4. Exports were about 286,000 metric tons in 1977 and 231,000 metric tons in 1978, including copolymer. Exports are anticipated to decrease due to increased penetration of Far Eastern markets by U.S. producers, startup of new facilities in the region, and higher production costs in Japan.

TABLE IV-A-4

JAPANESE LOW DENSITY POLYETHYLENE DEMAND
(Thousand Metric Tons)

	1977	1978	1980	1985	1990	AAGR, % (1978-1990)
Film	515	555	625	800	975	4.8
Laminates	100	108	125	175	225	6.3
Wire and cable	62	66	73	92	115	4.7
Injection molding	75	80	95	130	170	6.5
Pipe	6	6	7	8	10	4.3
Blow molding	33	35	40	50	60	4.6
Others	103	110	125	165	215	5.7
Domestic demand	894	960	1,090	1,420	1,770	5.2
Exports	286	231	200	150	100	(7.2)
Total demand	1,180	1,191	1,290	1,570	1,870	3.8

Film is the largest segment of the LDPE market, representing nearly 50 percent of domestic demand. Historically, this has been a major demand growth area, but demand is expected to grow only at about 5 percent per year throughout the study period. This is due to increased imports from Korea and Taiwan, increased penetration of thin high density polyethylene film, which is capturing some traditional low density polyethylene markets, and conservation brought about by higher prices. Usage in lamination, injection-molded articles and blow-molded articles is also anticipated to show moderate growth. On the other hand, growth of wire and cable uses is expected to be relatively slow.

Supply

The current low density polyethylene capacity in Japan is 1,520,000 metric tons per year, as shown in Table IV-A-5. At present, no expansions are under way. However, it is felt that capacity will probably increase by 100,000 metric tons per year by the mid-1980s, since Mitsubishi Petrochemical has been considering a facility and some other firms have long-range plans to expand in LDPE.

TABLE IV-A-5

JAPANESE LOW DENSITY POLYETHYLENE PRODUCERS, 1978
(Thousand Metric Tons per Year)

Company	Capacity
Mitsubishi Petrochemical	250
Sumitomo Chemical	242
Mitsui Polychemical	160
Nippon Unicar	165
Ube Kosan	140
Asahi Dow Chemical	124
Toyo Soda	158
Mitsubishi Chemical	97
Nippon Petrochemical	64
Showa Petrochemical	120
Total	1,520

Supply/Demand Situation

The potential supply/demand balance for LDPE in Japan is presented in Table IV-A-6. Basically, Japan is anticipated to have sufficient LDPE capacity to be self-sufficient until the mid-1980s. However, the higher cost of production could result in displacement of Japanese production with imported material. By the mid-1980s, Japan could be importing 100,000-200,000 metric tons per year.

TABLE IV-A-6

POTENTIAL SUPPLY/DEMAND BALANCE FOR LOW DENSITY POLYETHYLENE IN JAPAN
(Thousand Metric Tons)

	1978	1980	1985	1990
Potential supply*	1,520	1,520	1,620	1,620
Forecast demand	1,191	1,290	1,570	1,870
Surplus/(deficit)	331	230	50	(250)
Operating rate, %	78	85	97	

* 100 percent of nameplate capacity.

Pricing

LDPE prices in Japan are higher than world prices. Delivered prices were 215 yen per kilo (44.4 cents per pound) in late June 1979 for film-grade resin. Prices for other grades are somewhat higher. LDPE imports are subject to a duty of 28 yen per kilo.

b. Korea

Demand

The Korean demand for low density polyethylene was 135,000 metric tons in 1977 and 160,000 metric tons in 1978. Demand is forecast to increase to 205,000, 305,000 and 420,000 metric tons by 1980, 1985 and 1990, respectively. This represents an average annual growth of 8.4 percent over the period. Film and bags for fertilizer, agricultural and general packaging use represent about 80 percent of the market. Only about 10 percent of the converted product production is exported, but considerably larger quantities are exported in the form of packaged goods.

There are about 400 processors of low density polyethylene in Korea. The major consumers are listed in Table IV-A-7. These firms represent about half of Korean consumption.

TABLE IV-A-7

MAJOR KOREAN CONSUMERS OF LDPE

Ajin
Hyon Dae Chemical
Il Shin Chemical
Sam Yung Chemical
Hwa Sung Vinyl
Daihan
Sun-A Plastic
Lucky Ltd.
Chin Yang
National Plastic

Supply

Korea Pacific Chemical, a Dow Chemical affiliate, is the sole producer of low density polyethylene in Korea; its plant at Ulsan is rated at 70,000 metric tons per year. The firm is building a 100,000 metric ton per year unit at Yeosu, which is scheduled to be on stream in 1979. Union Carbide has also entered into a joint venture with Lucky Petrochemical to build a 150,000 metric ton per year LDPE plant at the new Yeosu complex. Start-up is expected in 1982-1983, but could be subject to delay.

Production at the Korea-Pacific plant in 1978 was 63,000 metric tons of material. Imports were 98,000 metric tons, which were handled by Korea-Pacific for the industry association.

Supply/Demand Situation

The supply/demand situation for low density polyethylene in Korea is shown in Table IV-A-8. Korea is anticipated to be a net importer in the early 1980s, but will be self-sufficient when the third unit comes on stream. Based upon projections and current philosophy, it is unlikely that Korea would build a fourth unit until the end of the 1980s, and thus they would again be an importer in the late 1980s.

TABLE IV-A-8

POTENTIAL SUPPLY/DEMAND BALANCE FOR LOW DENSITY POLYETHYLENE IN KOREA
(Thousand Metric Tons)

	1977	1978	1980	1985	1990
Potential supply	70	70	170	320	420*
Forecast demand	135	160	205	305	420
Surplus/(deficit)	(65)	(90)	(35)	15	0
Actual production	55	63			

* Anticipated new unit.

Pricing

LDPE pricing from domestic units is set by the government at levels sufficient to yield a reasonable return in the facilities, and it tends to be from 20 to 30 percent above world prices. Imports are normally made on a monthly tender basis at very attractive prices; however, with the resin shortages in recent months, Korea has had to pay premium prices for imported material. Imports are subject to import duties, a handling charge, defense tax and a commodity tax. However, duty drawback is obtained on material converted for export.

c. Taiwan

Demand

In 1977 and 1978, the total demand for low density polyethylene in Taiwan was 89,000 and 93,000 metric tons, respectively. This included resin utilized in domestic markets, produced for export, and imported for conversion into products for export. The domestic market accounts for about three-quarters of domestic demand. Film and bags constitute about 80 percent of this market.

Approximately 20-25 percent of the total resin demand is processed into goods for export. Taiwan is facing increased competition from other countries, such as Singapore, in film and bag markets. In addition, the U.S. film and bag producers are not about to let imported products acquire more than a small percentage of the market. As a result, the processing for export market is anticipated to grow only at about 5 percent per year for the next few years and then begin to level off. This is less than the growth in polyethylene consumption.

The domestic demand for low density polyethylene is forecast to increase from 70,000 and 75,000 metric tons in 1977 and 1978 to 85,000, 115,000 and 150,000 metric tons in 1980, 1985, and 1990, respectively. This represents an average annual growth rate (from a 1978 base) of 5.8

percent. Exports are expected to increase significantly in the early 1980s due to the desire to utilize the increased capacity available. A breakdown of consumption is presented in Table IV-A-9.

TABLE IV-A-9

TAIWAN DEMAND FOR LOW DENSITY POLYETHYLENE
(Thousand Metric Tons)

	1977	1978	1980	1985	1990	AAGR, % (1978-1990)
Total domestic demand	70	75	85	115	150	6.0
Exports	19	18	50	50	50	-
Total demand	89	93	135	165	200	6.6

Supply

The current Taiwanese capacity for low density polyethylene is 90,000 metric tons. Announced expansions should increase capacity to 215,000 metric tons by the end of 1979, as is shown in Table IV-A-10. Actual potential supply is estimated to be approximately 90 percent of nameplate capacity.

TABLE IV-A-10

TAIWAN LOW DENSITY POLYETHYLENE PRODUCERS, 1978
(Thousand Metric Tons)

Company	Location	Capacity	Expansions
Asia Polymer	Kaohsiung		75 (1979)
USI Far East	Kaohsiung	90	50 (1979)
		90	125

USI Far East was once completely owned by National Distillers and Chemical Corp., but it is now 50 percent owned by local Chinese interests. The firm produces for the local market and exports throughout Southeast Asia. The plant, which reached its current size in a few stages, is in the process of expansion by 50,000 metric tons. This expansion will be completed in 1979.

Asia Polymer is owned by China Gulf Plastics (an affiliate of Gulf Oil Corp.), Chinese Petrochemical Development Corp. (government-owned), and a

number of plastics fabricators. The firm has completed a 75,000 metric ton per year unit.

Supply/Demand Situation

The supply/demand balance for LDPE is shown in Table IV-A-11. After the current expansions are completed, there will be sufficient capacity in Taiwan to meet demand growth throughout the study period. As a result, there will be little opportunity for sales to Taiwanese firms except under special situations, such as imports for processing into products which will be exported.

TABLE IV-A-11

POTENTIAL SUPPLY/DEMAND BALANCE FOR LOW DENSITY POLYETHYLENE IN TAIWAN
(Thousand Metric Tons)

	1977	1978	1980	1985	1990
Potential supply*	81	81	194	194	194
Forecast demand	89	93	135	165	200
Surplus/(deficit)	(8)	(12)	59	29	(6)

* 90 percent of nameplate capacity.

Pricing

The domestic prices in Taiwan are normally substantially above Southeast Asian market prices. However, resin sold to processors for conversion to fabricated articles for export are sold at Southeast Asian market prices. LDPE imports are subject to high duties and taxes, but duty drawback can be obtained on processing for export situations.

d. Hong Kong

Hong Kong has no domestic low density polyethylene production, and it is very unlikely that this product would ever be produced in the colony. However, Hong Kong is a major consumer of the product (use in 1978 is estimated at 90,000 metric tons). Film is the major outlet for low

density polyethylene in Hong Kong, representing about 65-70 percent of overall consumption.

Consumption is expected to reach 100,000, 115,000 and 135,000 metric tons in 1980, 1985 and 1990, respectively. Domestic use for the product is expected to grow strongly for the next few years, reflecting economic growth in the colony. However, processing of low density polyethylene for export, which constitutes about 60 percent of the market, is anticipated to remain about constant. This is due to the nature of Hong Kong's economy: it specializes in the development of techniques to produce fabricated articles rather than in producing larger quantities of a given product.

There are over one thousand polyethylene consumers, most of whom order only a few bags at a time. In 1978, Japan, with exports of 50,000 metric tons to Hong Kong, had over 50 percent of the market. Other suppliers were U.S., Italian, French and German firms. There is no duty on LDPE imports to Hong Kong, and the material is normally sold at the Southeast Asian market price.

e. ASEAN Countries

LDPE demand in the ASEAN countries is anticipated to increase from 155,600 and 172,000 metric tons in 1977 and 1978, respectively, to 421,000 metric tons in 1990, as shown in Table IV-A-12. Film and bags represent most of the demand for the product.

TABLE IV-A-12

ASEAN COUNTRY LOW DENSITY POLYETHYLENE DEMAND
(Thousand Metric Tons)

	1977	1978	1980	1985	1990	AAGR, % (1978-1990)
Philippines	35	41	60	85	105	9.6
Singapore	24	25	28	36	46	5.2
Malaysia	23.6	25	28	37	50	6.0
Thailand	28	30	35	50	70	7.3
Indonesia	45	51	65	100	150	9.4
	155.6	172	188	308	421	7.7

At present, there are no producers of LDPE in the ASEAN region. A 100,000 metric ton per year plant, in which Sumitomo would have a dominant interest, is planned as part of a petrochemical complex in Singapore. The facility is scheduled to be onstream in late 1982. A 90,000 metric ton per year plant is planned for the Philippines, in which USI Far East would be the foreign partner. A facility of similar size is planned for Thailand by Chinese interests. These latter two projects are based on imported ethylene and are not firm at present.

f. People's Republic of China

In the past three years, the People's Republic of China has begun to install LDPE plants. At present, capacity totals about 200,000 metric tons; as a result, imports have fallen to relatively low levels, and the PRC has exported small quantities to Hong Kong. In future years, only modest imports are foreseen, so this market cannot be viewed as a significant secure market for an Alaskan facility.

3. Conclusions

Opportunities for an Alaskan Plant

The supply and demand for LDPE on the West Coast and in the Pacific Basin are summarized in Table IV-A-13.

TABLE IV-A-13

LOW DENSITY POLYETHYENE

	Demand				Capacity, per year	
	1978	1985	1990	AAGR, %	1978	Future
		(Million Pounds)				
West Coast	935	1,660	2,320	7.9	140	0
		(Thousand Metric Tons)				
Japan	960	1,420	1,770	5.2	1,520	1,620
Korea	160	305	420	8.4	70	320
Taiwan	75	115	150	6.0	90	215
Hong Kong	90	115	135	3.4	0	0
ASEAN Countries	172	308	421	7.7	0	100*

* Singapore project. Other projects possible.

AGO 559633

During the 1980s, it is expected that new grass-roots low density polyethylene facilities will have to have a capacity of at least 500 million pounds per year in order to be competitive.

Due to the established position of numerous suppliers, it is anticipated that a firm with Alaskan production could reasonably expect to capture only 15-20 percent of the merchant market on the West Coast. This would equate to 210-280 million pounds of the 1,400 million pound merchant market forecast within the region for 1985. By 1990, with the anticipated demand increase, sales should grow to 300-400 million pounds.

LDPE imports into Hong Kong and the ASEAN countries will total about 700 million pounds by 1985. About 40 percent of this demand should be met by exports from Japan and Taiwan. However, an Alaskan facility would be in a good position to capture a share of the remaining market. In addition, Japan, while it possesses sufficient LDPE capacity at present, is a relatively high cost producer. As a result, it could be advantageous to supplant domestic production with imports. Levels of about 200 million pounds per year would not be unreasonable. From a standpoint of market size and trends, production of LDPE in Alaska is viable.

B. High Density Polyethylene

1. West Coast Market

a. Demand

During 1978, consumption of HDPE within the West Coast region was estimated at 500 million pounds. California alone is estimated to have consumed more than 350 million pounds. Growth over the next 12 years is forecast at 10.3 percent per year, for a 1.6 billion pound market in 1990.

Blow molding accounts for about 35 percent of total HDPE demand in the West Coast region. This percentage is expected to be maintained over the entire study period. The consumption of HDPE, by application, from 1978 through 1990 is indicated in Table IV-B-1.

TABLE IV-B-1

WEST COAST HIGH DENSITY POLYETHYLENE DEMAND, 1978-1990
(Million Pounds)

Western U.S.	1978	1980	1985	1990	AAGR, % (1978-1990)
Film and sheet	40	65	160	250	16.5
Injection molding	110	135	210	325	9.4
Wire and cable	25	28	40	65	8.2
Blow molding	175	220	355	520	9.5
Pipe and conduit	60	80	135	215	11.2
Other uses (including roto molding)	70	87	130	175	7.9
Total Western U.S.	480	615	1,030	1,550	10.3
Western Canada	20	25	35	60	9.5
	500	635	1,065	1,610	10.3

Western U.S.

Film and Sheet

This category accounted for an estimated 40 million pounds in 1978, about 7 percent of the total U.S. West Coast market. HDPE film is used in

various applications such as merchandise bags, shipping sacks, coextruded food packaging and tissues. In essence, much of HDPE film's use is as a replacement for paper in, for example, bread wrap and fruit wrapping. In addition to typical plastics processors - Guardian Packaging (Newark, CA), Richmond Division of Pak-Well (Redlands, CA), Alchem (La Miranda, CA), Lustro (Valencia, CA), and LTD Packaging (Santa Fe Springs, CA) - companies that have traditionally made paper products, such as Crown Zellerbach, are also involved in the production of HDPE film. Film consumption alone on the West Coast area is estimated at 30 million pounds.

Sheet usage in the region is estimated at approximately 10 million pounds. The major application is in thermoforming for such diverse products as large containers, tote bags, toys and childrens' swimming pools. Gage Industries (Lake Oswego, OR) is the major sheet fabricator, but Lustro and Alchem are also manufacturers.

Injection Molding

About 25 percent of the U.S. West Coast HDPE resin consumption is used in injection molding for food containers, nursery tubs, toys, shipping drums and containers. Food containers and packaging injection molded products constitute about a third of this market. Production is primarily accounted for by about eight companies, with Crown Zellerbach, Molded Container, Gregg Foods and Owen-Illinois among the largest.

Nursery tubs and flower pots constitute about a quarter of the market. Anaheim Plastics and J.S. McConky are major producers.

Wire and Cable

Usage of HDPE resin in this category was estimated at 25 million pounds during 1978. About ten companies in the U.S. West Coast region use HDPE for wire insulation. They include Pacific Electricord (Gardena, CA), National Wire and Cable (Los Angeles, CA) and Raychem (Menlo Park, CA). However, the largest consumer is Western Electric of Phoenix, AZ, with an estimated annual usage of at least 15 million pounds.

A growth rate of 8.2 percent per year over the 1978-1990 period is forecast for the wire and cable extrusion market in the West Coast region.

Blow Molding

This is the major HDPE market in the West Coast, accounting for 175 million pounds of resin in 1978. Growth in this category is forecast at 9.5 percent per year, resulting in an anticipated market of 520 million pounds in 1990. About 50 firms blow mold HDPE in this region, with perhaps 20 of these accounting for 70 percent of total blow molding resin consumption. Many of the blow molders process resin for captive operations, such as Altadena Dairies, Carnation Dairies, Purex and Revlon. In addition, many of the major national packaging companies are involved, including American Can, Continental Can, Georgia Pacific, Monsanto and Owens-Illinois. Among the other processors are the following high volume companies - Born Free Plastics, Polytainer, Molded Container, Spokane Presto Log and Plastic Industries. Large (up to 55 gallon) drums are being blow molded by several companies. This market accounts for about 15 million pounds of the total consumption of blow molding resin. Born-Free, Applied Chemical Technology and Ziffco are the major producers of large drums.

Pipe and Conduit

Usage of HDPE resin in this application was estimated at 60 million pounds in 1978. This market is forecast to grow to 215 million pounds by 1990, an average annual growth rate of 11.2 percent over the period. The products are used in potable water and gas lines and in the production of 12" corrugated pipe. During 1973, corrugated pipe accounted for about half of the market, with gas and water distribution and oil patch pipe utilizing the rest.

Potable water pipe producers are Phillips Products (Watsonville, CA), AB&I Plastics (Newark, CA), Kerona Inc. (Santa Ana, CA), Pacific Plastic

Pipe Co. (Beaverton, OR), Portco Corp. (Vancouver, CA), Superlon Pipe Corp. (Tacoma, WA), Swanson Co. (Phoenix, AZ), Wes Flex Mfg. (Richmond, CA) and Western Plastics (Tacoma, WA and Denver, CO).

Other Uses

These include rotational molding for recreational vehicles, golf bags, crock pot covers and decoys. Companies involved in roto molding are Hollowform (Woodland Hills, CA), Rotoform (Santa Cruz, CA) and Peco (Portland, OR). There is also some extrusion coating and foam usage of HDPE. By 1990, the total "other" category is expected to reach 175 million pounds from the current level of 70 million pounds.

Western Canada

The HDPE market in Western Canada was 20 million pounds in 1978. Demand is forecast to increase at about 9.5 percent per year and reach 60 million pounds by 1990. Pipe, large containers, bottles and molded articles are produced within the area. Significant HDPE consumers include Capilano Plastics (large containers), Columbia Plastics (custom molder) and Pacific Plastics (pipe), all located in Vancouver.

b. Supply

There are no producers of HDPE resin on the U.S. West Coast, but there are 13 producers in the United States with a capacity totalling over 5 billion pounds. Announced expansions total about another 1 billion pounds.

Several of the U.S. producers of resin are significant suppliers to the U.S. West Coast. Among these, Phillips, Soltex, Chemplex, Arco and Allied Chemical account for about 70 percent of the total market.

There are no HDPE producers in Western Canada. The Canadian HDPE producers - Dow Chemical of Canada, DuPont Canada and Union Carbide Canada - supply the Western Region. In addition, firms such as Mitsui, Soltex, Phillips and Hoechst are also active in the region.

c. Captive Markets

The captive market for HDPE on the West Coast was about 50-60 million pounds in 1978, or approximately 10-13 percent of the overall market. The major captive user was Phillips through its pipe operation and through the Sealright container operation. Owens-Illinois, a 50 percent owner of National Petrochemical, is a significant factor in the blow molding market, and Amoco is also a producer of foamed food containers. No appreciable change in the captive share of the market for HDPE in the region is foreseen.

There is no captive HDPE consumption in British Columbia, but Phillips has an extruded pipe operation in Calgary.

d. Pricing

In July 1979, the U.S. prices for blow-molding, injection-molding and general-purpose extrusion grades of HDPE were 36.25 cents per pound, delivered. The same prices prevail on the U.S. West Coast as in the remainder of the United States. Prices increased about 25 percent since mid-1978. Further price increases should be related primarily to cost increases.

In Canada, the commodity grades of HDPE sold for $0.455-0.491 (Canadian) per pound delivered in bags in September 1979. Prices are anticipated to remain slightly above U.S. levels. The duty on LDPE is 10 percent ad valorem.

2. Pacific Basin Market

a. Japan

Demand

The domestic demand for high density polyethylene in Japan is forecast to increase from 320,000 metric tons in 1977 and 438,000 metric tons in 1978 to 550,000 metric tons in 1980, 780,000 in 1985 and 990,000 by 1990. Japan has been a substantial HDPE exporter, with exports totaling 176,000 metric tons in 1978. However, they are anticipated to decrease somewhat over the study period. As a result, total HDPE demand should increase from 614,000 metric tons in 1978 to 1,060,000 metric tons in 1990. This represents an average annual growth of 4.6 percent. The Japanese demand by end-use for this product is presented in Table IV-B-2.

TABLE IV-B-2

JAPANESE HIGH DENSITY POLYETHYLENE DEMAND
(Thousand Metric Tons)

	1977	1978	1980	1985	1990	AAGR, % (1978-1990)
Demand						
Injection molding	90	120	150	200	250	6.3
Blow molding	70	86	100	140	185	6.6
Film	50	95	130	210	280	9.4
Tape	10	14	17	25	30	6.6
Slit film yarn	29	34	45	55	65	5.5
Fiber	25	32	39	15	65	6.1
Pipe	7	9	11	15	20	6.9
Miscellaneous	39	48	58	80	95	5.9
Total domestic demand	320	438	550	780	990	7.0
Exports	182	176	130	100	70	(8.0)
Total demand	502	614	680	880	1,060	4.6

Injection molding applications are the largest segment of the HDPE market, with the major application being in the production of

containers. Demand is anticipated to increase about 12 percent per year in the 1978-1980 period, from 120,000 to 150,000 metric tons. Demand is expected to reach about 200,000 metric tons by 1985 and 250,000 metric tons by 1990, which represents a growth rate of 6.3 percent per year over the 1978 to 1990 period.

Blow molding is a relatively mature market, with demand growing an average of 6.6 percent over the study period.

Thin HDPE film has made substantial inroads in Japan in applications such as bags. Most of this market has been at the expense of LDPE. Overall HDPE film demand was about 95,000 metric tons in 1978, an increase of 90 percent over 1977. HDPE film is anticipated to increase to nearly 280,000 metric tons by 1990. Mitsui Petrochemical, Showa, Nissan, Asahi and Mitsubishi Chemical are among the producers of resins for this application. Package tape is currently a 14,000 metric ton per year market, which is anticipated to grow slightly above GNP.

Slit film yarn is used as a jute replacement. It also finds use as carpet backing, an application which is the province of polypropylene in the U.S. HDPE film yarn demand is anticipated to increase from 34,000 to 65,000 metric tons over the 1978-1990 period. Similar growth is anticipated for HDPE fiber. This product finds primary use in rope and fishnets. HDPE pipe is a small market in Japan, with consumption estimated at only 9,000 metric tons in 1978. Growth of about 7 percent per year is forecast.

Supply

The current high density polyethylene capacity in Japan is 882,000 metric tons. A list of Japanese HDPE producers is presented in Table IV-B-3.

At present, there are no expansions in progress. However, it appears likely that capacity increases will be made since, with the growth of thin HDPE film, the effective capacity is substantially reduced and the

TABLE IV-B-3

JAPANESE HIGH DENSITY POLYETHYLENE PRODUCERS, 1978
(Thousand Metric Tons per Year)

Company	Location	Capacity
Mitsui Petrochemical	Chiba/Iwakuni	209
Showa Petrochemical	Kawasaki	176
Asahi Chemical	Mizushima	90
Mitsubishi Chemical	Mizushima	88
Nisseki Resin Chemical	Kawasaki	87
Chubu Chemical	Yokkaichi	63
Idemitsu Petrochemical	Chiba	60
Nissan Chemical	Chiba	49
Chisso	Chiba	40
Mitsubishi Petrochemical	Yokkaichi	20
		882

producers are currently operating at about capacity. By 1985, it is anticipated that capacity will be expanded by at least 100,000 metric tons per year.

Supply/Demand Situation

The potential supply/demand balance for HDPE in Japan is presented in Table IV-B-4. Basically, Japan is anticipated to be in a relatively tight situation on HDPE.

TABLE IV-B-4

POTENTIAL SUPPLY/DEMAND BALANCE FOR HIGH DENSITY POLYETHYLENE IN JAPAN
(Thousand Metric Tons)

	1977	1978	1980	1985	1990
Potential supply*	750	750	750	835	835
Forecast demand	502	614	680	880	1,060
Surplus/(deficit)	248	136	70	(45)	(225)
Actual production	496	647			
Operating rate, %	56	73			

* 85 percent of nameplate capacity.

Pricing

The prices for HDPE were 210 yen per kilo (43.4 cents per pound) in late June 1979. Additional increases are anticipated in view of rising costs. The import duty on HDPE is 28 yen per kilo.

b. Korea

Demand

The demand for high density polyethylene in Korea is anticipated to increase from 36,000 metric tons in 1977 and 60,000 metric tons in 1978 to 85,000, 140,000 and 205,000 metric tons in 1980, 1985 and 1990, respectively. Rope, fishnets and flat yarn are the major products produced, but production of film and blow molded articles will grow rapidly over the study period.

Supply

Korea Petrochemical Industry Company (50 percent Korean interests/50 percent Chisso, Marubeni), the sole producer of high density polyethylene in Korea, has a nominal capacity of 35,000 metric tons per year in a facility at Ulsan. Amoco technology is used. In 1978, production from the unit was about 33,000 metric tons. Completion of the Korea Oil ethylene expansion in 1978 has allowed the facility to operate at near capacity levels. A 70,000 metric ton per year facility is being constructed by Honan Ethylene (Korean government) and Mitsui; this should be on-stream in 1980. The unit is part of the Yeosu project.

Supply/Demand Situation

The supply/demand situation for HDPE is presented in Table IV-B-5. With completion of the Yeosu plant, Korea is anticipated to have ample supply for this product only during the early 1980s, at which time it will probably again become an importer.

TABLE IV-B-5

POTENTIAL SUPPLY/DEMAND BALANCE FOR HIGH DENSITY POLYETHYLENE IN KOREA
(Thousand Metric Tons)

	1977	1978	1980	1985	1990
Potential supply	35	35	105	105	105
Forecast demand	36	60	85	140	205
Surplus/(deficit)	(1)	(25)	20	(35)	(100)

c. Taiwan

Demand

The demand for high density polyethylene in Taiwan is anticipated to increase from 35,000 metric tons in 1977 and 45,000 metric tons in 1978 to 58,000, 80,000 and 115,000 metric tons in 1980, 1985 and 1990, respectively. Rope and yarn, blow molding and film are the major markets.

Supply

The sole HDPE producer in Taiwan is United Polymer, a joint venture of USI, Solvay and China Development. The firm operates a single 50,000 metric ton per year plant at Toufen. This plant was expanded by 14,000 metric tons in 1978 and it is unlikely to be further expanded due to ethylene limitations at the site.

Formosa Plastics will build a 120,000 metric ton per year HDPE plant as part of Taiwan's fourth petrochemical complex planned at Lin Yuan. Start-up is expected in 1982.

Supply/Demand Situation

The supply/demand situation for HDPE in Taiwan is presented in Table IV-B-6. Taiwan will be an importer of HDPE for the next few years, but the new plant will meet growing demand.

TABLE IV-B-6

POTENTIAL SUPPLY/DEMAND BALANCE FOR HIGH DENSITY POLYETHYLENE IN TAIWAN
(Thousand Metric Tons)

	1977	1978	1980	1985	1990
Potential supply*	32	45	45	153	153
Forecast demand	35	45	58	80	115
Surplus/(deficit)	(3)	0	(13)	73	38
Actual production	29	34			

* Production at 90 percent of nameplate capacity.

d. Hong Kong

The demand for high density polyethylene in Hong Kong is forecast to increase from 30,000 to 63,000 metric tons over the 1978-1990 period as is shown in Table IV-B-7. The product is utilized mainly in the production of injection and blow molding articles, which are both used domestically and exported. However, part of the growth is anticipated to result from thin film applications. In 1978, Japan and the U.S. were the major sources of HDPE resin for Hong Kong.

TABLE IV-B-7

HONG KONG HIGH DENSITY POLYETHYLENE DEMAND
(Metric Tons)

1977	25,000
1978	30,000
1980	36,000
1985	48,000
1990	63,000
AAGR, % (Base 1978)	6.4

There are no high density polyethylene facilities in Hong Kong and none are expected over the study period.

e. ASEAN Countries

The HDPE demand in the ASEAN countries is anticipated to increase from 102,800 and 114,800 metric tons in 1977 and 1978 to 297,000 metric tons

in 1990, as shown in Table IV-B-8. The use pattern for HDPE varies from country to country. Injection and blow molding are the major uses in Malaysia, Thailand and Indonesia, film predominates in Singapore, and rope and fishnets are important in the Philippines.

At present, there are no production facilities within the region, but by 1985, capacity will be 80,000 metric tons per year when the facility in Singapore is brought on stream. In addition, a 50,000 metric ton per year facility based on imported ethylene, in which USI Far East would have an interest, is planned for Thailand. However, during the 1980s a deficit situation will persist.

TABLE IV-B-8

ASEAN COUNTRY HIGH DENSITY POLYETHYLENE DEMAND
(Thousand Metric Tons)

	1977	1978	1980	1985	1990	AAGR, % (Base 1978)
Philippines	22	25	30	45	65	9.4
Singapore	6.8	8.8	10	13	17	5.6
Malaysia	16	18	23	34	45	7.9
Thailand	16	17	22	38	60	11.1
Indonesia	42	46	54	78	110	7.5
	102.8	114.8	139	208	297	8.2

f. People's Republic of China

At present, the PRC has HDPE facilities with a capacity of about 120,000 metric tons per year. It is anticipated that imports will remain relatively modest.

3. Conclusions

Opportunities for an Alaskan Plant

The supply and demand for HDPE on the West Coast and in the Pacific Basin are summarized in Table IV-B-9.

TABLE IV-B-9

HIGH DENSITY POLYETHYENE

	Demand				Capacity, per year	
	1978	1985	1990	AAGR, %	1978	Future
	(Million Pounds)					
West Coast	500	1,065	1,610	10.3	0	0
	(Thousand Metric Tons)					
Japan	438	780	970	7.0	882	982*
Korea	60	140	205	10.1	35	105
Taiwan	45	80	115	8.1	50	170
Hong Kong	30	48	63	6.4	0	0
ASEAN Countries	115	208	297	8.2	0	80**

* Future projects not certain.
** Additional facilities possible.

It is anticipated that during the 1980s new grass-roots high density facilities will have to be at least 250 million pounds per year in size in order to be competitive. Due to the significant position of at least six firms, it is anticipated that a firm with Alaskan production could reasonably expect to capture only about 20-25 percent of the merchant market on the West Coast. This would equate to 180-225 million pounds. By 1990, with normal demand increases, sales should grow to over 300 million pounds. Any anticipated captive consumption within the region must be added to these figures.

In the mid-1980s, Korea, Hong Kong and the ASEAN countries will be major importers, with current demand totaling 450-500 million pounds. At best, about half of this current demand could be met by facilities in Japan and Taiwan since, with the trend to increased film and large container consumption, the effective capacity of HDPE units is reduced. An Alaskan facility would be well located to capture part of this current demand. In addition, Japanese producers could opt to place new HDPE capacity offshore in lieu of modernizing older plants and erecting new ones. Imports in the 200 million pound per year range would not be unreasonable.

Production of HDPE in Alaska is viable from a standpoint of market size and trends. Facilities in the 250-400 million pound per year range could be justified.

C. Polystyrene

1. West Coast Market

a. Demand

In 1978, the U.S. West Coast demand for polystyrene, including expandable beads, was estimated at 540 million pounds, or 15 percent of the total U.S. market of about 3.6 billion pounds. This 540 million pound Western U.S. market is made up of 480 million pounds of general-purpose and impact polystyrene and 60 million pounds of expandable beads. By 1990, total polystyrene demand is expected to reach 1,030 million pounds, an average annual growth rate of 5.5 percent over the 1978-1990 period, as shown in Table IV-C-1. Western Canadian consumption of about 15 million pounds in 1978 is expected to double over the period. Molding accounts for 45 percent of total polystyrene consumption. Nearly every molder in the West Coast region uses some polystyrene for proprietary products, housewares, electrical goods, toys or sporting equipment. Extrusion of polystyrene, including foamed sheet and regular film and sheet, accounted for somewhat over 30 percent of the polystyrene consumed during 1978. Foam and foamable materials, primarily expandable beads, accounted for about 20 percent.

TABLE IV-C-1

WEST COAST POLYSTYRENE DEMAND, 1978-1990
(Million Pounds)

Western U.S.	1978	1980	1985	1990	AAGR, % (1978-1990)
Molding	235	250	300	350	3.4
Extrusion	170	195	285	390	7.2
Foam and foamable materials	105	120	170	220	6.3
All other uses	30	35	50	70	7.3
Total Western U.S.	540	600	805	1,030	5.5
Western Canada	15	20	25	30	5.9
Total	555	620	830	1,060	5.5

Molding accounted for nearly 45 percent of the U.S. West Coast polystyrene consumption in 1978. Major markets were packaging, housewares, electrical and electronic applications, cassettes, toys, nursery tubs and containers. Typical of the molders is Amoco in La Mirada, CA. Amoco is a major producer of cups. High-impact polystyrene is molded by toymakers such as Mattel, Revell and Cox. In addition, Adams Brothers Plastic molds for Sears, Ideal and Tomy, a Japanese toy company. In housewares, Triplastics is a major molder of polystyrene. Another significant market for polystyrene is tape cassettes, which are produced by M.U. Engineering and UPM.

Extrusion of solid polystyrene sheet, shapes and profiles is widespread, accounting for about 30 percent of total polystyrene use. A prominent extruder is Gage Industries of Oregon, which produces sheet for thermoforming and also carries out thermoforming and vacuum forming of polystyrene. Most of Gage's output is used for packaging. Container Corporation and American Can thermoform high-impact polystyrene for hot drink cups.

About 20 ercent of the polystyrene market is comprised of foamed material either from expandable polystyrene beads (EPS) or foamed general-purpose material. There are about 20 significant processors of EPS beads in the West Coast region, including Dew Foam, Handi-Kup, W.D. Adam, K&B Mfg. and Thompson Industries, a subsidiary of Dart Industries located in Phoenix, AZ.

There are about ten producers of extruded foam sheet and molded board for insulation and other uses. A substantial portion of the total market is devoted to egg cartons by Dolco, Keyes and Packaging Corporation of America. Dow also makes foamed sheet in Torrance, CA.

Approximately 5 percent of the total polystyrene consumption is in the "other" category. This includes material for signs and material used in paper coating.

The polystyrene market in Western Canada was about 15 million pounds in 1978 and is anticipated to grow at nearly 6 percent per year and reach 30 million pounds by 1990. Foam products and molded articles are significant in the area. Significant polystyrene consumers include Gulf Plastics in Langley (foam packaging), Scott Plastics in Victoria (custom molding) and Plasti-Fab in Vancouver (foam insulation).

b. Supply

There are six producers of polystyrene on the U.S. West Coast, with a total capacity of 480 million pounds per year, as shown in Table IV-C-2. Two expansions, which will increase capacity by 70 million pounds per year, have been announced. Dow, Monsanto, Amoco and Cosden are among the major suppliers to the West Coast market.

TABLE IV-C-2

U.S. WEST COAST POLYSTYRENE PRODUCERS, 1978
(Million Pounds per Year)

Company	Location	Capacity	Expansions
A&E Plastik Pak	City of Industry, CA	45	
Amoco Chemical	Torrance, CA	65	
Cosden	Orange, CA	75	
Mobil	Santa Ana, CA	30	50
Dow Chemical	Torrance, CA	215	
Monsanto	Long Beach, CA	50	
Plastic Products	Los Angeles, CA		20
Total		480	70

There are no polystyrene producers in Western Canada. However, BASF, Dow, Monsanto and Polysar supply product from Eastern Canada. In addition, there are imports from U.S. producers.

c. Captive Market

About 20 percent, or 110 million pounds, of the polystyrene market is captive. Dow, A&E Plastik, Amoco and Mobil have captive operations within the region.

There is no captive consumption in Western Canada.

d. Pricing

Polystyrene is sold on a delivered basis in the Western U.S., with prices for the general-purpose and high-impact grades being 41 and 42 cents per pound, respectively, as of October 1, 1979. Prices have risen recently due to the styrene price increases caused by a tight benzene situation worldwide.

In Canada, general purpose polystyrene was priced at $0.526 (Canadian) per pound for general-purpose grade, with the high-impact grade moving for about 1 cent per pound more. Canadian prices should remain about the same or slightly above U.S. prices. Imports of polystyrene into Canada are subject to a 10 percent ad valorem duty.

2. Pacific Basin Market

a. Japan

Demand

Domestic demand for polystyrene in Japan is anticipated to increase from 530,000 to 1,030,000 metric tons during the 1978-1990 period. This represents a growth of 5.1 percent per year over the study period. Net polystyrene exports are currently about 60,000 metric tons, and they are anticipated to increase somewhat over the study period. The Japanese polystyrene demand by end-use is presented in Table IV-C-3.

TABLE IV-C-3

JAPANESE POLYSTYRENE DEMAND
(Thousand Metric Tons)

	1977	1978	1980	1985	1990	AAGR, % (1978-1990)
General-purpose and high-impact						
Electrical appliances	110	115	130	175	230	6.0
Mechanical appliances	12	13	15	20	25	5.6
Industrial goods	16	18	20	25	30	4.4
Packaging	145	160	175	215	260	4.1
Consumer items	100	110	125	170	220	5.9
Foam	147	154	175	220	265	4.6
Domestic demand	530	570	640	825	1,030	5.1
Exports	60	60	65	75	80	
	590	630	705	900	1,110	4.8

Electrical and electronics applications are anticipated to be a fast growing area for polystyrene, with demand increasing at about 6.0 percent per year over the study period. This figure reflects a slowing down of growth due to export of some consumer electronics activities to other countries and increasing difficulties in obtaining a larger share of the U.S. market. In 1977 and 1978, Japanese television manufacturers voluntarily curtailed shipments to the U.S., reducing polystyrene demand in that application. Use in nonelectric appliances and industrial goods is expected to remain small. Demand growth in the packaging, consumer items and foam (also largely packaging and consumer) categories is anticipated to rise at somewhat slower rates due to conservation efforts.

Supply

The current capacity of Japanese polystyrene producers is 739,000 metric tons, as shown in Table IV-C-4. At present, no expansions are in

progress. However, it is anticipated that additional expansions will be made in the early 1980s, primarily by firms such as Asahi-Dow, Shin Nippon Steel Chemical, Toyo Polystyrene and Mitsubishi Monsanto, which are either basic in styrene or have strong positions in the industry, coupled with styrene supplies through related companies.

TABLE IV-C-4

JAPANESE POLYSTYRENE PRODUCERS, 1978
(Thousand Metric Tons per Year)

Company	Location	Capacity
Asahi-Dow	Kawasaki	59
	Mizushima	135
	Chiba	50
Denki Kagaku	Chiba	70
Dainippon Ink	Chiba	14
	Yokkaichi	30
Idemitsu	Tokuyama	60
Mitsubishi Monsanto	Yokkaichi	91
	Kashima	24
Nippon Polystyrene	Kawasaki	52
Shin Nippon Steel Chemical	Tobata	60
Toyo Polystyrene	Kawasaki	60
	Sakai	34
		739

Supply/Demand Situation

The potential supply/demand situation for polystyrene in Japan is presented in Table IV-C-5. Basically, the existing Japanese polystyrene capacity is insufficient to meet demand beyond the early 1980s. However, it is anticipated that demand growth will be met by new facilities in Japan, and it is highly unlikely that significant polystyrene imports can be made from the U.S. except under extraordinary circumstances. For exports to Japan, a U.S. producer would be competing against other regional producers, such as Dow in Hong Kong, which have the advantage of not having to pay a tariff since Hong Kong is a "developing nation".

TABLE IV-C-5

POTENTIAL SUPPLY/DEMAND BALANCE FOR POLYSTYRENE IN JAPAN
(Thousand Metric Tons)

	1977	1978	1980	1985	1990
Potential supply*	739	739	739	739	739
Forecast demand	590	630	705	900	1,110
Surplus/(deficit)	149	109	34	(161)	(371)

* 100 percent of nameplate capacity.

Pricing

In June 1979, the Japanese price for general-purpose polystyrene was 40 yen per kilo (43.4 cents per pound). The duty on polystyrene resin is 14 percent, with the exception of the foam resin, which has a duty of 8 percent.

b. Korea

Demand for polystyrene in Korea is anticipated to increase from 48,000 metric tons in 1977 and 70,000 metric tons in 1978 to 85,000, 125,000 and 165,000 metric tons in 1980, 1985 and 1990, respectively. This represents an average annual growth of 7.4 percent from 1978. Consumption is primarily in general-purpose injection-molding grades. Demand for high-impact material for refrigerator door liners and other more demanding applications was met through imports.

Han Nam Chemical, a joint venture of Asahi-Dow and Korean interests, is the sole Korean producer with a 50,000 metric ton per year unit at Ulsan. Polystyrene imports were 17,000 metric tons in 1978. An additional 68,000 metric tons of capacity should come on stream in 1982-1983 as part of the new petrochemical complex at Yochon. It is expected that Korea will try to remain basically self-sufficient in the product, importing only those specialized grades not produced domestically.

c. Taiwan

Demand for polystyrene in Taiwan was increased from about 42,000 metric tons in 1977 to about 58,000 metric tons in 1978. Consumption exists primarily in the general-purpose injection-molding grades, although high-impact and expandable polystyrene are also utilized. Consumption is anticipated to reach 80,000 metric tons by 1980, due in part to growth in electronics and appliance sectors. By 1985 and 1990, demand is estimated to reach 110,000 and 135,000 metric tons, respectively. This represents an average annual growth of 7.3 percent over the 1978 to 1990 study period.

Taiwan has several small polystyrene producers; they have a total capacity of 69,800 metric tons per year, as shown in Table IV-C-6. In 1978, Taiwan was a net importer of about 6,000 metric tons of resin. It is anticipated that Taiwan will basically remain a small net importer of polystyrene over the study period.

TABLE IV-C-6

TAIWANESE POLYSTYRENE PRODUCERS, 1978
(Thousand Metric Tons per Year)

Company	
Poly	31.2
Taita	19.2
Shing-chi	2.4
Kao-fu	9.6
Others	7.4
	69.8

d. Hong Kong

The demand for polystyrene in Hong Kong in 1978 was roughly 100,000 metric tons. About 60-65 percent of this market consists of general-purpose resins. This market is anticipated to have reasonable growth due to expansion of the electronics industry, which utilizes

polystyrene components. Demand is anticipated to reach 120,000, 170,000 and 220,000 metric tons in 1980, 1985 and 1990, respectively. This represents an average annual growth of 6.8 percent.

Dow is the sole Hong Kong polystyrene producer with a 65,000 metric tons per year plant which came on stream in 1976. This plant supplies both local and export markets. Dow is planning to increase the capacity of this facility to 125,000 metric tons per year.

Since there is no tariff protection in Hong Kong, considerable polystyrene imports will continue throughout the study period. Imports were 75,000 metric tons in 1978. Due to the Dow plant expansion, they are expected to decrease in the early 1980s, but then increase to about 80,000 metric tons by 1985.

e. ASEAN Countries

Unlike the polyolefins, which are utilized in overwrap, bags and relatively unsophisticated applications, polystyrene finds use in electronics, appliances and more sophisticated packaging applications. As a result, it is generally the last of the major thermoplastic resins to achieve significant usage, and for this reason consumption in the ASEAN countries was only 53,000 metric tons in 1978, which is half of the consumption in Hong Kong, which only has 2 percent of the population of the ASEAN countries.

Polystyrene demand in the ASEAN countries is anticipated to increase from 42,200 and 53,600 metric tons in 1977 and 1978 to 70,000, 110,000 and 162,000 metric tons in 1980, 1985 and 1990, respectively, as shown in Table IV-C-7. Imports to the region were about 24,000 and 22,000 metric tons in 1977 and 1978. In spite of the increased production at the new Dow plant, imports are expected to increase to 45,000 metric tons by 1985 if no new capacity is introduced.

TABLE IV-C-7

ASEAN COUNTRY POLYSTYRENE DEMAND
(Thousand Metric Tons)

	1977	1978	1980	1985	1990	AAGR, % (1978 Basis)
Philippines	9	13	15	20	29	6.9
Singapore	12.8	15.1	22.6	33	46	9.7
Malaysia	3.4	4	6	10	15	11.6
Thailand	7.7	9	11	22	34	11.7
Indonesia	9.3	12.5	15.4	25	38	9.7
	42.2	53.6	70.0	110	212	12.1

f. People's Republic of China

Polystyrene production in the PRC is quite small, with production capacity reported at only 5,000 metric tons per year. Various polystyrene grades are imported, but significant growth in polystyrene consumption will be slow in developing for the next few years, and at that time the PRC should be in a position to manufacture most of its needs domestically.

3. Conclusions

Opportunities for an Alaskan Plant

The supply and demand for polystyrene on the U.S. West Coast and in the Pacific Basin are summarized in Table IV-C-8.

During the 1980s, it is anticipated that a new grass-roots polystyrene facility, producing both general-purpose and high-impact material, will have to be about 200 million pounds per year. A new polystyrene producer could expect to capture only about 15 percent of the U.S. West Coast merchant market, or about 100 million pounds in 1985.

TABLE IV-C-8

POLYSTYRENE

	Demand				Capacity, per year	
	1978	1985	1990	AAGR, %	1978	Future
		(Million Pounds)				
West Coast	555	830	1,060	5.5	480	550*
		(Thousand Metric Tons)				
Japan	570	825	1,030	5.1	739	739*
Korea	70	125	165	7.4	50	118*
Taiwan	58	110	135	7.3	70	70*
Hong Kong	100	170	220	6.8	65	125
ASEAN Countries	54	110	212	10.6	39	47*

* Additional expansions likely.

Most Pacific Basin countries are anticipated to be virtually self-sufficient in polystyrene. Due to the entrenched positions of Dow and the affiliates of Japanese companies in the Pacific Basin, polystyrene imports from facilities outside of the region are estimated at only 100-200 million pounds in 1985. As a result, shipments from a new Alaskan producer to the region probably would not exceed 20-30 million pounds per year. Basically, production of polystyrene in Alaska by a new producer does not look too attractive from a market standpoint, since it would generally be preferable to produce the polystyrene resin close to the point of consumption.

D. Polyvinyl Chloride

1. West Coast Market

a. Demand

The U.S. West Coast region consumed an estimated 680 million pounds of polyvinyl chloride resin in 1978. This accounted for about 12 percent of the U.S. domestic consumption of 5.5 billion pounds of PVC. By 1990, West Coast demand is expected to reach 1.9 billion pounds, representing an average annual growth rate of 8.7 percent over the period. The Western Canadian market was about 15 million pounds in 1978 and it is expected to reach 40 million pounds by 1990. The demand for PVC on the West Coast is shown in Table IV-D-1.

Over 70 percent of the regional demand in 1978 was used in extrusion, particularly pipe. Molding and calendering were the other significant markets for PVC, accounting for 12 and 9 percent of the market, respectively.

Calendering markets are traditionally divided into flooring, textile and others, which includes film and sheet. There is little textile-oriented manufacture in the U.S. West Coast region, so PVC consumption in this market is negligible. However, there is considerable activity in flooring, with the major product being vinyl asbestos tile. Five of the national flooring companies are active in the West Coast area: Armstrong, Nafer (National Flooring), Flintkote, Kentile and American Biltrite. Flooring is expected to show growth significantly higher than overall U.S. growth due to new construction in the region.

Consumption of PVC resin in film and sheet was about 30 million pounds in 1978. Growth of the market is forecast at 7-9 percent per year over the 1978-1990 period. This use area is somewhat small, since there is no

TABLE IV-D-1

WEST COAST POLYVINYL CHLORIDE DEMAND
(Million Pounds)

Western U.S.	1978	1980	1985	1990	AAGR, % (1978-1990)
Calendering					
Flooring	30	35	-	-	-
Textile	*	*	-	-	-
Other, including film and sheet	30	35	-	-	-
Subtotal	60	70	105	150	8.0
Coating					
Flooring	*	*	-	-	-
Textile and paper	*	*	-	-	-
Protective coatings	10	10	-	-	-
Adhesives and other	5	10	-	-	-
Subtotal	15	20	30	40	8.5
Extrusion					
Wire and cable	25	30	-	-	-
Film and sheet	15	20	-	-	-
Rigid pipe and tube	430	545	-	-	-
All other extrusion	20	25	-	-	-
Subtotal	490	620	960	1,370	9.0
Molding					
Bottles	5	10	-	-	-
Sound records	35	40	-	-	-
Fittings for pipe	25	30	-	-	-
Other molding	15	20	-	-	-
Subtotal	80	100	150	220	8.8
All other uses	35	40	55	70	6.0
Total Western U.S.	680	850	1,300	1,850	8.7
Western Canada	15	20	30	40	8.5
Total	695	870	1,330	1,890	8.7

* Small.

production for the auto industry. The 6 calenders in the West Coast region are operated by Columbus Coated Fabrics (Borden), Ellay Plastics (W.R. Grace) and Maclin.

Coating applications for PVC on the U.S. West Coast are small, accounting for only 15 million of the 500 million pound U.S. market in 1978. No significant usage in the flooring, textile and paper areas was found.

This is because the textile industry is small in the region and paper coating is a relatively small consumer of resin. In the protective coatings area, some PVC is used for solution vinyl. Adhesives uses were also small, consuming about 5 million pounds per year. The total coating category is expected to grow to 40 million pounds by 1990.

Extrusion applications constitute the largest market for PVC resins in the U.S. West Coast region, accounting for over 70 percent of resin consumption. Of the total market of 490 million pounds of PVC in 1978, 430 million pounds were consumed in rigid pipe and tubing, mainly for irrigation and land reclamation purposes. There are about ten major producers of pipe, including Certain-Teed, Johns-Manville, Robintech, Portco, Carlon, Simpson Timber, Apache Kerone, EPPCO, Celanese, Rainbird, Richdale and Thompson. There are a number of extruders of PVC film and sheet in the Western region, including Atlas Plastics, Raum Chemical and Lustro. The products are used mainly in packaging. Wire and cable extrusion in the West involves a number of companies, including Anaconda, Carol Cable, Coaxco, Icore International, National Wire and Cable, Pacific Electricord and Whitmore. The overall market for PVC in extrusion applications is expected to reach 1,370 million pounds by 1990. This represents growth of 9 percent per year.

Other uses, including fire retardant applications, foamed PVC, roto and slush molding are estimated at 35 million pounds in 1978. Growth to 1990 is expected to average 6.0 percent per year.

Western Canada

The polyvinyl chloride market in Western Canada was about 15 million pounds in 1978 and is anticipated to grow 8-9 percent per year and reach 40 million pounds by 1990. Pipe is the largest segment of the market, with Pacific Plastics (Vancouver) and Flex-Lox (Abbotsford), being significant consumers.

b. Supply

There are three producers of polyvinyl chloride in the Western U.S. - B.F. Goodrich, Keysor Century and Stauffer. Stauffer is the only company basic in vinyl chloride monomer. Total capacity is estimated at 370 million pounds, as is shown in Table IV-D-2.

TABLE IV-D-2

U.S. WEST COAST POLYVINYL CHLORIDE PRODUCERS
(Million Pounds per Year)

Company	Location	Capacity
B.F. Goodrich Chemical	Long Beach, CA	150
Keysor Century	Saugus, CA	50
Stauffer Chemical*	Carson, CA	170
Total		370

* Has VCM production at same site.

The supply within the region is not sufficient to meet demand. Significant marketers in the region, besides the producers, are Conoco, Diamond Shamrock, Union Carbide, Borden, Tenneco, Pantasote, Ethyl and Firestone.

There are no PVC producers in Western Canada. Esso Chemical Canada and B.F. Goodrich Canada supply material from the East, and some of the U.S. producers also serve the region. It is anticipated that the Diamond Shamrock Alberta Gas Chemical joint venture will become a significant supplier in the near future when their 220 million pound per year facilities at Ft. Saskatchewan, Alberta, are completed.

c. Captive Market

Borden, which produces film, is the sole captive consumer on the U.S. West Coast. It is estimated that its consumption is about 2-3 percent of

the total demand, and no significant change in this percentage over the study period is foreseen. There are no captive consumers in Western Canada.

2. Pacific Basin Market

a. Japan

The Japanese domestic demand for polyvinyl chloride resin is forecast to increase from 1,180,000 metric tons in 1978 to 2,060,000 metric tons in 1990 (Table IV-D-3), an average annual growth of 4.6 percent. In addition, Japan has in the past been a significant net exporter of these resins, with net exports totaling 80,00 metric tons in 1977. In 1978, net exports dropped to 20,000 metric tons. This was due to the yen's appreciation, which priced Japanese PVC out of competition on world markets. Although exports are expected to again reach the 1977 level during the 1980s, they are forecast to decline as other countries in the Asian region attain greater self-sufficiency.

Rigid PVC constitutes nearly 60 percent of the Japanese market. Demand for rigid sheet, which is used in packaging applications, is anticipated to grow 6.4 percent per year. Pipe is a relatively mature product in Japan. After a sharp rise in 1978, it is expected to level off at 5 percent per year. Plasticized PVC constitutes about 30 percent of the domestic market, of which film and sheet applications constitute about half. The principal use for film is as a moisture barrier, but it is being replaced in this use by polyethylene and polypropylene. Sheet applications, such as shower curtains, are similar to these applications in the U.S. As a result, film and sheet demand is expected to grow at only about 2-3 percent per year. Use in wire and cable insulation is anticipated to follow the growth of that industry at about 4-5 percent per year. The flooring market is primarily for commercial use, since tatami and carpeting are used in residences. PVC fiber is made by Teijin for flame resistant applications and is expected to remain a specialty fiber.

TABLE IV-D-3

JAPANESE POLYVINYL CHLORIDE DEMAND
(Thousand Metric Tons)

	1977	1978	1980	1985	1990	AAGR, % (1978-1990)
Rigid PVC						
Sheet	155	190	215	295	400	6.4
Pipe	270	355	410	530	650	5.1
Joints	30	40	45	55	65	4.1
Rain pipe	25	30	35	45	60	5.9
Others	45	50	55	75	95	5.5
Subtotal	525	665	760	1,000	1,270	5.5
Plasticized PVC						
Film and sheet	140	165	175	200	225	2.6
Artificial leather	50	65	70	85	100	3.6
Extrusions	60	70	75	85	95	2.6
Other	55	75	80	100	130	4.6
Subtotal	305	375	400	470	550	3.2
Miscellaneous						
Wire and cable	90	103	110	135	170	4.3
Flooring	15	20	25	30	35	4.7
Fiber	7	8	10	10	10	1.9
Others	8	9	10	15	25	8.8
Subtotal	120	140	155	190	240	4.6
Total domestic demand	950	1,180	1,315	1,660	2,060	4.8
Net exports	80	20	85	70	40	-
Total demand	1,030	1,200	1,400	1,730	2,100	4.8

Supply

In Japan, the 19 producers of PVC resin have a total capacity of 1,921 metric tons, with no announced expansions at present. A number of these facilities are small and may not be able to meet more stringent environmental standards. A list of the Japanese PVC resin producers is presented in Table IV-D-4.

TABLE IV-D-4

JAPANESE POLYVINYL CHLORIDE PRODUCERS, 1978
(Thousand Metric Tons)

Company	Capacity
Asahi Glass	28
Central Chemical	25
Chisso	145
Denki Kagaku	171
Kanegafuchi	216
Kawasaki Petrochemical	30
Kureha	138
Mitsubishi Monsanto	100
Mitsui-Toatsu	117
Nippon Geon	192
Nissan Chemical	30
Ryonichi	137
Shin-Etsu	225
Sumitomo	120
Sun Arrow	64
Toa Gosei	59
Tokuyama Sekisui	49
Toyo Soda	75
	1,921

Supply/Demand Situation

The potential supply/demand balance for PVC resin in Japan is presented in Table IV-D-5. Basically, the supply from existing plants is more than sufficient to meet the overall Japanese demand until 1990, when further capacity is expected to be added.

TABLE IV-D-5

POTENTIAL SUPPLY/DEMAND BALANCE FOR POLYVINYL CHLORIDE IN JAPAN
(Thousand Metric Tons)

	1977	1978	1980	1985	1990
Potential supply*	1,921	1,921	1,921	1,921	1,921
Forecast demand	1,030	1,200	1,400	1,730	2,100
Surplus/(deficit)	891	721	521	191	(179)

* 100 percent of nameplate capacity.

Pricing

In late June 1979, prices for general-purpose PVC resins were 162 yen per kilo (33.5 cents per pound). Prices are related primarily to vinyl chloride monomer costs.

The duty on polyvinyl chloride is 8 percent ad valorem.

b. Korea

Demand

Korean PVC demand totaled about 185,000 metric tons in 1978, of which approximately 120,000 metric tons was for domestic consumption and the remainder was processed into goods for export. Overall demand is expected to reach 240,000, 350,000 and 460,000 metric tons in 1980, 1985 and 1990, respectively. This represents an average annual growth of 7.9 percent over the period. Almost all material is general-purpose grade; however, the demand for pipe resin is increasing.

The major PVC processors in Korea are Lucky, Chin Yang Chemical, Daihan, National Plastic, Sam Yung Chemical and Korea Plastic Industry. These firms account for over 60 percent of consumption.

Supply

The current PVC capacity in Korea is 200,000 metric tons per year. Paste resins make up 10,000 metric tons per year of this total. Additional facilities are anticipated during the early 1980s to meet the growing demand. The Korean PVC producers and their capacities are presented in Table IV-D-6.

TABLE V-D-6

KOREAN POLYVINYL CHLORIDE PRODUCERS
(Thousand Metric Tons)

Company	Location	Capacity
Korea Plastics Industry	Kunsan, Luchon, Ulsan, Chin Hae, Pegan	150
Lucky Ltd.	Yeochon	50
		200

Supply/Demand Situation

The potential supply/demand balance for PVC resins in Korea is presented in Table IV-D-7. Basicaily, Korea is anticipated to be in an essentially balanced situation throughout the study period, assuming that new capacity is installed to utilize the available vinyl chloride monomer. In spite of the balanced situation, there will continue to be some importation of special product grades.

TABLE IV-D-7

POTENTIAL SUPPLY/DEMAND BALANCE FOR POLYVINYL CHLORIDE IN KOREA
(Thousand Metric Tons)

	1977	1978	1980	1985	1990
Potential supply	150	200	200	350*	460*
Forecast demand	150	185	240	350	460
Surplus/(deficit)	0	15	(40)	-	-
Actual production	124	195			

* Assumes new plant capacity.

c. Taiwan

Demand

Taiwan has a well-developed PVC industry, which probably is the largest in the world in relation to the size of the country. Demand in 1978, including exports of 60,000 metric tons, is estimated at 390,000 metric tons. Domestic demand is anticipated to reach 380,000, 535,000 and

695,000 metric tons in 1980, 1985 and 1990, respectively. Resin exports are expected to remain at about current levels.

The Taiwan PVC industry has been developed to serve world markets and generally has more sophisticated equipment than most major developed nations. As a result, exports in the form of sheet and finished products are anticipated to grow strongly. Most of the PVC produced is consumed captively. Formosa Plastics, China Gulf, Ocean Plastics and Cathay are major consumers.

Supply

In 1978, the Taiwan PVC industry capacity was 428,000 metric tons, with Formosa Plastics dominating the industry. Formosa Plastics added 24,000 metric tons of capacity in 1979, increasing the current industry capacity to 452,000 metric tons. At present, there are no major expansions in progress, but supply is anticipated to keep ahead of demand. The PVC producers and their capacities are listed in Table IV-D-8.

TABLE IV-D-8

TAIWAN POLYVINYL CHLORIDE PRODUCERS, 1978

Company	Capacity
Formosa Plastics	342
China Gulf Plastics	38
Cathay	30
Ocean	18
	428

Supply/Demand Situation

The potential supply/demand balance for PVC in Taiwan is presented in Table IV-D-9. Basically, capacity is expected to be added to meet demand in the future, and it is anticipated that imports of the material will be limited to special grades and spot situations.

TABLE IV-D-9

POTENTIAL SUPPLY/DEMAND BALANCE FOR POLYVINYL CHLORIDE IN TAIWAN
(Thousand Metric Tons)

	1977	1978	1980	1985	1990
Potential supply*	385	385	500**	650**	820**
Forecast demand***	315	390	450	600	770
Surplus/(deficit)	70	(5)	50	50	50
Production	310	390			

* 90 percent of nameplate capacity.
** Assumes new facilities.
*** Demand includes resin exports.

d. Hong Kong

There is no production of PVC resin in Hong Kong, nor is any expected. The total demand for PVC resins was approximately 50,000 metric tons in 1978 and is anticipated to increase to 56,000, 73,000 and 89,000 metric tons in 1980, 1985 and 1990, respectively.

The major products made from PVC are sandals, footwear and artificial leather. In recent years, the rigid pipe market has begun to be significant. Paste resin is consumed for use in dolls. The demand growth in Hong Kong is expected to be relatively modest since the economy is almost totally committed to the export market and its strength is in the development of techniques to make new products most efficiently, rather than in the production of more and more of the same product.

e. ASEAN Countries

Polyvinyl chloride demand in the ASEAN countries is anticipated to increase from 119,400 and 134,500 metric tons in 1977 and 1978 to 315,000 metric tons in 1990, as shown in Table IV-D-10. At present, the eight PVC producers in the region provided about 120,000 metric tons of the region's needs in 1978. The producers and their capacities are listed in

Table IV-D-11. Over the study period, expansion within the region will occur, such that imports from 1985 to 1990 should amount to approximately 50,000 metric tons yearly.

TABLE IV-D-10

ASEAN COUNTRY POLYVINYL CHLORIDE DEMAND
(Thousand Metric Tons)

	1977	1978	1980	1985	1990	AAGR, % (Base 1978)
Philippines	30	34	42	75	120	11.1
Singapore	11	12	15	20	30	7.9
Malaysia	18.4	21	28	45	70	10.6
Thailand	25	27.5	35	55	85	9.9
Indonesia	35	40	55	80	110	8.8
	119.4	134.5	175	275	415	9.8

f. People's Republic of China

The PVC market in the PRC is relatively small, and existing capacity is only about 20,000 metric tons per year. It is anticipated that Japan will continue to supply most of the modest imports of the product.

3. Conclusions

Opportunities for an Alaskan Plant

The supply and demand for PVC on the West Coast and in the Pacific Basin are summarized in Table IV-D-12.

It is anticipated that, during the 1980s, new grass-roots polyvinyl chloride facilities will have to be at least 200 million pounds per year in size in order to be competitive. Due to the highly competitive situation in PVC resins, a new West Coast producer could reasonably expect to capture only about 15 percent of the merchant market. This quantity would be sufficient to enable the facility to run essentially at capacity by 1985.

TABLE IV-D-11

ASEAN COUNTRY POLYVINYL CHLORIDE PRODUCERS
(Thousand Metric Tons Per Year)

Company	Capacity	Expansions
Philippines		
Mabuhay Vinyl	28	-
Philippine Vinyl Consortium	25	-
	53	
Singapore		
Singapore Polymer	15	-
Malaysia		
Malaysian Electro-Chemical Industries	12	-
Synthetic Resins	12	
	24	
Thailand		
Thai Plastics & Chemical	20-25	to 45 (1979) 70 (early 1980s)
Indonesia		
Eastern Polymer	15	20 (1979)
Standard Toyo Polymer	24	
	39	
Total	151-156	

TABLE IV-D-12

POLYSTYRENE

	Demand				Capacity, per year	
	1978	1985	1990	AAGR, %	1978	Future
	(Million Pounds)					
West Coast	695	1,330	1,890	8.7	370	370
	(Thousand Metric Tons)					
Japan	1,180	1,660	2,060	4.8	1,921	1,921*
Korea	185	350	460	7.9	200	200*
Taiwan	330	535	695	6.4	428	452*
Hong Kong	50	73	89	4.9	0	0
ASEAN Countries	135	275	415	8.8	151	221*

* Additional expansions likely.

Countries within the Pacific Basin are anticipated to be virtually self-sufficient in PVC. Imports required from outside the Pacific Basin countries are expected to be less than 100 million pounds in 1985, which provides very little opportunity for exports from an Alaskan plant.

Although there is the potential to supply PVC resin to the Pacific Basin countries, the nature of the PVC business generally makes it more attractive to ship vinyl chloride monomer and produce the resin near the consumption point.

E. Styrene

1. West Coast Market

a. Demand

The U.S. West Coast demand for styrene is forecast to increase from 597 million pounds in 1977 and 634 million pounds in 1978 to 715, 995 and 1,330 million pounds in 1980, 1985 and 1990, respectively, as shown in Table IV-E-1. Current consumption represents about 10 percent of U.S. domestic demand. At present, polystyrene, ABS resins, styrene-butadiene latices, unsaturated polyester resins and alkyd resins are the only styrene derivatives produced within the region. Production of SBR and various low-volume styrene derivatives is not anticipated over the study period. The West Canadian demand for styrene is about 5 million pounds per year, and it should double over the study period.

TABLE IV-E-1

WEST COAST STYRENE DEMAND
(Million Pounds)

Western U.S.	1977	1978	1980	1985	1990	AAGR, % (1978-1990)
Polystyrene	390	410	455	610	780	5.5
SBR elastomer	-	-	-	-	-	-
ABS resins	14	15	16	20	25	4.3
Styrene-butadiene latices	17	18	20	25	30	4.3
Unsaturated polyesters	130	140	166	260	390	8.9
Alkyd resins and other uses	46	51	58	80	105	6.2
Total Western U.S.	597	634	715	995	1,330	6.4
Western Canada	5	5	6	8	10	5.9
Total	602	639	721	1,003	1,340	6.4

Polystyrene is the largest application for styrene within the Western U.S. region. In 1976, about 82 percent of regional polystyrene demand was met by local production by A&E Plastik, Amoco, Cosden, Mobil, Dow and Monsanto. By 1980, locally produced material is expected to represent 80 percent of consumption; by 1985, however, the percentage should increase

to 85 percent due to the probable construction of new facilities by other producers, possibly BASF. Information on the polystyrene market is presented in Section IV-C.

SBR elastomer is not produced within the region and no production is anticipated over the study period. Dow and Union Oil produce styrene-butadiene latex. These firms have about 60 percent of the West Coast market and are expected to maintain their share of this relatively small market.

Dow Chemical, the only producer of ABS resins within the region, has a 30 million pounds per year plant at Torrance, CA. Because of the relatively small size of the ABS resin market, no new facilities are contemplated and only slow growth is anticipated in this application.

All unsaturated polyester resins utilized on the West Coast are produced within the region and, due to the nature of the product, the West Coast is expected to meet its needs with local production. Thus, styrene demand will follow regional growth in unsaturated polyester consumption. Unsaturated polyesters are produced by a number of firms within the region, as shown in Table IV-E-2.

TABLE IV-E-2

U.S. WEST COAST UNSATURATED POLYESTER RESIN PRODUCERS

Company	Location
Alpha Chemical	Perris, CA
Ashland Chemical	Los Angeles, CA
Cargill	Lynwood, CA
Glidden Durkee (SCM)	San Francisco, CA
Koppers	Richmond, CA
PPG Industries	Torrance, CA
Reichhold Chemicals	Azusa, CA
	S. San Francisco, CA
Sherwin Williams	Emeryville, CA
Synres Division of DSM	Anaheim, CA
USS Chemicals	Colton, CA
Vistron (Filon/Silmar)	Hawthorne, CA
Wittaker	Gardena, CA

Alkyd coating resins and molding compounds are produced within the region by at least a dozen firms, including Benjamin Moore, DuPont, Sherwin Williams and Synres. Demand for these products is forecast to grow at about 2.5 percent per year.

The Western Canadian region has styrene consumption for alkyd and unsaturated resin production. At present, demand is about 5 million pounds per year and is expected to double by 1990. Consumers include Bapco Paint at Surrey and Reichhold at Port Moody.

b. Supply

There are no producers of styrene in the West Coast region. Dow, Monsanto, Mobil, Cosden and Amoco have captive or pseudocaptive consumption of styrene, which is supplied from the Gulf Coast. Some of these firms and Gulf are the likely suppliers to the small alkyd and unsaturated polyester consumers. Polysar is the major styrene supplier in Western Canada.

c. Captive Market

In 1978, the captive market for styrene on the U.S. West Coast was about 365 million pounds, or 66 percent of regional demand. This percentage is expected to decrease to about 55 percent by 1985 due to the rapid growth of the unsaturated polyester resin market, which is almost entirely merchant. The captive styrene consumers are presented in Table IV-E-3. There is no captive styrene consumption in Western Canada.

TABLE IV-E-3

U.S. WEST COAST CAPTIVE STYRENE CONSUMERS

Company	Derivatives Made
Amoco	Polystyrene
Cosden	Polystyrene
Mobil	Polystyrene
Dow	Polystyrene, ABS, SB latices
Monsanto	Polystyrene
USS Chemicals	Unsaturated polyesters

d. Pricing

In the U.S., styrene is priced at 35 cents per pound, FOB works in tank cars. The Canadian price is $0.41 (Canadian) per pound FOB Sarnia. Styrene prices depend primarily on the price and availability of benzene and the market situation for styrene.

2. Pacific Basin Market

a. Japan

The Japanese demand for styrene was about 1,112,000 metric tons in 1978, including net exports of 12,000 metric tons. Domestic demand is forecast to increase to 1,215,000, 1,540,000 and 1,920,000 metric tons in 1980, 1985 and 1990, respectively, while exports are expected to decrease in 1980 due to the startup of facilities in Taiwan and Korea. The Japanese styrene demand is summarized in Table IV-E-4.

TABLE IV-E-4

JAPANESE STYRENE DEMAND
(Thousand Metric Tons)

	1977	1978	1980	1985	1990	AAGR, % (1978-1990)
Polystyrene	620	660	740	950	1,170	4.8
SBR elastomer and latex	135	140	145	165	185	2.3
Unsaturated polyesters	70	70	75	90	120	4.6
ABS resins	125	130	145	190	255	5.7
SAN resins	45	50	55	70	90	5.0
Others	45	50	55	75	100	5.9
Total domestic demand	1,040	1,100	1,215	1,540	1,920	4.8
Net exports	27	12	0	20	30	-
Total demand	1,067	1,112	1,215	1,560	1,950	4.8

General-purpose, high-impact and foam polystyrene constitute about 60 percent of styrene demand. Demand over the study period is anticipated to increase 4-5 percent per year. This is due to a slowdown in the growth of the electrical appliance and electronics industries as some manufacture is shifted to Korea, Taiwan and elsewhere. In addition,

polypropylene is capturing some markets traditionally held by styrene resins. Consumption in SBR elastomer and latex is anticipated to have only nominal growth. A substantial proportion of SBR is exported and the erection of similar export-oriented SBR facilities in Korea and Taiwan has reduced these exports. ABS resins, which find considerable use in the electrical and electronics industries, are also experiencing slow growth due to the inroads of polypropylene. Unsaturated polyester resins and other styrene applications also have only modest growth prospects.

Supply

The production capacity for styrene in Japan is 1,550,000 metric tons per year, as shown in Table IV-E-5. Mitsubishi Petrochemical is currently expanding by 30,000 metric tons per year, and expansions of at least 200,000 metric tons per year are expected in the early 1980s. Production in 1978 was 1,122,000 metric tons, some 10,000 metric tons above consumption for the year.

TABLE IV-E-5

JAPANESE STYRENE PRODUCERS, 1978
(Thousand Metric Tons per Year)

Company	Location	Capacity
Asahi Dow	Mizushima/Kawasaki	395
Chubu	Yokkaichi	80
Denki Kagaku	Chiba	75
Idemitsu Petrochemical	Chiba	90
Mitsubishi Petrochemical	Kashima/Yokkaichi	410
Mitsui Toatsu	Tokuyama	90
Nippon Oxirane	Chiba	225
Nippon Steel Chemical	Tobata/Ohita	85
Sumitomo Chemical	Chiba	100
		1,550

Supply/Demand Situation

The supply/demand situation for styrene in Japan is shown in Table IV-E-6. Basically, the existing supply is sufficient to meet forecast demand only until the early 1980s. However, during the 1980s, it is anticipated that the smaller, higher cost facilities will be replaced

with larger ones. Although Japan has been self-sufficient in styrene, importation of the product and/or ethylbenzene is a possibility. Japanese styrene producers view ethylbenzene imports as an opportunity to lower costs somewhat, at the same time retaining complete control over styrene manufacture and the styrene market.

Pricing

The Japanese price for styrene was 190 yen per kilo (39 cents per pound) in late June. Prices depend primarily upon benzene prices and market conditions. Styrene imports are subject to an 8 percent duty, while ethylbenzene exports are subject to a duty of only 2 percent.

TABLE IV-E-6

POTENTIAL SUPPLY/DEMAND BALANCE FOR STYRENE IN JAPAN
(Thousand Metric Tons)

	1978	1980	1985	1990
Potential supply*	1,300	1,330	1,530	1,530
Forecast demand	1,112	1,215	1,560	1,950
Surplus/(deficit)	188	105	(30)	(430)

* Estimated effective capacity.

b. Korea

The demand for styrene in Korea was 62,600 and 74,900 metric tons in 1977 and 1978, respectively. Demand is expected to reach 108,000, 167,000 and 235,000 metric tons in 1980, 1985 and 1990, respectively.

Polystyrene, SBR elastomer and unsaturated polyester resins are the major uses for the product in Korea. Almost all of the demand for these products will be met by local production. In addition, a small quantity is used for ABS production.

At present, there is one styrene producer in Korea. A 60,000 metric ton per year unit, owned by Ulsan Petrochemical at the Ulsan complex, came on stream in 1978. A second 125,000 metric ton per year unit, owned by

Chin Yang Chemical and located at the Yochon complex, is scheduled to be completed about 1983. Basically, Korea is anticipated to be self-sufficient in styrene, but the product will be imported in the early 1980s until a second unit is completed.

c. Taiwan

The demand for styrene in Taiwan is forecast to increase from 56,000 metric tons in 1977 to 107,000, 162,000 and 201,000 metric tons in 1980, 1985 and 1990, respectively. Styrene consumption for polystyrene will approximate polystyrene demand. Styrene demand for SBR should continue to grow fairly rapidly, paralleling the growth of domestic markets and tire and elastomer exports. Taiwan has a relatively high demand for unsaturated polyester resins due to the export-oriented sailboat, powerboat and yacht industry on the island. ABS resins are produced by Poly. The market for ABS resins is expected to remain relatively small.

The only styrene producer in Taiwan is Delta Petrochemical, which started production in late 1976 at Kaohsiung. The facility has a capacity of 100,000 metric tons per year. Delta will add 100,000 metric tons of styrene as part of the fourth petrochemical complex at Lin Yuan. With startup of the new unit expected in 1982, Taiwan will have excess styrene capacity until the end of the study period.

d. Hong Kong

Since Dow Chemicals' polystyrene facility is the only styrene consumer in Hong Kong, demand for the product will reflect its requirements, which are estimated as follows:

1978	74,000
1980	75,000
1985	125,000
1990	125,000

The styrene comes from Dow's U.S. and European facilities, although on occasion Asahi-Dow is the source of this material.

e. ASEAN Countries

Demand for styrene in the ASEAN countries is forecast to increase from 13,000 and 25,000 metric tons in 1977 and 1978, respectively, to 34,000 metric tons in 1980 and 125,000 metric tons in 1990, as shown in Table IV-E-7. Demand is almost entirely for polystyrene production. The demand figures for 1985 and 1990 assume additional polystyrene capacity within the region. Dow and affiliates of Japanese companies account for most of the styrene demand within the area.

TABLE IV-E-7

ASEAN COUNTRY STYRENE DEMAND
(Thousand Metric Tons)

	1977	1978	1980	1985	1990	AAGR, % (Base 1978)
Philippines	8	12	13			
Singapore	-	-	-			
Malaysia	5	6	7			
Thailand	-	7	14			
Indonesia	-	-	-			
Total	13	25	34	75	125	14.3

At present, there are no styrene plants in the ASEAN region, and it is unlikely that a facility will be built during the study period.

f. People's Republic of China

No significant styrene imports are foreseen over the study period, since the PRC would prefer to import the modest quantity of resins required.

3. Conclusions

Opportunities for an Alaskan Plant

The supply and demand for styrene on the U.S. West Coast and in the Pacific Basin are summarized in Table IV-E-8.

TABLE IV-E-8

STYRENE

	Demand				Capacity, per year	
	1978	1985	1990	AAGR, %	1978	Future
	(Million Pounds)					
West Coast	639	1,003	1,340	6.4	0	0
	(Thousand Metric Tons)					
Japan	1,112	1,540	1,920	4.8	1,550	1,780*
Korea	75	167	235	10.0	60	185
Taiwan	81	162	201	7.9	100	200
Hong Kong	74	125	125	4.5	0	0
ASEAN Countries	25	75	125	14.3	0	0

* Additional expansions likely.

During the 1980s, it is expected that a styrene plant will have to be at least 600-800 million pounds per year in size in order to be competitive. By 1985, the U.S. West Coast will have a requirement for 1,000 million pounds of styrene, but the merchant market will only be about 500 million pounds. The output from an Alaskan plant could be disposed of in the region through exchanges, but due to the nature of the styrene market, a commitment to styrene production would also involve a major commitment to the polystyrene business elsewhere in order to move the styrene produced.

There is no opportunity for the movement of styrene to the Pacific Basin over the long term without the involvement of Dow or the Japanese, which have the captive markets.

In order to produce styrene, it would be necessary to have a source of benzene. This could be obtained from the proposed Alpetco or Alberta facilities.

F. Vinyl Chloride Monomer

1. West Coast Market

a. Demand

The U.S. West Coast demand for VCM was estimated at 335 million pounds in 1978, or 5.1 percent of the total U.S. market of 6.5 billion pounds. The only use was for polyvinyl chloride polymer (PVC) production within the region. The three PVC producers, their PVC capacity and their estimated consumption of vinyl chloride monomer are shown in Table IV-F-1. There is no vinyl chloride consumption in Western Canada.

TABLE IV-F-1

WEST COAST VINYL CHLORIDE MONOMER DEMAND
(Million Pounds)

Company	Location	PVC Capacity	Estimated VCM Demand	
			1978	1980
B.F. Goodrich	Long Beach, CA	150	150	150
Keysor Century	Saugus, CA	50	45	50
Stauffer	Carson, CA	160	140	160
Total		360	335	360

The future demand for vinyl chloride monomer on the West Coast is tied to PVC production levels in the region. By 1980, it is anticipated that the existing facilities will be operating at capacity levels due to market growth. As a result, VCM demand will reach about 360 million pounds, and it will remain at this level during the 1980s unless additional facilities are built. Since the West Coast PVC market is expected to reach 1,890 million pounds by 1990, erection of additional facilities is likely, particularly if an adequate supply of VCM exists within the region. As a result, regional VCM demand could approach 500-600 million pounds by 1985 if there were an incentive to build additional facilities.

b. Supply

Stauffer is the only producer of vinyl chloride monomer in the Western region, with a 175 million pound a year plant in Carson, CA. This facility normally operates at close to capacity and meets about half of the regional VCM needs. The remainder is brought into the region by Goodrich. The long-term viability of the Stauffer plant is questionable and it is felt that this unit and the Arco ethylene plant, which supplies it, will be shut down within the next few years.

c. Captive Market

Stauffer is estimated to have utilized 140 million pounds for captive use. Goodrich meets most of its vinyl chloride requirements with captive production, but the firm probably supplies the West Coast with purchased material. As a result, about 40 percent of the total VCM consumed in the U.S. West Coast represents captive production.

d. Pricing

The price for vinyl chloride monomer as of October 1979 was 17 cents per pound. Price levels are primarily determined by energy costs and the supply/demand situation for the product.

2. Pacific Basin Market

a. Japan

Demand

The Japanese demand for vinyl chloride monomer is forecast to increase from 1,550,000 metric tons in 1978 to 1,690,000, 2,090,000 and 2,540,000 metric tons in 1980, 1985 and 1990, respectively, as shown in Table IV-F-2. Details of the polyvinyl chloride market for VCM are provided in

Section IV-D. Other uses are as a chemical intermediate and in the production of modacrylic fibers. In 1978, Japan exported 180,000 metric tons of VCM to Far Eastern countries and Australia. Exports are anticipated to drop by 1980 due to the new facilities in Korea and Taiwan. However, they should rise in the 1980-1990 period, primarily due to increased demand in the ASEAN countries.

TABLE IV-F-2

JAPANESE VINYL CHLORIDE MONOMER DEMAND
(Thousand Metric Tons)

	1977	1978	1980	1985	1990	AAGR, % (1978-1990)
Polyvinyl chloride	1,080	1,260	1,470	1,810	2,200	4.8
Other uses	105	110	120	160	210	5.5
Domestic demand	1,185	1,370	1,590	1,970	2,410	4.8
Exports	165	180	100	120	130	-
Total demand	1,350	1,550	1,690	2,090	2,540	4.2
Actual production	1,340	1,505				

Supply

The current Japanese VCM capacity is 2,191,000 metric tons per year, as shown in Table IV-F-3. Since the operating factor for VCM is low, some small facilities are now on standby.

Although there are no expansions in progress at present, an additional 475,000 metric tons of capacity was announced for the early to mid-1980s. In addition, there could be replacement of smaller facilities with new, larger plants.

Supply/Demand Situation

Basically, there is enough current and planned capacity to more than meet demand throughout the study period. However, due to the chlorine/caustic imbalance there could be imports of vinyl chloride or ethylene dichloride into the country in spite of sufficient domestic capacity.

TABLE IV-F-3

JAPANESE VINYL CHLORIDE MONOMER PRODUCERS, 1978
(Thousand Metric Tons Per Year)

Company	Location	Capacity
Asahi Glass	Chiba	56
	Kashima	
Central Chemical	Kawasaki	80
Chiba Enbi Monomer	Chiba	160
Chisso	Minamata	73
Denki Kagaku	Ohmi	42
Kanagafuchi	Takasago	140
Kashima Enbi Monomer	Kashima	220
Kureha	Nishiki	150
Mitsubishi Monsanto	Yokkaichi	80
Mitsui Toatsu	Nagoya	60
	Senpoku	66
Nippon Geon	Takaoka	120
Nissan Chemical	Chiba	60
Ryonichi	Mizushima	220
Sanyo Monomer	Mizushima	150
Sun Arrow Kagaku	Tokuyama	110
Sumitomo Chemical	Niihama	55
Toi Gosei	Tokushima	50
Toyo Soda	Nanyo	170
	Yokkaichi	129
		2,191

b. Korea

The demand for VCM in Korea is expected to increase from an estimated 130,000 metric tons in 1977 and 200,000 metric tons in 1978 to 245,000, 360,000 and 470,000 metric tons in 1980, 1985 and 1990, respectively, in order to meet the production forecast for PVC. This represents an average annual growth of 7.4 percent from 1978.

The current capacity for VCM in Korea is 78,000 metric tons per year, as shown in Table IV-F-4. Capacity will increase by 150,000 metric tons per year in 1979, but the overall capacity should only be 210,000 metric tons per year since the acetylene-based units will be placed on standby. An additional facility is anticipated onstream about 1983 as part of the Yochon complex.

TABLE IV-F-4

KOREAN VINYL CHLORIDE MONOMER PRODUCERS, 1978
(Thousand Metric Tons)

Company	Capacity	Expansions	Process
Korea Plastic Industry (4 plants)	18	-	Acetylene
Korea Pacific	60	150 (1979)	Ethylene
	78	200 (1983)	
		350	

The supply/demand balance for VCM in Korea is presented in Table IV-F-5. The local industry operates, when possible, essentially at capacity, with imports filling the remainder of the demand. After completion of the new VCM plants, Korea will have excess capacity. It is anticipated that this material will be exported in the form of both VCM and ethylene dichloride to Australia and other Far Eastern nations.

TABLE IV-F-5

POTENTIAL SUPPLY/DEMAND BALANCE FOR VINYL CHLORIDE MONOMER IN KOREA
(Thousand Metric Tons)

	1977	1978	1980	1985	1990
Potential supply	78	78	230	410	410
Forecast demand	130	200	245	360	470
Surplus/(deficit)	(52)	(122)	(15)	50	(60)
Actual production	73	65			

c. Taiwan

The demand for VCM is anticipated to increase from about 320,000 metric tons in 1977 and 400,000 metric tons in 1978 to 460,000, 615,000 and 785,000 metric tons in 1980, 1985 and 1990, respectively, in order to meet the PVC resin production forecast. This represents an average annual growth of 5.8 percent from 1978. VCM exports are expected to be small.

The capacity for VCM production in Taiwan is estimated at 360,000 metric tons per year, as shown in Table IV-F-6.

TABLE IV-F-6

TAIWAN VINYL CHLORIDE MONOMER PRODUCERS, 1978
(Thousand Metric Tons)

	Capacity
Formosa Plastics	240
Taiwan VCM	120
	360

In 1978, Taiwan produced about 330,000 metric tons of VCM and imported 70,000 metric tons. VCM capacity in Taiwan is expected to increase to meet forecast demand throughout the study period. A significant part of the additional needs will be met through ethylene dichloride imports.

d. Hong Kong

There is no PVC production in Hong Kong nor is any expected throughout the study period. As a result, there is no anticipated requirement for VCM.

e. ASEAN Countries

ASEAN countries' VCM demand is forecast to increase from 108,000 and 120,000 metric tons in 1977 and 1978, to an estimated 149,000, 235,000 and 365,000 metric tons in 1980, 1985 and 1990, respectively, as shown in Table IV-F-7. These demand forecasts take into account anticipated increased production within the region from facilities which would be built in the 1980-1990 period.

TABLE IV-F-7

ASEAN COUNTRY VINYL CHLORIDE MONOMER DEMAND
(Thousand Metric Tons)

	1977	1978	1980	1985	1990	AAGR, % (Base 1978)
Philippines	27	31	42	70	115	11.5
Singapore	15	15	15	15	15	-
Malaysia	18	20	24	40	65	10.3
Thailand	24	27	33	50	75	8.9
Indonesia	24	27	35	60	95	11.1
Total	108	120	149	235	365	9.7

At present, there is no supply of VCM within the ASEAN countries.

f. People's Republic of China

Vinyl chloride imports into the PRC are insignificant in relation to a world-scale plant and, as such, were not considered.

3. Conclusions

Opportunities for an Alaskan Plant

The supply and demand of vinyl chloride monomer on the West Coast and in the Pacific Basin are summarized in Table IV-F-8.

TABLE IV-F-8

VINYL CHLORIDE MONOMER

	Demand*				Capacity, per year	
	1978	1985	1990	AAGR, %	1978	Future
	(Million Pounds)					
West Coast	335	500-600	500-600	-	175	175**
	(Thousand Metric Tons)					
Japan	1,370	1,970	2,410	4.8	2,191	2,191
Korea	200	360	470	7.4	78	410
Taiwan	400	615	785	5.8	360	700
Hong Kong	0	0	0	0	0	0
ASEAN Countries	120	235	365	9.7	0	0

* In part dependent upon new PVC facilities.
** Plant may shut down.

Vinyl chloride monomer consumption on the West Coast was about 335 million pounds in 1978, and it could conceivably reach 500-600 million pounds by 1985 if there were a large-scale availability of material within the region. All of this material would have to be supplied by a new producer, since the existing Stauffer plant is expected to be shut down within the new few years.

The ASEAN countries are expected to be major VCM importers through the study period. In addition, both Japan and Taiwan have severe chlorine/caustic soda imbalances and thus could be substantial importers of vinyl chloride and/or ethylene dichloride in spite of adequate domestic capacity.

The production of vinyl chloride monomer and/or ethylene dichloride in Alaska would entail producing or bringing chlorine into the plant site. In the future, it is anticipated that the West Coast area could support an 800 million to 1 billion pound per year VCM plant without causing a surplus of caustic soda in the region.

G. Ethylene Glycol

1. West Coast Market

a. Demand

The U.S. West Coast demand for ethylene glycol was 200 million pounds in 1977 and 185 million pounds in 1978. Essentially all was used in antifreeze manufacture. By 1990, ethylene glycol demand is expected to be 230 million pounds, a 1.8 percent average annual growth rate over the period, as shown in Table IV-G-1. The Western Canadian ethylene glycol market was about 15 million pounds in 1978, and only nominal growth is forecast.

TABLE IV-G-1

WEST COAST ETHYLENE GLYCOL DEMAND
(Million Pounds)

Western U.S.	1977	1978	1980	1985	1990	AAGR, % (1978-1990)
Antifreeze	197	182	191	210	224	1.7
Polyester fiber	-	-	-	-	-	-
Polyester film	-	-	-	-	-	-
Other	3	3	4	5	6	-
Total Western U.S.	200	185	195	215	230	1.8
Western Canada	15	15	16	17	18	1.5
Total	215	200	211	232	248	1.8

The U.S. West Coast accounts for only about 5 percent of the ethylene glycol market, since there is no consumption for polyester fiber and film within the region.

About 10 percent of U.S. antifreeze consumption is on the West Coast. This market is forecast to grow slowly due to saturation of the automobile market and decreasing cooling system size. Most antifreeze is sold as branched products. The remaining consumption is in specialty applications such as in latex paints.

The Canadian ethylene glycol market is utilized almost entirely for antifreeze. Minor amounts are used in paints.

b. Supply

There are no production facilities on the West Coast. All ethylene glycol is shipped into the region. Union Carbide and Dow are the major suppliers to the U.S. West Coast. Other suppliers include PPG, BASF-Wyandotte, Texas and Northern Petrochemical. Most of the Canadian market is also supplied by Union Carbide and Dow.

c. Captive Market

Approximately 60-70 percent of the West Coast market for ethylene glycol is represented by the national antifreeze brands of the ethylene glycol manufacturers and by the petroleum companies with a captive ethylene glycol source.

Although the antifreeze is merchanted, the consumer is purchasing a branded item, so this market is really not available to an independent ethylene glcyol producer. It is anticipated that the percentage of the market attained by firms with a captive ethylene glycol source will increase by 5-10 percent over the study period, following a national trend.

d. Pricing

The U.S. ethylene glycol price is 28 cents per pound, while the Canadian price is $0.35 (Canadian) per pound at producing locations. Glycol prices are primarily related to ethylene costs and market conditions. Ethylene glycol imports into Canada are subject to a 10 percent ad valorem duty.

2. Pacific Basin Market

a. Japan

In Japan, the situation for ethylene glycol is related to the overall ethylene oxide picture. The demand for ethylene oxide in Japan (Table IV-G-2) depends largely upon the production of ethylene glycol to meet both domestic and export needs. Demand is anticipated to grow 6.0 percent per year during the 1977-1990 period, primarily to meet increases in domestic textile consumption. Textile exports are anticipated to remain static or decline, while fiber exports are expected to show only modest growth, with an increasing percentage of exports consisting of the more specialized grades. Demand growth in the post-1980 period is anticipated at about 3 percent per year due to saturation of domestic markets and a declining export market.

Polyester film is used in x-ray, photographic, fiber, and audio and video tapes. Antifreeze sales are tied to domestic vehicle registrations and export sales of vehicles and will also be enhanced by the trend to the production of somewhat larger vehicles. The industrial markets for ethylene glycol and the higher glycols are forecast to grow at about 5 percent per year.

Ethylene glycol net exports were 200,000 metric tons in 1978. A substantial decline is anticipated by 1980, primarily because of the start-up of new glycol plants in Taiwan and Korea.

Other uses for ethylene glycol include surfactants, ethanolamines, glycol ethers and other derivatives. Growth in the 4-5 percent per year range is anticipated.

Overall demand for ethylene oxide was 538,000 metric tons in 1977 and 631,000 metric tons in 1978. Demand is forecast to reach 615,000, 775,000 and 925,000 metric tons in 1980, 1985 and 1990, respectively. This represents an average annual growth rate of 3.2 percent during the 1978-1990 period.

TABLE IV-G-2

JAPANESE ETHYLENE OXIDE/GLYCOL DEMAND
(Thousand Metric Tons)

	1977	1978	1980	1985	1990	AAGR, % (1978-1990)
Ethylene glycol						
Polyester fiber	210	235	250	310	340	3.1
Polyester film	12	13	15	20	25	5.6
Polyethylene terephthalate resin	1	3	5	15	20	17.1
Antifreeze	40	43	50	65	80	5.3
Others, individual higher glycols	110	116	130	165	210	5.0
Total domestic demand	373	410	450	575	675	4.2
Net exports	195	200	130	145	165	-
Total demand	568	610	580	720	840	2.7
Inventory change	(45)	20	-	-	-	-
Ethylene glycol production	523	630	580	720	840	2.4
Ethylene oxide						
Ethylene glycol	382	473	435	540	630	2.4
Other uses	156	158	180	235	295	5.3
Total demand	538	631	615	775	925	3.2

Supply

The current ethylene oxide capacity in Japan is 635,000 metric tons per year. Capacity should increase by 120,000 metric tons per year in the next 2-3 years, with completion of the new Mitsubishi Petrochemical facility. Glycol capacity is currently at the 575,000 metric tons per year level, and it will increase by 100,000 metric tons per year, as is shown in Table IV-G-3.

TABLE IV-G-3

JAPANESE ETHYLENE OXIDE/GLYCOL PRODUCERS
(Thousand Metric Tons per Year)

Company	Capacity		Expansions
	Ethylene Oxide	Ethylene Glycol	
Mitsubishi Petrochemical	105	95	120/100 (early 1980s)
Mitsui Petrochemical	207	190	
Nippon Catalytic Chemical	195	180	
Nisso Petrochemical	128	110	
	635	575	

Supply/Demand Situation

The supply/demand balance for ethylene oxide in Japan is shown in Table IV-G-4. Basically, existing and announced capacity is sufficient to meet demand until 1985.

TABLE IV-G-4

POTENTIAL SUPPLY/DEMAND BALANCE FOR ETHYLENE OXIDE IN JAPAN
(Thousand Metric Tons)

	1977	1978	1980	1985	1990
Potential supply*	635	635	635	755	755
Forecast demand	538	631	615	775	925
Surplus/(deficit)	97	4	20	(20)	(170)
Actual production	538	631			
Operating rate, %	85	99			

* 100 percent of nameplate capacity.

Pricing

In August 1979, the Japanese prices for industrial and antifreeze ethylene glycol were 184 and 178 yen per kilo, respectively (38 and 36.8 cents per pound). Glycol prices are primarily related to ethylene costs.

b. Korea

Polyester fiber production represents almost all ethylene glycol use in Korea. A small amount is used as antifreeze. The Korean demand for ethylene glycol is forecast to grow from 80,000 metric tons in 1978 to 220,000 metric tons in 1990, as shown in Table IV-G-5. About 70 percent of Korean polyester fiber production is exported, primarily in the form of finished goods.

TABLE IV-G-5

KOREAN ETHYLENE GLYCOL DEMAND
(Thousand Metric Tons)

	1977	1978	1980	1985	1990	AAGR, % (1978-1990)
Polyester fiber production	158	190	250	380	520	8.8
Ethylene glycol requirement	65	75	100	150	210	8.8
Other glycol uses	4	5	6	8	10	-
Total demand	69	80	106	158	220	8.8

At present, there are no ethylene glycol producers in Korea. However, an 80,000 metric ton per year facility in which Mitsui is a part owner is under construction at Yeosu. Completion is anticipated in 1979. Since demand is increasing at a faster pace than capacity, Korea is expected to be an importer of the product in increasing volumes throughout the early 1980s.

c. Taiwan

Almost all ethylene glycol in Taiwan is used for the production of polyester fibers. The polyester fiber industry relies almost completely upon exports since domestic consumption represents only about 10 percent of production. Of the material exported, about half is shipped as filament and yarn, while the remainder is in the form of finished goods and textiles. As shown in Table IV-G-6, ethylene glycol demand in Taiwan is expected to increase from 85,000 metric tons in 1977 and 120,000 metric tons in 1978 to 160,000, 240,000 and 300,000 metric tons in 1980, 1985 and 1990, respectively.

TABLE IV-G-6

TAIWAN ETHYLENE GLYCOL DEMAND
(Thousand Metric Tons)

	1977	1978	1980	1985	1990	AAGR, % (1978-1990)
Polyester fiber production	210	300	400	600	750	8.0
Ethylene glycol demand	85	120	160	240	300	8.0

The current ethylene glycol capacity in Taiwan is 175,000 metric tons per year. Capacity will be increased by 50,000 metric tons per year when the planned petrochemical complex at Lin Yuan comes on stream in 1983, as shown in Table IV-G-7.

TABLE IV-G-7

TAIWAN ETHYLENE GLYCOL PRODUCERS, 1978
(Thousand Metric Tons per Year)

Company	Location	Capacity	Expansions
China Man-Made Fiber	Kaohsiung	50	
Oriental Union Chemical	Kaohsiung	125	50 (1983)
		175	

The China Man-Made unit was completed in early 1976. The firm is 100 percent owned by local interests. The Oriental Union Chemical plant is owned by Oriental Chemical (20 percent), China Development (25 percent), Central Investment (30 percent) and Union Carbide (25 percent). Union Carbide is currently handling export sales from this plant and has been active in Southeast Asian markets.

d. Hong Kong

The current demand for ethylene glycol in Hong Kong is about 200 metric tons per year and is expected to remain small since it is very unlikely that polyester fiber production will commence in spite of substantial demand in the Colony. This is due to the absence of import duties and business relationships between local textile producers and Japanese fiber producers.

There are no producers of ethylene glycol in Hong Kong nor are any expected throughout the study period.

e. ASEAN Countries

Polyester fiber production is the only use for ethylene glycol in the ASEAN countries. Polyester fiber production within the ASEAN group and

estimated ethylene glycol consumption by country are presented in Table IV-G-8. Ethylene glycol consumption is forecast to increase from 57,000 metric tons in 1977 and 69,000 metric tons in 1978 to 77,000, 98,000 and 126,000 metric tons in 1980, 1985 and 1990, respectively.

TABLE IV-G-8

ASEAN COUNTRY ETHYLENE GLYCOL DEMAND
(Thousand Metric Tons)

	1977	1978	1980	1985	1990	AAGR, % (1978-1990)
ASEAN country polyester fiber production	142	171	195	247	317	5.3
Ethylene glycol						
Philippines	9	10	11	16	25	7.9
Singapore	-	-	-	-	-	-
Malaysia	12	13	14	14	14	0.6
Thailand	20	28	30	36	44	3.8
Indonesia	16	18	23	32	43	7.5
Total ethylene glycol demand	57	69	78	98	125	5.3

At present, there are no ethylene glycol facilities within the ASEAN countries. A 120,000 metric ton per year facility is planned as part of the Singapore petrochemical project. This plant would be at least partially owned by the four Japanese ethylene glycol producers. Completion is anticipated in the 1982-1983 period. Firms have also been investigating the possibility of erecting a facility in Indonesia, but completion before 1985 appears unlikely.

A large part of the polyester fiber industry in the ASEAN countries is controlled by affiliates of the Japanese fiber companies. These firms have traditionally purchased most of their ethylene glycol from Japanese sources.

f. People's Republic of China

Ethylene glycol consumption in the PRC will grow rapidly due to the planned emphasis on polyester fibers. However, it is anticipated that essentially all of the ethylene glycol required will ultimately be produced within the country.

3. Conclusions

Opportunities for an Alaskan Plant

Supply and demand for ethylene glycol on the West Coast and in the Pacific Basin are summarized in Table IV-G-9.

TABLE IV-G-9

ETHYLENE GLYCOL

	Demand				Capacity, per year	
	1978	1985	1990	AAGR, %*	1978	Future
	(Million Pounds)					
West Coast	200	232	248	1.8	0	0
	(Thousand Metric Tons)					
Japan	410	575	675	4.2	575	675
Korea	80	158	220	8.8	0	80
Taiwan	120	240	300	8.0	175	225
Hong Kong	neg.	neg.	neg.	-	0	0
ASEAN Countries	69	98	126	5.3	0	120*

* Future project not certain.

The ethylene glycol market available to a new producer is small and has little prospect for growth. Korea and the ASEAN countries are the only countries in the Pacific Basin region which will require imports of ethylene glycol during the mid-1980s. However, since much of the fiber industry in these countries is controlled by Japanese firms, it is anticipated that almost all of the ethylene glycol required will be supplied by Japan, either directly or through the Singapore project and by Taiwan, which will have considerable excess capacity until the mid-1980s.

H. Ethylene

Ethylene boils at -119°F and must be shipped in cryogenic tankers. As a result, shipment of ethylene is not widespread and is primarily limited to coastal movements in Japan and special situations in Europe. It is generally preferable to ship ethylene in the form of derivatives rather than as the product itself.

Shipment of liquid ethylene to West Coast markets for derivative manufacture would have to compete with derivatives manufactured in large facilities on the Gulf Coast. This is not considered to be a viable alternative.

The only really large potential market for liquid ethylene in the Pacific Basin countries would be in Japan. On the basis of discussions with major Japanese companies, it is felt that importation (vs incremental production in existing plants) would not be viable due to the high costs for transportation and the necessity of building a large receiving and storage terminal. It is felt that Japanese firms would prefer to import ethylene in the form of derivatives, especially derivatives such as ethylene dichloride or vinyl chloride monomer, which are energy-intensive.

At present, projects based upon imported ethylene are being planned in the Philippines and Thailand. The Philippine project would require up to 90,000 metric tons per year for LDPE manufacture, while the Thai project would require 90,000 and 50,000 metric tons per year for LDPE and HDPE manufacture, respectively. Completion of both projects is planned for the 1983-1985 period, but additional delays could occur. In both cases, eventual ethylene production at the plant site is anticipated. As a result, supplying some incremental ethylne to these projects from an Alaskan plant is feasible, but shipment of liquid ethylene on a large scale for a long period of time does not appear to be viable.

I. Polypropylene

1. West Coast Market

a. Demand

The demand for polypropylene resin in the U.S. West Coast region in 1977 and 1978 is estimated at 110 and 125 million pounds, respectively. In addition, some polypropylene film was shipped into the region by converters during the year. Compared to the total U.S. market, the western consumption of resin in small, being only 4.6 percent of the U.S. total. The reason for this is that the West Coast states do not have the three largest consuming industries for polypropylene, namely fibers, automotive component production and major appliances.

By 1990, demand is expected to total 355 million pounds, an average annual growth rate of 9.1 percent over the 1978-1990 period. The growth pattern, by broad end use category, is shown in Table IV-I-1. Western Canadian demand is currently 5-10 million pounds and is anticipated to reach 20 million pounds by 1990.

TABLE IV-I-1

WEST COAST POLYPROPYLENE DEMAND
(Million Pounds)

Western U.S.	1977	1978	1980	1985	1990	AAGR, % (1978-1990)
Injection molding	69	73	90	130	190	8.3
Film and sheet	6	7	10	15	20	9.1
Fiber and filaments	-	-	-	-	-	-
Other extrusions	20	25	30	45	70	9.0
All other uses	15	20	30	55	75	11.6
Total Western U.S.	110	125	160	245	355	9.1
Western Canada	5	5	10	15	20	12.0
Total	115	130	170	260	375	9.1

The largest end use in the U.S. West Coast region is that of injection molding, which accounts for about 60 percent of polypropylene consumption. Typical uses for injection-molded products are food

containers, nursery tubs, toys, instrumentation, housewares, medical uses and battery cases. Film and sheet, mainly for packaging, account for only 5-6 percent of the resin use. The remaining resin is used for extruded pipe, for cordage, for sweeper brushes and for wire coating.

Injection molding consumed an estimated 73 million pounds of polypropylene resin in 1978. This end use is expected to grow to 190 million pounds by 1990, an 8.3 percent average annual growth rate. The end-use markets for injection-molded products are varied. They include food containers by Triplastics, pens by Paper Mate, razors by Gillette, spray pumps by Calmar, toys by Mattel, medical products by Cutter Labs and battery cases, which are made by Amerace, Gould, Delco, Globe Union and Richardson.

Film and sheet needs for resin are relatively small, with very few companies actually extruding film. A number of companies convert polypropylene film, which is shipped to the West Coast from the Gulf Coast.

Among the extruders of film on the West Coast are Richland Corporation, Crown Zellerbach and Dixico (La Mirada, CA). Gage Industries of Oregon is the only extruder of polypropylene sheet on the West Coast.

Extrusions, other than for film, fibers and filaments, accounted for 25 million pounds of resin in 1978. There was consumption of polypropylene resin for straws by NSF, Diamond Straw and Maryland Corporation; for rope and cordage by Tubs Cordage and Straplock; and for extruded pipe by U.S. Plastic Pipe and R. H. Sloane.

All other uses, consuming 20 million pounds of resin in 1978, included substantial amounts for medical use, specifically saline solutions. There is also some blow molding carried out by Continental Can. In addition, glass-reinforced polypropylene is being used in appliances.

The Western Canadian polypropylene market is currently in the 5-10 million pound per year range. It is anticipated to reach 20 million

pounds by 1990. Among the consumers are Canada Western Cordage, Vancouver (monofilament) and Cameo Plastic Products, Langley, B.C. (drinking straws).

b. Supply

There are no producers of polypropylene resin in the U.S. West Coast region. The demand for resin is met mostly by six U.S. producers: Hercules, Exxon, Eastman, Dart, Amoco and Novamont. Hercules is by far the largest supplier. Hercules is the sole Canadian producer, and Shell is also starting up a facility; both of these plants are in Eastern Canada. These firms and other U.S. producers serve the Canadian market.

c. Captive Consumption

Captive consumption of polypropylene on the West Coast is small, and it is anticipated that the percentage will remain low through the study period. There is no captive consumption in Western Canada.

d. Pricing

The price of polypropylene in the Western U.S. was 32 cents per pound for the homopolymer, delivered in bulk. Copolymer prices are 3 cents per pound higher. Canadian prices are $0.38 and 0.42 (Canadian) per pound, respectively. Canadian imports of polypropylene are subject to a 10 percent ad valorem duty.

2. Pacific Basin Market

a. Japan

Demand

Japanese domestic demand for polypropylene is forecast to increase from 507,000 metric tons in 1977 and 577,000 metric tons in 1978 to 1,045,000 metric tons in 1990, an average annual growth of 5.1 percent. In addition, Japan has been a significant exporter of polypropylene, with

exports totaling 136,000 metric tons in 1978. Exports are anticipated to decline somewhat in future due primarily to the impact of new facilities in the region. Japanese polypropylene demand by end use is presented in Table IV-I-2.

TABLE IV-I-2

JAPANESE POLYPROPYLENE DEMAND
(Thousand Metric Tons)

	1977	1978	1980	1985	1990	AAGR, % (1978-1990)
Domestic demand						
Film	152	171	205	260	320	5.4
Injection molding	206	239	285	360	435	5.1
Blow molding	20	20	23	30	40	5.9
Film yarn	47	61	67	85	105	4.6
Fiber	28	29	30	30	30	-
Extrusion and misc.	54	57	65	90	115	6.0
Total domestic demand	507	577	675	855	1,045	5.1
Exports	124	136	100	95	85	-
Total demand	631	713	775	950	1,130	3.9

Both cast and oriented polypropylene are produced in Japan. Since usage of these products is considerably greater than in the U.S. and polypropylene has already penetrated most potential markets, demand growth is anticipated to be in line with GNP growth. Injection molding applications are the largest use for the product. Demand is expected to increase about 5 percent per year. Slit film yarn for bags and carpet backing is a relatively mature market, and Japan is facing increased competition from South Korea and Taiwan in export markets. Polypropylene fiber is relatively minor in Japan since very little is used as a carpet face fiber and in upholstery. Significant applications for fiber include rope and other industrial uses and as a filler in comforters. In this latter application, polypropylene is facing increased competition from polyester.

Supply

The present capacity of the Japanese polypropylene industry is 1.1 million metric tons, as shown in Table IV-I-3. New facilities by Chubu,

Mitsui Petrochemical, and Tonen and are anticipated to increase capacity by 200,000 metric tons per year by the early 1980s. In addition, Sumitomo will probably build a facility in the 100,000 metric ton per year range if their proposed plant in Singapore is not built.

TABLE IV-I-3

JAPANESE POLYPROPYLENE PRODUCERS, 1978

Company	Location	Capacity	Expansions
Chisso	Chiba	155	
Chubu	Yokkaichi		40
Idemitsu	Chiba	60	
Mitsubishi Chemical	Mizushima	30	
Mitsubishi Petrochemical	Yokkaichi	105	
	Kashima	85	
Mitsui Petrochemical	Chiba	120	100
Mitsui-Toatsu	Ohtake	90	
	Senpoku	65	
Showa Petrochemical	Ohita	75	
Sumitomo	Chiba	96	
	Niihama	30	
Tonen	Kawasaki	60	60
Tokuyama Soda	Tokuyama	70	
Ube	Sakai	90	
Total		1,131	200

Supply/Demand Situation

The potential supply/demand situation for polypropylene in Japan is presented in Table IV-I-4. Existing and announced capacity for the product is sufficient to meet domestic demand plus significant export demand through the study period. Polypropylene is a product in which the Japanese specialize, and there is little potential for exports from an Alaskan plant to Japan under ordinary circumstances.

TABLE IV-I-4

POTENTIAL SUPPLY/DEMAND BALANCE FOR POLYPROPYLENE IN JAPAN
(Thousand Metric Tons)

	1978	1980	1985	1990
Potential supply*	1,131	1,131	1,331	1,331
Forecast demand	713	775	950	1,130
Surplus/(deficit)	418	356	381	201

* 100 percent of nameplate capacity.

Pricing

In late June 1979, the price for polypropylene was 210 yen per kilo (43.4 cents per pound), delivered. Polypropylene prices in Japan depend upon propylene costs, and they tend to be similar to prices for polystyrene resins, with which they compete. Polypropylene imports into Japan are subject to an 8 percent ad valorem duty.

b. Korea

Demand

In 1978, the Korean polypropylene demand was 131,000 metric tons. Demand is anticipated to reach 170,000, 245,000 and 330,000 metric tons by 1975, 1980 and 1985, respectively. Woven bags constitute the largest market. Film, fiber and injection-molded articles are also made.

Supply

The sole Korean producer of polypropylene is Korea Petrochemical Industry Company (50 percent Korean interests/50 percent Chisso, Marubeni) at Ulsan, which has facilities capable of producing 110,000 metric tons per year of high density polyethylene and polypropylene. Capacity was increased to 140,000 metric tons per year during 1978 by adding a new line.

About one-third of the propylene feedstock for the unit is obtained from Korea Oil, with the remainder being obtained from imports from Europe, Japan and the U.S. The firm anticipates being a propylene importer until the Yeosu project comes on stream, at which time it will receive propylene from this source.

Honam Petrochemical (50 percent Honam Ethylene (Korean Government)/50 percent Mitsui Group) is also constructing an 80,000 metric ton per year unit at Yeochon, which is anticipated to be on stream during 1980.

Supply/Demand Situation

The potential supply/demand situation for polypropylene in Korea is shown in Table IV-I-5.

TABLE IV-I-5

POTENTIAL SUPPLY/DEMAND BALANCE FOR POLYPROPYLENE IN KOREA
(Thousand Metric Tons)

	1977	1978	1980	1985	1990
Potential supply*	55	70	150	150	150
Forecast demand	123	131	170	245	330
Surplus/(deficit)	(68)	(61)	(20)	(95)	(180)
Actual production	110	74			

* Ulsan plant taken at 50 percent capacity for polypropylene.

Basically, even with expansion of the Korean Petrochemical Industry plant and the new Honam Petrochemical facility, Korea will remain a net importer of polypropylene. The country cannot, however, be considered a long-term consumer of material from an Alaskan plant.

c. Taiwan

The demand for polypropylene in Taiwan is anticipated to increase from 55,000 metric tons in 1977 and 74,000 metric tons in 1978 to 225,000

metric tons in 1990, as shown in Table IV-I-6. Consumption is primarily for the production of molded items and film for packaging applications and for slit film. Polypropylene fiber consumption is relatively small.

TABLE IV-I-6

TAIWAN POLYPROPYLENE DEMAND
(Metric Tons)

1977	55,000
1978	74,000
1980	95,000
1985	155,000
1990	225,000
AAGR, % (1978-1990)	9.7

Taiwan Polypropylene, in which Hercules has an interest, is the sole producer of polypropylene at present, with a 50,000 metric ton per year facility. This plant started up in late 1976, and there are plans to double the size of the plant in the early 1980s. Formosa Plastics is planning an 80,000 metric ton per year plant as part of a new petrochemical complex at Lin Yuan. Start-up is expected in 1982. As a result, there should be some export opportunities to Taiwan in the early 1980s, but Taiwan cannot be considered as a long-term export market from an Alaskan facility. The supply/demand balance for the product is shown in Table IV-I-7.

TABLE IV-I-7

POTENTIAL SUPPLY/DEMAND BALANCE FOR POLYPROPYLENE IN TAIWAN
(Thousand Metric Tons)

	1977	1978	1980	1985	1990
Potential supply*	45	45	45	165	165
Forecast demand	55	74	95	155	225
Surplus/(deficit)	(10)	(29)	(50)	10	(60)

* 90 percent of nameplate capacity.

d. Hong Kong

The demand for polypropylene in Hong Kong is anticipated to increase from 18,000 metric tons in 1978 to 41,000 metric tons in 1990, as shown in Table IV-I-8. Demand in Hong Kong is essentially for production of molded articles and film. Although Hong Kong has a very large polystyrene consumption, it is anticipated that the inroads of polypropylene into these markets will be relatively modest. As a result, demand for polypropylene in the Colony will remain small relative to that for polyethylene and polystyrene.

TABLE IV-I-8

HONG KONG POLYPROPYLENE DEMAND
(Metric Tons)

1977	15,000
1978	18,000
1980	25,000
1985	33,000
1990	41,000
AAGR, % (1978-1990)	7.1

At present there are no polypropylene producers in Hong Kong, and none are foreseen. Hong Kong represents a long-term export market from an Alaskan facility, but unfortunately the market is relatively small.

e. ASEAN Countries

Demand

The demand for polypropylene in the ASEAN countries is anticipated to increase from 94,000 and 105,000 metric tons in 1977 and 1978 to 303,000 metric tons in 1990. The forecast demand, by country, is presented in Table IV-I-9. Most of the demand is in film and injection molding applications. Indonesia is the largest market, with consumption being relatively high due to the use of polypropylene in some traditional polyethylene applications. This is due to the efforts of Pertamina, which has a polypropylene facility.

TABLE IV-I-9

ASEAN COUNTRY POLYPROPYLENE DEMAND
(Thousand Metric Tons)

	1977	1978	1980	1985	1990	AAGR, % (Base 1978)
Philippines	26	28	35	64	95	10.7
Singapore	6	7	9	14	18	8.2
Malaysia	12	15	18	26	35	7.3
Thailand	17	19	22	35	55	9.3
Indonesia	33	36	45	70	100	8.9
Total	94	105	119	209	303	9.2

Supply

The only polypropylene plant in the ASEAN countries is the 20,000 metric ton per year plant of Pertamina in Indonesia. Propylene from an adjacent refinery is used as the feedstock and, as a result of refining operating conditions, polypropylene production was only about 6,000 metric tons in 1978. No change in this situation is foreseen at least through the mid-1980s.

Two additional projects for the region have been announced: Sumitomo has plans for a 100,000 metric ton per year facility as part of the Singapore petrochemical complex, scheduled to come on stream in 1983, and Hercules has plans for a 60,000 metric ton per year plant as part of the Philippines petrochemical project. The latter project is not firm at present.

Supply/Demand Situation

The supply/demand balance within the ASEAN group will depend upon the completion of the proposed projects. By 1985 the Sumitomo project will be on stream, and by 1990 the Philippines project should be on stream. As a result, imports are anticipated to remain at over 100,000 metric tons from 1985 to 1990.

f. People's Republic of China

Capacity for production of polypropylene in the PRC is about 40,000 metric tons per year. Imports of the products are anticipated to be relatively small.

3. Conclusions

Opportunities for an Alaskan Plant

The supply and demand for polypropylene on the West Coast and in the Pacific Basin are summarized in Table IV-I-10.

TABLE IV-I-10

POLYPROPYLENE

	Demand				Capacity, per year	
	1978	1985	1990	AAGR, %*	1978	Future
		(Million Pounds)				
West Coast	130	260	375	9.1	0	0
		(Thousand Metric Tons)				
Japan	577	855	1,045	5.1	1,131	1,331
Korea	131	245	330	8.0	70	150
Taiwan	74	155	225	9.7	50	180
Hong Kong	13	33	41	7.1	0	0
ASEAN Countries	105	209	303	9.2	20	100-200*

* Future projects not certain.

During the 1980s, it is anticipated that new grass-roots polypropylene facilities will have to be at least 220 million pounds per year in size in order to be competitive. Because the market is dominated by Hercules, it is anticipated that a polypropylene producer with a West Coast plant could, at most, expect to obtain 25 percent of the market. However, this would amount to 65 million pounds in 1985, or less than 30 percent of plant capacity.

In 1985, the Pacific Basin countries are anticipated to have imports totaling 400-500 million pounds, of which at least half would be supplied from countries within the area. Because a large number of firms compete for this business, the maximum exports to the Pacific Basin region would be about 40 million pounds.

Unless the firm were already a major polypropylene supplier to the region, polypropylene production would not be too attractive, except to utilize propylene feedstock that had no other use.

J. Phenol

1. West Coast Market

a. Demand

The demand for phenol on the West Coast is forecast to increase from about 305 million pounds in 1978 to 520 million pounds in 1990, as shown in Table IV-J-1. Phenolic resins, alkylphenols and some specialty products are the only phenol derivatives produced within the region.

TABLE IV-J-1

WEST COAST PHENOL DEMAND
(Million Pounds)

Western U.S.	1977	1978	1980	1985	1990	AAGR, % (1978-1990)
Phenolic resins	225	235	265	325	385	4.2
Bisphenol-A	-	-	-	-	-	-
Caprolactam	-	-	-	-	-	-
Alkylphenols	10	10	11	13	15	3.4
Phenolic plasticizers	-	-	-	-	-	-
Salicylic acid	-	-	-	-	-	-
2,6-Xylenol	-	-	-	-	-	-
Miscellaneous	30	35	39	52	70	6.0
Total Western U.S.	265	280	315	390	470	4.4
Western Canada	25	25	30	40	50	5.9
Total	290	305	335	430	520	4.5

Phenolic resins represent over 80 percent of U.S. West Coast phenol consumption. In 1978, an estimated 320 million pounds of phenolic resins were consumed, or about 18 percent of overall U.S. consumption. The major use is in plywood manufacture, although hardboard, laminates and insulation usage is also significant. West Coast phenolic resin producers include Reichhold, Borden, Georgia-Pacific, Monsanto, Skelly, Simpson Timber, Univar and Weyerhauser.

Alkylphenol production on the U.S. West Coast was estimated at 25 million pounds in 1978. The largest use areas for alkylphenols are surfactants, lube oil additives, resin copolymers and rubber and plastic additives.

Kalama Chemical produces nonylphenol in Kalama, Washington, at its 20 million pound per year capacity plant. Productol has a 5 million pound per year capacity plant in Santa Fe Springs, California, and also has a small capacity for producing octylphenol.

Miscellaneous uses of phenol accounted for an estimated 35 million pounds in 1978. This category includes phenolphthalein, 2,4-D, pentachlorophenol, petroleum refining, para-tert-butylphenol and agricultural chemicals.

Phenolic consumption in Western Canada was about 25 million pounds in 1978, and consumption is expected to double by 1990. Consumption is almost entirely for phenolic resin production from plywood, particle board and glass fiber insulation use. The phenolic resin producers in Western Canada are Reichhold at Port Moody and Kamloops and Borden at Vancouver. Each of these firms has 40-50 million pounds per year of resin capacity.

Cumene

Actual cumene consumption on the West Coast is about 70 million pounds per year. Potential cumene demand, if the region were self-sufficient in phenol, is forecast to increase from 315 million pounds in 1978 to 600 million pounds in 1990, as shown in Table IV-J-2. Cumene is not the only feedstock for phenol in the region, since Kalama Chemical and Dow at Ladner, B.C. utilize toluene.

TABLE IV-J-2

POTENTIAL U.S. WEST COAST CUMENE DEMAND
(Million Pounds)

	1977	1978	1980	1985	1990	AAGR, % (1978-1990)
Phenol demand	290	305	335	430	520	4.5
Less: phenol by other routes	80	80	90	90	90	
Phenol from cumene	210	225	245	340	430	
Cumene requirement	295	315	345	475	600	

b. Supply

Chevron is the only producer of cumene in the Western region, with a 100 million pound per year plant at El Segundo, CA. Chevron uses its cumene captively for the production of phenol and acetone in a 55 million pounds per year phenol plant. Kalama Chemical at Kalama, WA, and Dow at Ladner, B.C., also produce phenol, but by the toluene oxidation route. The West Coast phenol producers are summarized in Table IV-J-3. Productol recovers small quantities of natural phenol at its Santa Fe Springs, CA, facility.

TABLE IV-J-3

U.S. WEST COAST PHENOL PRODUCERS, 1978
(Million Pounds per Year)

Company	Location	Capacity	Process
Chevron	Richmond, CA	55	Cumene
Dow	Ladner, BC	30	Toluene Oxidation
Kalama Chemical	Kalama, WA	80	Toluene Oxidation
Productol	Sante Fe Springs, CA	neg.	Natural
Total		165	

All of the U.S. phenol producers, except Clark, are reported to market on the West Coast. In addition to the local producers, Shell, Dow and Monsanto are major suppliers. Dow supplies the entire Western Canadian market.

c. Captive Market

It is estimated that the captive market for phenol in the Western region was about 130-140 million pounds in 1978. Among the largest users of phenol for phenolic resins in the region are Monsanto, Reichhold, Skelly and Georgia-Pacific. Chevron uses phenol internally for agricultural products, and Kalama and Productol produce alkylphenols. No significant change in the percentage of captive consumption is anticipated over the study period.

d. Pricing

The U.S. price for phenol was 36 cents per pound as of October 1, 1979. Canadian prices were $0.45 (Canadian) per pound for the Eastern Canadian plants. Phenol prices are primarily related to the price and availability of benzene feedstock and the supply/demand situation for the product. Phenol imports into Canada are subject to a 15 percent ad valorem duty, but some Canadian resin producers are able to take advantage of duty drawback situations.

2. Pacific Basin Market

a. Japan

Demand

Japan's domestic demand for phenol is forecast to increase from 202,000 metric tons in 1978 to 405,000 metric tons in 1990, a growth rate of 3.9 percent per year over the period. Imports are due to the cumene toll processing agreement between Mitsubishi Petrochemical and Dow. Exports should decline throughout the study period, reaching zero by 1990.

The Japanese demand for phenol is presented in Table IV-J-4.

TABLE IV-J-4

JAPANESE PHENOL DEMAND
(Thousand Metric Tons)

	1977	1978	1980	1985	1990	AAGR, % (1978-1990)
Phenolic resins	106	110	125	175	240	6.7
Bisphenol-A	55	53	55	70	90	4.5
Alkylphenols	15	15	15	20	30	5.9
Phenolic plasticizers	2	2	2	3	4	6.0
Aniline	20	20	21	24	37	5.3
Other	2	2	2	3	4	6.0
Total domestic	200	202	220	295	405	6.0
Exports	33	53	25	5	-	-
Total demand	233	255	245	300	405	3.9

Phenolic resins demand is forecast to grow at around 6.7 percent per year. Bisphenol-A is used in Japan primarily for epoxy resins (50 percent) and polycarbonates (45 percent). Growth of bisphenol-A demand for epoxies and polycarbonates has been slower than in other parts of the world, and a relatively slow growth of only 4.5 percent is projected for the study period. Alkylphenols are used for alkylphenol ethoxylate manufacture and for production of lube oil additives, agricultural chemicals and antioxidants. Demand growth should average nearly 6 percent over the study period. Aniline is produced from phenol by Mitsui Petrochemical, and the aniline needs of the Mitsui group tend to be met from this source. Other applications include surfactants, agricultural chemicals, pharmaceuticals, plasticizers and stabilizers.

Supply

Current phenol capacity is 316,000 metric tons per year, as indicated in Table IV-J-5. No expansions are in progress. However, a new 100,000 metric ton per year plant, which should be built in the 1980s, is being planned by Mitsubishi Petrochemical. As a result, Japan is anticipated to be self-sufficient in phenol.

TABLE IV-J-5

JAPANESE PHENOL PRODUCERS, 1979
(Thousand Metric Tons per Year)

Company	Location	Capacity	Process
Mitsui Toatsu	Senpoku	100	Cumene
	Nagoya	36	Sulfonation
Mitsui Petrochemical	Chiba	150	Cumene
	Iwakuni	30	Cumene
		316	

Pricing

The Japanese price for phenol was 220 yen per kilo (45.4 cents per pound) as of early August. Phenol imports are subject to an 8 percent duty.

b. Korea

Korean demand for phenol was about 9,000 metric tons in 1977 and 10,000 metric tons in 1978. Demand should reach 14,000, 24,000 and 35,000 metric tons by 1980, 1985 and 1990, respectively. Use is primarily for the production of resins.

Keumho Chemical is constructing a 25,000 metric ton per year phenol plant at Yeosu. This facility and an associated 35,000 metric ton per year cumene unit should be on stream in the 1979-1980 period. As a result, Korea should be self-sufficient in phenol through the mid-1980s.

c. Taiwan

The demand for phenol in Taiwan was about 5,000 metric tons in 1977 and 8,000 metric tons in 1978. Demand is forecast to reach 12,000, 18,000 and 24,000 metric tons by 1980, 1985 and 1990, respectively. Essentially all demand is for the manufacture of phenolic resins.

At present, there is no phenol production in Taiwan. The government has been attempting to promote production of the material, but the low demand makes production unlikely until at least the mid-1980s.

d. Hong Kong

The demand for phenol in Hong Kong is about 300-400 metric tons per year. In addition, the Colony imports about 4,000 metric tons per year of phenolic resins. The demand for phenol is anticipated to remain small, and no local production is foreseen.

e. ASEAN Countries

Phenol demand in the ASEAN countries is forecast to increase from 7,800 and 12,000 metric tons in 1977 and 1978 to 14,100, 17,900 and 22,800 in 1980, 1985 and 1990, respectively, as shown in Table IV-J-6. Essentially all of the material is used in the production of plywood adhesives.

There are no phenol producers in the ASEAN countries, and no production is anticipated during the study period.

TABLE IV-J-6

ASEAN COUNTRY PHENOL DEMAND
(Thousand Metric Tons)

	1977	1978	1980	1985	1990	AAGR, % (Base 1978)
Philippines	1.9	2.2	2.4	2.9	3.5	3.9
Singapore	2.7	5.0	5.5	6.0	6.5	2.2
Malaysia	2.6	4.0	5.0	6.5	8.3	6.3
Thailand	0.6	0.7	1.0	2.0	3.0	12.9
Indonesia	nil	0.1	0.2	0.5	1.5	25
Total	7.8	12.0	14.1	17.9	22.8	5.5

f. People's Republic of China

Phenol imports to the PRC are very small.

3. Conclusions

Opportunities for an Alaskan Plant

The supply and demand for phenol on the West Coast and in the Pacific Basin are summarized in Table IV-J-7.

TABLE IV-J-7

PHENOL

	Demand				Capacity, per year	
	1978	1985	1990	AAGR, %	1978	Future
	(Million Pounds)					
West Coast	305	430	520	4.5	0	165
	(Thousand Metric Tons)					
Japan	202	295	405	6.0	316	416
Korea	10	24	35	11.0	0	30
Taiwan	8	18	24	9.6	0	0
Hong Kong	neg.	neg.	neg.	-	0	0
ASEAN Countries	12	18	23	5.5	0	0

During the 1980s, the minimum size for a phenol plant will be 400-500 million pounds per year. The relatively small merchant market on the West Coast, coupled with small markets in the Pacific Basin countries, makes production in Alaska relatively unattractive under normal circumstances.

K. Acrylonitrile

1. West Coast Market

a. Demand

The U.S. West Coast demand for acrylonitrile was about 7-8 million pounds in 1978. It is expected to grow to about 10 million pounds in 1985 and 13 million pounds by 1990. The only major market for the product on the West Coast is for the production of ABS resins by Dow, which is a merchant consumer. There is no acrylonitrile consumption in Western Canada.

b. Supply

There are no producers of acrylonitrile in the West Coast region. Abundant capacity exists in the U.S. to supply this region.

c. Captive Market

There is no captive consumption of acrylonitrile on the West Coast.

d. Pricing

The price for acrylonitrile as of October 1, 1979, was 27.5 cents per pound.

2. Pacific Basin Market

a. Japan

Demand

Japanese domestic acrylonitrile demand is forecast to increase from 515,000 metric tons in 1978 to 550,000, 700,000 and 860,000 metric tons in 1980, 1985 and 1990, respectively. This represents an average annual

growth of 4.4 percent. Exports were 95,000 metric tons in 1978, and these are expected to decrease due to the addition of plant capacity in Korea, the major export market. On an overall basis, demand is expected to increase from 610,000 metric tons in 1978 to 930,000 metric tons in 1990, as shown in Table IV-K-1.

TABLE IV-K-1

JAPANESE ACRYLONITRILE DEMAND
(Thousand Metric Tons)

	1977	1978	1980	1985	1990	AAGR, % (1978-1990)
Acrylic fiber	320	320	335	430	525	4.2
ABS resin and nitrile rubber	85	90	100	130	160	4.9
Others	100	105	115	140	175	4.3
Total domestic demand	505	515	550	700	860	4.4
Exports	90	95	60	60	70	-
Total demand	595	610	610	760	930	3.6

About 60-65 percent of Japanese acrylonitrile is in the production of acrylic fibers. Acrylic fiber demand is expected to grow at nearly 5 percent per year, due to the growth of the Japanese carpet market. In 1978, imports of acrylic staple from the U.S. rose sharply, due primarily to the lower cost of the U.S. products. In Japan, higher naphtha prices have resulted in imports of U.S. acrylic fiber selling for about 20 percent less than the domestic product. It is believed that Japan will limit these imports by 1980 through the imposition of import tariffs or other means. Acrylonitrile demand for fibers is thus expected to exhibit slow growth until about 1980 and then average about 4 to 5 percent per year throughout the study period. ABS resins will have a growth of about 5 percent per year. Other applications include acrylamide and adiponitrile for hexamethylenediamine production.

Supply

At the end of 1978, Japanese acrylonitrile capacity totaled 744,000 metric tons, divided among seven producers. The Japanese acrylonitrile producers are shown in Table IV-K-2.

TABLE IV-K-2

JAPANESE ACRYLONITRILE PRODUCERS

Asahi Chemical Industry
Mitsubishi Chemical
Mitsui Petrochemical
Mitsui-Toatsu
Nitto Chemical
Showa Denko
Sumitomo Chemical

Supply/Demand Situation

The supply/demand for acrylonitrile in Japan is relatively tight, as shown in Table IV-K-3. In 1978, the operting rate was 82 percent, and additional capacity will be required by 1985 in order to meet demand growth.

TABLE IV-K-3

POTENTIAL SUPPLY/DEMAND BALANCE FOR ACRYLONITRILE IN JAPAN
(Thousand Metric Tons)

	1977	1978	1980	1985	1990
Potential supply*	744	744	744	744**	744**
Forecast demand	595	610	610	760	930
Surplus/(deficit)	149	134	134	(16)	(186)
Operating rate, %	80	82	82	-	-

* 100 percent of nameplate capacity.
** Additional expansions likely.

Pricing

The Japanese acrylonitrile price was 210 yen per kilo (43.4 cents per pound) in early August 1979. Imports of acrylonitrile into Japan are subject to an 8 percent ad valorem duty.

b. Korea

The Korean demand for acrylonitrile was 116,000 metric tons in 1977 and 124,000 metric tons in 1978. Demand is forecast to reach 150,000, 190,000 and 240,000 metric tons in 1980, 1985 and 1990, respectively. Acrylic fiber is the major use, but there is also demand for ABS resins and other applications.

The sole producer of acrylonitrile in Korea is Tongsuh Petrochemical, which expanded capacity from 27,000 to 77,000 metric tons per year in 1978. An additional 100,000 metric tons of capacity are planned at the third petrochemical complex at Yochon, which is expected to be on stream by the mid-1980s.

c. Taiwan

Domestic demand for acrylonitrile in Taiwan increased from 53,000 metric tons in 1977 to 84,000 metric tons in 1978. It is expected to increase to 105,000, 154,000 and 198,000 metric tons in 1980, 1985 and 1990, respectively.

Acrylic fiber is the major application for acrylonitrile, representing over 90 percent of the demand. Acrylic fibers are used in the country's export-oriented textile business.

China Petrochemical Development Corporation is the only producer of acrylonitrile in Taiwan, with a nameplate capacity of 132,000 metric tons per year. The country has sufficient capacity to meet demand until the early 1980s.

d. Other Countries

Other countries in the Pacific Basin area do not consume acrylonitrile.

3. Conclusions

Opportunities for an Alaskan Plant

The supply and demand for acrylonitrile on the West Coast and in the Pacific Basin are summarized in Table IV-K-4.

TABLE IV-K-4

ACRYLONITRILE

	Demand				Capacity, per year	
	1978	1985	1990	AAGR, %	1978	Future
	(Million Pounds)					
West Coast	8	10	13	4.2	0	0
	(Thousand Metric Tons)					
Japan	515	700	860	4.4	744	744
Korea	124	190	240	5.7	77	177
Taiwan	84	154	198	7.4	132	132*
Hong Kong	neg.	neg.	neg.	-	0	0
ASEAN Countries	neg.	neg.	neg.	-	0	0

* Additional facilities expected.

The acrylonitrile market on the West Coast is very small, and markets in the Far East are anticipated to grow modestly, with the region being generally self-sufficient in the product. As a result, there is little opportunity for large acrylonitrile exports from an Alaskan facility, and a plant would not be viable.

L. Isopropyl Alcohol

1. West Coast Market

a. Demand

Isopropyl alcohol consumption in 1978 in the Western region totaled 165 million pounds, of which about 100 million was used captively for acetone production by Shell. Isopropanol is used in chemical extraction, pharmaceuticals and coatings. Some isopropanol is sold for use in its own right as an alcohol. The breakdown of isopropanol use is shown in Table IV-L-1.

TABLE IV-L-1

WEST COAST ISOPROPANOL DEMAND
(Million Pounds)

Western U.S.	1977	1978	1980	1985	1990	AAGR, % (1978-1990)
Acetone	120	100	100	100	104	-
Other uses and export	55	60	71	90	106	-
Total Western U.S.	175	160	171	190	210	2.3
Western Canada	5	5	6	8	10	5.7
Total	180	165	177	198	220	2.4

Acetone is the largest use for isopropanol, consuming 100 million pounds in 1978. Very little growth in demand is expected over the 1978-1990 period due to capacity limitations of the Shell unit.

Coatings and solvent still provide a large market for isopropanol; they account for over half of the "other" uses. Oils, gums, shellac and synthetic resins are typical solvent uses. One significant chemical use is the extraction of pectin from rind. Pharmaceuticals and various miscellaneous uses account for the remaining use of isopropanol in the West Coast region.

b. Supply

There is only one producer of isopropanol in the West. Shell has a 215 million pound plant in Dominguez, California. Shell has most of the market, with Exxon and others also supplying the area. Shell, Van Waters & Rogers and Shore-Line Engineering distribute in Western Canada.

c. Captive Market

The only captive consumption on the West Coast is Shell's use of isopropanol for acetone production. This use will remain at about 100 million pounds per year over the study period unless increased by-product acetone in available from a new phenol plant.

d. Pricing

The price for anhydrous isopropyl alcohol in the U.S. was $1.25 per gallon as of October 1, 1979. The Canadian price in late September was $0.243 (Canadian) per pound in the east, with prices somewhat higher in the west. Canadian imports of isopropyl alcohol are subject to an 8 percent ad valorem duty.

2. Pacific Basin Region

a. Japan

Isopropanol demand in Japan is relatively modest since very little is used for the production of acetone. Overall demand is anticipated to have modest but continued growth over the study period, with demand increasing from 75,000 metric tons in 1978 to 100,000 metric tons by 1990, as shown in Table IV-L-2.

TABLE IV-L-2

JAPANESE ISOPROPANOL DEMAND
(Million Pounds)

	1977	1978	1980	1985	1990	AAGR, % (1978-1990)
Solvent	31	32	33	36	39	1.7
Agricultural chemicals	5	5	6	8	10	-
Medical uses	5	5	6	8	10	-
Surfactants	5	5	6	8	10	-
Chemical manufacture	3	3	4	5	6	-
Miscellaneous	13	15	16	18	20	-
Total domestic demand	62	65	71	83	95	3.2
Exports	10	10	9	7	5	-
Total demand	72	75	80	90	100	2.4

Supply

Japanese producers of isopropanol are listed in Table IV-L-3. Existing isopropanol capacity is 105,000 metric tons per year. There are no expansions in progress, but Tokuyama Soda has considered a 15,000 metric ton per year expansion. It is anticipated that supply of isopropanol will be sufficient to meet Japanese and some export demand.

TABLE IV-L-3

JAPANESE ISOPROPANOL PRODUCERS, 1978
(Thousand Metric Tons per Year)

Company	Location	Capacity
Mitsui-Toatsu	Senpoku	30
Nippon Petrochemical	Kawasaki	60
Tokuyama Soda	Tokuyama	15
		105

Pricing

The Japanese isopropyl alcohol price was 160 yen per kilo (33 cents per pound) in early August 1979. Isopropyl alcohol imports are subject to an 8 percent ad valorem duty.

b. Korea

Demand for isopropanol in Korea is modest, with demand for this material expected to remain under 2,000-3,000 metric tons per year throughout the study period.

c. Taiwan

In 1978, isopropanol demand in Taiwan was estimated at or near 1,000 metric tons. Demand is expected to reach over 2,000 metric tons by 1990 in existing applications. The major use for the product is in cosmetics and toilet goods.

At present, isopropanol is not produced in Taiwan. A 30,000 metric ton per year isopropanol unit has been planned as part of the fourth petrochemical complex and is expected on stream about 1983. The material would be used for acetone manufacture.

d. Hong Kong

Hong Kong consumption of isopropanol in 1978 was about 1,700 metric tons. Consumption of this material is forecast to grow 6-8 percent per year over the study period. There is no production of isopropanol in the Colony and none is anticipated.

e. ASEAN Countries

Demand for isopropanol in the ASEAN countries is expected to increase from 7,000 metric tons in 1978 to 15,000 metric tons in 1990, as shown in Table IV-L-4.

TABLE IV-L-4

ASEAN COUNTRY ISOPROPANOL DEMAND
(Thousand Metric Tons)

1977	6.5
1978	7
1980	8
1985	11
1990	15
AAGR (base 1978), %	6.6

The Philippines accounts for about half of isopropanol demand. Imports for Singapore, Malaysia and Indonesia, which are handled through Singapore, account for most of the remaining consumption.

There are no isopropanol facilities in the ASEAN countries and none are expected throughout the study period.

f. People's Republic of China

PRC isopropyl alcohol imports are insignificant.

3. Conclusions

Opportunities for an Alaskan Plant

The supply and demand for isopropyl alcohol on the West Coast and in the Pacific Basin are summarized in Table IV-L-5.

Since there is sufficient capacity to meet forecast demand during the study period throughout the Pacific Basin countries, an isopropyl alcohol plant in Alaska is not viable.

TABLE IV-L-5

ISOPROPYL ALCOHOL

	Demand				Capacity, per year	
	1978	1985	1990	AAGR, %	1978	Future
	(Million Pounds)					
West Coast	165	198	220	2.4	215	215
	(Thousand Metric Tons)					
Japan	65	83	95	3.2	105	105
Korea	2	3	3	-	0	0
Taiwan	1	32	32	-	0	30
Hong Kong	2	3	4	-	0	0
ASEAN Countries	7	11	15	6.6	0	0

M. Propylene

Propylene is normally consumed in derivative plants at or near the production site. However, Korea has been a significant importer due to a supply/demand imbalance, but all other countries have sufficient propylene or have imported the product in the form of derivatives. The imbalance in Korea is not anticipated to continue, since new sources of supply will come on stream in the early 1980s. It has been proposed that propylene be imported as feedstock for a new polypropylene plant in the Philippines. Requirements would be about 150 million pounds per year. At present, however, it is uncertain if this project will proceed.

Over the longer term, it is expected that propylene will be in surplus in the Pacific Rim area and, as a result, no significant propylene markets exist for production from an Alaskan facility.

V. FEASIBILITY OF AN ALASKAN PETROCHEMICAL COMPLEX

The core of a natural gas liquids-based petrochemical complex is an olefins plant which produces ethylene as the prime product. The simplest and lowest cost olefin units are based on ethane feed. If propane and/or butane are used instead, significant quantities of propylene are also produced.

For a petrochemical complex to be viable, a sufficient volume of derivatives must be produced to utilize the production from a world-scale olefins unit. The economic size is at least 1 billion pounds per year of ethylene capacity.

As shown in the analyses presented in Section IV, the manufacture of low and high density polyethylene, styrene, vinyl chloride and ethylene glycol in world-scale units were found to be viable. Table V-1 summarizes the potential ethylene consumption by derivative.

TABLE V-1

POTENTIAL ETHYLENE CONSUMPTION BY DERIVATIVE
(Million Pounds Per Year)

Derivative	Derivative Plant Size	Ethylene Consumption at Capacity
Low density polyethylene	500	525
High density polyethylene	250-400	260-420
Styrene	600-800	200-270
Vinyl chloride	500-1,000	250-500
Ethylene glycol	400-500	320-400
		1,555-2,115

Based on the market situations, an Alaskan petrochemical complex would most likely consist of low and high density polyethylene facilities, plus a styrene, vinyl chloride, or ethylene glycol plant. The choice of units would primarily be dictated by the nature of the firms involved in the project.

The market for propylene derivatives does not look very good. However, if it were necessary to use propane and/or butanes as part of the feed, a 200 million pound per year polypropylene plant would probably be viable.

Basically, the petrochemical markets in the Pacific Rim area are sufficient to support a major complex in Alaska at present and probably a second complex in the late 1980s.