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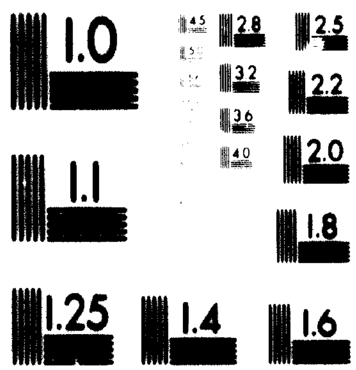

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MACROSCOPIC MARKET SURVEY
AND
EVALUATION OF EXPORT POSSIBILITIES
FOR
PETROCHEMICALS FROM TRINIDAD AND TOBAGO

FEBRUARY 1971

JAPAN GASOLINE CO., LTD.

TOKYO, JAPAN

UNIDO CONTRACT NO. 70/36
SERIAL NO. 2 5

MACROSCOPIC MARKET SURVEY AND EVALUATION OF EXPORT POSSIBILITIES FOR PETROCHEMICALS FROM TRINIDAD AND TOBAGO

Report prepared for the United Nations Industrial Development Organization acting as Participating and Executing Agency for the United Nations Development Program (Special Industrial Services).

FEBRUARY 1971

JAPAN GASOLINE CO., LTD.

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Abbreviations

LDPE	low density polyethylene
HDPE	high density polyethylene
EO	ethylene oxide
EG	ethylene glycole
EDC	ethylene dichloride
VCM	vinyl chloride monomer
PVC	polyvinyl chloride
PP	polypropylene
PG	propylene glycole
IPA	isopropyl alcohol
SBR	styrene butadiene rubber
BR	cis-polybutadiene rubber
TDI	toluene di-isocyanate
DMT	dimethyl terphthalate
DOP	dioctyl phthalate
THF	tetrahydrofuran
C.I.	Capital Investment

Dollars in this report is meant US dollars unless particularly remarked.

Tons in this report is meant metric tons unless particularly remarked.

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I. Introduction

1. General Situation

The petrochemical industry in Trinidad and Tobago was born in 1945. The birth was the outcome of advances in refining technology and the first petrochemical was in fact a by-product of the refining operations.

In 1959, natural gas began to be used as a raw material for the petrochemical industry in Trinidad and Tobago.

At present the petrochemical plants shown in the following table are in operation in Trinidad and Tobago.

Petrochemical Plants in Trinidad and Tobago

Companies	Plants	Capacities	Production in 1968
Texaco Inc.	Nonene	250 bbls/d	31,477 bbls
	Dodecene	100 "	54,067 "
	Di-isobutylene	150 "	44,915 "
	Benzene)		213,602 "
	Toluene)	3,000 "	356,622 "
	Xylenes)		19,215 "
	Cyclohexane	720 "	158,475 "
	Normal Paraffines	1,500 "	616,307 "
Federation Chemical	Ammonia	1,500 tons/d	501,000 tons
	Ammonium Sulphate	270 "	78,878 "
	Urea	220 "	68,528 "
	Sulphuric Acid	190 "	n.a.
	Naphthenic Acid	100 "	17,246 bbls
Lever Brothers	Synthetic Detergent	10 "	n.a.

As Trinidad and Tobago has only about one million population and has no big industry which consumes petrochemicals, almost all the petrochemicals produced in Trinidad and Tobago are exported.

Recently, Amoco Trinidad, a subsidiary of Standard Oil of Indiana, discovered the oil and gas fields in the Offshore Point Radix area, 25 miles east of the island, and the Southeast Galeata area, 45 miles southeast. 12,000 - 20,000 bbls/day of condensate and 300 - 500 MMSCFD of gas are expected. Other developments are being done by several other companies.

More recently Trinidad-Tesoro Petroleum Co., Ltd. was established, owned equally by the Government of Trinidad and Tobago and Tesore Petroleum Corporation of the United States. The Government of Trinidad and Tobago expects the utilisation of naphtha from Trinidad-Tesoro Petroleum Co., Ltd. as a raw material for petrochemicals.
To sum up, the main characteristics of the petrochemical industry in Trinidad and Tobago are the abundance of basic and first generation petrochemicals, the absence of the petrochemicals of upgrading stages and a limited domestic market of a little more than one million resident inhabitants.

In order to increase the value added to the exporting products the Government of Trinidad and Tobago is viewing with considerable interest the further expansion and diversification of its petrochemical building blocks, natural gas and naphtha. This has been made even more urgent by the recent discovery of vast natural gas reserves and prospective naphtha from Trinidad-Tesoro. The Government of Trinidad and Tobago established liberal investment incentives for pioneer enterprises, including tax holiday privileges and accelerated depreciation allowances. Firms may establish plants in Trinidad and Tobago with foreign capital, or in participation with local industrialists or jointly with Government and private entrepreneurs.
The Government of Trinidad and Tobago entrusted the Industrial Development Corporation of Trinidad and Tobago with a petrochemical feasibility study.

2. The Contract between UNIDO and JGC

Based upon the request of the Government of Trinidad and Tobago, the United Nations Industrial Development Organisation (UNIDO) invited tenders for the execution of the assistance to petrochemical industrialization for Trinidad and Tobago in April, 1970.

Consequently, Japan Gasoline Co., Ltd. (JGC) was accepted by UNIDO to carry on the assistance, thus the contract (UNIDO contract No. 70/36) between UNIDO and JGC was signed on August 21, 1970.

3. Objectives of the Project

This study is meant to be a precursor to a major launching and marketing project, possibly coupled with some feasibility studies provided it can supply evidence for the existence of a potential export market for petrochemicals from Trinidad and Tobago.

Its objective is to provide the Government with a realistic evaluation of the export market for a number of petrochemicals which can be produced competitively from locally available raw materials and/or basic intermediates.

This will require reviewing and interpreting the findings of the "Pre-feasibility Studies on Petrochemical Plants for Trinidad and Tobago" prepared by the Industrial Development Corporation of Trinidad and Tobago, and evaluation of the export possibilities for the products selected.

Further areas of assistance to Trinidad and Tobago in the petrochemical field will be recommended as well.

II. Conclusion and Recommendation

1. Conclusion

a) Raw Materials

We examined the most profitable selection from the group of raw materials of natural gas, condensate accompanied therewith and naphtha.

These raw materials were advised of their possibilities in availability in Trinidad and Tobago and of their prospective quantities, qualities and prices by IDC.

Presently a petrochemical plant of Trinidad Texaco exists in Trinidad. The product streams are decided by Texaco's world wide policy on their petrochemical production and sales, and at this moment benzene, toluene, xylene, cyclohexane and n-paraffine are being produced and exported. Therefore we examined what petrochemical complexes would be prospected from the combinations of petrochemical raw materials supplied by Texaco petrochemical plant with (1) natural gas and condensate accompanied therewith (2) condensate only, and (3) naphtha by case study.

Namely we laid down the typical petrochemical complex scheme which would produce as many kind petrochemical products as possible in marketability in world market upon the consumption of the quantities of raw materials available in Trinidad and Tobago, and calculated the production costs and selling prices of petrochemical products. The result reveals that the complex based on the third type of raw materials, i.e., a combination of naphtha with the petrochemicals from the Texaco plant, can provide the more profitable products than do the other two types of complex.

This was obtained mainly by reflecting the scale merit, in other words it means that the petrochemicals derived from the complex of third type are safely competitive in the world market from the view point of cost and price, but it presuppose the availabity of sales network in world market, which will make possible of the mass sales to maintain the high stream factor of the complex, and the huge investment for materialization of this big complex.

b) Exportabilities

Summarized below are the possibilities of exporting the petrochemicals produced in Trinidad and Tobago to several regions of the world.

(i) North America

Of the 18 selected petrochemicals, 13 commodities have competitiveness in the export makrets, whereas the other 5 commodities have not.

Competitive petrochemicals are: LDPE, HDPE, PVC, polystyrene, acrylonitrile, acrylic fiber, PP, SBR, maleic anhydride, caprolactam, polyaminde fiber, TDI, and polyester fiber.

Incompetitive petrochemicals are: VCM, styrene, PG, alkylbenzene, and DMT.

(ii) Latin America

Although different in their developmental stages, the petrochemical industry in Latin American countries is generally a lately developing industry. Most of the governments thus have been imposing high-rate customs duties on imported petrochemicals or following the import prohibition policy in order to protect and develop their own petrochemical industries. For the Trinidad and Tobago products, therefore, Latin America will be no more than a spot market, and will never be a market to which continuous exports are expectable.

(iii) W. Europe

Of the 18 selected petrochemicals, 16 commodities are competitive, with a exception of PG and SBR.

(iv) Southeast Asia

Except for a few products, most of the petrochemicals are imcompetitive.

Table II-1 (page 12) gives the delivered prices of the petrochemicals forwarded from Trinidad and Tobago to each trade area and the domestic prices of the corresponding products in each area.

c) Rates of Return on Investments

Table VIII-1 (page 126) gives the rates of return on investment with all petrochemicals in Case 3. Considering these data, the most recommendable petrochemical complex under the given conditions is shown in Fig. II-1 (page 13). The overall rate of return on investment with this most recommendable petrochemical complex is 19.9%.

2. Recommendation

1) Further Investiation

In order to materialize the petrochemical industrialisation program in Trinidad and Tobago, further investigation should be required forcussing on the following points:

a) Launching and Marketing Studies

Situations in petrochemicals are vary by countries in terms of demand and supply balance, prices, tariffs, and import policies. It is necessary, therefore, to check by country on the exportabilities of petrochemicals while taking above factors into consideration.

It is thus recommended that the marketing studies should be carried out in more details for USA, EEC and EFTA countries including UK and Spain, where this report has found exportabilities.

b) Chronological Consideration

In this study all plants constituting the complex were assumed to start up their operations simultaneously in 1975. But practically the simultaneous start-up of all plants would be impossible, moreover the set-up of 100% stream factor from the first year could not be achieved.

Therefore it is recommended that in addition to by-country studies, the more detailed chronological market studies should be carried out so that the more detailed chronological plan of construction of complex could be formed. In other words the possibility of start-up of the complex of smaller scale than 300,000 t/y ethylene capacity, which will be followed by the gradual capacity increase, should be checked.

c) Tie-up with International Petrochemical Companies

As a large-scale (international scale) petrochemical complex is assumed in this report (since the Trinidad and Tobago petrochemical industry has substantially no market in her country so that the T & T petrochemical producers must export almost all products and undergo severe competition in world market) the T & T petrochemical industry needs a huge amount of investments not only for mass production but also for mass sales. Accordingly it is strongly recommended to get ties with such international petrochemical companies as able not only to invest a huge amount of capital but also to use their own sales networks over the world.

d) Incentive Policies

Incentive policies have been found successful in some countries like Puerto Rico and etc. Government of these countries have been adopting the elaborated policies such as tax exemption, of which duration is made variable by region, depending on priority in regional development and special terms favorable to those industries and/or products which are contributable to the national economy.

Of the petrochemicals selected in this study, nylon 6, for example, will required approximately 1,400 workers, and will contribute to the national economy through increased employment. Some special measures favorable to this product can be considered as an effective means for the national economy.

Therefore, as an important factor influencing the materialization of plan, some incentive policies should desirably be investigated in a later stage when the project will have taken a more definite shape. Such investigation will, of course, have to be made from a standpoint of national economy.

e) Raw Materials

In this report, the study was performed based upon the available data at present of quantities, qualities and prices with raw materials.

In Trinidad and Tobago, the development of natural gas (condensate accompanied therewith) is being proceeded by AMOCO Co. and the expansion of refinery plant of Trinidad Tesoro Co., which will be able to afford a large quantity of naphtha, is under blueprint. Although AMOCO and Tesoro adviced us the informations as accurately as possible, at present stage the assured data with raw materials are not available. It is strongly recommended to closely follow the situations of raw material developments to obtain the non-presumptive data.

f) Utilization of Natural Gas

It has been found that natural gas is more disadvantageous as the starting material than naphtha in producing petrochemicals in Trinidad and Tobago. As a result, the natural gas, now under development there, should have other channels of utilization than as the raw material for petrochemicals.

It is thus recommended that further investigations should be carried out on the possibilities of:

(i) Development of electrochemical industry using natural gas as the fuel; for example, aluminum smelting, and production of chlorine and caustic soda by means of electrolytic processes.

(ii) Establishment of liquefied natural gas plant (LNG).

2) Gradual Implementation in Attainment of the Recommended Petrochemical Complex

Although the large complex should be recommended from the view point of competitiveness in world market, in the light of the realities of the situation in the petroleum industries in Trinidad and Tobago the recommended petrochemical complex should be implemented in stages.

Therefore the start of petrochemical industry is recommended concentrated on the raw materials of aromatics, cyclohexane and n-paraffin which are presently produced and exported in Trinidad & Tobago, and the following three products are selected as the first group from the view point of prospective availability of principal and subsidiary raw materials.

(1) Nylon-6 (2) Linear alkylbenzene

(3) Maleic anhydride

Regarding the olefinic derivatives it is considered to start from building a complex of smaller size than the recommended objective complex in which a smaller cracker exists as a core plant.

In this case the kind of end products must be lesser because the capacity of production of a product should be of international scale for competitiveness on price in world market, and it will be necessary to confirm the security of whole complex upon the more careful and more circumstantial examination in the marketabilities of these end products.

As to the feed to this cracker, condensate is selected because condensate has an advantage over naphtha in price and the prospective available quantity of condensate is large enough to this smaller sized cracker on the present data.

The following products are selected as the second group mainly from the view point of rate of return on investment. With butadiene derivative, SBR is bustituted by BR (cis polybutadiene rubber) since no styrene is planned to be produced.

(1) HDPE (2) PVC

(3) Acrylonitrile or PP

(4) BR

There is a possibility of combination of the first and the second group as the third group.

The preliminary calculations on these groups for economic assessment are shown in Annex T.

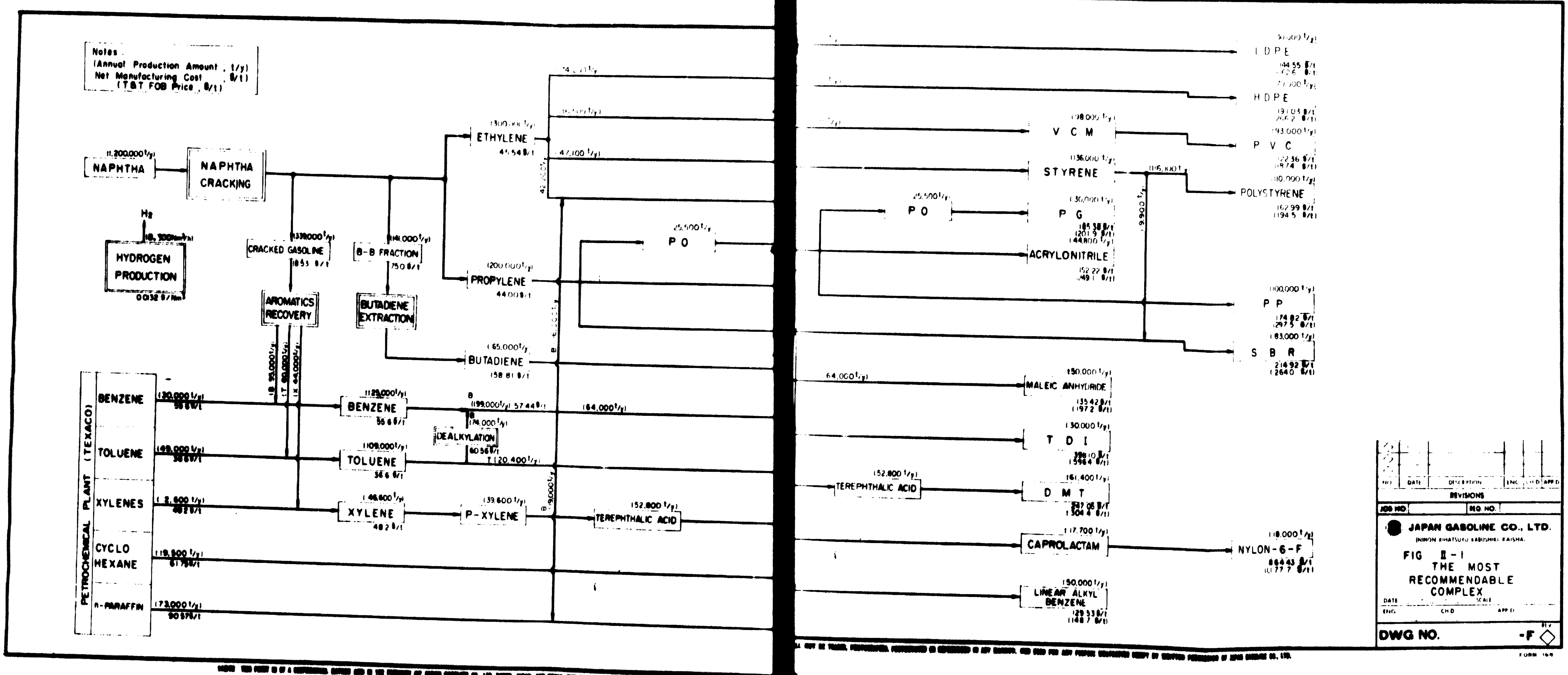
TABLE II - 1

EXPORTABILITIES OF SELECTED PETROCHEMICALS

(Unit: $/t)

Petrochemicals	Selling Price	U K		Other European Countries		North America		Southeast Asia	
		Delivered Price	Domestic Price	Delivered Price	Domestic Price	Delivered Price	Domestic Price	Delivered Price	Domestic Price
LDPE	168.47	211	353	270	292	286	287	342	287
HDPE	229.80	280	474	360	488	363	397	411	386
VCM	93.27	130	n.a.	165	180	191	110	172	147
PVC	139.41	178	294	227	318	236	309	219	218
Styrene	112.05	151	198	180	208	213	176	196	186
Polystyrene	191.13	236	298	307	332	315	326	283	258
PG	203.26	254	310	325	301	326	287	319	206
Acrylonitrile	177.69	225	311	277	438	283	320	279	291
Acrylic Fiber	1,105.83	1,265	1,760	1,566	n.a.	1,310	1,963	1,485	1,110
PP	206.02	253	534	326	584	331	463	398	367
SBR	238.64	290	325	346	328	295	391	306	349
Maleic Anhydride	154.72	200	400	245	473	284	353	250	300
Alkylbenzene	143.93	188	n.a.	230	n.a.	270	232	230	221
Caprolactam	319.05	385	n.a.	470	n.a.	480	540	458	410
Polyamide Fiber	1,073.03	1,226	1,390	1,520	1,936	1,273	1,984	1,444	1,696
TDI	469.47	555	817	688	843	690	815	650	380
DMT	287.23	348	n.a.	430	n.a.	378	330	426	503
Polyester Fiber	1,022.44	1,170	1,440	1,420	n.a.	1,216	1,525	1,376	1,278

Remarks: Refer to Annex V. as the calculation basis for delivered price and domestic price.



SECTION 1

SECTION 2

III General Conception of Petrochemical Complex in the World

1. Petrochemical Industries in the 1970's

The petrochemical industries which achieved marvellous growth in the USA, Europe and Japan in the 1960's are expected to continue their rapid growth in the 1970's. During the past ten years the petrochemical industries in the USA and Europe have developed at an annual rate of 11-12% and this tendency is expected to continue in the coming decade. The Japanese petrochemical industry is expected to show a nearly 20% growth for the coming several years and a more-than-10% growth for a decade thereafter.

The following tables show a forecast of growth of petrochemicals presented at the joint symposium of the American Chemical Society and the Chemical Institute of Canada held in Toronto, Canada in May 1970. The figures indicated are generally considered to be of conservative value.

Ethylene Output in the World (Unit: million t/y)

	1970	1975	1980
USA	7.5	12.0	18.0
W. Europe	6.0	12.0	19.0
Japan	2.4	4.4	7.0
Other Western Countries	0.7	2.1	5.0 - 6.0

Anticipated Development of Petrochemical Industries (Growth of Ethylene) 1970 - 1980

	USA	W.Europe	Japan	Other Western Countries	Total
New Demand (millions t/y)	9.00	7.65	4.50	6.75	29.90
Equivalent Capacity (")	9.90	8.55	4.95	7.65	31.05
Existing Capacity to be scrapped (")	5.40	2.70	1.35	1.80	11.25
Total Newly Required Capacity (")	15.30	11.25	6.30	9.75	42.30
Approx. No. of Plants	28	25	16	30	99
Approx. Total Investment for New Installation (millions $)	12.00	11.00	6.00	10.00	42.00

The Advisory Committee for Energy of the Ministry of International Trade and Industry, Japan, reported in July 1970 that the total ethylene production in Japan will be 6.6 millions t/y in 1975 and 17-19 millions t/y in 1985. In industrialized countries, the petrochemical industry is becoming one of the key industries essential to the development of the natural economy, in parallel with the growth of the nation.

Many developing countries are proceeding with establishment of petrochemical industries as a means of gaining their economic independence. The petrochemical industries to be set up in the developing countries in Asia, Africa and Latin America will be highlights of the international industrial growth in the 1970's.

On the other hand, however, the world-wide development of petrochemical industries has raised the cost of raw materials because of increasing demands, and the increase in labor cost and investment cost due to world-wide inflation is causing rises in operating cost. And yet, owing to intensifying competition in sales and prices of petrochemicals in world markets, it is impossible to raise the prices of petrochemicals to the extent of fully absorbing the increases in manufacturing cost, thus portending the world-wide trend to the so-called "profitless prosperity."

2. Problems Relating to Reduction in Product Price

Petrochemical producers in the world are making every effort to reduce their manufacturing cost so as to avoid any decrease in profits. Main steps being taken are:

a) Increase in plant size
b) Higher stream factor
c) Overall utilisation of each fraction
d) Purchase of low-price raw materials
e) Development of new techniques

a) Increase in Plant Size

Due to the fact that the petrochemical industry is a typical process industry which requires huge capital investment and high fixed costs, the size of petrochemical plants has been increased year after year since the latter half of the 1960's for "scale merit" to reduce manufacturing costs to cope with the increasing demand for petrochemicals.

Fig III-1 shows the economic efficiency of the increase in size of the ethylene plant, the core plant of the petrochemical complex. This figure compares ethylene manufacturing cost by size of plant. As the capacity is increased from 100,000 tons to 300,000 tons and from 300,000 tons to 500,000 tons, the ethylene manufacturing cost at 90% of stream factor will be reduced by 0.9 ¢/kg and 0.45¢/kg respectively.

In the early 1960's, the size of an ethylene plant was 100,000 t/y to 200,000 t/y. At present the standard capacity is 300,000 t/y to 500,000 t/y. During the period of 1970 to 1972, ethylene plants having a capacity of 500,000 t/y are scheduled to start up in succession in the USA, W. Germany, Italy and Puerto Rico. A 750,000 tons ethylene plant is being planned for 1974 completion by Reinische Olefin Werk (ROW) in W. Germany.

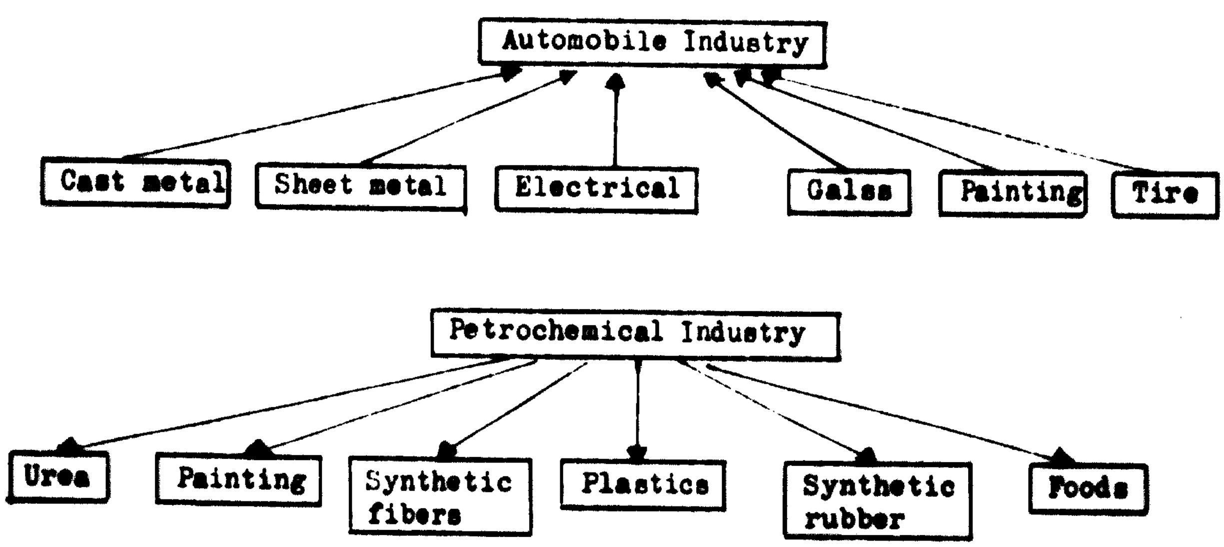
With the installation of such large-size ethylene plants, the larger-size other petrochemical production facilities are being planned and built. The capacities of the largest plants by product now in operation or being planned are as follows:

Ammonia	340,000 - 500,000 tons/y
Methanol	340,000 - 600,000 tons/y
Styrene monomer	250,000 - 450,000 tons/y
PVC	200,000 - 300,000 tons/y
Ethylene oxide/Ethylene glycol	100,000 - 150,000 tons/y
Aromatics	500,000 - 600,000 tons/y
O-xylene	100,000 tons/y
P-xylene	80,000 tons/y
Phthalic Anhydride	70,000 tons/y
Telephthalic Acid	180,000 tons/y
DMT	100,000 tons/y

b) Higher Stream Factor

The capacities of petrochemical plants are becoming larger and larger to reduce the operating and manufacturing costs. To achieve this, a very high stream factor is required. The Fig. III-1 shows also the relationship of the capacity and stream factor over ethylene cost. Ethylene manufacturing cost is reduced from 4.3 ¢/kg to 3.4 ¢/kg when the capacity is increased from 100,000 t/y to 300,000 t/y. However, if the stream factor is decreased from 90% to 70%, the ethylene cost would be 4.2 ¢/kg and the scale merit is lost. It is very important to keep a close relation with market for maintaining the higher stream factor and in view of this, marketing survey before the decision of the size of the plant would be an important factor.

However, the petrochemical industries different from the electronic or automobile industry and provides basic materials. The electronic and automobile industries are industries of the "convergent" type for assembling different kinds of parts supplied by their related industries, while the petrochemical industry is the "divergent" type industry providing primary products from which petrochemical derivatives are produced and processed to final products for marketing, that is, it is indirectly connected with the final demand through several intermediate courses. The manufacturing scheme becomes complicated as the processing course proceeds from basic products to intermediate products, and the market survey itself becomes more difficult.



One of the problems in the petrochemical industry is, therefore, that the product cost can be reduced by satisfying the two contradiotory conditions of "plant size increase" and "higher stream factor".

c) Overall Utilization of Each Fraction

As a third means for reducing the manufacturing cost in the industrialized countries, there is the overall utilization of each fraction from cracker.

In Japan and W. Europe where naphtha is used as raw material for petrochemicals, the output of each fraotion from naphtha cracker is inevitably increased with the increase in ethylene capacity, and overall utilization of such fraction is the key to larger plants.

Namely, the manufacturing cost varies depending on whether to increase the added value by effectively utilizing fractions other than ethylene as chemical raw materials or to use them only as fuel.

In Japan, utilization of ethylene for petrochemical (ethylene consumption for petrochemical products over the total ethylene production) has been more than 90% from the initial stage of development of the petrochemical industry. The utilisation of propylene and B-B fractions was 22% and 76.3% respectively in 1960. At present, these numbers have been raised to about 90% and particularly the propylene market is even expected to become tight. Today, the utilization of each fraction is forcussed on C_5 fractions or C_9 + fractions. In several years the utilisation of these fractions is expected to exceed 90%.

d) Purchase of Low-Price Raw Materials

The manufacturing cost is sensitively influenced by the raw material cost. Fig. III-2 shows how ethylene cost is affected by the raw material cost. Raw material at low cost is desired, but the

World-wide petrochemical boom has caused the increase of raw material cost. In the USA, LPG is now becoming short in supply with the increase of demand for petrochemicals though it was in surplus in the past. If lead is removed from gasoline, some anticipate that with the increase of demand for propylene, butylene and aromatics, the allocation system of petroleum import will be revised in the USA in the future and the main portion of the raw materials for petrochemicals would be changed to naphtha or gas oil. If this is the case, the naphtha shortage would become serious with the rising naphtha price.
In Japan, negotiations on raising of petrochemical naphtha price are being conducted between petroleum refiners as naphtha suppliers and petrochemical companies as purchasers. The raising of the price was 28 ¢/Kl last year; however, the increase to 83 ¢/Kl has been recently proposed by the refiners again. In the future, gas oil or kerosene or crude will be more used than naphtha.
In any way, the prices of petrochemical raw materials will be more and more increased and never be decreased under the present situation.

e) Development of New Techniques

As in the past, the rapid development of techniques is one of the characteristics of the petrochemical industry such as conversion of raw materials, direct methods, simplicity of processing scheme, etc. Therefore, there is always anxiety that the present technique will soon become obsolete by the development of new techniques. The earliest return of investment by gaining more profit with the reduction of cost is most important.

It is also important to develop or improve techniques by the manufacturer itself; however too much weight should not be given to the possibility of development of techniques by manufacturers as a tool for cost reduction.

As discussed above, there are so many problems involved for reduction of cost in the petrochemical industries in the world, and management of the petrochemical industries even in the industrialised countries will not be easy in the future.

3. Petrochemical Industries in Developing Countries

Many developing countries plan the installation of petrochemical facilities for the 1970's and some of them will be realized. However, the following problems will be anticipated in the industrialization of petrochemical industries in developing countries.

(1) Domestic market is small.

(2) There is no firm assurance of possibility of exporting most of the petrochemical products, though so planned.

(3) Funds are not available.

(4) As raw materials are limited in quantity, it is difficult to commercialize the petrochemical industry in as large a scale as they can have international competitiveness.

The situation varies by each country and difficulty is anticipated for realization of the projects in most cases as mentioned above. In the case where there is sufficient internal demand for petrochemical products such as synthetic resin, synthetic fiber and the presently imported petrochemicals can be switched to internal products, the projects may be, with less difficulty, realized although the relation between the marketing situation and minimum economic size of plant, and availability of raw material should be considered. In many cases, in fact, the projects of this kind have been successful.

On the other hand, difficulties will be encountered in the case where the local market is very limited and all the products are to be exported. It would be right that the products sell if produced at lower cost with raw materials at lower prices but the petrochemical industries are flooded with the projects with raw materials at lower cost and severe competition will be encountered in the world market where industrialized countries are fighting furiously.

The success of the petrochemical industries in Puerto Rico is drawing the world's attention; however, Puerto Rico is a territory of the USA and protected by the tariff barriers and all the products can be freely marketed in the USA with no federal tax. The tax system is left to the judgement of the Government of Puerto Rico by which petrochemical manufacturers are completely tax free for 10-17 years in order to promote the development of petrochemical industries. In addition, the Government of Puerto Rico is supporting the industries in financing, purchase of land, etc.

The most attractive point by petrochemical manufacturers in the USA is that the raw material is available in Puerto Rico at about 40-50% of the price available in the USA. In Puerto Rico naphtha can be imported from Venezuela or Trinidad and Tobago free of tax without any import allocation. Success lies not only in the availability of the raw material at low cost, but in good marketing situation.

Therefore, in order to set up a petrochemical industry in a developing country, it is essential to give careful consideration to long-term industrialisation policies on such factors as availability of low-cost raw materials, securing of product markets, incentive policies, availability of financing, and market development and joint development of natural resources through regional cooperation.

FIG III-1 EFFECT OF CAPACITY AND STREAM FACTOR OVER ETHYLENE COST

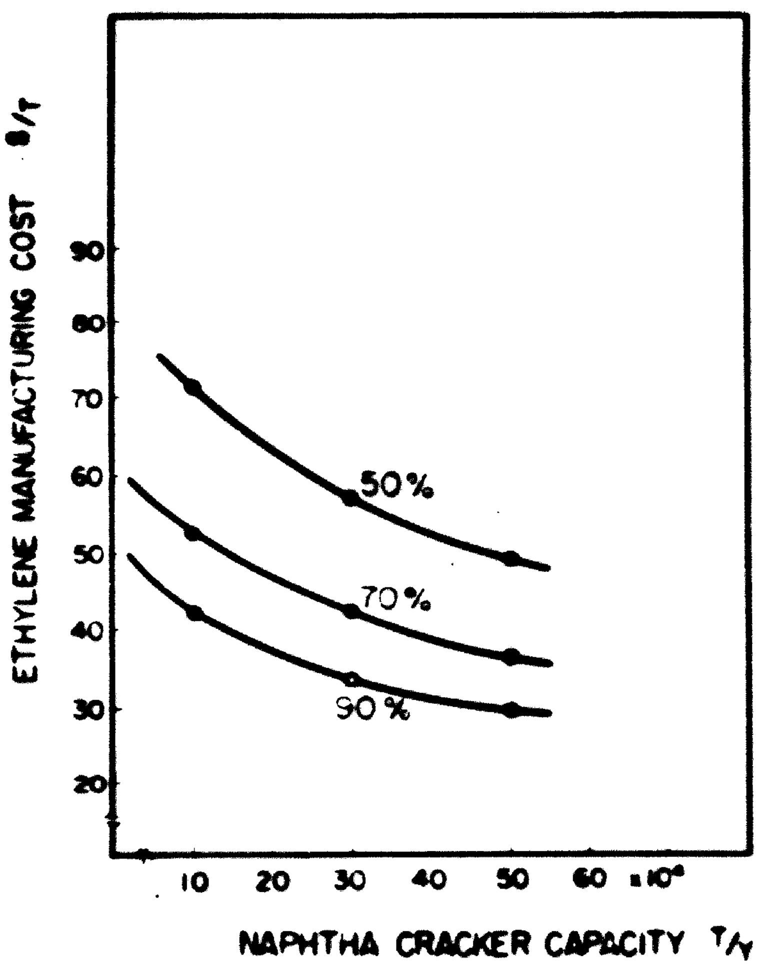
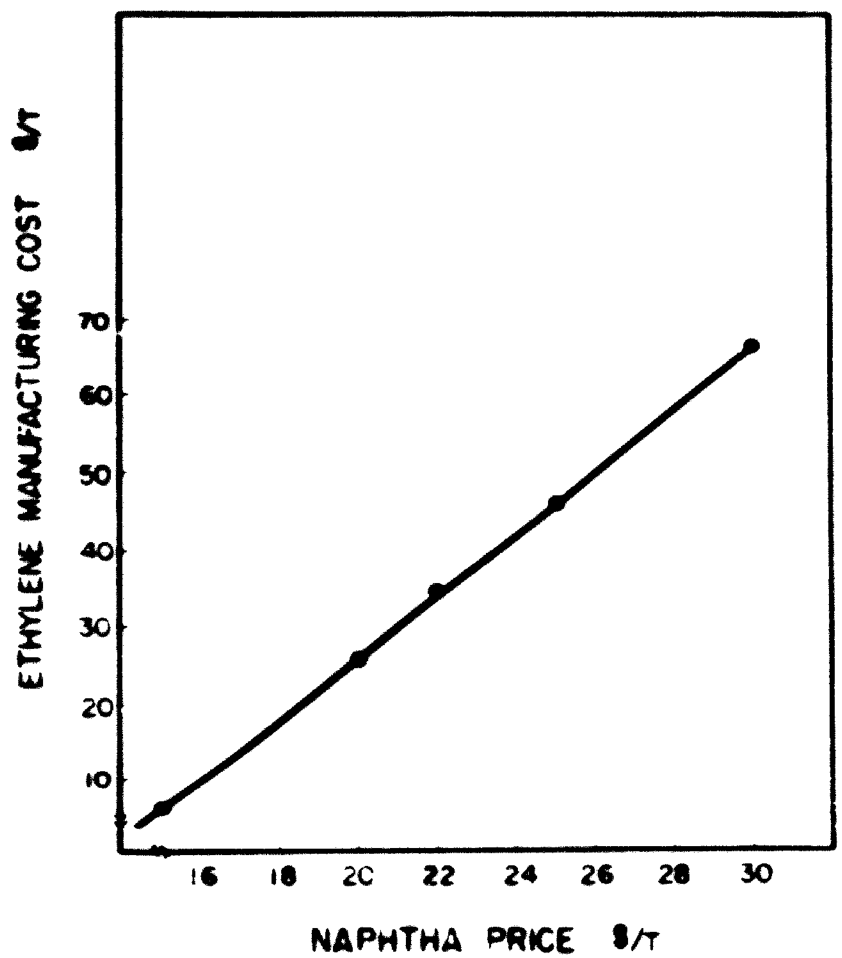


FIG III-2 EFFECT OF RAW MATERIAL COST OVER ETHYLENE COST (CAPACITY : 300.000 T/Y)



IV. Selection of Petrochemicals to be Produced in Trinidad and Tobago

1. Methodology

In the selection of petrochemicals to be produced in Trinidad and Tobago, "Full Range Possible Complex" * was checked in accordance with the following steps.

* Full Range Possible Complex is shown in Fig. IV-1 of "the Prefeasibility Studies on Petrochemical Plants for Trinidad and Tobago" prepared by Economic Studies and Planning Division, Industrial Development Corporation of Trinidad and Tobago in September, 1969.

i) The obsolete or commercially unproved processes are to be excluded.

ii) The materials which are chemically toxic or easily explosive and not suitable for long distance transportation are to be excluded.

iii) Based on the estimated world-wide demand and supply balance in the future the petrochemicals which are anticipated not to considerably expand in demand or which are assumed to become dull in the demand/supply balance are to be excluded.

2. Selection of Petrochemicals

1) Processes considered to be obsolete or commercially unproved

a) Ethylalcohol ⟶ Acetaldehyde (Obsolete)

Acetaldehyde production processes presently used are as follows:

i) Oxidation (hydrogenation) of ethylalcohol
ii) Hydration of acetylene
iii) Direct oxidation of ethylene
iv) Oxidation of butane-propane

The process of oxidation of ethylalcohol has been used for acetaldehyde production in USA and the process of hydration of acetylene was used in Japan. However, with the development of an ethylene direct oxidation process by Consortium für Electrochemische Industrie of Germany in 1959 and with the commercialization by Wacker and Hoechst, this new process of ethylene direct oxidation is adopted for all the acetaldehyde production by taking advantage of its low production cost.

	Price (¢/lb)	Acetaldehyde Produced (¢/lb)
Acetylene	6	3.7
Ethanol	6	6.9
Ethylene	3.5	2.4

The oxidation of butane-propane is the process executed only by Celanese Co. of USA. The separation section of this process is very complicated because various oxides such as aldehydes, ketones, alcohols and esters are produced as by-products.

The direct oxidation of ethylene is employed for production of acetaldehyde.

b) IPA ⟶ Acetone (Obsolete)

The followings are the acetone production processes.

i) IPA Process (Propylene ⟶ IPA ⟶ Acetone)

ii) Hoechst-Wacker Process
(Propylene - "direct oxidation" ⟶ Acetone)

iii) Cumene Process (Propylene, Benzene) ⟶ Cumene ⟶ (Acetone, Phenol)

In USA, 72% of the total acetone produced in 1965 was by IPA process. This is due mainly to the fact that IPA process has its long history in this field and that most of the facilities in USA were already paid out. In the petrochemical industry in Japan which started in 1960's, 42% of acetone production is by Cumene process, 42% by Hoechst Wacker, 13% by IPA process and 3% by others. The cost calculations in ECN July 26, 1963 and ECN July 19, 1963 issues indicate the advantage of Hoechst Wacker process over IPA process as follows:

	Acetone Produced $/ton
IPA process	83
Hoechst Wacker process	81

In the Cumene process, acetone and phenol are simultaneously produced and the economic evaluation of acetone and phenol is an important factor. Phenol is expected to be produced at about $156/ton and acetone at about $77/ton. Accordingly the main process of acetone production in the future will be the Cumene process.

In this report, the following process is considered for acetone production.

Propylene, Benzene → Cumene → Acetone, Phenol

c) Isobutylene Formaldehyde → Isoprene → Polyisoprene
(Commercially unproven)

The following table shows polyisoprene manufacturers in the world in 1969.

Manufacturers	Plant Location	Capacity (1000 t/y)	Catalyst
Goodyear	Orange, Texas, USA	60	Ziegler
Goodrich-Gulf	Orange, Texas, USA	47	Ziegler
Shell	Marietta, Ohio, USA	36*	Li
Shell	Pernis, Netherlands	45	Li
USSR	-	40	Ziegler

* including 9,000 tons (dry base) of polyisoprene latex

The production of polyisoprene rubber in 1970 is estimated low in quantity compared with 2.9 million tons of SBR and 601,000 tons of BR and is only about 4% of the total synthetic rubber production.

This lower percentage may be due to unavailability of isoprene monomer at low price.

Isoprene Monomer Production Processes

	Process	Remarks
i)	Separation from naphtha cracked gasoline (extract distillation)	Isoprene content of cracked gasoline is as low as 3 - 6%. Therefore, the raw material should be available in quite large quantity (cf: Butadiene content of B-B fraction is 40 - 50%)
ii)	Propylene dimerisation - thermal cracking	By Good-Year Co. (GY-SD Process)
iii)	Isoamylene dehydrogenation	By Shell, Goodrich-Gulf, Enjav Co.
iv)	Isobutylene formaldehyde	By USSR (IFP Process)
v)	Acetone - acetylene	SNAM Process
vi)	Isopentane dehydrogenation	Houdry Process

The above isoprene monomer production processes have not been sufficiently proven to succeed in the commercialization from techno-economical view point. Goodyear and Michelin (France) planned to build the isoprene plant with propylene dimerization process by joint venture in 1967, however, after techno-economical study this plan was abandoned. In Japan, Japan Synthetic Rubber Co. planned to establish Japan Isoprene Co. by 1972 jointly with Goodyear Co. and introduced IFP process instead of GY-SD process, however they have reportedly decided to use a process of separation from naphtha cracked gasoline. The situation around the isoprene production is not stable.

The properties of polyisoprene rubber is almost same as those of natural rubber, compared with BR (anti-abrasion and low heat build-up) and SBR (low price, good processability), so that its marketing is directly influenced by natural rubber marketing situation. Recently, natural rubber producing countries in Southeast Asia are making more effort to improve natural rubber production in both of quality and quantity. Furthermore, in consideration of speculativeness of natural rubber market, one who plans to start the production of polyisoprene rubber should, they say, have close connection with big rubber users such as tire makers.

From the above discussion, it is anticipated that many difficulties would be encountered in starting the production of polyisoprene in the developing countries.

d) **Benzoic acid ⟶ Phenol (Obsolete)**

The following are phenol production process presently used.

i) Cumene Process (Cumene ⟶ Phenol + Acetone)
ii) Raschig Process(Benzene ⟶ Chlorobenzene ⟶ Phenol)
iii) Toluene Process(Toluene ⟶ Benzoic Acid ⟶ Phenol)
iv) Cyclohexane Process (Benzene ⟶ Cyclohexane ⟶ Cyclohexanol/hexanone ⟶ Phenol)
v) Chlorination Process(Benzene ⟶ Chlorobenzene ⟶ Phenol)
vi) Sulfonation Process (Benzene ⟶ Benzene sulfonate ⟶ Phenol)
vii) Direct Benzene Oxidation Process (Benzene ⟶ Phenol)

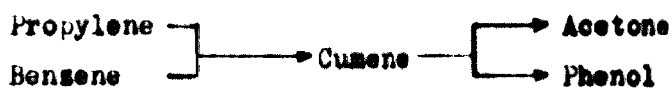
These processes were used at the following ratio based on the capacity in 1967 in the world.

Cumene process	70%
Sulfonation process	10%
Chlorination process	10%
Others	10%

The production costs are calculated as follows:

	Phenol produced ($/ton)
Cumene process	156
Raschig process	169
Toluene process	170
Cyclohexane process	183
Chlorination process	195
Sulfonation process	176

In this report the cumene process is adopted for production of phenol.



2) Dangerous Materials by Chemical Properties

a) EO and PO

EO and PO are treated as a dangerous materials by the following reasons;

* Wide range of explosion limits.
* Vapour causes irritation of nose and eyes, loss of equilebruum, dyspnea and death.
* Causes delay burn of the skin and also causes severe burn of eyeball accompanied by permanent impectiment when it is contacted.

Therefore, maximum care is required for the handling of EO and PO and the long distance transportation is costly and not desirable. In this respect, very little trade of EO and PO have been made.

3) Selection from the Point of Macroscopic World Market

The petrochemicals after being checked by the above items 1) and 2) are shown in Fig.IV-2. Of these petrochemicals, the most promising ones for marketing should be selected.

Table IV-1 shows the supply and demand of the petrochemicals shown in the Fig.IV-2 in the four areas (North America, Latin America, West Europe and Southeast Asia).

The selection and exclusion is to be made, considering the estimated world-wide supply and demand balance and the promising marketing situation in the future.

a) Selection of Ethylene Derivatives

The following is the summary on the estimated market in 1975 and it's annual growth rate up to 1975 of the ethylene derivatives as a total of the said four areas.

(unit : 1,000 tons)

Ethylene Derivatives		Growth Rate	Demand in 1975
i)	HDPE	14.6%	3,342
ii)	LDPE	14.4%	9,495
iii)	Styrene	13.1%	8,105
iv)	PVC	12.2%	8,862
v)	VCM	12.1%	10,150
vi)	Polystyrene	9.3%	3,113
vii)	EG	7.8%	2,680
viii)	Acetaldehyde	7.4%	3,188
ix)	Acetic Acid	6.4%	2,965
x)	Butanol	6.1%	1,073
xi)	Ethanol	5.0%	3,715

Of these petrochemicals, HDPE, LDPE, Styrene, PVC, VCM and Polystyrene are selected from the point of view of the higher growth rate of the market in the future. The growth rate of EG, butanol, acetaldehyde, acetic acid and ethanol are relatively low. As shown in Table IV-1,no active expansion or new installation programme up to 1973 are seen in the said four areas. Accordingly, EG, butanol, acetaldehyde, acetic acid, and ethanol are excluded from this study.

b) Selection of Propylene Derivatives

The following is the summary on the estimated market in 1975 and it's growth rate up to 1975 of propylene derivatives as a total of the four areas.

(Unit : 1,000 tons)

Propylene Derivatives	Growth Rate	Demand in 1975
i) PP	18.1%	3,309
ii) Acrylonitrile	14.3%	2,839
iii) Acrylic Fiber	10.8%	1,040
iv) PG	9.6%	805
v) Acetone	7.7%	1,868
vi) IPA	6.1%	1,753

PP, acrylonitrile, Acrylic Fiber and PG are to be selected. Acetone is produced together with phenol by Cumene process, as shown in the item IV-2.-1)-b). The expected growth rate of both products up to 1975 are comparatively low. Accordingly, it is thought that acetone and phenol production by Cumene process should be excluded. The main end use for IPA is aceton. As shown in the item IV-2.-1)-b), acetone production is changing to Cumene process or Hoechst Wacker process from IPA process, and the future growth rate of IPA is estimated relatively low. Accordingly, IPA is to be excluded.

c) Selection of Butadiene Derivatives

The following shows the estimated demand in 1975 and it's growth rate up to 1975 of the Butadiene derivatives as a total of the four areas.

(Unit : 1,000 tons)

Butadiene Derivatives	Growth Rate	Demand in 1975
i) SBR	5.6%	3,820
ii) BR	8.8%	918

The growth rate of BR is exceeding SBR, however in the light of the size of market, SBR is considerably exceeding BR. BR has been spot-lighted for synthetic rubber by the technique of it's sophisticated stereopolymerization. Polybutadiene made its debut while the problem of raw material with polyisoprene has not been solved and has grown rapidly, however there is still some problems in processing. BR by itself does not process well in conventional rubber mixing and curing equipment so that it is always used in conjunction with SBR or natural rubber, and from the view point of properties of the product BR cannot be used effectively in blends beyond 50 percent. Above the 50 percent level, tread cutting and chipping become a problem. Most manufacturers of passenger-car tires find that blends of BR with SBR in the ratios of 20 - 25% work best in the tread formations (in other words, SBR is used in this blend by 75 - 80%). For heavy duty tires BR is used in a little larger percent than for passenger tire, but is never used in non-blending form. Accordingly, the spectacular growth of BR in the USA and Europe during the last these years does not necessarily mean that it will excel the other general purpose rubbers in absolute consumption. It will be advisable for a new comer into the rubber business to start from SBR which has background of stable technique with long history and is still supplying the absolute quantity in the market. In this thoughts, 20,000 tons of butadiene is to be used for the production of SBR rather than BR.

d) Selection of Aromatic Derivatives

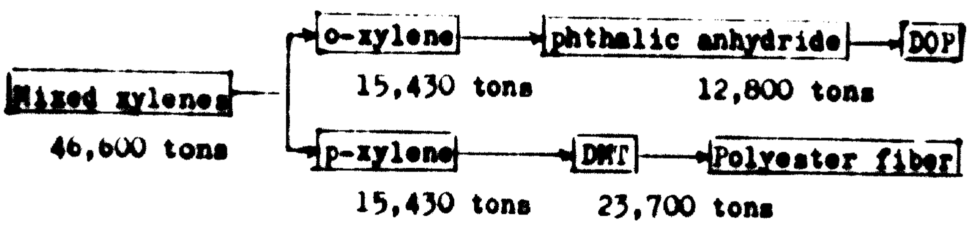
The following is the summary on the estimated market in 1975 and it's growth rate up to 1975 of aromatic derivatives as a total of the four areas.

(Unit : 1,000 tons)

Aromatic Derivatives	Raw Materials	Growth Rate	Demand in 1975
i) Maleic anhydride	Benzene	13.2%	564
ii) Caprolactam	"	12.2%	2,245
iii) Polyamide fiber	"	11.7%	3,253
iv) Alkylbenzene	"	7.7%	1,315
v) Phenol	"	6.7%	2,378
i) TDI	Toluene	17.9%	585
i) Polyester fiber	Xylenes	17.3%	3,129
ii) DMT	"	16.4%	3,820
iii) DOP	"	12.1%	1,200
iv) Phthalic anhydride	"	10.4%	1,798

Maleic anhydride, caprolactam, polyamide fiber, alkylbenzene, TDI, DMT and polyester fiber are to be selected. Phenol is excluded as same reason as acetone shown in the item b) of this section.

Phthalic anhydride and DOP are excluded. 46,600 tons of mixed xylenes are separated 15,430 tons of o-xylene and p-xylene each other. 12,800 tons of phthalic anhydride are produced from 15,430 tons of o-xylene and 23,700 tons of DMT are produced from 15,430 tons of p-xylene.



At present, the capacities of the largest plant of phthalic anhydride and DMT are 70,000 t/y and 100,000 t/y respectively in the world. In this situation, the plants with the capacities of 12,800 t/y of phthalic anhydride and 15,430 t/y of DMT are not competitive in the world market. It is not good idea to take both lines. (o-xylene ⟶ phthalic anhydride ⟶ DOP, p-xylene ⟶ DMT ⟶ polyester fiber)
It should be focused on one line by capacity up. The line, p-xylene ⟶ DMT ⟶ polyester fiber, is selected on account of the higher growth rate of demand than the line, o-xylene ⟶ phthalic anhydride ⟶ DOP.

e) Selection of Other Petrochemicals

The growth rate up to 1975 and the demand in 1975 of petrochemicals other than those in the item a) through d) of this section are as follows:

(Unit : 1,000 tons)

Other Petrochemicals		Growth Rate	Demand in 1975
i)	Phenolic Resin	9.9%	1,821
ii)	Methanol	9.2%	8,339
iii)	Urea Resin	6.7%	2,259
iv)	Ammonium Nitrate	2.7%	17,706

The demand and supply balance of methanol has become tight from the later half of the last year to this year in USA and Europe as shown in Table IV-1 and Annex Q-1 and methanol manufacturers have much interest in the new installations or expansion of methanol production facilities. Particularly, larger size of plant is being considered using the recent developed ICI process. If and when all these projects are realized, the total capacity of methanol production would reach 10.8 million tons per year as a total of the four areas by 1973, which will exceed 8.3 million tons of the estimated total demand in the four areas by 1975 and the present tight market situation may turn to loose. It is felt, therefore, that the new installation or expansion of the existing methanol facilities should be suspended. In this respect, it is thought that it is very difficult for new comer to market the methanol by 1975. Accordingly, methanol is excluded from this study.

Phenolic resin and urea resin are produced by reaction of phenol and urea with formaldehyde respectively. Since methanol and phenol, which are raw materials for these resins, are excluded from this study, there is no appreciable advantage of the production of these resins even by importing the raw material.

The growth rate of ammonium nitrate demand is very low, and the production capacity in 1973 is anticipated to considerably exceed the demand in 1975 as shown in Table IV-1. Therefore, it would be advisable that the new installation or expansion of ammonium nitrate should be suspended for a while by the same situation as methanol case.

3. Block Diagram of Petrochemicals

The petrochemicals selected by above steps are shown in the Fig. IV-3.

IV-1

MARKET SITUATION OF PETROCHEMICALS

(Unit : 1,000 tons, %)

Petrochemical Products	Areas	1965 Capacity	1965 Demand	1970 Capacity	1970 Demand	1973 Capacity	1973 Demand	1975 Demand	Annual Average Growth Rate of Demand 1965--1970	Annual Average Growth Rate of Demand 1970--1975
LDPE	North America	1,110	951	2,300	1,860	2,582	2,483	3,010 A	14.4	10.1
	Latin America	51	77	240	177	350	357	569	18.1	26.3
	W. Europe	925	737	3,120	2,000	5,086	3,121	4,200 C	22.1	16.0
	Southeast Asia	299	301	1,595	916	1,905	1,275	1,716 B	22.1	16.0
	Total	2,385	2,066	7,255	4,853	9,871	7,236	9,495	18.6	14.4
HDPE	North America	370	318	1,298	760	1,487	1,063	1,330 A	19.0	11.8
	Latin America	7	19	43	50	85	110	186	21.4	30.0
	W. Europe	292	201	928	536	1,711	783	1,008	21.7	13.5
	Southeast Asia	112	86	654	343	1,104	578	818 B	31.9	19.0
	Total	781	624	2,923	1,689	4,387	2,534	3,342	22.5	14.6
Polystyrene	North America	825	660	1,295	810	1,598	1,066	1,280 A	4.2	9.6
	Latin America	57	43	77	72	77	104	133	10.9	13.1
	W. Europe	604	417	1,000	800	1,754	942	1,050	13.9	5.6
	Southeast Asia	150	85	500	316	584	487	650 B	30.0	15.5
	Total	1,636	1,205	2,872	1,998	4,013	2,599	3,123	10.6	9.3
Ethylene Glycol	North America	900	750	1,362	1,100	1,415	1,370	1,500 D	8.0	6.4
	Latin America	-	12	24	35	55	46	56	23.9	9.9
	W. Europe	480	310	690	480	740	586	670 C	9.1	6.9
	Southeast Asia	60	65	324	235	574	353	464 B	23.3	14.6
	Total	1,440	1,137	2,400	1,850	2,734	2,355	2,680	10.3	7.5
Styrene Monomer	North America	1,45[illegible]	1,[illegible]	2,600	2,100	2,6[illegible]	2,600	3,000	11.[illegible]	7.4
	Latin America	21	46	[illegible]	200	150	265	[illegible]	[illegible]	10.2
	W. Europe	7[illegible]	547	1,428	1,580	3,700	2,[illegible]20	3,[illegible]	[illegible]	12.1
	Southeast Asia	[illegible]24	[illegible]	780	500	650	750	[illegible]	[illegible].1	14.4
	Total	[illegible]	[illegible]	4,427	4,[illegible]	7,4[illegible]	[illegible]	[illegible],1[illegible]	17.1	1[illegible].1

Petrochemical Products	Areas	1965 Capacity	1965 Demand	1970 Capacity	1970 Demand	1973 Capacity	1973 Demand	1975 Demand	Annual Average Growth Rate of Demand 1965--1970	Annual Average Growth Rate of Demand 1970--1975
Acetaldehyde	North America	664	500	1,180	855	1,180	1,024	1,155 B	11.3	6.2
	Latin America	23	12	85	56	163	85	113	36.1	15.1
	W. Europe	600	490	963	800	1,123	953	1,070 CG	10.3	6.0
	Southeast Asia	290	278	627	516	900	696	850 B	13.2	10.5
	Total	1,577	1,280	2,855	2,227	3,366	2,758	3,188	11.7	7.4
Acetic Acid	North America	700	650	1,200	1,050	1,350	1,179	1,290 B	9.6	4.6
	Latin America	41	22	80	100	180	169	240	35.4	19.1
	W. Europe	400	300	600	510	600	617	700 G	11.2	6.5
	Southeast Asia	248	155	555	533	555	646	735 B	28.0	6.6
	Total	1,389	1,127	2,435	2,173	2,685	2,611	2,965	14.0	6.4
Butanol	North America	220	150	286	200	328	225	243 H	5.9	4.0
	Latin America	-	10	14	30	36	41	50	24.6	10.7
	W. Europe	n.a.	268	550	420	600	500	560	9.4	6.0
	Southeast Asia	78	76	141	150	160	169	220 B	14.6	8.0
	Total	n.a.	504	991	800	1,124	955	1,073	9.7	6.1
Ethanol (1,000 kl)	North America	1,300	1,050	1,813	1,178	1,851	1,300	1,388 B	2.3	3.3
	Latin America	680	646	n.a.	1,170	n.a.	1,358	1,500	12.5	5.9
	W. Europe	350	286	560	475	796	581	665 C	10.7	7.0
	Southeast Asia	71	60	105	87	130	126	162	7.7	13.2
	Total	2,401	2,042	n.a.	2,910	n.a.	3,365	3,715	7.3	5.0
Polypropylene	North America	247	156	1,067	520	1,380	761	980 A	27.2	13.5
	Latin America	-	3	15	66	50	85	100	85.6	8.7
	W. Europe	136	79	457	320	1,078	595	900 C	32.3	23.0
	Southeast Asia	73	61	790	535	1,055	924	1,329 D	54.4	20.0
	Total	456	299	2,023	1,441	3,563	2,365	3,309	37.0	18.1

Petrochemical Products	Areas	1965		1970		1973		1975	Annual Average Growth Rate of Demand	
		Capacity	Demand	Capacity	Demand	Capacity	Demand	Demand	1965 --1970	1970 --1975
Acrylonitrile	North America	369	270	670	515	906	701	860 B	13.8	10.8
	Latin America	-	-	15	22	72	43	67	-	24.9
	W. Europe	145	128	520	500	1,110	824	1,150 C	31.3	18.1
	Southeast Asia	159	151	641	416	641	598	762 B	22.5	12.9
	Total	673	549	2,846	1,453	2,729	2,166	2,839	21.5	14.3
Aceton	North America	580	540	680	645	850	801	925 C	3.6	7.5
	Latin America	7	14	25	33	55	44	53	18.7	9.9
	W. Europe	437	310	610	430	725	504	560 G	6.8	5.4
	Southeast Asia	74	64	220	184	295	261	330 B	23.5	12.4
	Total	1,098	928	1,535	1,292	1,925	1,610	1,868	6.8	7.7
IPA	North America	761	698	1,077	875	1,077	1,044	1,174 D	4.6	6.1
	Latin America	-	13	38	20	38	30	40	9.0	14.9
	W. Europe	400	300	399	364	569	413	450 C	3.9	4.3
	Southeast Asia	16	13	52	44	105	67	89	27.6	15.1
	Total	1,177	1,024	1,528	1,303	1,789	1,554	1,753	4.9	6.1
SBR	North America	1,678	1,175	1,922	1,450	1,922	1,567	1,650 F	4.3	2.6
	Latin America	110	102	199	190	248	283	370	13.2	14.3
	W. Europe	530	650	1,090	812	1,148	920	1,000 C	4.6	4.3
	Southeast Asia	250	150	489	456	671	639	800 B	24.9	11.9
	Total	2,568	2,077	3,700	2,908	3,989	3,409	3,820	7.0	5.6
B R	North America	200	143	410	295	496	327	350 F	15.6	3.5
	Latin America	28	5	35	29	45	39	48	42.1	10.6
	W. Europe	140	90	211	167	266	233	290 C	13.2	11.7
	Southeast Asia	20	10	123	110	213	171	230 B	61.5	15.9
	Total	388	248	779	601	[illegible]	770	918	19.4	8.8

Petrochemical Products	Area	1965 Capacity	1965 Demand	1970 Capacity	1970 Demand	1973 Capacity	1973 Demand	1975 Demand	Annual Average Growth Rate of Demand 1965--1970	Annual Average Growth Rate of Demand 1970--1975
Methanol	North America	1,560	1,290	3,600	2,170	5,460	3,037	3,800 [J]	11.0	11.9
	Latin America	25	44	139	93	189	121	145 [K]	16.1	9.3
	W. Europe	1,257	[illegible]	2,574	2,070	3,342	2,534	2,900	8.8	7.0
	Southeast Asia	571	470	1,236	1,040	1,831	1,292	1,494 [illegible]	17.2	7.5
	Total	3,411	3,164	7,547	5,373	10,822	6,984	8,33[illegible]	11.2	9.2
Phenolic Resin	North America		378		500		627	750 [A]	5.8	7.3
	Latin America		16		43		61	77	21.9	12.4
	W. Europe		270		430		546	640 [E]	9.8	8.3
	Southeast Asia		57		200		291	374 [B]	28.5	13.[illegible]
	Total		721		1,173		1,525	1,821	9.5	9.9
Urea Resin	North America		200		287		312	330 [A]	7.5	2.8
	Latin America		30		66		83	97	17.1	8.0
	W. Europe		359		777		957	1,100 [E]	16.7	7.2
	Southeast Asia		210		500		628	732 [B]	18.9	7.9
	Total		799		1,630		1,980	2,259	15.3	6.7
Ammonium Nitrate	North America	6,900	5,122	9,761	6,020	9,761	6,362	6,600 [O]	3.3	1.9
	Latin America	250	323	741	500	1,120	594	666 [O]	9.1	5.9
	W. Europe	6,900	5,548	9,800	6,920	15,400	7,606	8,100 [O]	4.5	3.2
	Southeast Asia	381	1,525	1,400	2,100	2,580	2,240	2,340 [O]	6.7	2.1
	Total	14,431	12,518	21,702	15,540	28,861	16,802	17,706	4.4	2.7
TDI	North America	65	63	170	120	380	193	265	13.8	17.2
	Latin America	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-	-
	W. Europe	43	40	120	90	225	141	190	17.6	16.1
	Southeast Asia	17	18	62	46	117	86	130	20.6	23.1
	Total	[illegible]	121	352	256	[illegible]	420	585	16.2	17.9

Petrochemical Products	Areas	1965 Capacity	1965 Demand	1970 Capacity	1970 Demand	1973 Capacity	1973 Demand	1975 Demand	Annual Average Growth Rate of Demand 1965--1970	Annual Average Growth Rate of Demand 1970--1975
Alkylbenzene	North America	300	230	555	240	600	280	310 [B]	0.9	5.3
	Latin America	56	60	95	127	125	169	205	16.2	10.1
	W. Europe	300	236	517	410	592	489	550 [C]	11.7	6.1
	Southeast Asia	65	70	142	134	195	188	250	13.9	12.1
	Total	721	596	1,154	911	1,511	1,156	1,315	8.9	7.6
Maleic Anhydride	North America	80	60	139	135	177	181	220 [I]	17.6	10.3
	Latin America	-	3	1	16	6	23	30	39.8	13.4
	W. Europe	63	60	132	115	204	162	204 [C]	13.9	12.1
	Southeast Asia	n.a.	7	55	37	80	71	110	39.5	24.3
	Total	n.a.	130	327	303	467	437	564	18.4	13.2
Phenol	North America	600	580	1,140	830	1,525	950	1,040 [L]	7.4	4.6
	Latin America	16	13	127	24	135	35	44	13.0	12.9
	W. Europe	565	490	955	685	n.a.	839	960 [M]	6.9	7.0
	Southeast Asia	103	84	259	182	459	262	334 [B]	16.7	12.9
	Total	1,284	1,167	2,451	1,721	n.a.	2,523	2,378	8.1	6.7
Polyamide Fiber	North America	481	427	867	780	937	1,016	1,212 [B]	12.8	9.2
	Latin America	50	39	89	110	125	205	310	23.0	23.0
	W. Europe	484	310	852	700	853	918	1,100 [P]	17.7	9.5
	Southeast Asia	132	140	375	280	375	456	631 [B]	14.9	17.6
	Total	1,147	916	2,163	1,870	2,290	2,595	3,253	15.3	11.7
P-Xylene	North America	230	190	1,500	600	1,500	830	1,000 [N]	25.8	10.8
	Latin America	-	15	44	30	80	52	75	14.9	20.0
	W. Europe	190	150	444	370	900	572	700 [N]	19.7	13.6
	Southeast Asia	33	50	285	241	415	382	500	36.9	15.8
	Total	453	405	2,273	1,241	2,895	1,836	2,275	25.2	12.9

Petrochemical Products	Areas	1965 Capacity	1965 Demand	1970 Capacity	1970 Demand	1973 Capacity	1973 Demand	1975 Demand	Annual Average Growth Rate of Demand 1965--1970	Annual Average Growth Rate of Demand 1970--1975
VCM	North America	1,200	1,000	4,000	2,900	4,057	3,870	4,700	23.7	10.1
	Latin America	-	-	130	100	240	143	100	-	11.5
	W. Europe	587	245	2,115	1,410	4,050	2,222	3,020	[illegible]	16.4
	Southeast Asia	215	170	1,550	1,300	1,800	1,020	2,250	[illegible]	11.6
	Total	2,002	1,415	7,795	5,710	10,147	7,255	10,150	32.2	12.1
Caprolactam	North America	125	140	280	250	330	326	380	12.3	8.7
	Latin America	10	15	32	137	156	235	340	55.6	19.9
	W. Europe	265	196	783	500	1,123	650	775	20.6	9.1
	Southeast Asia	250	180	416	375	486	570	750	15.8	14.9
	Total	650	531	1,511	1,262	2,095	1,781	2,245	18.9	12.2
DMT	North America	383	260	800	780	910	1,180	1,550	24.6	14.7
	Latin America	-	12	14	60	44	131	220	38.0	29.7
	W. Europe	n.a.	150	810	606	1,000	940	1,250	32.2	15.6
	Southeast Asia	131	100	442	340	565	585	800	27.8	18.7
	Total	-	522	2,116	1,786	2,319	2,836	3,820	27.8	16.4
Acrylic Fiber	North America	107	82	170	121	200	163	200	20.8	10.5
	Latin America	-	4	10	25	18	47	70	44.4	22.8
	W. Europe	34	120	250	240	330	366	480	14.9	15.0
	Southeast Asia	88	34	261	239	273	336	420	23.2	12.0
	Total	289	290	691	625	821	912	1,040	11.5	10.8
Polyester Fiber	North America	250	197	1,146	660	1,431	1,021	1,365 J	27.355	15.6
	Latin America	13	11	33	50	40	110	185 B	35.365	29.9
	W. Europe	130	120	576	450	678	727	1,000 E	30.259	17.3
	Southeast Asia	110	106	390	250	456	414	579 D	18.721	18.2
	Total	563	454	2,151	1,410	2,605	2,272	3,129	26.574	17.2

Petrochemical Products	Areas	1965 Capacity	1965 Demand	1970 Capacity	1970 Demand	1973 Capacity	1973 Demand	1975 Demand	Annual Average Growth Rate of Demand 1965--1970	Annual Average Growth Rate of Demand 1970--1975
PVC	North America	1,205	877	2,164	1,400	2,262	1,855	2,238	9.8	9.8
	Latin America	78	69	131	168	330	271	372	19.5	17.2
	W. Europe	1,545	1,172	3,030	2,185	5,226	3,141	4,000	13.3	12.9
	Southeast Asia	585	456	1,934	1,225	2,114	1,765	2,252	21.9	13.0
	Total	3,413	2,574	7,259	4,978	9,954	7,032	8,862	14.1	12.2
Phthalic Anhydride	North America	360	275	660	500	900	627	730	12.7	7.9
	Latin America	26	19	86	47	106	66	83	19.8	12.0
	W. Europe	350	250	760	410	830	525	615	10.4	8.5
	Southeast Asia	140	95	255	238	420	315	370	20.3	9.3
	Total	876	639	1,761	1,095	2,256	1,533	1,798	11.4	10.4
DOP	North America		110		200		250	330	13.0	10.5
	Latin America		8		22		37	50	22.4	17.9
	W. Europe		140		285		418	540	15.4	13.6
	Southeast Asia		75		170		230	280	17.8	10.5
	Total		333		677		935	1,200	15.3	12.1
PG	North America	150	100	186	170	186	239	300	11.2	12.0
	Latin America	-	3	-	7	25	11	15	18.5	16.5
	W. Europe	90	60	320	302	350	368	420	38.2	6.8
	Southeast Asia	19	13	38	31	50	51	70	19.0	17.7
	Total	259	176	544	510	611	669	805	23.7	9.6

Remarks of Table IV-1

1. Each area consists of following countries:

North America	USA, Canada
Latin America	Argentina, Brasil, Colombia, Central American Countries, Chile, Ecuador, Mexico, Peru, Uruguay, Venezuela and etc.
W. Europe	EEC Countries, EFTA Countries, Spain and Greece
Southeast Asia	Burma, Cambodia, Ceylon, Hong Kong, India, Indonesia, Japan, Korea, Malaysia, Philippines, Singapore, Taiwan, Thailand and etc.

2. Demand in 1975 is based on the published data. Following table is the references.

3. Demand in 1973 is calculated by the average annual growth rate between 1970 and 1975.

4. Capacity in 1973 is based on the published data.

References:

A. Modern Plastics Jan. 1970 P.97 -- 102

B. "Long-Term Demand Forecast of Petrochemicals" by CMC Corp.

C. "Development in the Organic Sector of the European Chemical Industry" by Economic Commission for Europe

D. Kagaku Keizai (Japanese Magazine) Oct. 1970 P.59 -- 65

E. ECN June 26, 1970 P.10

F. CW March 18, 1970 P.56

G. "Future European Chemical Growth Patterns" by Dr. Robbert Rickles

H. Canadian Chemical Process Oct. 1969 P.68

I. OPD Report Dec. 22, 1969 P.12

J. Hydrocarbon Processing, July 1970 P.132

K. Hydrocarbon Processing, Aug. 1970 P.117 -- 119

L. OPD Report June 1, 1970 P.3

M. ECN April 4, 1969 P.6

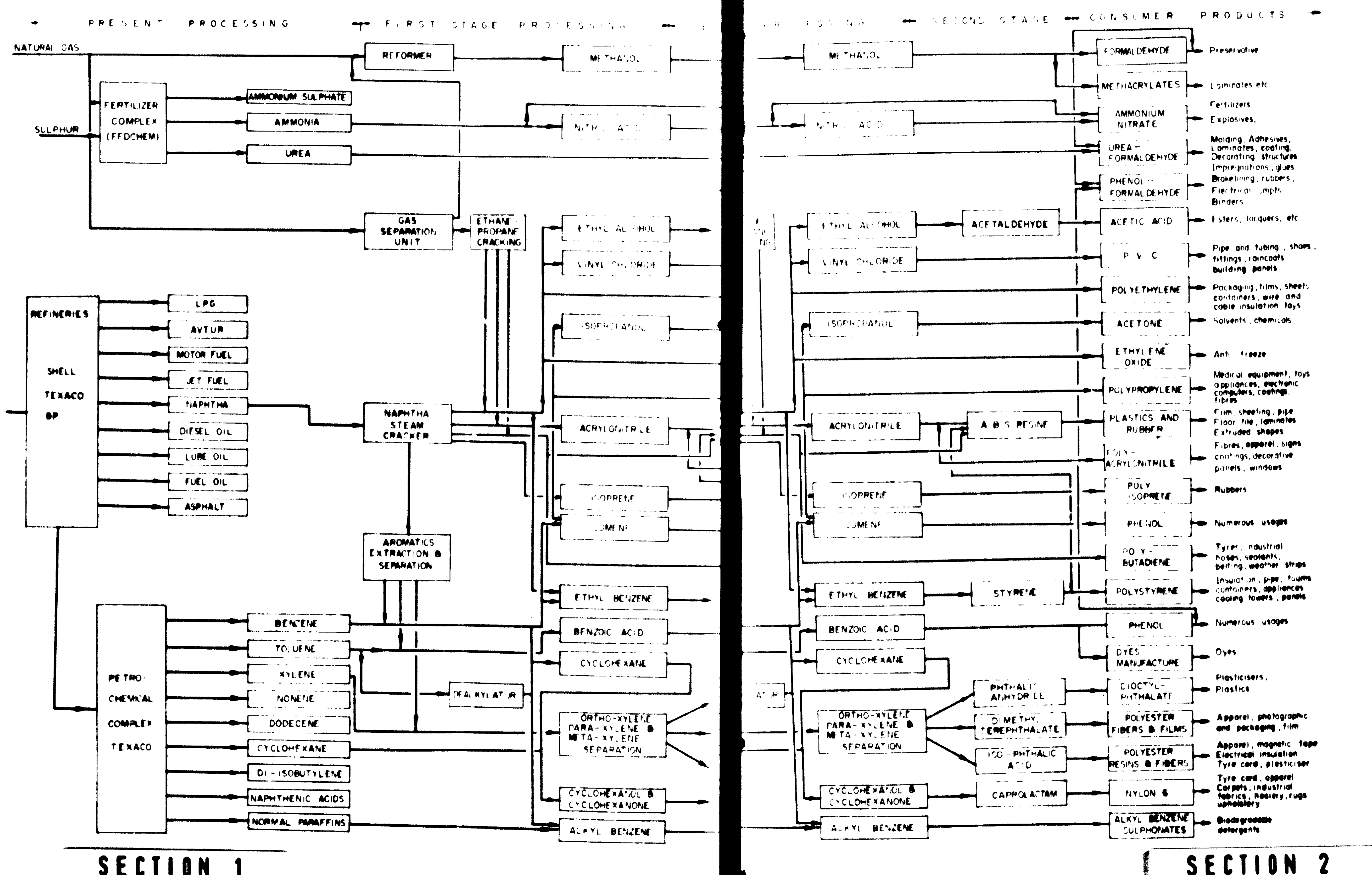
N. ECN Sept.26, 1969 P.10 -- 12

O. "Ammonium Nitrate Supply and Demand 1967/1977" by British Sulpher Corp.

P. C & EN Oct. 13, 1969 P.26

Q. C & EN Dec. 15, 1969

FIG. IV-1 FULL RANGE OF POSSIBLE COMPLEXES



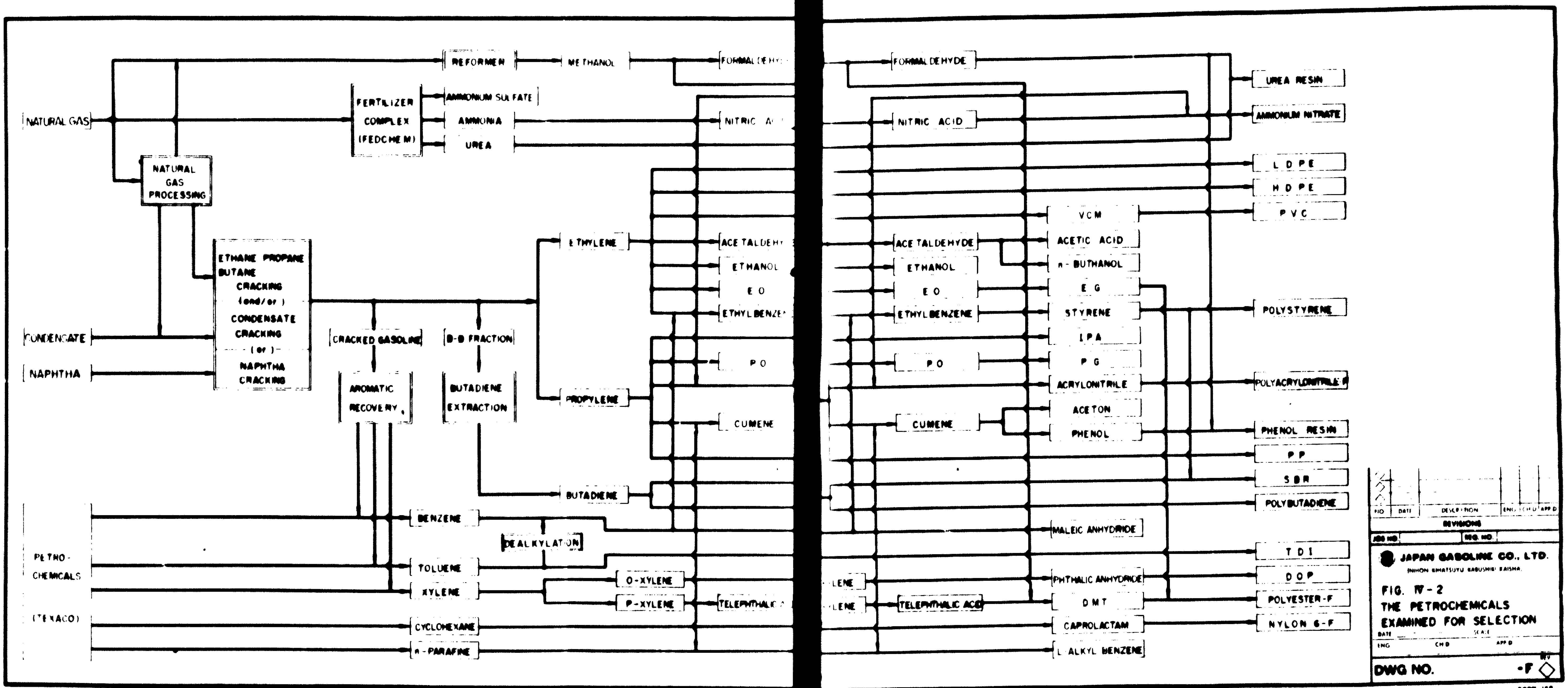
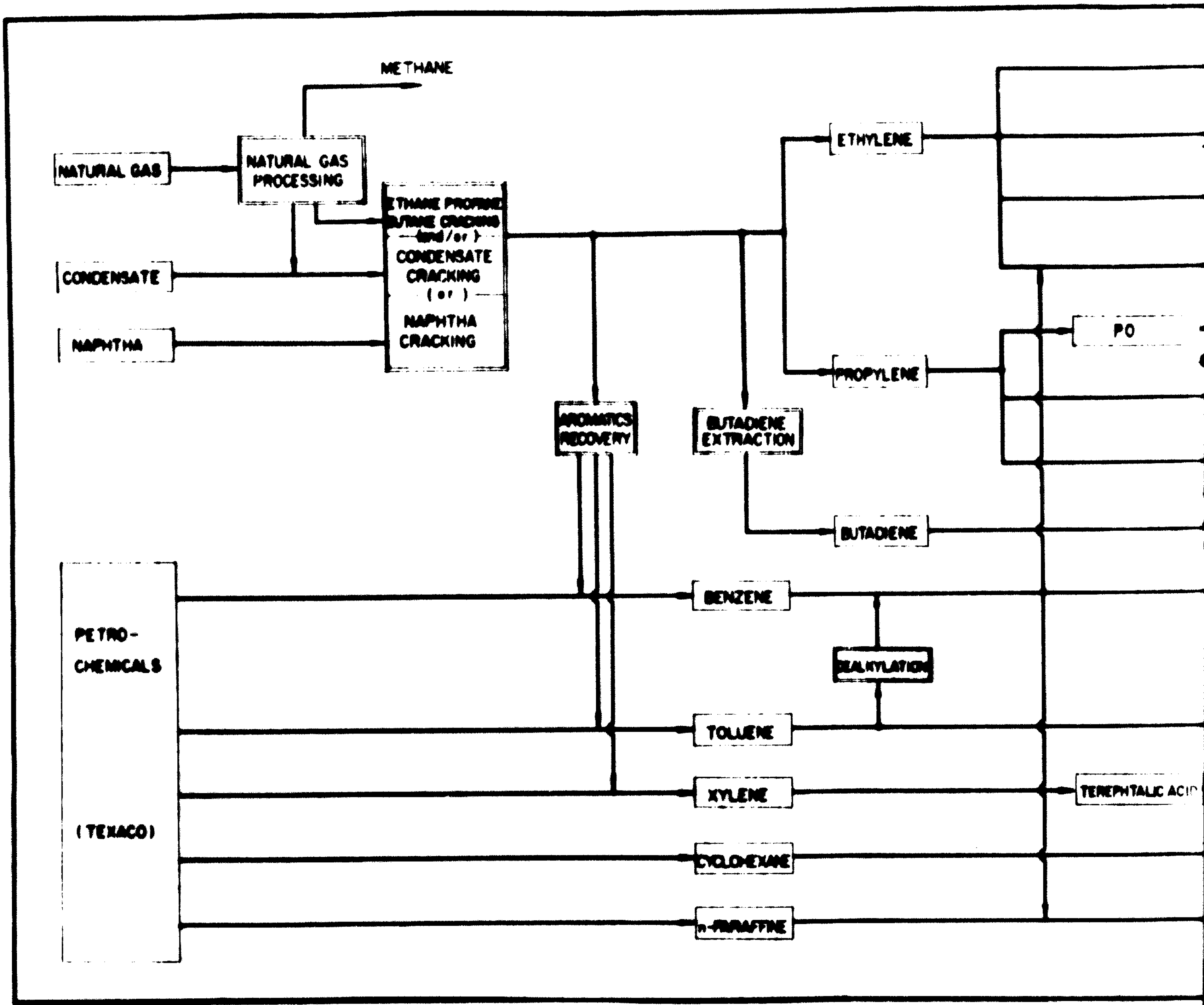


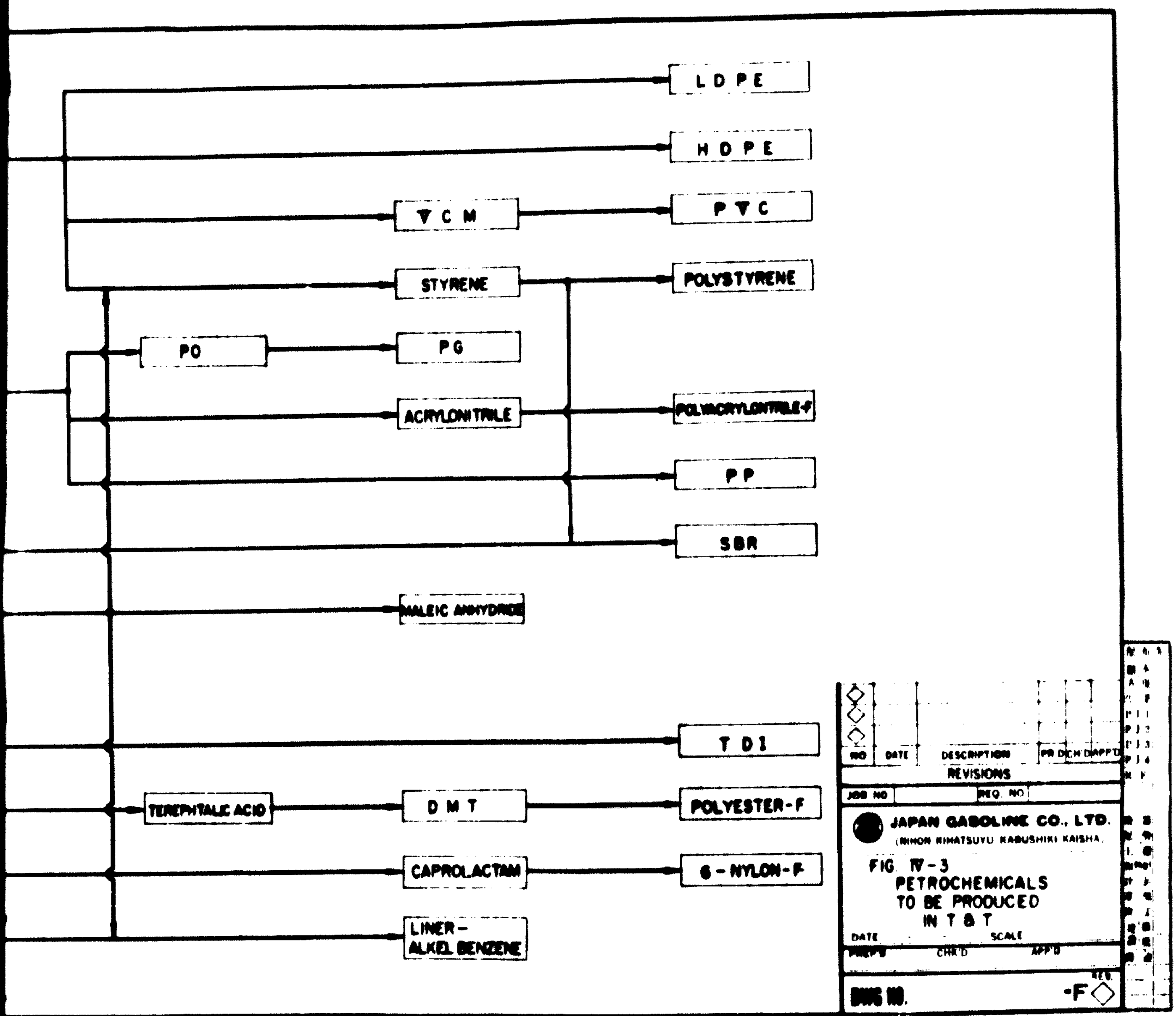
FIG. IV-2 THE PETROCHEMICALS EXAMINED FOR SELECTION

SECTION 1

SECTION 2


METHANE
NATURAL GAS
NATURAL GAS PROCESSING
CONDENSATE
NAPHTHA
(and/or)
CONDENSATE CRACKING
(or)
NAPHTHA CRACKING
ETHYLENE
PROPYLENE
PO
AROMATICS RECOVERY
BUTADIENE EXTRACTION
BUTADIENE
PETRO-CHEMICALS
(TEXACO)
BENZENE
DEALKYLATION
TOLUENE
XYLENE
CYCLOHEXANE
n-PARAFFINE

SECTION 1


LDPE
HDPE
VCM
PVC
STYRENE
POLYSTYRENE
PO
PG
ACRYLONITRILE
POLYACRYLONITRILE-F
PP
SBR
MALEIC ANHYDRIDE
TDI
TEREPHTALIC ACID
DMT
POLYESTER-F
CAPROLACTAM
6-NYLON-F
LINER-
ALKEL BENZENE
NO
DATE
DESCRIPTION
REVISIONS
JOB NO
REQ. NO
JAPAN GASOLINE CO., LTD.
(NIHON KIHATSUYU KABUSHIKI KAISHA)
FIG. IV-3
PETROCHEMICALS
TO BE PRODUCED
IN T & T
DATE
SCALE
CHK'D
APP'D
DWG NO.
REV.
-F

SECTION 2

V. Resources for Petrochemicals in Trinidad and Tobago

1. Utilisation of Natural Gas and Associated Condensate as Raw Materials for Petrochemicals (Case 1)

1) General

The situation of the development of natural gas in Trinidad and Tobago is cleared in Chapter I and the government of Trinidad and Tobago expects the new petrochemical projects based on these natural gas and associated condensate.

The informations about natural gas and condensate in Trinidad and Tobago are given as follows:

Natural Gas*

a) Quantity : 300 - 500 MMSCF/D (Prospective)

b) Composition :

Component	Mol Percent
H_2S	Nil
H_2	0.35
CO_2	0.36
C_1	94.48
C_2	2.92
C_3	1.08
iC_4	0.19
nC_4	0.28
C_5	0.16
C_6	0.07
C_7	0.11
	100.00

c) Pressure : 300 PSIG

d) Price : 15 ¢/MSCF (This price was adviced at the Second Meeting held in October, 1970 between IDC and JGC Mission).

Condensate*

a) Quantity : 25 barrels per MSCF of gas
b) Quality : API gravity 40° - 57°
c) Price : not quoted

* In addition to the information provided by IDC, we tried to have the more detailed informations from AMOCO International Oil Co. which is presently executing the natural gas development offshore of Trinidad, but unfortunately we were conceived that it was too early to get the assured and detailed informations due to the comparatively early stage of its present development and these data are the best available.
(Annex A and B)

2) Calculation of Costs of Basic Materials (Ethylene, Propylene, Butadiene and BTX) derived from Natural Gas and Condensate.

a) General Assumption in this Calculation

For examining the possibility of natural gas and condensate utilisation under these circumstances, we calculated the costs of ethylene, propylene, butadiene and BTX on the following assumptions.

i) The quantity of natural gas and condensate are respectively 2,731,000 t/y (400 MMSCF/D) and 410,000 t/y.

ii) The composition of all natural gas is same as the above mentioned, although AMOCO notes that the ultimate make-up of a gas production stream will be a function of the relative amount of reserves discovered and placed on production from different areas in the concession, and the gas composition could vary substantially from the data shown.

The API gravity of condensate is 49°.

iii) The price of natural gas at plant site is 15 ¢/MSCF (7.25 $/t).

The price of condensate is 16.65 $/t which is an average present export price of naphthas from Trinidad and Tobago.

b) Block Diagram of Estimated Material Balance

i) Natural Gas Processing:
Refer to Annex F.

ii) Pyrolysis:
Ethane, propane and butane from natural gas are thermally cracked by ethane, propane and butane cracker. Condensate associated with natural gas and pentane plus, which is recovered from natural gas, are cracked by condensate cracker.

iii) Gas Compression and Purification:
The product streams from both crackers are treated together in the same treating plants.

iv) Butadiene Extraction:
B-B fraction produced by pyrolysis is treated to extract butadiene.

v) Aromatics Recovery:
Cracked gasoline produced by pyrolysis is treated to recover benzene, toluene and xylenes.

The block diagram is shown in FIG. V-1.

c) Calculation

Refer to Annex F and E.

d) Results

	Amount (t/y)	Unit Cost ($/t)
Ethylene	241,000	71.58
Propylene	101,600	50.00
Butadiene	29,900	113.34
Benzene*	109,300**	59.22**
Toluene*	(66,500)**	(36.6)**
Xylene*	13,700	48.2
Cyclohexane*	19,500	61.75
n-Paraffine*	73,000	90.57

* Taking the petrochemicals delivered from the existing TEXACO Petrochemical Plant into consideration to give this result.

** Toluene is dealkylated to benzene.

3) Additional Remarks

As methane is a main component in the composition of the natural gas, we make the following remarks specially.

In this study the use of methane as a raw material for petrochemicals is limited to methanol, nitric acid and ammonium nitrate besides ammonium, ammonium sulfate and urea since ethylene route is now ascertained or world-widely noticed superior to acetylene route.

The use of methane may also be considered for fuel for power generation to develop electrochemical industry such as aluminum, caustic soda and chlorine. Furthermore methane may be exported to USA considering the increasing demand of LNG.

The overall and most effective utilization of methane must be developed by taking the above into consideration. In this study, however, the utilization of methane as fuel or LNG source is eliminated since the aluminum project may raise some political problem with other CARIFTA countries and the use of methane as energy source will require the extensive survey beyond of this study, and furthermore these are considered not to belong to the field of petrochemical industry.

2. Utilisation of Condensate as a Raw Material for Petrochemicals (Case 2)

1) General

As the content of C_2 plus fraction in the natural gas of Trinidad, according to AMOCO Information, is in general consideration too small for production of ethylene by pyrolysis of natural gas, we studied the possibility of condensate utilisation without use of natural gas in this Case 2.

2) Calculation of Costs of Basic Materials derived from Condensate Pyrolysis

a) General Assumption in this Calculation:
Same as that in Case 1.

b) Block Diagram of Estimated Material Balance
Shown in FIG. V-2.

c) Calculation
Refer to Annex G and H.

d) Results

	Amount (t/y)	Unit Cost ($/t)
Ethylene	128,000	56.64
Propylene	75,500	50.00
Butadiene	24,000	116.63
Benzene*	105,600**	59.32**
Toluene*	(64,800)**	(36.6)**
Xylene*	12,600	48.2
Cyclohexane*	19,500	61.75
n-Paraffine*	73,000	90.57

* Taking the petrochemicals delivered from the existing TEXACO Petrochemical Plant into consideration to give this result.

** Toluene is dealkylated to benzene.

3. Utilization of Naphtha as a Raw Material for Petrochemicals (Case 3)

1) General

In Trinidad and Tobago there exist the refinery plants of TEXACO TRINIDAD INC. (350,000 bbls/day) and of Shell Trinidad Ltd. (61,000 bbls/day). In addition to this refining capacity the plan of the establishment of a 150,000 bbls/day refinery is being proceeded by the Trinidad TESORO CO. Ltd.

We visited TEXACO Head Office to have their advice of naphtha utilisation but TEXACO did not clarify the availability and price of naphtha for petrochemical industry (refer to Annex C).

Since the delivery of naphtha for petrochemical raw material will result inevitably in decrease of TEXACO products of such motor gasoline and aviation gasoline as produced from naphtha fraction, TEXACO will not be in a positive attitude to afford naphtha for petrochemical raw material unless the price of naphtha as petrochemical raw material be at same level or above the price of gasoline. Such a price of naphtha is considered at present undesirable in petrochemical industry.

At the Second Meeting held in October, 1970 between IDC and JGC Mission, the plan of the establishment of a 150,000 bbls/day refinery by the TRINIDAD TESORO CO. was disclosed and IDC advised us the availability of naphtha of approximately 1.2 million tons per annum.

In these respects it is preferable to form a petrochemical complex scheme not based on the utilisation of naphtha from TEXACO but based only on the naphtha from TRINIDAD TESORO.

In this connection 1.2 million tons per annum of naphtha is large enough for supplying the petrochemical raw materials to a Petrochemical Complex of international level.

The information about naphtha from TRINIDAD TESORO are given as follows: (refer to Annex D and E)

Naphtha

a) Quantity : 1,200,000 tons/year

b) Properties :

Naphtha from the indigenous crude

Crude Quantity bbls/day	Naphtha Cut Boiling Range °C	Chemical Analysis P	O	N	A
		wt %			
60,000	100 - 150	39	0	42	19
	150 - 200	28	0	51	21
20,000	100 - 150	27	0	52	21
	150 - 200	5	0	71	24

IBP : The IBP of the naphtha will be determined by the IBP of the crude to be used.

EBP : approx. 350°F.

c) Price : 6 - 6-1/2 US¢/gal(US) (22.02 US$/t)

d) Crude to be used (for reference) :
The input to the refinery would be a combination of 80,000 bbl/day of local (indigenous) and 70,000 bbl/day of foreign-based (imported) crude.

The foreign crude would possibly be imported from Nigeria.

The specifications of the indigenous crude

Quantity bbls/day	Approx Chemical Analysis P	O	N	A	API Gravity	% light fraction	% gas oil D.I.53-57	% fuel oil
	wt %							
60,000	33	-	48	19	26	18.8	15.1	66.1
20,000	33	-	48	19	23	11.4	28.5	60.1

2) **Calculation of Costs of Basic Materials derived from Naphtha Pyrolysis**

a) **General Assumption in this Calculation**

The input of Nigerian Light Export Crude (Bonny) is assumed for this refinery.

The specifications of the Distillate (50° - 175°C) of Nigerian Light Export Crude (Bonny).

Yield % on Crude	Specific gravity 60°F / 60°F	Chemical Analysis wt % P	O	N	A
22	0.76	24	-	67	9

b) Block Diagram of Estimated Material Balance
Shown in FIG. V-3.

c) Calculation
Refer to Annex H.

d) Results

	Amount (t/y)	Unit Cost ($/t)
Ethylene	300,000	45.54
Propylene	200,000	44.00
Butadiene	65,000	158.81
Benzene*	199,000**	57.44**
Toluene*	20,200**	36.6
Xylene*	46,600	48.2
Cyclohexane*	19,500	61.75
n-Paraffine*	73,000	90.57

* Taking the petrochemicals delivered from the existing TEXACO Petrochemical Plant into consideration to give this result.

** 88,800 t/y of toluene is dealkylated to benzene.

4. Utilisation of Benzene, Toluene, Xylene, Cyclohexane and n-Paraffine supplied by Existing TEXACO Plant.

1) General

According to the information provided by IDC, TEXACO Petrochemical Plant in Trinidad is producing the following chemicals.

	bbls/year		t/year	(in 1968) $/t
Benzene	213,602	-	30,000	55.6
Toluene	356,622	-	49,000	36.6
Xylene	19,215	-	2,600	48.2
Cyclohexane	158,475	-	19,500	61.75
n-Paraffine	606,307	-	73,000	90.57

Since Trinidad and Tobago Government hopes both of the utilisation of the prospective raw materials and the upgrading of the existing petrochemicals in Trinidad and Tobago, all of these existing petrochemicals are subjected for upgrading as much as possible.

2) General Assumption

The quantities of these basic petrochemicals delivered from TEXACO Petrochemical Plant depend upon TEXACO's policy, which will be affected by the demand in blending base for gasoline, to vary year by year.

In this study it is assumed that these petrochemicals be available at the same quantities and the same prices as delivered in 1968 in every year.

FIG. V - I

BLOCK DIAGRAM OF ESTIMATED MATERIAL BALANCE (Case I)

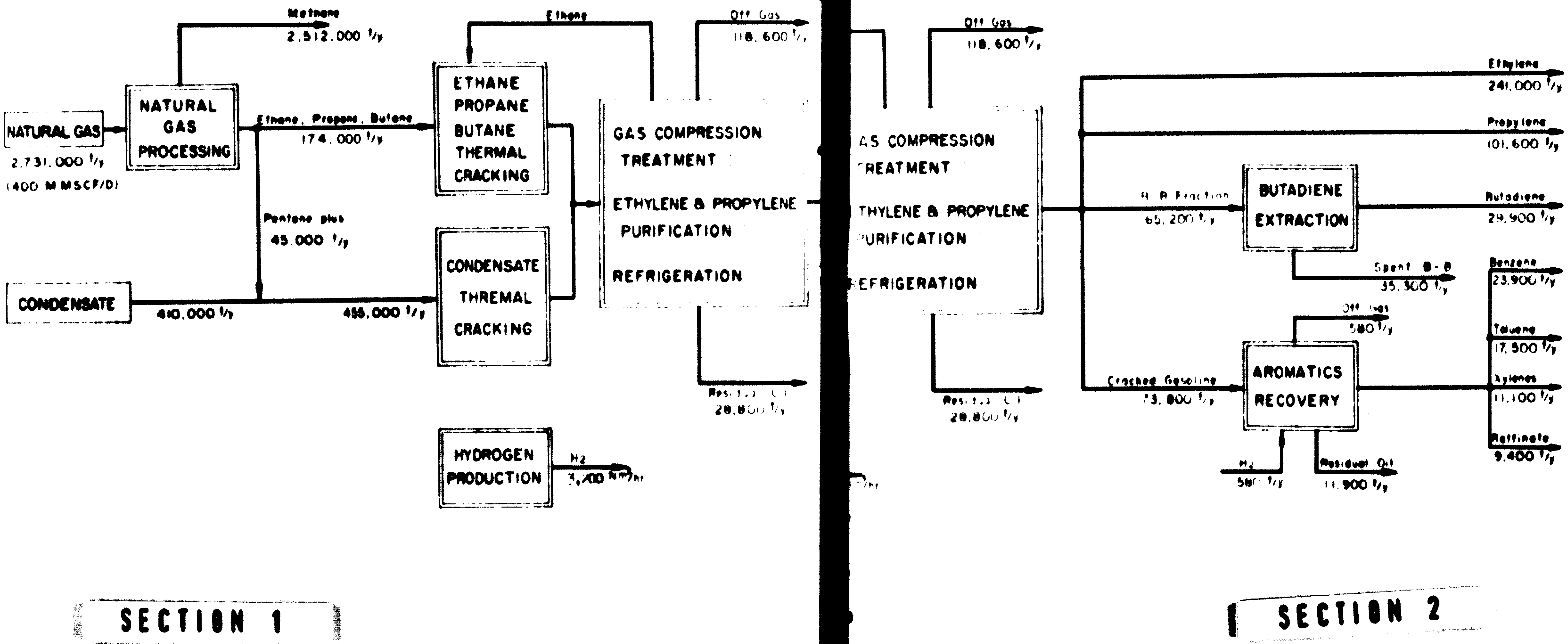
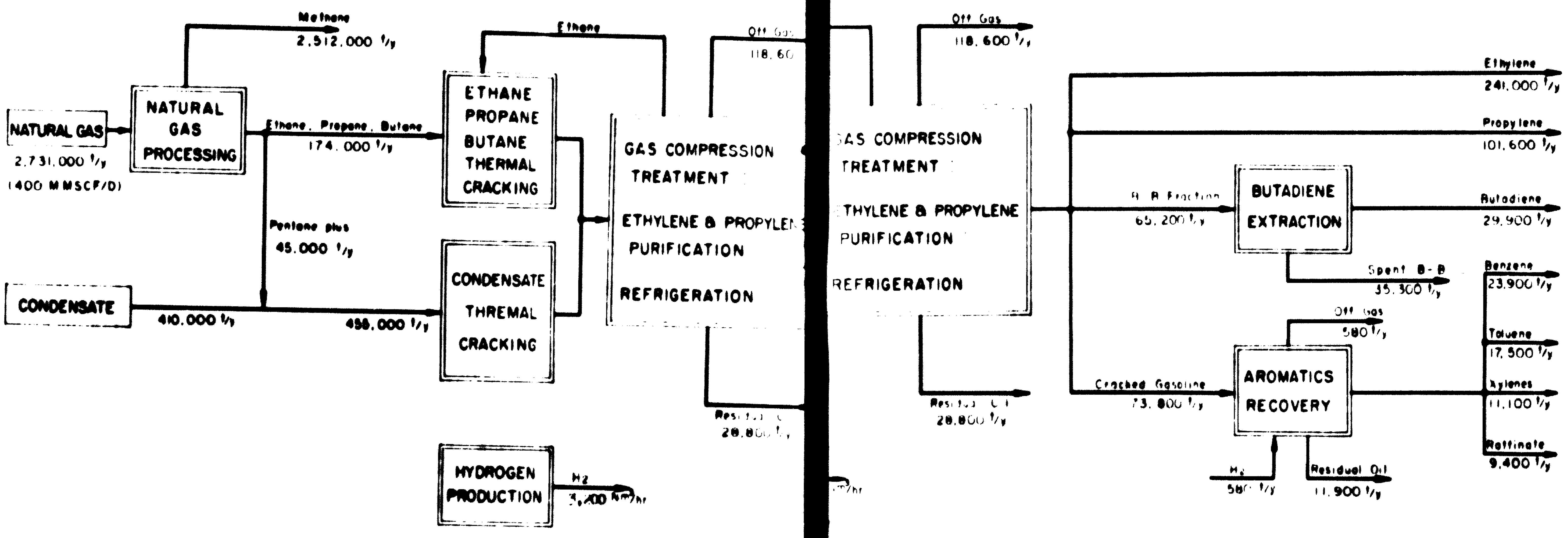


FIG. V - 1

BLOCK DIAGRAM OF ESTIMATED MATERIAL BALANCE (Case I)



SECTION 1

SECTION 2

FIG. V-2

BLOCK DIAGRAM OF ESTIMATED MATERIAL BALANCE (Case 2)

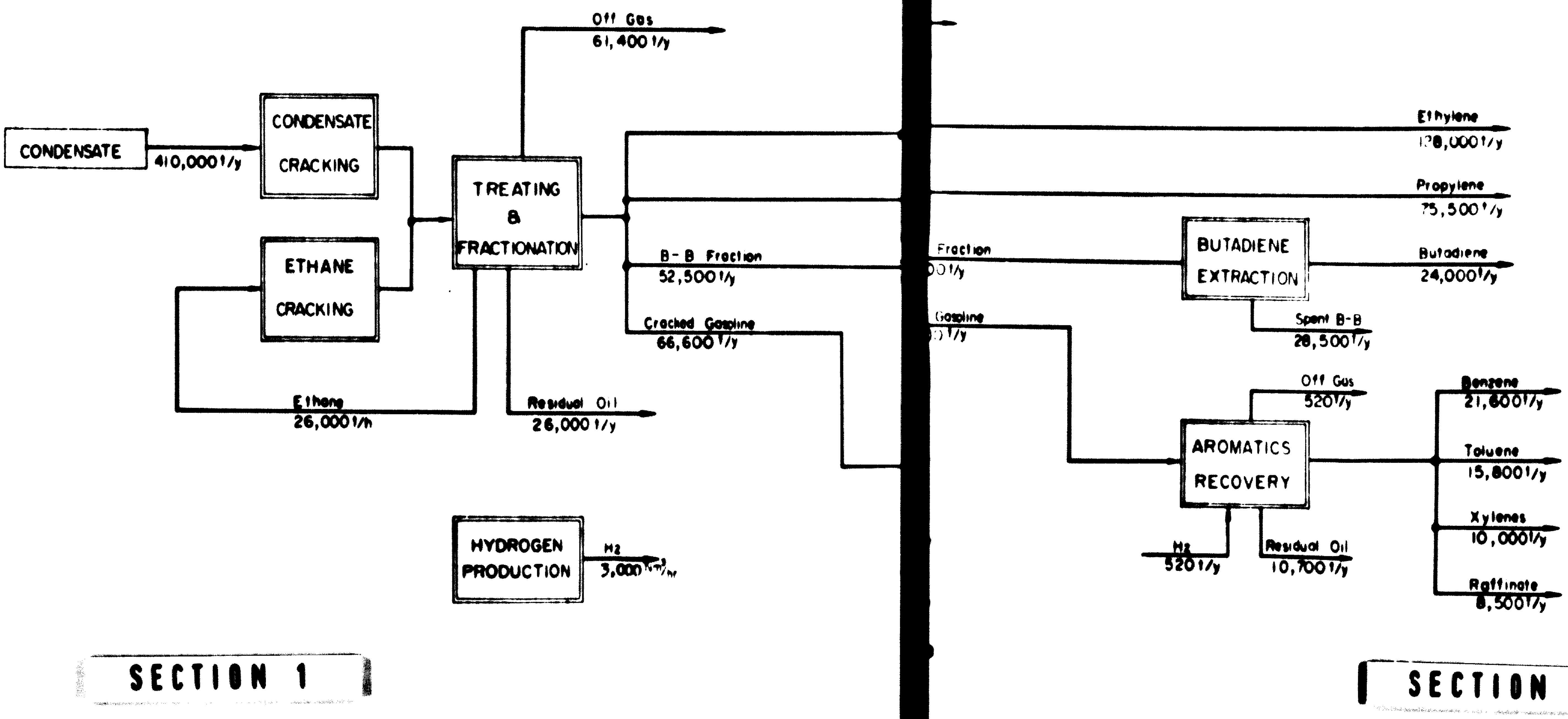
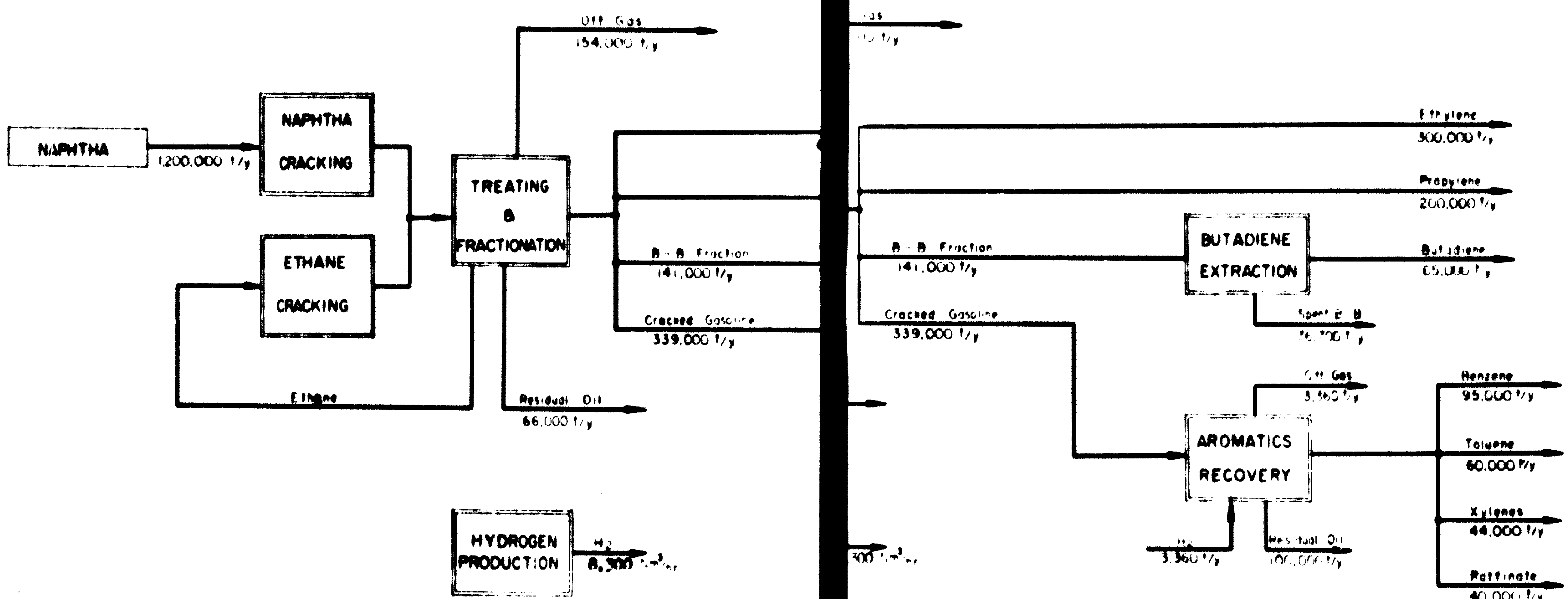


FIG V - 3

BLOCK DIAGRAM OF ESTIMATED M... ESTIMATED MATERIAL BALANCE (Case 3)



SECTION 1

SECTION 2

VI. Process Study for Complex Scheme Planning

The schemes of the petrochemical complexes based upon the resources of (1) Natural Gas and Condensate, and the petrochemicals delivered from the existing TEXACO Petrochemical Plant (2) Condensate and the petrochemicals delivered from the existing TEXACO Plant and (3) Naphtha and the petrochemicals delivered from the existing TEXACO Petrochemical Plant were laid down respectively.

The net production costs and the selling prices of the petrochemical products delivered from these Complexes were estimated.

1. Petrochemical Complex Scheme

With respect to Plant Capacity, in general, on the one hand the larger capacity is the better to pursue the scale merit, but on the other hand the larger capacity causes the more difficulty to keep the operating efficiency at high level.

As to the number of the petrochemical products delivered from the Complex, the more is the better to secure the Complex as whole against the fluctuation in balance of demand and supply.

- Generally speaking in petrochemical industry, the increase in demand draws a smooth upward curve with years, but the supply increases stepwisely.
  In other words even when the petrochemical industry grows steadily, the over supply for a short time is not avoidable with almost all petrochemicals. This gives rise to a difficult selling time or a decline in price for a while with each of the petrochemicals respectively.
  So it is preferable to constitute the complex with as many kind petrochemicals as possible so that they compensate each other their difficult time of selling.

In these respects the schemes of the Complexes were laid down by the following criteria:

1) to constitute the Complex with as many petrochemicals selected in Chapter IV as possible.

2) to make the plant capacity as large as possible under the limitation of the available amount of raw materials.

The proposed schemes are not necessarily definiteve or may be modified by one upon his philosophy, but these schemes must make one obtain a realistic image about a petrochemical complex possible in Trinidad and Tobago under the given conditions.

The proposed complex schemes are shown in Fig. VI-1, -2 and -3.

2. Calculation of Net Manufacturing Cost and Selling Price

The results are shown in Table VI-1 and refer to Annex M, as to detailed calculation refer to Annex L.

In the calculation it is assumed that the subsidiary materials, such as chlorine, lime, ammonia, oleum, sulfuric acid and nitric acid, and the raw materials, of which the requisite amounts are small, such as methanol, ethylene glycol will be supplied at the international prices from outside of Complexes.

As to the end product via intermediate produced in the Complex, the intermediate product is assumed to be supplied to the end product plant at its selling price.

The selling prices were calculated in accordance with the method of "Prefeasibility Studies on Petrochemical Plants for Trinidad and Tobago" prepared by IDC only with the difference of adopting tax holiday provision.

In this connection the rate of return on investment calculated by the discounted cash flow method is 10.3% uniformly with all petrochemical products when 10% of C.I is taken as the net income in every year with every product disregarding the end or the intermediate product.

3. Capital Investments, Utilities and Labours of Complex

Integrated capital investments, utilities (electric power, steam, cooling water, fuel) and labour are shown in Table VI-2. (refer to Annex P)

4. Comparison of Case 1, 2 and 3

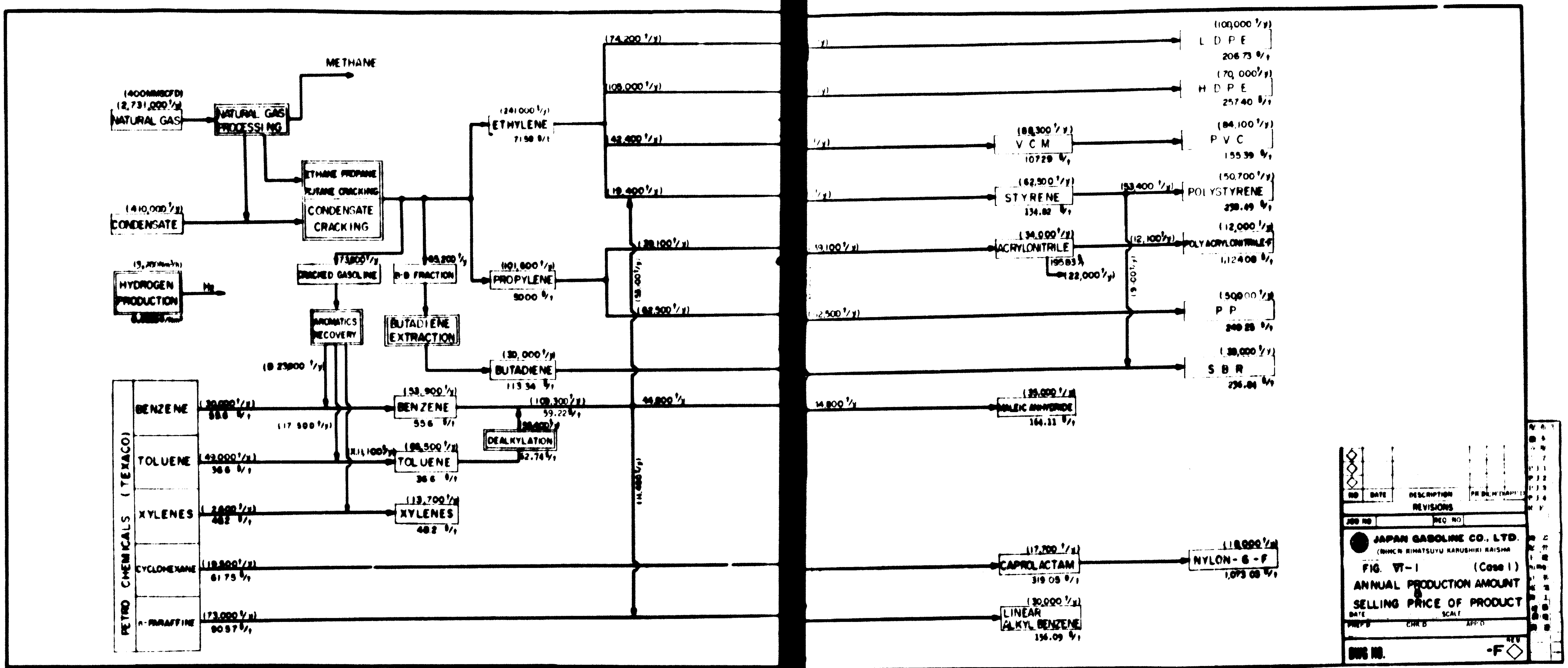
As Table VI-1 shows, the most advantageous result was given in Case 3.

The main factors, that are considered to produce the differences in the net manufacturing costs and selling prices with the examined Cases, are the cost of natural gas processing, the scale effect, the cost allocation among the basic materials, and the given or estimated prices of raw materials.

Among them the scale effect is the most important factor to favour Case 3.

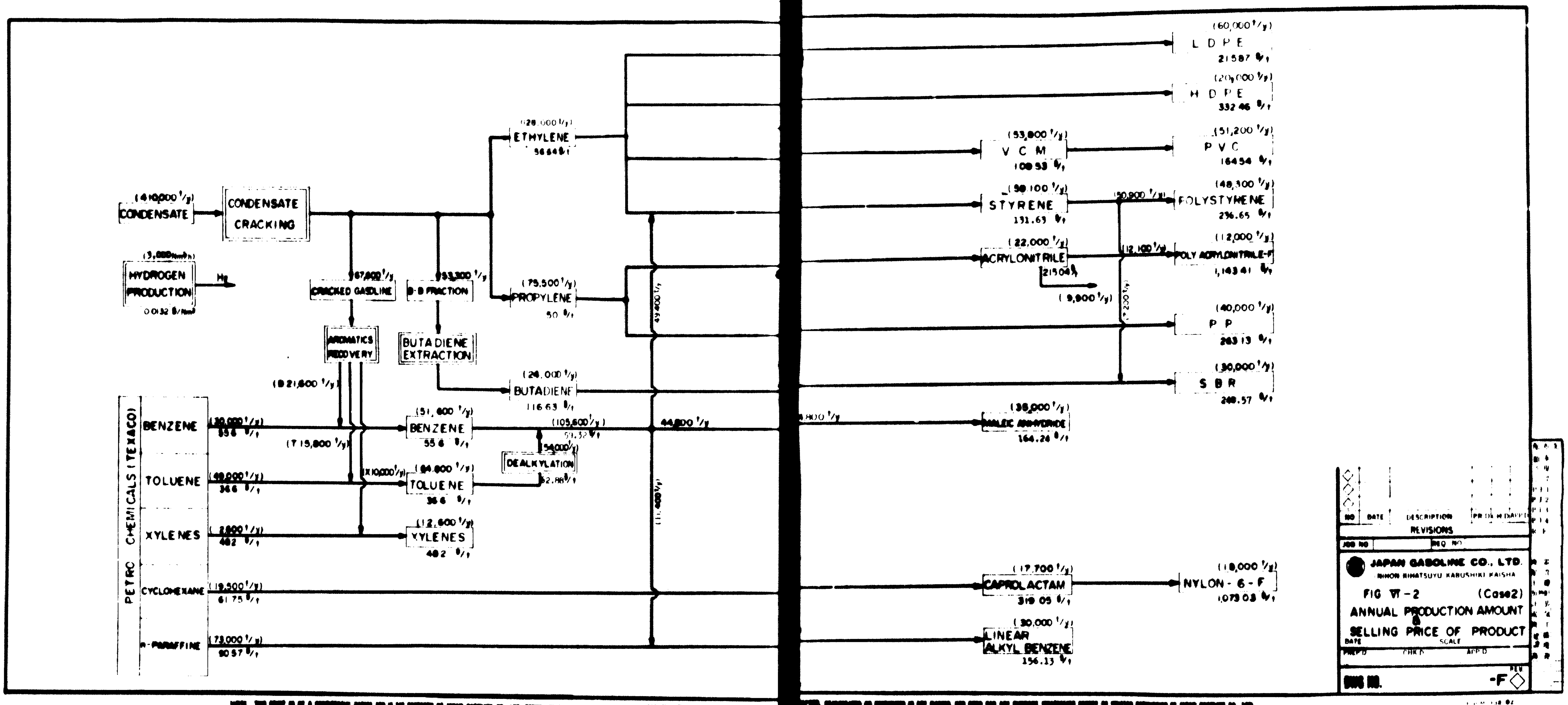
The Complex based upon naphtha utilisation is most recommendable as compared with the other two Complexes.

Accordingly the following study about export possibilities from Trinidad and Tobago will be executed upon the petrochemical products delivered from Case 3 Complex.



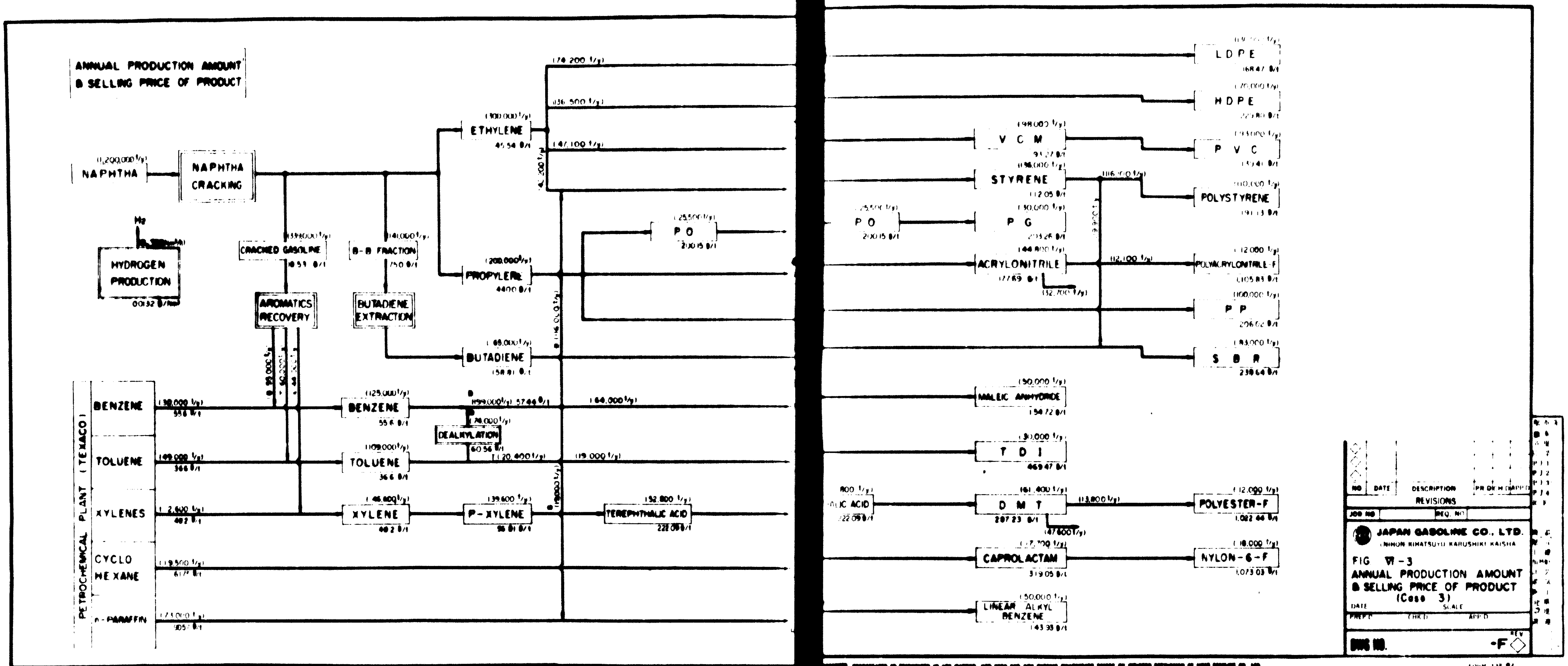
SECTION 1

SECTION 2



SECTION 1

SECTION 2



SECTION 1

SECTION 2

Table VI-1. Net Manufacturing Costs and Selling Prices

	T & T	Case 1			Case 2			Case 3		
	FOB Price	Capacity(t/y)	Cost($/t)	Price($/t)	Capacity(t/y)	Cost($/t)	Price($/t)	Capacity(t/y)	Cost($/t)	Price($/t)
1. LDPE	162.6	100,000	180.11	206.73	60,000	183.25	215.87	130,000	144.55	168.47
2. HDPE	266.2	70,000	218.63	257.40	20,000	270.06	332.46	70,000	191.03	229.80
3. V C M	87.3	88,300	98.78	107.29	53,800	98.16	108.53	98,000	85.12	93.27
4. P V C	187.4	84,100	146.70	155.39	51,200	153.95	164.54	93,000	131.07	139.41
5. Styrene	111.5	62,500	120.91	134.82	58,100	117.36	131.63	136,000	101.88	112.05
6. Polystyrene	194.5	50,700	214.11	238.49	48,300	211.81	236.65	110,000	173.24	191.13
7. P G	201.9	-	-	-	-	-	-	30,000	196.93	203.26
8. Acrylonitrile	249.1	34,000	167.38	195.83	22,000	181.22	215.04	44,800	152.22	177.69
9. Polyacrylonitrile-F	1,213.5	12,000	911.16	1,124.08	12,000	930.49	1,143.41	12,000	892.92	1,105.83
10. P P	297.5	50,000	208.09	249.25	40,000	218.13	263.13	100,000	174.82	206.02
11. S B R	264.0	38,000	209.90	236.84	30,000	218.97	248.57	83,000	219.05	238.64
12. Maleic Anhydride	197.2	35,000	141.88	164.11	35,000	142.01	164.24	50,000	135.42	154.72
13. L. Alkylbenzene	148.7	30,000	1[illegible].49	156.09	30,000	138.53	156.13	50,000	129.53	143.93
14. Caprolactam	311.0	17,700	254.30	319.05	17,700	254.30	319.05	17,700	254.30	319.05
15. Nylon 6-F	1,177.7	18,000	940.92	1,073.03	18,000	940.92	1,073.03	18,000	940.92	1,073.03
16. T D I	596.4	-	-	-	-	-	-	30,000	398.10	469.47
17. D M F	304.4	-	-	-	-	-	-	61,400	270.16	287.23
18. Polyester-F	1,055.7	-	-	-	-	-	-	12,000	880.77	1,022.44

Table VI-2

Capital Investments, Utilities and Labours of Complex (Case 1)

	PLANT NAME	NATURAL GAS PROCESSING (+ CONDENSATE) CRACKING	BUTADIENE EXTRACTION	AROMATICS RECOVERY	DEALKYLATION	HYDROGEN PRODUCTION
	CAPACITY (t/y)	241,000	30,000	53,000	55,400	3,200 Nm^3/hr)
	CAPITAL INVESTMENT ($)	46,236,000	2,676,000	3,900,000	1,584,000	970,000
UTILITIES	POWER : kw	4,294	568	354	1,050	149
	STEAM : t/h (lb/h)	342(753,968)	13.3(29,321)	17.4(38,360)	4.0(8,818)	-
	COOLING WATER : t/h (GPM)	23,775(104,734)	758 (3,337)	609 (2,682)	3,987 (17,564)	86 (377)
	PROCESS WATER : t/h (GPM)	-	-	-	-	4.2(18.8)
	FUEL : 10^6 kcal/h (10^6 BTU/h)	3.03(12.02)	-	0.80(3.19)	-9.1(-36.11)	5.35(21.21)
LABOUR	OPERATOR	104	12	36	12	12
	SUPERVISOR	16	4	4	4	4

	PLANT NAME	LDPE	HDPE	VCM	PVC	STYRENE	POLYSTYRENE
	CAPACITY (t/y)	100,000	70,000	88,300	84,100	62,500	50,700
	CAPITAL INVESTMENT ($)	26,620,000	27,140,000	7,510,000	7,310,000	8,695,000	12,360,000
UTILITIES	POWER : kw	25,253	7,955	3,122	2,124	1,184	1,568
	STEAM : t/h (lb/h)	18.9(41,667)	61.9(136,464)	27.9(61,447)	21.2(46,737)	94.7(208,774)	4.0(8,913)
	COOLING WATER : t/h (GPM)	3,283 (14,462)	6,187 (27,254)	2,230 (9,825)	5,309 (23,387)	1,184 (5,214)	131 (575)
	PROCESS WATER : t/h (GPM)	-	-	-	-	-	11.5(50.8)
	FUEL : 10^6 kcal/h (10^6 BTU/h)	-	-	13.38(53.09)	-	25.25(100.21)	-
LABOUR	OPERATOR	260	200	80	72	16	56
	SUPERVISOR	16	20	12	16	4	8

	PLANT NAME	ACTYLONITRILE	POLY ACRYLONITRILE-F	P P	SBR	MALEIC ANHYDRIDE
	CAPACITY (t/y)	34,000	12,000	50,000	38,000	35,000
	CAPITAL INVESTMENT ($)	9,672,000	25,550,000	20,580,000	10,236,000	7,782,000
UTILITIES	POWER : kw	2,576	2,121	6,944	2,577	7,645
	STEAM : t/h (lb/h)	34.3(75,617)	3.8(8,377)	52.4(115,518)	15.8(34,906)	-29.2(-64,300)
	COOLING WATER : t/h (GPM)	2,146 (9,456)	455 (2,002)	5,051 (22,248)	1,391 (6,129)	795 (3,504)
	PROCESS WATER : t/h (GPM)	-	15.2(66.7)	-	7.7(33.8)	-
	FUEL : 10^6 kcal/h (10^6 BTU/h)	-	-	-	-	-
LABOUR	OPERATOR	48	252	64	120	40
	SUPERVISOR	4	16	8	12	8

	PLANT NAME	CAPROLACTAM	NYLON-6 (CHIP)	NYLON-6-F	LINEAR ALKYLBENZENE	TOTAL
	CAPACITY (t/y)	17,700	18,500	18,000	30,000	
	CAPITAL INVESTMENT ($)	11,460,000	1,790,000	23,780,000	5,280,000	261,131,000
UTILITIES	POWER : kw	2,011	631	430	1,303	73,859
	STEAM : t/h (lb/h)	26.8(59,083)	6.1(13,448)	-	2.5(5,511)	717.8(1,582,636)
	COOLING WATER : t/h (GPM)	313 (1,378)	213 (936)	18(80)	1,909 (8,410)	59,830 (263,552)
	PROCESS WATER : t/h (GPM)	-	-	-	-	38.6(170.1)
	FUEL : 10^6 kcal/h (10^6 BTU/h)	6.70(26.60)	0.82 (3.24)	-	20.45(81.17)	66.11(266.51)
LABOUR	OPERATOR	32	36	1,200	16	2,668
	SUPERVISOR	8	4	120	4	292

Table VI-2 (Case 2)

	PLANT NAME	CONDENSATE CRACKING	BUTADIENE EXTRACTION	AROMATICS RECOVERY	DEALKYLATION	HYDROGEN PRODUCTION
	CAPACITY (t/y)	130,000	24,000	48,000	54,000	3,000(Nm^3/hr)
	CAPITAL INVESTMENT ($)	21,000,000	2,340,000	3,670,000	1,560,000	912,000
UTILITIES	POWER : kw	1,313	455	321	1,023	140
	STEAM : t/h (lb/h)	54.2(119,489)	10.6(23,382)	15.8(34,739)	3.9(8,568)	-
	COOLING WATER : t/h (GPM)	7,879 (34,709)	606 (2,670)	552 (2,430)	3,886 (17,120)	80(353)
	PROCESS WATER : t/h (GPM)	-	-	-	-	4.0(17.6)
	FUEL : 10^6 kcal/h (10^6 BTU/h)	-	-	0.73(2.89)	-8.86(-35.16)	5.01(19.88)
LABOUR	OPERATOR	60	12	36	12	12
	SUPERVISOR	8	4	4	4	4

	PLANT NAME	LDPE	HDPE	VCM	PVC	STYRENE	POLYSTYRENE
	CAPACITY (t/y)	60,000	20,000	53,800	51,200	58,100	48,300
	CAPITAL INVESTMENT ($)	19,570,000	12,480,000	5,580,000	5,420,000	8,290,000	12,000,000
UTILITIES	POWER : kw	15,152	2,273	1,902	1,293	1,100	1,494
	STEAM : t/h (lb/h)	11.4(25,052)	17.7(38,970)	17.0(37,439)	12.9(28,504)	88.0(194,070)	3.9(8,497)
	COOLING WATER : t/h (GPM)	1,970 (8,677)	1,768 (7,787)	1,359 (5,985)	3,232 (14,239)	1,100 (4,847)	124 (548)
	PROCESS WATER : t/h (GPM)	-	-	-	-	-	11.0(48.4)
	FUEL : 10^6 kcal/h (10^6 BTU/h)	-	-	8.15(32.35)	-	23.47(93.15)	-
LABOUR	OPERATOR	240	120	80	64	16	52
	SUPERVISOR	12	12	12	12	4	8

PLANT NAME	ACRYLONITRILE	POLYACRYLONITRILE-F	PP	SBR	MALEIC ANHYDRIDE
CAPACITY (t/y)	22,000	12,000	40,000	30,000	35,000
CAPITAL INVESTMENT ($)	7,440,000	25,550,000	18,000,000	8,880,000	7,782,000
UTILITIES					
POWER : kw	1,667	2,121	5,556	2,034	7,645
STEAM : t/h (lb/h)	22.2(48,991)	3.9(8,351)	41.9(92,414)	12.5(27,557)	-29.2(-64,300)
COOLING WATER : t/h (GPM)	1,389 (6,118)	455 (2,002)	4,040 (17,799)	1,098 (4,839)	795 (3,504)
PROCESS WATER : t/h (GPM)	-	15.2(66.7)	-	6.1(26.7)	-
FUEL : 10^6 kcal/h (10^6 BTU/h)	-	-	-	-	-
LABOUR					
OPERATOR	36	252	60	100	40
SUPERVISOR	4	16	8	12	8

PLANT NAME	CAPROLACTAM	NYLON-6 (CHIP)	NYLON-6-F	LINEAR ALKYLBENZENE	TOTAL
CAPACITY (/ty)	17,700	18,500	18,000	30,000	
CAPITAL INVESTMENT ($)	11,460,000	1,790,000	25,780,000	5,280,000	202,784,000
UTILITIES					
POWER : kw	2,011	631	430	1,303	49,864
STEAM : t/h (lb/h)	26.8(59,123)	6.1(13,389)	-	2.5(5,595)	322.1(709,830)
COOLING WATER : t/h (GPM)	313 (1,378)	213 (936)	18(80)	1,909 (8,410)	32,784 (144,431)
PROCESS WATER : t/h (GPM)	-	-	-	-	36.3(159.4)
FUEL : 10^6 kcal/h (10^6 BTU/h)	6.70(26.60)	0.82(3.24)	-	20.45(81.17)	56.47(224.12)
LABOUR					
OPERATOR	32	36	1,200	16	2,476
SUPERVISOR	8	4	120	4	268

Table VI-2 (Case 3)

	PLANT NAME	NAPHTHA CRACKING	BUTADIENE EXTRACTION	AROMATICS RECOVERY	DEALKYLATION	HYDROGEN PRODUCTION
	CAPACITY (t/y)	300,000	65,000	199,000	74,000	8,[illegible]00 (Nm^3/hr)
	CAPITAL INVESTMENT ($)	34,600,000	4,250,000	8,620,000	1,860,000	1,728,000
UTILITIES	POWER : kw	3,030	1,231	1,332	1,402	387
	STEAM : t/h (lb/h)	125.0(275.6)	28.7(63.3)	65.3(144.0)	5.33(11.74)	-
	COOLING WATER : t/h (GPM)	18,182 (80,095)	1,641 (7,231)	2,286 (10,072)	5,326 (21.135)	222 (977)
	PROCESS WATER : t/h (GPM)	-	-	-	-	11 (48.7)
	FUEL : 10^6 kcal/h (10^6 BTU/h)	-	-	3.02(11.96)	-12.15(-48.21)	13.87(55.01)
LABOUR	OPERATOR	60	12	36	12	12
	SUPERVISOR	8	4	4	4	4

	PLANT NAME	LDPE	HDPE	VCM	PVC	STYRENE	POLY STYRENE
	CAPACITY (t/y)	130,000	70,000	98,000	95,000	136,000	110,000
	CAPITAL INVESTMENT ($)	31,100,000	27,140,000	7,990,000	7,760,000	13,830,000	19,680,000
UTILITIES	POWER : kw	32,828	7,955	3,465	2,348	3,576	3,403
	STEAM : t/h (lb/h)	24.6(54.3)	61.9(136.4)	30.9(68.2)	23.5(51.8)	206.1(454.3)	8.8(19.4)
	COOLING WATER : t/h (GPM)	4,268(18,800)	6,187 (27,254)	2,475(10,902)	5,871(25,864)	2,576(11,347)	283 (1,248)
	PROCESS WATER : t/h (GPM)	-	-	-	-	-	25.0(110.1)
	FUEL : 10^6 kcal/h (10^6 BTU/h)	-	-	14.85(58.92)	-	54.95(218.05)	-
LABOUR	OPERATOR	260	200	80	80	20	80
	SUPERVISOR	16	20	12	16	4	12

	PLANT NAME	PO	PG	ACRYLONITRIL	POLYACRYLONITRILE-F	PP
	CAPACITY (t/y)	25,500	30,000	44,800	12,000	100,000
	CAPITAL INVESTMENT ($)	3,500,000	1,900,000	11,410,000	25,500,000	31,200,000
UTILITIES	POWER : kw	644	758	3,394	2,121	13,889
	STEAM : t/h (lb/h)	29.3(64.6)	18.9(41.8)	45.3(99.8)	3.8(8.4)	104.8(231.0)
	COOLING WATER : t/h (GPM)	1,288 (5,674)	758 (3,337)	2,828 (12,459)	455 (2,002)	10,101 (44,497)
	PROCESS WATER : t/h (GPM)	-	-	-	15.2(66.7)	-
	FUEL : 10^6 kcal/h (10^6 BTU/h)	-	-	-	-	-
LABOUR	OPERATOR	80	48	48	252	76
	SUPERVISOR	12	8	4	16	8

	PLANT NAME	SBR	MALEIC ANHYDRIDE	TDI	P-XYLENE	TEREPHTHALIC ACID
	CAPACITY (t/y)	85,000	50,000	30,000	39,600	52,800
	CAPITAL INVESTMENT ($)	16,260,000	9,650,000	21,410,000	4,000,000	14,460,000
UTILITIES	POWER : kw	5,628	10,922	4,860	1,865	4,115
	STEAM : t/h (lb/h)	34.6(76.2)	-41.7(-91.9)	30.0(66.1)	-	30.0(66.1)
	COOLING WATER : t/h (GPM)	3,039 (13,388)	1,136 (5,006)	3,580 (15,769)	200(881)	2,223 (9,794)
	PROCESS WATER : t/h (GPM)	16.8(73.9)	-	-	-	203.8(897.8)
	FUEL : 10^6 kcal/h (10^6 BTU/h)	-	-	-	0.01(0.06)	6.53(25.93)
LABOUR	OPERATOR	180	40	32	20	40
	SUPERVISOR	20	8	8	4	8

	PLANT NAME	DMT	POLYESTER-F	CAPROLACTAM	NYLON-6(CHIP)	NYLON-6-F
	CAPACITY (t/y)	61,400	12,000	17,700	18,500	18,000
	CAPITAL INVESTMENT ($)	10,480,000	17,000,000	11,460,000	1,790,000	23,780,000
UTILITIES	POWER : kw	664	4,394	2,011	631	430
	STEAM : t/h (lb/h)	66.25(146.04)	3.8(8.4)	26.8(59.1)	6.1(13.4)	-
	COOLING WATER : t/h (GPM)	1,938 (8,538)	2,652(11,680)	313(1,378)	213(938)	18(80)
	PROCESS WATER : t/h (GPM)	43.1 (189.8)	-	-	-	-
	FUEL : 10^6 kcal/h (10^6 BTU/h)	6.33(25.13)	-	6.70(26.60)	0.82(3.24)	-
LABOUR	OPERATOR	32	320	32	36	1,200
	SUPERVISOR	4	20	8	4	120

	PLANT NAME	LINEAR ALKYLBENZENE	TOTAL
	CAPACITY (t/y)	50,000	
	CAPITAL INVESTMENT ($)	7,200,000	369,828,000
UTILITIES	POWER : kw	2,172	119,475
	STEAM : t/h (lb/h)	4.2(9.3)	942.3(2,077.38)
	COOLING WATER : t/h (GPM)	3,182 (14,027)	83,[illegible] (364,863)
	PROCESS WATER : t/h (GPM)	-	296 (1,313)
	FUEL : 10^6 kcal/h (10^6 BTU/h)	34.09(135.28)	129.02 (511.97)
LABOUR	OPERATOR	20	3,308
	SUPERVISOR	4	360

VII. Market Survey and Export Possibility of Selected Petrochemicals

1. Market Survey

1) Ethylene Derivatives

(a) LDPE

Polyethylene has played a leading role in the development of petrochemical industry. The following table shows the percentage of ethylene demand for polyethylene over the total ethylene demand in USA, UK and Japan.

Ethylene Demand for Polyethylene over the Total Ethylene Demand in USA, UK and Japan (Unit : 1,000 tons)

	USA		UK		Japan	
	1965	1970	1965	1970	1965	1970
Total Ethylene Demand	3,400	8,400	300	1,320	726	3,107
Ethylene Demand for Polyethylene	1,330	2,980	167	630	387	1,275
%	39.1	35.5	55.7	47.7	53.3	41.0

From this table, ethylene demand for polyethylene production was in the order of 40 - 55% of total ethylene demand in these three countries in 1965. Polyethylene has made a great contribution to the development of petrochemical complex. Though, the percentage of ethylene demand for polyethylene has slightly decreased gradually, the role of polyethylene in the petrochemical industry will not change.

LDPE demand has shown a repid increase. From Table IV-1, total LDPE demand in the four areas (North America, Latin America, West Europe and Southeast Asia) in 1970 is estimated to be up to 4.85 million tons. The growth rate in Southeast Asia with Japan as a leading nation, from 1965 through 1970 is 22.1% in awerage, which is the highest of all, followed by Latin America of 18.1%. The average of the four areas is 18.6%. The rapid increase of LDPE is owning, to a large extent, to the increase of film and sheet consumption for which about 50% of total LDPE demand is utilised. While the average annual growth rate of the consumption of film and sheet in USA, UK and Japan during the three years from 1967 to 1970 is 17.8%, 14.7% and 10.5% respectively, the growth rate of the total LDPE demand is 12.2% in USA, 11.9% in UK and Japan and the growth rate of film and sheet demand in USA and UK exceeds that of the total LDPE demand.

End Use Pattern of LDPE in USA, UK and Japan
(1970 Estimate)

(Unit: 1,000 tons)

End Use	USA Consump.	USA %	UK Consump.	UK %	Japan Consump.	Japan %
Film and Sheet	780	53.0	134	54.6	350	55.0
Injection Molding	234	16.0	37	15.0	56	8.8
Extrusion Coating	207	14.0	12	5.0	82	12.8
Wire and Cable	167	11.0	22	9.1	54	8.4
Pipe and Conduit	36	2.4	6	2.4	7	1.1
Blow Molding	26	1.7	25	10.3	24	3.8
Roto Molding	27	1.9	-	-	-	-
Miscellaneous	-	-	9	3.6	64	10.1
Total	1,477	100	245	100	637	100

Sources : Ref. 1, 2, 3.

Next to film and sheet, LDPE is used for injection molding. In USA and UK, about 15% of total LDPE demand goes to injection molding. The capacity of LDPE in the said four areas during the five years from 1965 to 1970 was increased by about 4.9 million t/y whereby the total capacity will reach 7.3 million t/y by the end of 1970. In the meantime, the capacity per plant is becoming larger with the average of 60,000 - 70,000 t/y per plant. In the past, the average capacity of a plant was in the range of 20,000 t/y to 30,000 t/y. Annex Q-2 shows the LDPE Producers with present and under planning capacity in the western countries.

The following table shows LDPE prices in the main countries. These are local delivered prices based on single deliveries in each country and LDPE is being sold to bulk users at the lower rate by 10-20% than these local delivered prices (Same study can be said regarding the other products).

LDPE Prices in the Main Countries

(Unit : ¢/lb)

Grade	Countries	1965	1970
	USA	16.25	13
	UK	18.6	16
Injection Grade	Japan	-	-
(10 ton lots)	W. Germany	18.1	16
	France	19.4	11.7
	Italy	18.9	12.1
	USA	18.75	12.75
	UK	22.1	19
Industrial Film Grade	Japan*	19	13
(10 ton lots)	W. Germany	21.0	21.2
	France	20.8	12.2
	Italy	22.6	12.9
	USA	19.25	15.25
	UK	25.0	21.50
Pipe Extrusion Grade	Japan	-	-
(10 ton lots)	W. Germany	22.6	23.1
	France	23.6	14.6
	Italy	25.3	12.9

* Average price of LDPE in Japan

Source : Ref. 4

In the United States, the LDPE price was decreased by 3 - 6 cents/lb in the past five years. In UK it was decreased by 2 - 3 cents/lb, in France and Italy by 7 - 13 cents. In West Germany, however, the price has little fluctuated. In Japan, it is decreased by 6 cents. In the other words, the price of LDPE was decreased by 15 - 20% except W. Germany, during the period of 1965 to 1970, in some instances by 50% such as pipe extrusion grade in Italy. However, in the beginning of 1975, the price went up by 1 - 2 ¢/lb which was initiated by Union Carbide Corp.

The expected demand for LDPE up to 1975 will be lower than the average growth rate for the five years from 1965 to 1970 in the said four areas, but the demand will be increased by 14.4% per year and the total demand in the four areas will reach 9.5 million tons in 1975. From the geographical point, the growth rate in Latin America is 26.3%, the most remarkable of all, which exceeds the annual average growth rate during the five years from 1965 - 1970. Southeast Asia is also expected to continuously increase the demand, say, about by 10% per year. Under these circumstances, each manufacturer is quite interested in the expansion of its production capacity as seen from Annex Q-2. Up to 1973, new installations of 282,000 t/y in North America, 110,000 t/y in Latin America, 1,966,000 t/y in W. Europe and 310,000 t/y in Southeast Asia are planned.

To estimate the prices in 1975 is very difficult, but it can be said that such considerable decrease in prices as observed during the five year from 1965 to 1970 would not take place. The decrease in price during the past five years is due mainly to the effect of scale merit by larger capacity of plant and rationalisation of production facilities and circulation of product.
However, considering that these countermeasures have nearly arrived at an economic limit and also in view of the inflation of production cost, there is a symptom that the price of LDPE will either remain at the present level or go up rather than down.

(b) HDPE

HDPE is competitive with PP and PVC in many fields and its demand is not so high as LDPE. The percentage of HDPE for total polyethylene demand is around 22 - 30%. The increase of HDPE demand from 1965 to 1970 is 22.5% in total of the said four areas as shown in Table IV-1, which indicates the considerable increase of HDPE in its own marketing field in spite of the severe competition with PP and PVC. Geographically, the demand has considerably increased by as high as 21.7% in the annual average in Southeast Asia, followed by Latin America of 21.4%.

The following table shows the end use pattern of HDPE.

End Use Pattern of HDPE in USA, UK and Japan (1970 Estimate)

(Unit : 1,000 tons)

	USA		UK		Japan	
	Consump.	%	Consump.	%	Consump.	%
Blow Molding	268.0	50.7	286.59	46.6	55.65	23.6
Injection Molding	137.0	26.0	204.18	33.2	80.15	34.0
Pipe and Conduit	39.8	7.5	24.6	4.0	6.2	2.6
Fiber	3.2	0.6	33.21	5.4	66.9	28.4
Film and Sheet	30.3	5.7	30.75	5.0	16.64	7.1
Roto Molding	15.8	3.0	-	-	-	-
Wire and Cable	22.6	4.3	19.68	3.2	-	-
Extrusion Coating	11.8	2.2	-	-	-	-
Miscellaneous	-	-	15.99	2.6	10.44	4.3
Total	528.5	100	615	100	235.98	100

Source : Ref. 1, 2, 3.

The main consumption of HDPE is for blow molding in USA and UK, occupying 50.7% and 46.6% respectively, followed by injection molding of 26.0% and 33.2% respectively. In Japan adversely, 34.0% of HDPE is consumed for injection molding and 23.6% for blow molding. In France and W. Germany, the same pattern is observed as in Japan. This is because that the plastic bottle have not so widely spread as in USA and UK.

In many countries, the used milk bottle is creating problem of solid waste disposal, however, if plastics bottle is more widely accepted, HDPE demand will be further increased. The production capacity of HDPE has increased 3.7 times from 1965 to 1970 and will became 2.9 million tons/y by the end of 1970. Annex Q-3 shows the present and planned capacities by HDPE Producers in the western countries. In the petrochemical industrialisation programme of developing countries, it is general that the LDPE is planned prior to HDPE. From this point, the plant capacities in Latin America and Southeast Asia except Japan is on the very low level compared with LDPE.

The following table compares the recent prices of HDPE with those of 1965.

HDPE Prices in the Main Countries

(Unit : ¢/lb)

Grade	Countries	1965	1970
	USA	25.0	18.0
	UK	24.4	21.5
Injection Grade	Japan*	21.6	17.5
(10 ton lots)	W. Germany	31.7	25.1
	France	32.3	18.5
	Italy	26.2	22.8
	USA	25.0	18.0
	UK	26	21.6
Bottle Grade	Japan	-	-
(10 ton lots)	W. Germany	32.9	26.6
	France	32.1	19.3
	Italy	29.0	22.8

* Average price of HDPE in Japan

Source : Ref. 4

The prices have decreased in all the countries with considerable decrease of more than 40% in France. In even England where the price is said to be most stable, the price went down by 10 - 15%.

The growth rate of the estimated HDPE demand in the four areas up to 1975 is slow in comparison with that for the five years from 1965 to 1970, but it is still expected that the demand will be increased by about 14.6% per year in average, with particular emphasis on Latin America where the demand is expected to increase by more than 30% which would exceed the growth rate for the five years from 1965 to 1970. In Southeast Asia, too, the demand will be still increased as high as 19% while in North America and W. Europe the increase is expected about 12 - 13% in average.
In USA and other developed countries, milk bottles and other glass bottles are being changed from glass to plastics. Presently in USA, about 5 - 8% of milk bottles are of HDPE plastics. Phillips

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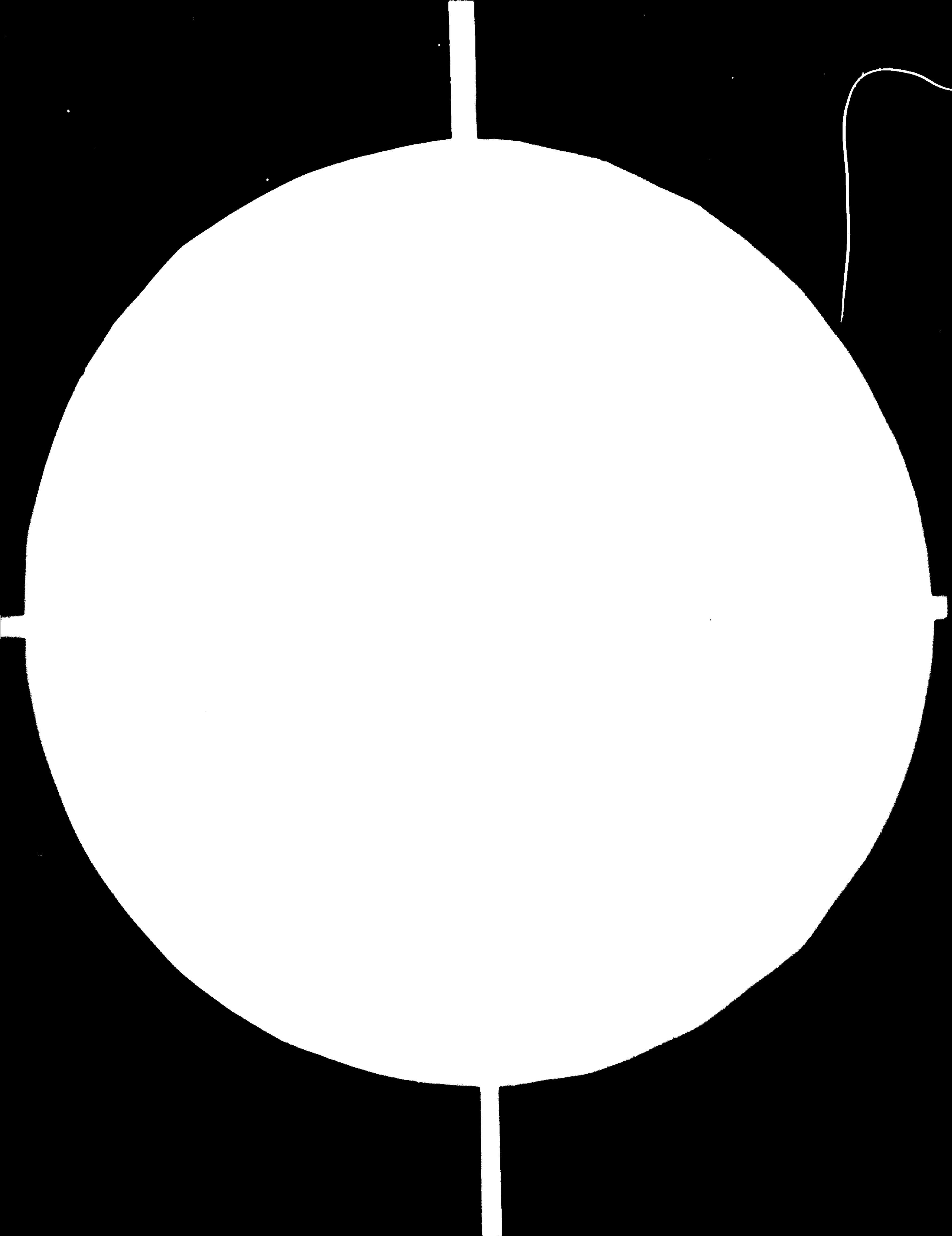

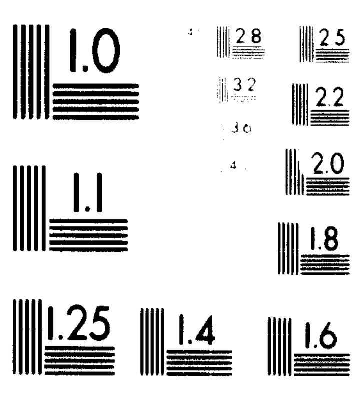

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Petroleum Co. forecasts that the figure of 5 - 8% will be increased to 25% by 1973. In such was, the conversion of bottles from glass to plastics will be proceeded speedily. With regard to new installations or expansion of HDPE facilities, positive planning has been announced same as LDPE. In Southeast Asia, the almost doubling of the capacity in 1970 was announced while planning new or additional facilities for 783,000 t/y in W. Europe and for 190,000 t/y in USA was announced.

The price in 1975 will not be decreased to large extent since scale merit and rationalization would be offset with the increase of cost by increase of wages. In USA, HDPE is being sold to big users at about 16 - 17 ¢/lb. A director of Monsanto recently indicated that this price could be further reduced by 2 - 3 ¢/lb.

(c) VCM

The raw material for VCM has been rapidly shifting from acetylene to EDC, as the ethylene price has been decreasing with the scale-up of ethylene production facilities. It is forecasted that Japan will completely shift the raw material to EDC by the end of 1971. The USA has already produced 88% of VCM through EDC. In W. Europe, however, production of VCM through EDC accounts for only 55%.

The VCM demand has rapidly increased. From 1965 to 1970 the demand increased at an annual rate of 30%, and in 1970 the demand is estimated to reach 5.16 million tons in the four areas as a whole.

EDC prices are given in the following table.

VCM Prices in Main Countries

(Unit : ¢/lb)

Grade	Countries	1965	1970
	USA	8.00	5.00
	Japan	8.00	7.00
HTC	W. Germany	7.7	8.8
	France	n.a.	7.6
	Italy	8.0	8.1

The price in the USA has decreased from 8 ¢/lb to 5 ¢/lb and Japan showed 1 ¢/lb decrease between 1965 and 1970. On the other hand the prices in most countries of W. Europe showed slightly upward.

The future demand for VCM mainly depends upon the growth rate of the PVC demand. It is estimated that PVC demand will increase by 12% during the next five years and that VCM will also show the same growth rate, reaching 10 million tons in 1975 in the four areas as a whole. Whereas shifting of raw material to EDC has nearly been completed in both the USA and Japan, shifting in W. Europe will reach 80% in total vinyl chloride production for the next five years.

(d) PVC

PVC, paralleled with LDPE, is a plastic having much demand. The demand is expected to reach about five million tons as a total of the said four areas in 1970. Geographically, as shown in Table IV-1 the highest in the growth rate is Southeast Asia that is annual average of 22%, amounting to 1.2 million tons, followed by Latin America of 19.4% amounting to 0.2 million tons and W. Europe of 13.2% amounting to 2.19 million tons and North America of 9.9% amounting to 1.4 million tons.

PVC is a material very widely used for many things and the following table shows its end use pattern. In each country about 10% is used for calendared sheet, wire and cable, flooring and pipe. The items which have shown the most significant increase for these several years are wire and cable, and flooring in USA, bottle and pipe in W. Europe, and sheet, and wire and cable in Japan.

End Use Pattern of PVC

in USA, UK and Japan (1969)

(Unit : 1000 tons)

USA

End Use	Consumption	%
Film and sheet	272.2	22.8
Calendering flooring	127.0	10.7
Coating flooring	30.4	2.6
Paper and textile	49.0	4.1
Protective and adhesive	40.8	3.4
Extrusion film and sheet	68.0	5.7
Wire and cable	176.9	14.8
Other extruded products	190.5	16.0
Molding injection and blow	39.9	3.4
Plastisol	56.7	4.8
Records	52.6	4.4
Miscellaneous	88.0	7.3
Total	1,192.0	100.0

UK

End Use	Consumption	%
Calendered sheet	20.4	15.8
Fabric and paper coating	11.2	8.6
Flooring	14.8	11.3
Belting	2.3	1.7
Cables	19.9	15.1
Other extrusions	6.8	5.2
Dipping, slush molding and solutions	5.2	3.5
Footwear	5.2	3.5
Sheet and film	5.7	4.3
Extrusions	26.9	20.3
Records	4.5	3.5
Bottles	1.8	1.5
Other injection molding	3.9	3.0
Miscellaneous	3.6	2.7
Total	132.2	100.0

Japan

End Use	Consumption	%
Rigid		
Rigid plate	35.9	3.7
Corgated plate	74.5	7.8
Pipe	232.6	24.2
Fittings	20.0	2.1
Sheet	83.0	8.6
Rigid fulume and gutter	34.5	3.6
Other use	46.2	4.8
Flexible		
Film and sheet general purpose	108.5	11.3
Film and sheet for agricultural	35.7	3.7
Leather	73.5	7.6
Extrusion	55.0	5.7
Other use	27.2	2.8
Others		
Wire and cable	94.1	9.5
Flooring	24.7	2.6
Fiber	12.2	1.3
Miscellaneous	6.2	0.7
Total	961.1	100.0

Source : Ref. 1, 2, 3.

The following table compares prices of PVC in the main countries.

PVC Prices in the Main Countries

(Unit : ¢/lb)

Grade	Countries	1965	1970
	USA	24.00	24.00
	UK	17.00	17.06
Paste forming grade	Japan	21.60	17.50
	W. Germany	18.10	17.60
	France	-	15.00
	Italy	16.17	17.10

Grade	Countries	1965	1970
	USA	16.00	14.00
	UK	15.80	13.55
Purpose mech. grade	Japan	12.50	11.00
	W. Germany	15.90	16.30
	France	17.60	12.50
	Italy	16.00	14.40

Source : Ref. 4

Of all the thermoplastics, PVC is a plastic which has showed least fluctuation in price for the past five years. In USA, UK and Italy, the prices of paste forming grade have made no appreciable fluctuation, but in Japan the price went down from 21.60 ¢/lb. to 17.50 ¢/lb. The price of the purpose mech. grade went down in all countries except W. Germany. The range of falling in price is 2 - 3 ¢/lb. except 5.10 ¢/lb. in France. Little fluctuation in PVC price is due mostly to the rising of chlorine price as seen in the following table by the world wide shortage in chlorine caused by increase of PVC demand.

Chlorine Price in the Main Countries

(Unit : ¢/lb)

Grade	Countries	1965	1970
	USA	3.25	3.75
	UK	3.20	3.45
Liquid form	Japan	3.21	3.46
	W. Germany	2.90	3.50
	France	3.10	3.40
	Italy	3.60	3.80

Source : Ref. 4

For this reason the PVC producers are making effort of reducing cost by either converting the raw material from acetylene to ethylene or using EDC Process or oxichlorination process.

The increase in the future PVC demand may be lower than that for the five years from 1965 to 1970 but 12.2% increase in annual average will be expected, amounting to 8.86 million tons as a total of the said four areas by 1975. In each country, considerable increase in PVC bottles are equally seen. It is expected that beer bottles in Germany and wine bottles in France will be substituted with PVC. However, the solution of the problem of treatment of wasted PVC will be key to the development of PVC in this field. Most PVC manufacturers are quite active in expansion of the facilities as shown in Annex Q-4.

The price of PVC in the future will not be decreased unless chlorine shortage problem is solved. In Europe and Japan, large size of electrolysis cells are being installed in a positive manner, however, this will not satisfy all the demand and there is little possibility that chlorine price will decrease in the immediate future. The price of PVC will continue on the long side.

(e) Styrene monomer

Styrene monomer is an intermediate with a wide range of used as raw material for polystyrene, ABS resin, SAN resin, styrene-butadiene copolymer, SBR, etc. During five years from 1965 to 1970 the demand for styrene monomer showed a high rate of increase of 17.1% in the four areas, and over 20% in areas other than North America.

The following table gives end use pattern of styrene monomer in the USA, W. Europe, and Japan.

End Use Pattern of Styrene Monomer in USA, W. Europe and Japan

(Unit : %)

	USA	W. Europe	Japan
Polystyrene	54.5	70.0	68.4
SBR	18.3	22.8	14.5
Polyester resin	6.0	0.8	5.7
ABS	16.2	5.2	9.9
Miscellaneous	5.0	1.2	1.5

Polystyrene predominates in 55 - 70% of these areas, and SBR is in second place, ranging from 15 - 23%.

The price trend for styrene monomer in the main countries is as follows:

Styrene Monomer Prices in the Main Countries

(Unit : ¢/lb)

Grade	Countries	1965	1970
	USA	8.00	8.00
	UK	10.20	9.00
Polymer grade	Japan	13.10	7.60
	W. Germany	13.20	9.20
	France	10.00	8.10
	Italy	10.20	11.00

The 1970 price in USA has been the same as in 1965, i.e., 8 ¢/lb. In Italy the price increased 0.8¢/lb, whereas in the UK, Japan, W. Germany, and France the prices fell. Among them, Japan set a record of 42% reduction in price.

The future demand for styrene monomer is expected to grow at a rate of 13%, and in 1975 it will reach 8.1 million tons. The growth rates will be lower in all these areas, as compared with five years between 1965 and 1970; in North America the rate is estimated to be 7.4%, and the other three areas will range from 10 to 14%.

Styrene is produced from high purity ethylbenzene, most of which is, in turn, obtained by alkylating benzene with ethylene. Therefore, price of styrene monomer is determined by the prices of ethylene and benzene. The ethylene price is unlikely to be lowered, because the scale-up merit has reached a limit, and because the main raw materials for ethylene, i.e., natural gas and naphtha, is unlikely to show a large reduction in price. Meanwhile, the benzene price is estimated to increase in the future, owing to the move to eliminate lead from gasoline.

In view of the above price trends, and taking account of world wide inflation, it can be estimated that the styrene monomer price will either remain on the same level or increase.

(f) Polystyrene

Polystyrene demand has rapidly increased as other plastics. The total demand in the said four areas increased by 10.6% in average for the five years from 1965 to 1970 and will reach 2.0 million tons in 1970. Geographically, the growth rate in Latin America and W. Europe is 11 - 14% while that in Southeast Asia is more than 30% which is almost double the increase in the other areas. The polystyrene end use pattern in the main countries is as follows. Because of the different ways of classification by countries, accurate comparison is difficult. In each country, however, polystyrene is mostly used for packaging with 48% in UK, 27% in USA and 48% in Japan. The total existing polystyrene production capacity in the said four areas is about 2.9 million t/y. This is considerably over supply for the present demand.

End Use Pattern of Polystyrene (GP HI)
in USA, UK and Japan (1969)

(Unit : 1000 tons)

USA

End Use	Consumption	%
Combs, brushes, eyeglasses, etc.	15.9	2.1
Drain pipe	20.4	2.7
Foamed sheet	31.8	4.2
Furniture	36.3	4.8
Housewares	90.7	12.0
Lighting and sings	19.1	2.6
Major appliances	12.7	1.7
Monofilament	2.3	0.4
Packaging	204.1	27.0
Radio and TV	31.8	4.2
Refrigerators	29.5	4.0
Small appliances	10.9	1.5
Toys	108.9	14.4
Miscellaneous	137.4	18.4
Total	751.6	100 (%)

Source : Ref. 2

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End Use	Consumption	%
Packaging	55.0	48
Sheet, excluding packaging	8.0	7
Household and office appliances	7.0	6.25
Household and premium offer goods	13.0	11
Toys and novelties	12.3	10.5
Shoe heels	3.6	3
Light fittings	2.8	2.5
Cisterns and bathroom accessories	3.9	3.5
Combs, brushes and trinkets	1.4	1.25
Miscellaneous	8.0	7
Total	115.0	100.00

Source : Ref. 1

Japan

End Use	Consumption	%
TV	13.8	6.2
Refrigerators	14.7	6.5
Radio	9.1	4.0
Other electric appliances	33.2	14.7
General machinery	14.6	6.6
Packaging	106.9	48.0
Toys	20.6	9.3
Office appliances	11.0	4.7
Total	223.9	100.00

Source : Ref. 3

The following table compares the price of 1965 with that of 1970. In USA and W. Germany, there is no big change or slight increase in the price. In the other countries the prices went down by 20 - 30%.

Polystyrene Prices in the Main Countries

(Unit : ¢/lb)

Grade	Countries	1965	1970
	USA	14.5	14.8
	UK	18.7	13.5
General Crystal	Japan	-	-
(10 ton lots)	W. Germany	17	18
	France	17.1	13.5
	Italy	16.7	13.7
	USA	21	21
	UK	28	20.5
High Impact	Japan*	20.8	11.7
(10 ton lots)	W. Germany	23.8	25
	France	24.1	18.2
	Italy	23.2	19.7

* The average price of GP and HI in Japan

Source : Ref. 4

It is said in USA that the industry needs at least 15 ¢/lb. in flow cars for general purpose polystyrene to get a return on investment (Ref. 5) and that polystyrene manufacturers are not gaining much profit.

The anticipated growth rate of polystyrene up to 1975 is 9.3% as total in the said four areas, reaching 3.1 million t/y in 1975. The growth rate in North America, Latin America and W. Europe are 10%, 13% and 6% respectively while that in Southeast Asia with Japan is still very high as 15.5%.

The new installation or expansion programs of polystyrene vary by each area at present. In West Europe, the active programs of new or additional 750,000 t/y polystyrene production has been announced. In North America and Southeast Asia, new or additional installation programs of 300,000 t/y and 84,000 t/y have been announced. The polystyrene price is maintaining 15 ¢/lb. for the past several years as stated previously and the price in the future is anticipated to fluctuate within the range of plus or minus 10% of 15 ¢/lb.

2) Propylene Derivatives

(a) PG

The demand for PG has made a rapid growth with particular emphasis on the increase in polyester resin consumption. Table IV-1 shows that for the period of five years from 1965 to 1970 PG demand increased by as much as 23.7% as a total of the said four areas. Particularly in W. Europe the growth rate was remarkable and the demand is expected to arrive at 300,000 tons by the end of 1970 which is as much as 5 times that of 1965. The growth rate in North America and Southeast Asia is also high at 11% and 19% respectively. The end use pattern of PG is shown in the following table.

End Use Pattern of PG

(Unit : %)

	U.S.A.	W. Europe	Japan
Polyester Resins	45.1	22.7	55.1
Cellophane	17.2	32.0	8.2
Plasticizers	5.6	21.4	-
Cosmetics	12.7	16.0	28.2
Miscellaneous	19.4	7.9	8.5

In USA and Japan, 45 - 55% of the total PG demand goes to polyester resins, however, in W. Europe 32% goes to cellophane and 22% to polyester resin. Today plastics is substituting cellophane and in the not distant future, PG will be used for polyester resin to a largest extent. The following table compares prices of PG in 1965 with those in 1970.

PG Prices in the Main Countries

(Unit : ¢/lb)

Grade	Countries	1965	1970
	USA	12.50	13.00
	UK	14.50	12.96
Standard	Japan	17.10	19.10
	W. Germany	13.10	13.50
	France	12.70	13.80
	Italy	12.30	13.70

Source : Ref. 4

From this table, in all countries except UK the prices increased by 0.5 ¢/lb to 2 ¢/lb due to the world wide stringency of propylene supply. The propylene shortage is anticipated to continue and PG prices will keep the present level or will go up.

The future demand for PG will be increased by 10% on the stable basis supported by the expected raising of polyester resins demand. Geographically, in W. Europe, the demand for PG shows a very rapid increase such as about 38% in annual average for the five years from 1965 to 1970 and is expected to enjoy a stable increase maintaining 7% in the annual average. In USA, with the increase of the polyester resin consumption, PG demand will be increased by about 12% which will slightly exceed the demand for the past five years. In Latin America and Southeast Asia the growth rate would be in the range of 16 - 17%.

(b) Acrylonitrile

Acrylonitrile demand has shown such a big increase as high as 22% in annual average supported by the high consumption of acrilic fiber. The increase in W. Europe is 30% that is the highest of all areas with 500,000 tons of consumption being expected in 1970. The growth in Southeast Asia is also remarkable with the growth rate of 22.5% in average for the past five years, reaching 416,000 tons by the end of in 1970. The end use pattern of acrylonitrile is shown in the following table.

End Use Pattern of Acrylonitrile
in USA, W. Europe and Japan

(Unit : %)

	USA	W. Europe	Japan
Fiber	64.5	77.5	73.8
Plastics	14.0	15.5	11.0
Rubber	6.8	6.2	2.9
Others	14.8	0.8	12.3

Source : Ref. 3, 6, 7.

In each country, 65 - 78% of acrylonitrile is used for fiber, followed by plastic for which 11 - 16% of acrylonitrile is used. Recently, in cope with the increasing acrylic fiber consumption, construction of acrylonitrile production plants are being mashroomed. In W. Europe, new installations or expansions were made up to 1.1 million t/y of acrylonitrile from last year and further, 598,000 t/y of additional installations by 1973 were announced.

The following table compares the acrylonitrile prices in the main countries.

Acrylonitrile Prices in the Main Countries

(Unit : ¢/lb)

	Countries	1965	1970
	USA	17.00	14.50
	UK	16.50	14.15
Acrylonitrile	Japan	20.60	13.20
RTC	W. Germany	19.80	24.40
	France	22.60	15.50
	Italy	21.10	19.70

Source : Ref. 4

In W. Germany, the price went up from 19.80 ¢/lb to 24.40 ¢/lb. In the other countries the prices went down. Particularly, in Japan and France, the prices went down by more than 30% and in UK by about 14%.

With the development of Sohio Process, the raw materials for acrylonitrile production has been changed from acetylene-hydrogen cyanede to propylene-ammonia of low cost. This change in the raw material has made a contribution to the production of acrylonitrile in low cost.

The forecast of the future demand for acrylonitrile depends, to a large extent, on the increase of consumption of acrylic fiber for which acrylonitrile is mainly used. As shown in the following table, acrylic fiber demand in 1975 is expected to increase by 10.5% in North America, 22.8% in Latin America, 15.0% in W. Europe and 12.0% in Southeast Asia.

Forecast of Acrylic Fiber Demand

(Unit : 1,000 tons)

	1965	1970	1975	Annual Average Growth Rate 1965-1970	1970-1975
North America	82	121	200	20.8	10.5
Latin America	4	25	70	44.4	22.8
W. Europe	120	240	480	14.9	15.0
Southeast Asia	84	239	420	23.2	12.0
Total	290	625	1,170	11.5	13.4

Influenced by such high increase of acrylic fiber, acrylonitrile demand is also expected to increase at the rate close to acrylic fiber. In other words, acrylonitrile demand will be increase by 14.3%. Geographically, the increase in Latin America is the highest by 25%, but the quantity is very small such as 67,000 tons. In North America, W. Europe and Southeast Asia, the growth rate is 11%, 18% and 13%, amounting to 860,000 tons, 1.15 million tons and 762,000 tons, respectively.

The acrylonitrile price in the future is anticipated to maintain the present level or to go up by the following reasons:

(1) Similar to the other petrochemical products, it will have influence of cost push by raising wages.

(2) Because of the anticipated world wide shortage in propylene of raw material, no decrease in price is expected.

(3) It is conceivable that decreasing returns on the N. content of fertilizers due to increasing competition in that market could have the effect of raising prices for industrial ammonia (Ref. 8).

(c) Acrylic Fibers

Acrylic fiber technology was first introduced in 1948, however at the initial stages dyeing and other problems held back appreciable market development. Later, when such problems were solved, and when improvements in the strength of acrylic fibers and its excellent resistance to moisture, moths, mildew, and deterioration caused by chlorine and sunlight were commonly realized, the demand for acrylic fibers recorded a sharp increase.

During 1965 - 1970 the demand has been increasing at an annual average rate of 16.5% in the total four areas.

The following table gives end use patterns of acrylic fibers in USA.

End Use Patterns of Acrylic Fibers in USA

(Unit : %)

Carpets and rugs	40.6
Seaters	20.0
Knit products (e.g., sweaters)	14.2
Pile fabrics	9.9
Broad woven goods	7.0
Blankets	4.8
Miscellaneous	3.5
Total	100.0

Source : Ref. 11

Acrylic fibers also have so diversified deniers and uses which are different with respect to countries, precise comparison is almost impossible. The following table gives a few examples of acrylic fiber prices in the USA, UK, and Japan.

Acrylic Fiber Prices in USA, UK, and Japan

(Unit : ¢/lb)

	USA	UK	Japan
1.5 - 3 deniers	89	80	49-53

Future demand for acrylic fiber is estimated to grow at an annual rate of 11%, reaching 1.04 million tons in the total four areas. Of the four areas, W. Europe has an outstanding increase in demand, and is estimated to grow at the same rate as in the past five years.

(d) PP

PP which made a gay debut as a fiber with most ideal property was not widely accepted for fiber due mainly to poor dyeability. Rather it has grown for plastics in spite of fine material, it was questionable in the initial stage, that due to poor dyeability and difficulty in processing PP would take some share competing with HDPE and PVC.

However, with the improvement in processing technique and appraisal of excellence of material, PP has shown a rapid growth since 1964 and the growth rate was remarkably high, showing 37% increase in average as a total of the said four areas from the period of 1965 through 1970. In Japan, Mitsubishi Petrochemical Co., Sumitomo Chemical Co. and Mitsui Petrochemical Ind. introduced Montecatini's technique at the one same time, followed by Chisso Co. which introduced Avisan's technique, whereby they made a great contribution to the marvelous growth of higher than 54% for the five years from 1965 to 1970. In North America and W. Europe, too, large increase such as 27% and 32%, respectively, in annual average is expected for these five years. The end use pattern of PP is shown in the following table.

End Use Pattern of PP in USA, UK and Japan (1970 Estimate)

(Unit : 1000 tons)

End Use	USA Consump.	USA %	UK Consump.	UK %	Japan Consump.	Japan %
Injection and blow molding	221.0	54.9	47.5	50.0	27.5	48.3
Film	48.5	12.0	14.3	15.0	15.7	27.3
Fibers	119.0	29.6	29.1	30.6	12.5	21.9
Sheet and pipe	9.1	2.3	3.0	3.2	n.a.	n.a.
Miscellaneous	5.9	1.2	1.1	1.2	1.3	2.5
Total	403.5	100	95.0	100	57.0	100

Source : Ref. 4

From this table, PP is used for injection molding to a extent of 50%, then for fiber and filament of about 30%.

Annex Q - 8 shows PP producers with the present and planned capacities in the western world.

The PP prices are shown in the following table. During the past five years, PP prices in all the countries except W. Germany has been decreased.

PP Prices in the Main Countries

(Unit : ¢/lb)

Grade	Countries	1965	1970
	USA	28.0	21.0
	UK	27.4	24.2
General Purpose	Japan*	22.7	13.4
(10 ton lots)	W. Germany	32.9	36.2
	France	-	20.4
	Italy	25.4	22.8

* Injection Grade

Source : Ref. 4

The PP demand in the four areas is expected to considerably increase in the future with the increase by 18.11% amounting to 3.3 million tons in 1975. Geographically, Southeast Asia is expected about 20% growth, followed by W. Europe of 23.0% both of which are on the high level.

The PP price may go down in the future since the PP price is rather high compared with other polyolefine resin although the world wide stringency of propylene is anticipated.

3) Butaidene Derivatives

(a) SBR

Consumption of synthetic rubber in the world has made a stable increase at the level of 7.2% in the annual average shown in the following table.

Consumption of New Rubber in the World

(Unit : 1000 L/Tons)

Year	Total	Natural Rubber	Synthetic Rubber	Ratio of Synthetic Rubber
1960	3,868	2,065	1,803	46.6
61	4,040	2,128	1,913	47.4
62	4,393	2,220	2,173	49.5
63	4,595	2,230	2,365	51.5
64	6,003	2,260	2,743	54.8
65	5,368	2,380	2,988	55.7
66	5,813	2,545	3,268	56.2
67	5,815	2,467	3,348	57.6
68	6,683	2,790	3,893	58.3
69*	7,160	2,850	4,310	59.0
70*	7,470	2,900	4,570	61.2

* Estimate.

Source : Ref. 4

Synthetic rubber outdid natural rubber in its consumption for the first time in 1963 and the share of synthetic rubbers is expected to increase year by year and will occupy the share of 61.2% by the end of 1970. Of all the synthetic rubbers, SBR has the biggest share and in each country the share is more than 60%. While in North America and West Europe the demand is now stable with about 4% of the average growth rate for the past five years, in Latin America and Southeast Asia, high level of increase such as 13.2% and 24.9%, respectively, is observed.

SBR has various uses such as tires, tubes, shoes, wire and cables, belts, etc. As shown in the following table, tires and tubes alone have the share of nearly 70 - 80%.

End Use Pattern of SBR in USA, UK and Japan (1969)

(Unit : 1000 tons)

	USA		UK		Japan	
End Use	Consump.	%	Consump.	%	Consump.	%
For tire	458	68	50	75	120	82
For non tire	216	32	17	25	26	18
Total	674	100	67	100	146	100

The prices of SBR are shown in the following table.

SBR Prices in the Main Countries

(Unit : ¢/1b)

Grade	Countries	1965	1970
1500 grade	USA	23.00	23.00
	UK	21.80	18.00
	Japan	27.00	25.30
	W. Germany	22.20	19.30
	France	20.00	17.00
	Italy	19.80	20.40
1712 grade	USA	17.75	17.75
	UK	17.70	14.75
	Japan	21.20	20.40
	W. Germany	18.10	15.50
	France	15.60	13.50
	Italy	15.00	15.60

Source : Ref. 4

In USA, the prices of both 1500 grade and 1712 grade remain unchanged at 23 ¢/1b. and 17.75 ¢/1b. for the past five years. In Italy, the prices in 1970 are 20.40 ¢/1b. and 15.60 ¢/1b. for both grade respectively with the increase of each 0.60 ¢/1b. from 1965, however, in UK, West Germany and France, the decrease of about 13 - 17% for 1500 grade and 1712 grade are recorded.

The future demand for SBR depends on the increase of tire for which SBR is mainly used. In USA, no large increase of automobile production is expected in the future. With this the increase of tire production is not much expected. Accordingly, the growth rate will be about 2.6% which will be under the annual average growth rate for the past five years. In Europe, however, with the expected increase of automobile production, the growth rate of SBR would be about 4.3%. In Southeast Asia with Japan as a leading country, the growth rate would be more than 11.9%.

4) **Aromatics Derivatives**

(a) Maleic Anhydride

Maleic anhydride is a basic chemical product as a unsaturated bibasic acid and with many chemical reactions it has various uses. The quantity used is not so high and the demand in North America and W. Europe in 1965 was each 60,000 tons and even the total of the said four areas is not more than 130,000 tons. At that time, the production of maleic anhydride was surplus world wide and effort was concentrated to the development of new market. Owing to this efforts, the variety of uses as today were developed as shown in the following table.

End Use Pattern of Maleic Anhydride

USA	%
Unsaturated polyester resins	50
Fumaric acid	18
Alkyl resins	5
Agricultural chemicals	10
Copolymers	-
Miscellaneous	17
Total	100
Japan	
Unsaturated polyester resins	52.3
Sizing	8.8
Stabilizer	3.2
Foods	3.6
Paint and ink	3.3
Agricultural chemicals	3.6
Miscellaneous	15.6
T H F	9.6
Total	100

Source : Ref. 6, 3.

With the recent rapid increase of unsaturated polyester resins, maleic anhydride also made rapid growth in consumption and the growth rate is 18.4% as a total of the said four areas for the period of five years from 1965 to 1970, which is presenting world wide shortage problems. To solve the shortage problem, each manufacturer has announced its expansion programs. Annex Q-10 shows new or additional installation of 38,000 t/y in North America, 72,000 t/y in W. Europe and 35,000 t/y in Southeast Asia with the capacity of one unit ranging from 20,000 t/y - 30,000 t/y. The capacity of one unit is becoming larger.

The following table shows prices of maleic anhydride in the main countries.

Maleic Anhydride Price in the Main Countries

(Unit : ¢/lb)

	Countries	1965	1970
10 ton lots	USA	14.50	17.00
	UK	13.70	18.14
	Japan	18.20	19.70
	W. Germany	10.40	18.60
	France	11.10	18.40
	Italy	11.90	27.30

Source : Ref. 4

From the above table, the prices are increasing in each countries. In Italy, price went up 2.3 times and in W. Germany and France by 70 - 80%. In Japan and USA where the prices are said to be relatively stabilized, the increase by 8% and 17% respectively are observed.

The future demand for maleic anhydride is promising since the demand for unsaturated polyester resins is expected to increase by 12 - 20% in annual average in Japan and USA and tetrahydrofuran which is a raw material for Nylon 4 appeared in new field of maleic anhydride demand. As shown in Table IV-1 the expected growth rate of maleic anhydride in 1975 is 10.3% in North America, 12.1% in W. Europe and 24.3% in Southeast Asia.

The price of maleic anhydride is still continuing to go up due to serious product shortage. The demand and supply is said not to be balanced until 1972 and the tendency of the raising price will further continue. However the price by 1975 will go down as same level as that of 1965.

(b) Alkylbenzene

Since alkylbenzene made a debut as raw material for synthetic detergent after the World War 11 and its demand increased considerably with the rapid increase of synthetic detergent. The official statistics of detergent consumption in the world is not published each year. The report of Henkel Company in West Germany about production, consumption of detergent in 120 countries issued in 1966 indicates that the total consumption in the world would reach 5.88 million tons by 1966 as shown in the following table.

World Production & Consumption of Synthetic Detergent (1966)

(Unit : 1000 tons)

Area	Production	Consumption	Per Capita Consumption
North America	2,567.5	2,539.6	11.7
Latin America	81.6	85.3	0.5
Central America	95.0	100.8	1.4
W. Europe	1,992.1	1,897.1	5.8
E. Europe	566.8	568.2	1.6
Asia	500.3	506.2	0.3
Africa	88.0	116.4	0.4
Oceania	65.8	68.5	4.8
Total	5,957.1	5,882.1	

The consumption of detergent in the world is said to be increasing by 6 - 7% each year. Based on the Henkel's report, the detergent consumption in 1970 in the world would be about 7.5 million tons. This considerable amount of synthetic detergent consumption has created a problem of pollution of river and underground water since hard type detergent used at houses is poured into drainage and rivers without being desolved by vacteria, causing the lowering of the function of the drainage treatment.

To remedy this problem, a biodegradable liniar alkylbenzene sulphonates (LAS) was developed and tetrapropylbenzene sulphonates (ABS) is being actively converted to LAS in the main countries.

In UK, a committee was established in 1953 at the Government's request and after many studies the conversion to LAS was made. In West Germany, a regulation was set up in October, 1964, whereby biodegradable detergent of more than 80% by the biodegradable test authorized by the regulation can only be sold. In USA stipulated by the legislation in W. Germany, the industry voluntary converted the detergent from hard type to soft type after July 1, 1965. In Japan, the conversion to soft type was started in 1966.

Today, in UK, W. Germany, USA and Japan, the conversion to soft type detergent has been completed, but in Italy and France, both hard and soft type detergents are being used. In a world wide sense, it is assumed that about 65% of the synthetic detergent is of soft type with the remaining 35% being of hard type. Recently, higher alcohol and α -olefin other than LAB are considered as raw material to which attention is being paid. Particularly, the development of technique for the production of higher alcohol is progressing and the production from petroleum has now been commercially proven which has made it possible to supply higher alcohol as a raw material in a relatively low price.

Table IV-1 shows the estimated alkylbenzene demand in the said four areas in 1970. The estimated demand in 1970 is 240,000 tons in North America, 127,000 tons in Latin America, 410,000 tons in W. Europe and 134,000 tons in Southeast Asia. While, in North America, alkylbenzene is 100% LAS, in Latin America 10% LAS, in W. Europe 71% and in Southeast Asia 67%. The following table shows alkylbenzene prices in the main countries.

Alkylbenzene Prices in the Main Countries

(Unit : ¢/lb)

Grade	Countries	1965	1970
	USA	9.75	-
	UK	7.60	-
Hard Type bulk purchase	Japan	15.20	11.40
	W. Germany	9.90	9.50
	France	7.30	6.90
	Italy	8.00	9.90
	USA	-	10.50
	UK	-	-
Soft Type bulk purchase	Japan	-	13.10
	W. Germany	-	13.80
	France	-	-
	Italy	-	-

Source : Ref. 4

In USA and UK, a hard type detergent is not being sold and the prices are not shown in ECN Price Table. The present prices in West Germany and France are lower by 0.4 ¢/lb. than those in 1965, however, the price in Italy is higher by 1.90 ¢/lb. than 1965. Since the marketing of soft type detergent was begun around 1965, the prices are not shown in ECN Price Table. The prices in 1970 shown in the ECN Price Table are only those in USA and UK, but the prices may be in order of 10 - 14 ¢/lb. in other countries.

The increase in alkylbenzene demand in the future depends on the increase of synthetic detergent, conversion of the detergent of hard type to soft type, and the development of higher alcohol and α-olefin. The increase of synthetic detergent is expected to be stable at the rate 5 - 6%. As a raw material of this synthetic detergent, either ABS, LAS, higher alcohol or α-olefins are used. From the fact that in North America and most European countries and Japan the conversion of hard type synthetic detergent to soft type has been completed or in progress. As the tendency of using soft type detergent in the developing countries will be anticipated to become more prominent from around 1975, ABS demand will be decreased. Therefore, a raw material of synthetic detergent will be selected from LAS, α-olefin or higher alcohol. Generally, LAS has more advantage in price. Higher alcohol is mild to skin because of high biodegradability and will be more used as home synthetic detergent.

From the above discussion, in North America and W. Europe the increase of synthetic detergent derived from higher alcohol is expected while demand for alkylbenzene will increase at the low level. In Latin America and Southeast Asia, however, alkylbenzene will be more used for its low prices. The demand for alkylbenzene in Latin America is expected to increase by about 10% in annual average, amounting to 205,000 tons in 1975. As for the Southeast Asia, though Japan, the leading country in this area, will convert to higher alcohol in some portion, the total demand in Southeast Asia is estimated 250,000 tons, which is 12% per year, in 1975.

(c) Caprolactum

Polyamide fibers with caprolactum as the raw materials (Nylon 6), was first commercialized in West Germany in the early 1940s. Since then, Nylon 6 production has marked rapid increases in W. Germany, Japan, Italy, and the Netherlands. From 1965 to 1970 the caprolactum demand marked a sharp increase of 19%, and the demand in 1970 is estimated to reach total 1.3 million tons in the four areas.

The caprolactam prices in 1965 are compared to those in 1970 in the following table.

Caprolactam Prices in the main Countries

(Unit : ¢/lb)

		1965	1970
	USA	41.00	24.50
	UK	n.a.	n.a.
frake, bag.	Japan	32.30	18.70
	W. Germany	n.a.	n.a.
	France	n.a.	n.a.
	Italy	n.a.	n.a.

Source : Ref. 4

Caprolactam prices in European countries are unknown, for the prices are not given in the ECN Price Table. The price in the USA was 41.00 ¢/lb in 1965, sharply fell to 24.50 ¢/lb in 1970. Likewise, in Japan, a considerable decrease from 32.30 to 18.70 ¢/lb was recorded in the same period.

Future demand for caprolactam is strictly dependent upon Nylon 6 demand. Previously it was believed that the share of Nylon 66 exceeded that of Nylon 6, but recent estimates show that Nylon 6 accounted for nearly 50%. As given in Table IV-1, it has been forecasted that the demand for total polyamide fibers will increase by 11.7%. Growth rate for caprolactam is also estimated to come close to 12.2%, with the demand reaching 2.2 million tons in the four areas as a whole.

Future prices of caprolactam will generally be upward, since the price of benzene, the raw material, will either remaining on the same level or increasing.

(d) Polyamide Fiber

Since the development of nylon by E. I du Pont de Nemours & Company in 1939 as the first noncellulosic fiber, the demand has made a rapid increase. In spite of the recent high competition with polyester fiber and acrylic fiber, nylon is still enjoying its largest share as shown in the following table.

World Consumption of Synthetic Fiber

(Unit : Million tons)

	1969 Consumption	Share
Polyamide fiber	1.8	40.9
Polyester fiber	1.4	31.8
Acrylic fiber	0.9	20.4
Other synthetic fibers	0.3	6.9
Total	4.4	100.0

Polyamide fibers are made from long chain polymers in which receiving amide groups (- CONH -) form an integral part of the main polymer chain. They are widely known by the generic term "nylon".

There are many kind of polyamide fibers as shown in the following table.

The Type of Nylon & Developed Companies

Type	Developed Companies	Law Material
Nylon 66	Du Pont (USA)	Adipic acid hexamethylene-diamine
Nylon 6	Prof. P. Schlach (W. Germany)	Caproactam
Nylon 11	Aquitaina-Organico (France)	11-aminoundecanoic acid
Nylon 610	Du Pont (USA)	Hexamethylenediamin sebacic acid
Nylon 4	Minesota Mining & Mtb. Co.	2-pyrrolidone
	GAF Corporation	
	ICI America, Inc. (USA)	
Nylon 7	USSR	7-aminoheptanoic acid

Besides those indicated above, there are many types of nylons such as Nylon 12, Nylon 3, Nylon 8 and MXD-6 although they have not been commercially proved yet.

Of all nylons, Nylon 66 and Nylon 6 have overwhelmingly large share. At present, demand for Nylon 66 exceeds Nylon 6 in USA, UK and France and vice versa in W. Germany, Japan, Italy and Netherlands. The demand and capacity of Polyamide fiber in Table IV-1 include all these nylons. The total demand in the said four areas for the five years from 1965 to 1970 is more than 15% in annual average and is expected to reach 1.87 million tons by the end of 1970. Geographically, W. Europe, increase of 17.7% in annual average is observed. North America is the biggest market for W. Europe. The following table shows end use pattern of polyamide fiber in USA.

End Use Pattern of Polyamide Fiber in USA

Tire Cord	28.5%
Apparel	28.1
Home Furnishings	27.3
Industrial Uses	8.2
Other Consumer Product	7.9

Tire cord, apparel and home furnishings are on the nearly same line at about 28% in the end use. The end use pattern in W. Europe is not known, but the share of tire cord is much lower than USA and the share of apparel and home furnishings is higher. The prices of Nylon 66 and Nylon 6 in the main countries in 1965 and 1970 are shown in the following table.

Nylon Prices in the Main Countries

(Unit : ¢/lb)

Grade	Countries	1965	1970
	USA	90.00	90.00
Nylon 6	UK	80.50	63.00
general purpose	Japan	82.00	63.00
(10 ton lots)	W. Germany	87.70	96.10
	France	89.80	61.30
	Italy	78.40	59.20

Grade	Countries	1965	1970
	USA	90.00	90.00
Nylon 66	UK	80.50	63.00
general purpose	Japan	-	-
(10 ton lots)	W. Germany	93.50	102.30
	France	101.80	91.60
	Italy	76.20	70.00

* Average price of polyamide fiber in Japan

Source : Ref. 4

From the above table, the prices of Nylon 66 and Nylon 6 in USA has not changed at the level of 90 ¢/lb. In W. Germany the prices of both Nylon 66 and Nylon 6 increased by about 9% from 1965 and in the other main countries, prices have all decreased; that is, decrease by 20% for both Nylon 66 and Nylon 6 in UK and by 31.8% for Nylon 66 and 10.2% for Nylon 6 in France, and by 24.6% for Nylon 6 and 8.2% for Nylon 66 in Italy. The expected growth rate of polyamide fiber is stable at 11.7% as a total of the said four areas, reaching 3.25 million tons by 1975. Geographically, the increase in Latin America and Southeast Asia is expected prominent such as 23% and 17%, respectively. The increase in North America and W. Europe is also expected stable at 9%, reaching 1.2 million tons and 1.1 million tons, respectively.

Annex Q - 13 shows the new and additional installations. At this moment, the installations in North America are unexpectedly low. This is because of 222,000 t/y of new or additional installations already made in 1970. In W. Europe, the plan of only 69,000 tons are announced. They are not much interested in the expansion in W. Europe and Southeast Asia by the fact that they want to delay their plan for the next time due mainly to the recent regulation problem of fiber import by USA.

(e) TDI

Approximately 90% of TDI is used for the manufacture of urethane foam. Accordingly, the demand for TDI is largely dependent upon the demand for foam. As can be seen in the table below, the demand for polyurethane foam marked rapid growth rates during the past five years; 14.3% in the USA and 17.3% in W. Europe.

Demand for Urethane in USA and W. Europe

(Unit : 1,000 tons)

	USA		W. Europe	
	1965	1970	1965	1970
Flexible foam	100	230	144	290
Rigid foam	38	91	17	60
Surface coatings	12	27	12	28
Solid elastomers	6	11	4	12
Sealants	4	6	-	-
Fibers	3)	9	4	7
Miscellaneous	19)		-	3
Total	182	374	181	400

Source : Ref. 11, 6

With the increase in the urethane demand, the TDI demand also increased rapidly. During five years from 1965 to 1970 the rate of increase was 13.8% in North America, 17.6% in W. Europe, and 20.6% in Southeast Asia, respectively. The demand in Latin America is unknown, due to inavailability of statistical data.

The TDI prices in the main countries are as follows:

TDI Prices in the Main Countries

(Unit : ¢/lb)

Grade	Countries	1965	1970
	USA	65.0	37.0
TDI 80%	UK	51.3	37.1
	Japan	20.2	17.2
	W. Germany	47.6	41.8
2,4-isomer	France	45.3	38.7
	Italy	50.8	34.3

The prices for 1970 represent a large fall over 1965 in countries other than Japan. However, TDI has been running short for the last two years everywhere in the world because of the rise in the polyurethane demand, and hence the price trend is upward.

As mentioned before, future demand for TDI largely depends upon the demand for polyurethane. In light of Modern Plastics, future demand for polyurethane foam is based on the anticipation that demand will grow at an annual rate of 11%, as seen in the table below. A Japanese institute estimates that the annual average rate of increase in the demand for polyurethane foam in Japan will be 22%. Thus, anticipation is that demand for polyurethane foam will considerably increase.

Demand for Polyurethane Foam in USA

(Unit : 1,000 tons)

	1970	1975	1980
Flexible foam	118	196	303
Rigid foam	45	80	128
Total	163	276	431

Accordingly, a similar rate of increase can be anticipated for the TDI demand. The demand is estimated to be 17.2% in North America, 16.1% in W. Europe, and 23.1% in Southeast Asia, respectively, with the total demand reaching 585,000 tons in 1975 in the four areas as whole.

Future TDI price will be affected to some extent by the price of toluene, the raw material for TDI, because amount of toluene mixed with gasoline is increasing, and toluene prices will enjoy an upward trend due to this mixing use.

(f) DMT

DMT is derived from terephthalic acid by esterification with methanol. A greater part of DMT is used to make polyethylene terephthalate, the polymer from which polyester fibers and films are formed. The DMT demand, therefore, is always in parallel with the polyester fiber demand. As will be described later, the polyester fiber demand in the total four areas during five years from 1965 to 1970 showed an annual rate of increase of 26%. In line with this rate, an increase of the DMT demand was 28%. The demand is estimated to reach 1.79 million tons in 1970 in the total four areas.

The DMT price is not given in the price table in "European Chemical News" or "Oil, Paint and Drug Reporter", therefore, price comparison by country is impossible. At present, DMT is reportedly on sales at a price of 15 - 17 cents per pound in the USA and 20 - 23 cents in Japan.

It is estimated that future demand for DMT will grow at a rate of 17% - similar rate to that in the polyester fiber demand - and will reach 3.82 million tons in 1975 in the total four areas. DMT producers are now actively working on plans for new construction and expansion of equipment, in answer to the strong demand for polyester fibers.

In the USA, Amoco Chemical and Hercules have announced their expansion plans to produce a total of 110,000 tons of DMT annually. Du Pont and Eastman have already decided expansion of polyester fiber equipment, so that plans will soon follow on the expansion of DMT equipment.

In Europe, Hoechst announced plans to construct a 45,000 t/y plant in W. Germany and a 84,000 t/y plant in the Netherlands, aiming at completion in 1972. ICI is planning on construction of a new plant at a cost of $24 million. Thus, Europe as a whole will have capacity of 1 million tons per year by 1973.

(g) Polyester Fiber

Since the original patents on polyester fibers have expired in most countries, the original producers - ICI and Du Pont - have been joined by many other companies. This is partly because of the strong demand for polyester fibers and partly because of its fierce competition with other synthetics in nearly all textile markets. During five years from 1965 to 1970 the total demand in the four areas has increased at an annual average rate of 26.6%, marking the highest rate among the three major synthetic fibers. Polyester fiber is divided into two forms - staple and filament yarn. Staple is generally combined with other materials into a polyester/cotton, polyester/wool, or polyester/rayon blend, to take advantages of such qualities imparted by the polyester as abrasion resistance and wrinkle resistance. The latter, filament yarn, is mostly used in knit goods (particularly textile yarn) and in tire cord.

The following table gives end use pattern of polyester fiber in USA.

End Use Pattern of Polyester Fibers in USA

(Unit : %)

Broadwoven apparel and home furnishings	44.5
Bed sheets	7.1
Carpets and rugs	8.2
Jersey and other knits	4.6
Double knits	3.2
Industrial use	2.7
Fiberfill	3.9
Miscellaneous	1.2
Staple total	75.4
Tire cord	11.0
Textile yarn	11.0
Industrial use	2.1
Carpets	0.5
Filament yarn total	24.6
Total	100.0

Polyester fibers are made in a large and changing variety of deniers number of filaments per multifilament yarn and grades by countries. This makes it difficult to compare the prices and follow up the price history.

The following table gives some examples of polyester fiber prices that are comparable in USA, UK and Japan.

Polyester Fiber Prices in USA, UK and Japan

(Unit : ¢/lb)

		USA	UK	Japan
Filament	50 deniers	180-185	150	161-164
	100 deniers	163-168	140	145-151
Staple		61-63	62-67	54-62

It is estimated that future demand for polyester fibers will mark the highest growth of all three major synthetic fibers, so that in 1975 polyester demand may catch up with that of polyamide. For the total four areas the demand is estimated to grow at an annual average rate of 17.2% by 1975, reaching 3.13 million tons.

Now construction or expansion programs now announced are given in Table Q-14, which indicates 285,000 t/y in USA and 210,000 t/y in W. Europe.

2. Customs Barriers and Other Regulations

1) GATT

Almost all countries have customs to protect their domestic industries and to maintain the financial income and balance of payment. The customs policy is based on tariff autonomy and the customs system and tariff rates differ by each country which are very closely related to the nations economic and diplomatic polices.

In the World Panic of 1930's, each nation took policy of higher tariff, allocation of import material and exchange control to maintain the nations employment level. This policy led to the raising of protectionism, which created the interruption of the development of the international trade with the depression grown. From this bitter experience, the first tariff negotiation was held in Geneve in 1947 and GATT (The General Agreement of Tariff and Trade) was drafted and came into effect on January 1, 1948. GATT is to provide a framework within which negotiations can be held for the reduction of tariffs and other trade barriers and for embodying the results of these negotiations in a legal instrument. In accordance with the fundamental principles of GATT, six main negotiating sessions were held. The negotiating session in 1964 - 1967, so-called "Kennedy Round" was the most significant one that has been held. In this Kennedy Round session, it was promised that tariff be reduced by 50% for the period of five years up to 1972 and each nation is now the process of the reduction of tariff.

Two procedures are being considered for the reduction of tariff.

a) To reduce tariff on January 1, 1968 by 20% of the difference between the standard tariff rate and the final concession rate and to continue to make reduction by 20% on January 1 of each year up to 1972. Australia, Austria, Canada, Chile, Ireland, New Zealand, Peru, Portugal, South Africa, Switzerland, Turkey, USA and Yugoslavia are.

b) To reduce the tariff on July 1, 1968 by 40% of the difference between the standard tariff rate and final concession rate and then to make reduction by 20% on January 1 of each year from 1970 to 1972. The following nations are taking this case. Czechoslovakia, Denmark, EEC (6 countries), Finland, Greece, Israel, Japan, Norway, Spain, Sweden, Trinidad and Tobago and UK.

It was said that the tariff concessions agreed upon involved over $40 billion in international trade and 60,000 different commodities and that the countries which directly participated in the negotiations represented approximately 80% of total world trade. At the General Session in Autumn of 1967, the policy of (1) trade of industrial material, (2) trade of agricultural products and (3) the development of trade of the developing countries has been decided. Presently, a measure to further remove the tariff barriers after the complete execution of the Kennedy Round and also to take off or reduce the trade barriers are being discussed. In this way GATT is now a treasure to the development of the international trade. The execution of the Kennedy Round has made it a rule to reduce the tariff collectively, not individual reduction by each country. In the broader aspect of the development of the international trade, the tariff barriers and the other obstacle for the trades will be undoubtedly diminished in the future.

2) Customs Tariff and Other Regulations of Selected Petrochemicals

Annex R-1 shows for quick reference, tariffs in W. Europe, North America, Latin America of the selected petrochemicals. When imposing duties, there are two systems (1) Ad Valorem Duties System which is based on the prices of the imported commodities and (2) Specific Duties System which is based on number and size of the imported commodities. Ad Valorem Duties System is being employed by EEC countries, Sweden, Canada, Brazil, Argentina, etc. and Specific Duties System by Venezuela. In USA, Mexico and Peru, the combination of Ad Valorem Duties System and Specific Duties System is employed. The assessable price to be applied for duties in Ad Valorem Duties System varies by each country as shown in Annex R-1 .

Annex R - 2 shows the import taxes other than duties in each country. This is mainly intended for financial incomes, reflecting economical and polytical situations of each nation.

As stated above, rates of duties and other import taxes vary by each nation and yet these rates have a great effect on the export prices. Accordingly in the actual practice of export, full study should be made of the duties and the related information in each nation.

3. Export Possibility of Selected Petrochemicals

1) Delivered Prices

In the case where selected petrochemicals are exportd from Trinidad and Tobago to North America, UK, other countries of W. Europe, Southeast Asia and Latin America, the rough delivered prices for users in these areas and countries are estimated as indicated in Table VII-1.

Primarily, the delivered prices are to be calculated at the time when these petrochemicals are produced. However as there are so many uncertainties such as custom duty and other taxes, freight rate and insurances in each area in the future, calculation based on assumption of these uncertainties will only widen the range of the observational error. In this study the calculation was made based on the present freight rate, insurances and custom duty and other taxes. The calculation method and assumption employed are as follows.

Delivered Price = Selling Price + Freight Charge + Insurance + Custom Duty and Other Taxes + Other Expenses

(a) The freight rates are subject to change by the size of the ship, amount to be loaded, the liner services established or not, whether the ship has cargo on one trip or round trip. In this study the following freight rate was used.

<u>Liner Rate for Solid Products in Bags or Bulk</u>

Port of Spain -	US East Coast	US $24.00/M.T.
"	W. Europe	US $19.25/M.T.
"	Argentina	US $23.00/M.T.
"	Japan	US $33.00/M.T.

Source : Ref. 9, 10

Liner Rate for Liquid Cargoes

Port of Spain -	US East Coast	US $25.00/M.T.
"	W. Europe	US $22.75/M.T.
"	Argentina	US $25.75/M.T.
"	Japan	US $43.50/M.T.

Source : Ref. 9, 10

The information given relates to ships of a size between 2,500 - 10,000 tons. Under liner terms all expenses are paid by the shipping company. All the vessels engaged in transporting liquid cargoes like those under consideration operate on a long term contract basis to manufacturers and neither tramp nor liner rates are available.

(b) Insurance

The insurance rate depends upon the properties of commodities, frequency of occurance of risk at the port and during the navigation and the scope of damage compensation. In this study the following equation was used for the calculation of the insurance.

Insurance = (CIF price x 110%) x 2%

(c) Import Duty and Other Taxes

The number for 1970 in Annex R-1, 2 was employed for the calculation of the import duty and other taxes.

(d) Other Expenses

This item includes agenda or commission paid to distributors or miscellaneous items which are not included in a) - c) and these expenses are calculated at 10% of CIF prices of all products.

2) Export Possibility of Selected Petrochemicals

As mentioned in Section III-1, in the developed countries in petrochemical industry such as USA, Japan, UK, W. Germany, and France, the chemical companies are making efforts to reduce the costs of petrochemicals by such steps as scale-up of plant capacity, development of new process and integrated utilization of raw materials in order to cope with the ever-intensifying competition in both the domestic and overseas markets, and these countries are far superior to other in international competition. In these countries the demands of almost all petrochemicals are selfsufficient and they are exporting a considerable portion of their production into the international market. Therefore, Trinidad and Tobago petrochemical industry have to compeat with the big chemical companies of the developed countries in the world market. It is almost difficult at present to know exactly how many quantities of petrochemicals can be exported to each area or country. In this respect, it seems necessary in the future to conduct a more detailed marketing study for each country.

In this report, prices of the petrochemicals delivered from Trinidad and Tobago are compared with domestic prices in each area, to examine the competitiveness of the Trinidad and Tobago petrochemicals in each area.

The export possibility is not determined, of course, by the low prices only, but also by the supply and demand balance of a product, custom duty system and 'the specific circumstances under which individual users are placed. Future surveys will be necessary to analyse these latter factors.

Table VII-1 gives comparisons of the delivered prices of the petrochemicals from Trinidad and Tobago to each area and the domestic prices of the corresponding products in each area, wherein both prices are calculated in a manner described in the previous paragraph. These comparisons reveal that in general, most of the Trinidad and Tobago petrochemicals are kept competitive in W. Europe including the UK, whereas in Southeast Asia those products other than maleic anhydride, and DMT are not competitive. In North America, 13 commodities including LDPE, HDPE, maleic anhydride, etc. are kept competitive, while other 5 commodities including VCM, styrene, alkylbenzene, etc. are not.

a) Export possibility to North America

The following table shows the competition of Trinidad and Tobago Petrochemicals in North America market.

Competitive	Incompetitive
1. LDPE	1. VCM
2. HDPE	2. Styrene
3. PVC	3. PG
4. Polystyrene	4. Alkylbenzene
5. Acrylonitrile	5. DMT
6. Acrylic fiber	
7. PP	
8. SBR	
9. Maletic anhydride	
10. Caprolactam	
11. Polyamide fiber	
12. TDI	
13. Polyester fiber	

Final products such as plastics, synthetic fibers, synthetic rubber, etc. are competitive, whereas intermediates such as VCM, Styrene, and DMT are not competitive.

Of the 13 competitive petrochemicals, acrylic fiber, polyamide fiber, polyester fiber, PP, and SBR have rather large differences between delivered and domestic prices. On the other hand, differences are small between the two prices of acrylonitrile, LDPE, HDPE, and polystyrene. If market situations for the latter group worsen, then there is a fear that those products of the latter group can hardly stand in the markets.

b) Export possibility to UK

The United Kingdom has adopted the preferential tariff system for the goods imported from the British Commonwealth of nations, and thus petrochemicals are imported tax-free from these nations. This situation enables most of the petrochemicals from Trinidad and Tobago to stand competitive in the UK market.

c) Export possibility to Other West European Countries

All the products, except SBR and PG, are competitive in other West European countries. However, differences between the delivered and the domestic prices are small in LDPE, VCM, styrene, and polyamide fiber. Depending on future changes in the market situations, therefore, these products may lose their competitiveness.

d) Export possibility to Southeast Asia

Since it is difficult to obtain data on average domestic prices of petrochemicals in each Southeast Asian country, Table VII-1 gives only domestic prices in Japan. Japanese petrochemicals have been occupying very large market shares in Southeast Asia, so that domestic prices of petrochemicals are inevitably influenced by the prices in Japan. The exports prices of Japanese products forwarded to Southeast Asia are lower than domestic prices in Japan. It can be said, therefore, that those products are not also competitive in Southeast Asia, unless their prices can compete against the domestic prices in Japan.

In view of the above discussion, most of petrochemicals are incompetitive in this area, with exceptions of maleic anhydride, and DMT. (The delivered price of SBR is lower than the domestic price, however considering the existence of the biggest suppliers of natural rubber in the world such as Malaysia and Indonesia, there is no possibility to export SBR to this area.) Southeast Asia is far distant from Trinidad and Tobago, and freight charges will be high, accordingly. Furthermore, Southeast Asia has long been large markets of Japanese products. These circumstance makes almost impossible the exports from Trinidad and Tobago to this area.

e) Export Possibility to Latin America

CIF prices are compared here, because of the difficulties in obtaining data on average domestic prices in Latin America. According to these comparisons, most of the commodities are competitive. The Trinidad and Tobago petrochemicals will be able to take a more advantageous position in Latin America, than do the products from the USA or W. Europe, owing to the close distance to the markets.

Petrochemical industries in the Latin American countries are on different development stages. For example, Mexico, Brazil, and Argentina have already established their own petrochemical industries and will go on to further develop them. Venezuela, Colombia, Peru, and Chile, on the other hand, are now beginning to start their petrochemical project.

Bolivia, Chile, Colombia, Ecuador, and Peru have organized the Andean Group with a view to tax- free trade of petrochemicals among the Group nations, while setting up an agreed high tariff barrier against those petrochemicals imported from outside the Group, so that their own industries may be protected.

Even Latin American leading countries in this field - Argentina and Brazil - have been applying high tariff rates to petrochemical imports, because their own industries have just been industrialized and thus have only weak competitiveness. Their high-tariff policies are extremely severe, as can be seen in the following table, which shows 30% or more of tariff rates imposed on major petrochemicals.

Products	Argentina %	Brazil %
LDPE	100	45
HDPE	100	45
VCM	60	30
PVC	100	55
Styrene	60	*
Polystyrene	100	55
Acrylic fiber	70	30
PP	60	55
Acrylic fiber	70	30
PP	60	55
SBR	100	*
Maleic anhydride	*	37
Alkylbenzene	n.a.	37
Nylon 6	70	30
Polyester fiber	70	30

* less than 30%

In Mexico, petrochemical industries has developed under the mexicanization policy. At present, the proportion of self-sufficiency of petrochemicals is more than 80%, and imports of petrochemicals are decreasing year by year.

Thus as long as CIF prices are compared, the Trinidad and Tobago products are still competitive in the Latin American market, however, all indications of the present market situations are that Latin America won't be a market for continuous exports, but only a spot market (i.e., a market for emergency imports on the occasions of unbalanced demand and supply).

TABLE VII - 1

EXPORTABILITIES OF SELECTED PETROCHEMICALS

Petrochemicals	Selling Price	UK		Other European Countires		North America		Southeast Asia		Latin America	
		Delivered Price	Domestic Price	Delivered Price	Domestic Price	Delivered Price	Domestic Price	Delivered Price	Domestic Price	CIF Price from T & T	CIF Price at Latin America
LDPE	168.47	211	353	270	292	286	287	342	287	195	226
HDPE	229.80	280	474	360	488	363	397	411	386	258	375
VCM	93.27	130	n.a.	165	180	191	110	172	147	123	n.a.
PVC	139.41	178	294	227	318	236	309	219	218	166	305
Styrene	112.05	151	198	180	208	213	176	196	186	140	200
Polystyrene	191.13	236	298	307	332	315	326	283	258	218	323
PG	203.26	254	310	325	301	326	287	319	206	236	278
Acrylonitrile	177.69	225	311	277	438	283	320	279	291	208	340
Acrylic Fiber	1,105.83	1,265	1,760	1,566	n.a.	1,310	1,963	1,485	1,110	1,154	1,440
PP	206.02	253	534	326	584	331	463	398	367	234	430
SBR	238.64	290	325	346	328	295	391	306	349	267	345
Maleic Anhydride	154.72	200	400	245	473	284	353	250	300	184	350
Alkylbenzene	143.93	188	n.a.	230	n.a.	270	232	230	221	173	205
Caprolactam	319.05	385	n.a.	470	n.a.	480	540	458	410	352	440
Polyamide Fiber	1,073.03	1,226	1,390	1,520	1,936	1,273	1,984	1,444	1,696	1,120	1,960
TDI	469.47	555	817	688	843	690	815	650	380	507	780
DMT	287.23	348	n.a.	430	n.a.	378	330	426	503	319	385
Polyester Fiber	1,022.44	1,170	1,440	1,420	n.a.	1,216	1,525	1,376	1,276	1,068	1,520

Remarks : Refer to Annex ''. as the calculation basis for delivered price and domestic price.

VIII. The Rate of Return on Investment and the Recommended Complex Scheme

1. FOB Prices at Trinidad

Calculation of rates of return on investments necessitates determination of selling prices of each selected petrochemicals; especially determination of FOB prices in the case of Trinidad and Tobago, where total petrochemicals will have to be exported.

FOB prices vary by market; a product may be exported to a market at a dumping price, while it may be exported to another market at a highly profitable price, so as to bring a proper profit on an average.

Now that markets concerned, or volumes of sales in each of them, are not fixed, we had difficulties in determining, by country, the reliable FOB prices and the volumes of sales. We, therefore, tried to obtain an average FOB price at Trinidad, which would be able to stand in the world market, in order to calculate the rates of return on investments.

The FOB prices at Trinidad were calculated according to the following equation:

FOB price = Domestic price - (Freight rate + Insurance + Custom duty and other taxes + Other expenses)

VII-3)-1) gives figures of all factors included in this equation, from which the FOB prices at Trinidad were calculated for the products sent to the USA, UK, France, W. Germany, Italy, and Japan. From these prices was then obtained an average FOB price at Trinidad.

Accordingly, it is noted that the findings on the export possibility to each area, do not always coincide with the findings on the rates of return on investments calculated upon an average FOB price at Trinidad of each selected petrochemicals.

2. The Rate of Return on Investment

The rate of return on investment with each petrochemical product was calculated by the discounted cash flow method.
The results are shown in Table VIII-1 and for detail refer to Annex O.
The calculation was done upon the following assumptions.

1) The factory price of the petrochemical is assumed equal to the T&T FOB price which is shown in the above section VIII-1.
In other words the profit is taken as the balance between the net production cost and T&T FOB price.

2) All of the plant capital is invested by a year prior to the start of operation.

3) The project covers the 10 years period after the start of operation. The declining balance method of depreciation for 10 years is used and the salvage value is nil.

4) The tax holiday provision for 5 years is adopted, and after the 5th year the corporate tax rate of 45% is charged.

5) As to the final product which is produced via intermediate product in the Complex, the consolidated rate of return on investment is calculated. For example as to PVC (expressed as VCM-PVC), VCM is delivered to PVC plant at VCM net manufacturing cost, and the cash flow obtained from PVC selling is taken as the cash flow to VCM-PVC consolidated plant.

6) As to basic Materials (ethylene, propylene, butadiene, benzene, toluene, xylene, p-xylene), the uniform rate of return on investment of 10.3% (net income of 10% of C.I) is used and these basic materials are not subjected to consolidation.

3. Recommended Complex Scheme

The recommended complex scheme was derived by examining the rate of return on investment with each petrochemical product, and is shown in Fig. VIII-1.

Table VIII-1

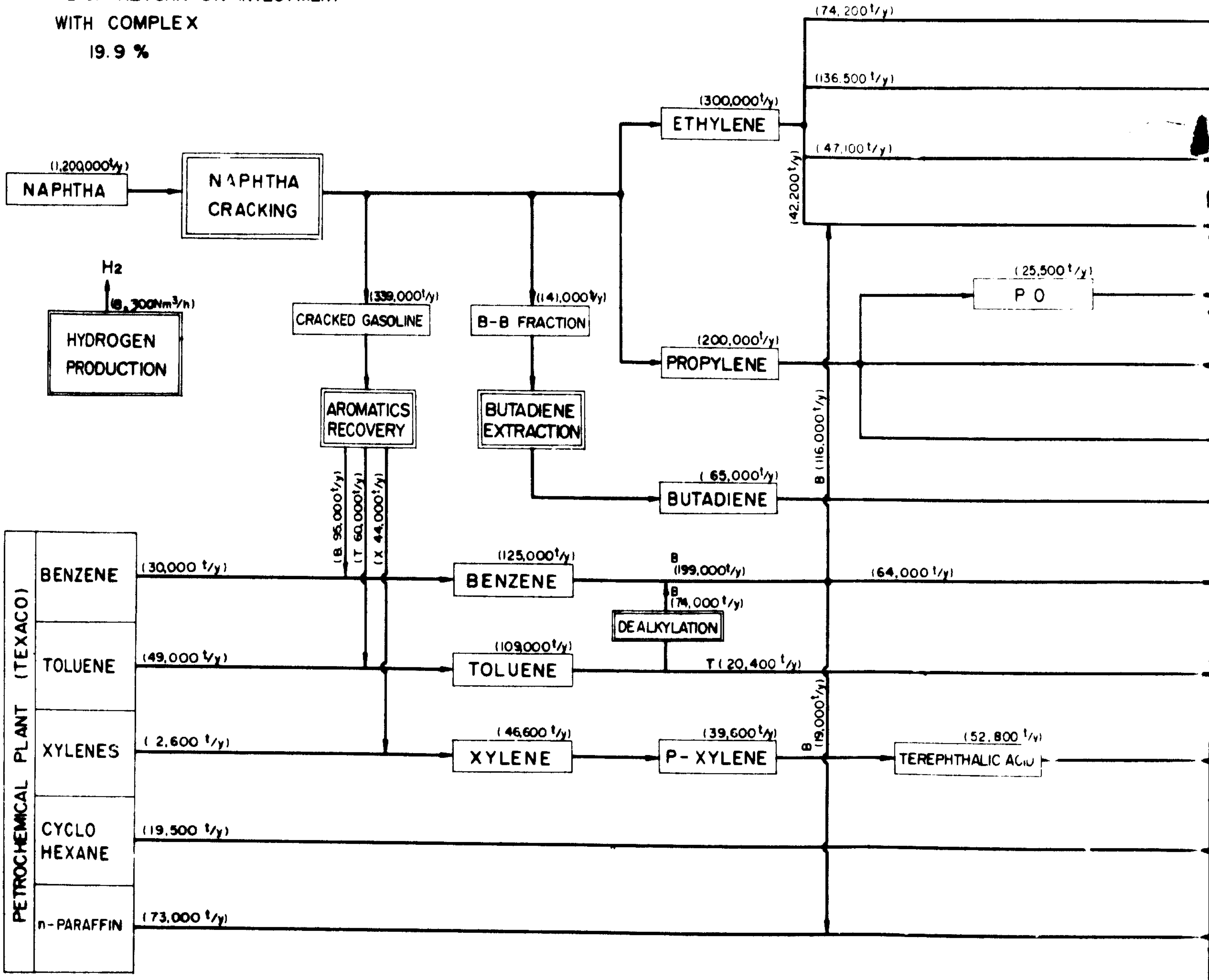
T&T FOB Price and Rate of Return on Investment

	(1) Total Capital Investment (1,000 $)	(2) Total Sales Amount (t/y)	(3) T & T FOB Price ($/t)	(4),(2)x(3) Total Sales Value (1,000 $/t)	(5) Net Manufacturing Cost per Unit ($/t)	(6),(2)x(5) Total Manufacturing Cost (1,000 $/y)	(7),(4)-(6) Total Net Profit (1,000 $/t)	(8) From(1)&(7) Rate of Return on Investment (%)
① LDPE	31,100	130,000	162.6	21,190	144.55	18,793	2,397	8.2
② HDPE	27,140	70,000	266.2	18,620	191.03	13,372	5,248	18.4
3. VCM	7,990	98,000	87.3	8,526	85.12	8,346	180	2.6
* ④ VCM - PVC	15,750	93,000	187.4	17,391	122.36	11,381	6,010	31.8
5. STYRENE	13,830	136,000	111.5	15,232	101.88	13,877	1,355	10.2
* ⑥ STYRENE - POLYSTYRENE	31,475	110,000	194.5	21,450	162.99	17,956	3,494	11.4
* ⑦ PO - PG	5,400	30,000	201.9	6,060	185.38	5,561	499	9.7
⑧ ACRYLONITRILE	11,410	44,800	249.1	11,155	152.22	6,823	4,332	31.7
* 9. ACRYLONITRILE-POLYACRYLONITRILE-F	28,630	12,000	1,213.5	14,568	861.14	10,429	4,139	14.4
* ⑩. P P	31,200	100,000	297.5	29,800	174.82	17,482	12,318	32.0
* ⑪. STYRENE - SBR	18,295	83,000	264.0	21,912	214.92	17,839	4,073	20.7
⑫. MALEIC ANHYDRIDE	9,650	50,000	197.2	9,850	135.42	6,913	2,937	26.6
⑬. LINEAR ALKYLBENZENE	7,200	50,000	148.7	7,450	129.53	6,476	974	13.6
14. CAPROLACTAM	11,460	17,700	311.0	5,505	254.30	4,501	1,004	9.3
* ⑮. CAPROLACTAM - NYLON-6-F	37,030	18,000	1,177.7	21,204	864.43	15,554	5,650	15.1
⑯. TDI	21,410	30,000	596.4	17,880	398.10	11,942	5,938	24.7
* ⑰. TEREPHTHALIC ACID - DMT	24,940	61,400	304.4	18,666	247.05	15,170	3,496	14.0
* 18. TEREPHTHALIC ACID - DMT - POLYESTER-F	22,600	12,000	1,055.7	12,672	832.76	9,993	2,679	12.1
** ⑲. TOTAL COMPLEX	323,351	-	-	261,562	-	199,078	62,484	19.9

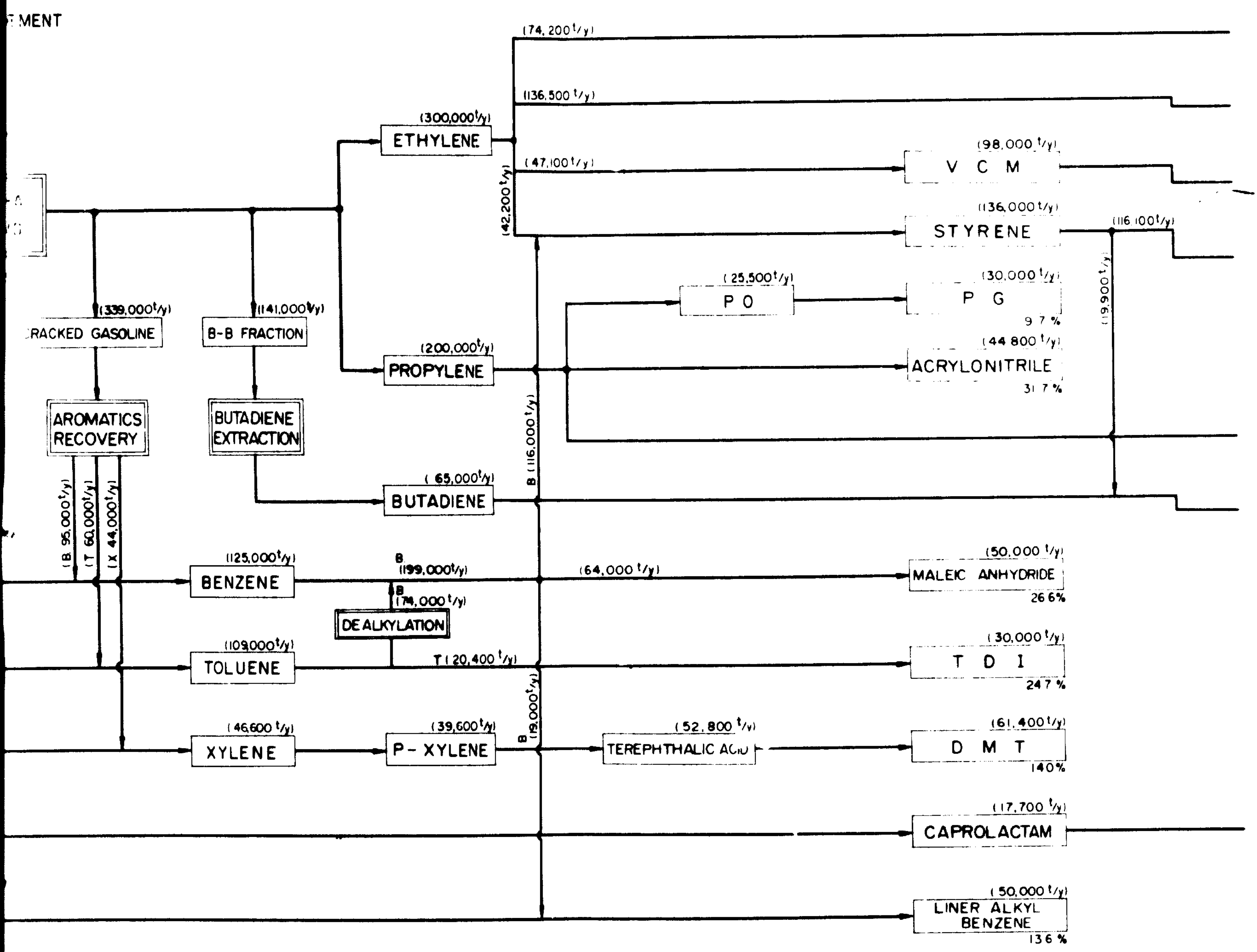
* Consolidated Rate of Return in calculated, Refer to Annex N.

** TOTAL COMPLEX consists of ○ marked commodity production, naphtha cracker, hydrogen production, aromatics recovery, toluene dealkylation, and butadiene extraction plants.

OVERALL RATE OF RETURN ON INVESTMENT
WITH COMPLEX
19.9 %

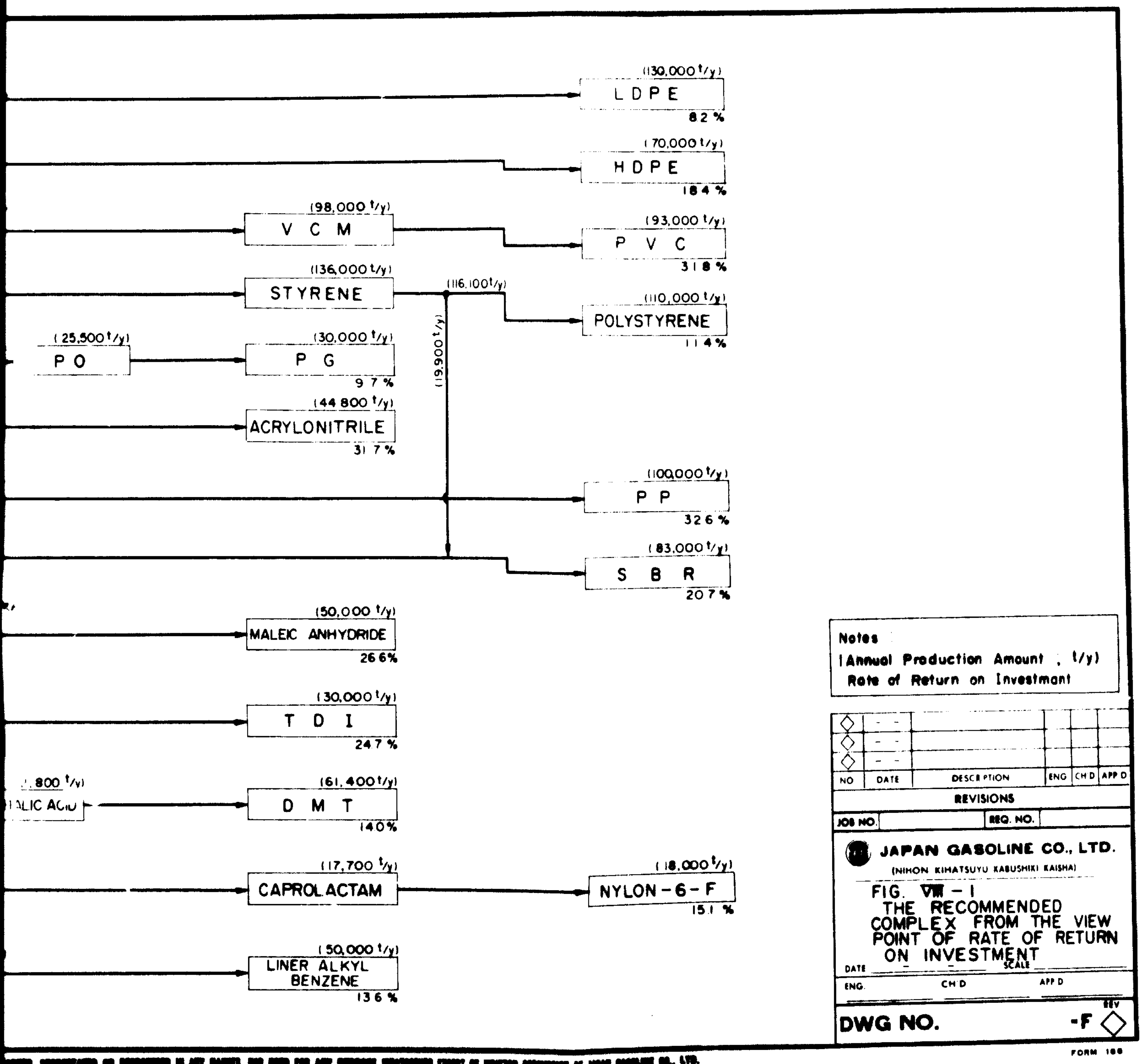


SECTION 1



MENT
(74,200 t/y)
(136,500 t/y)
(300,000 t/y)
ETHYLENE
(47,100 t/y)
(98,000 t/y)
V C M
(42,200 t/y)
(136,000 t/y)
STYRENE
(116,100 t/y)
(19,900 t/y)
(25,500 t/y)
P O
(30,000 t/y)
P G
9.7 %
(339,000 t/y)
CRACKED GASOLINE
(141,000 t/y)
B-B FRACTION
(200,000 t/y)
PROPYLENE
(44,800 t/y)
ACRYLONITRILE
31.7 %
B (116,000 t/y)
AROMATICS RECOVERY
BUTADIENE EXTRACTION
(65,000 t/y)
BUTADIENE
(B 95,000 t/y)
(T 60,000 t/y)
(X 44,000 t/y)
(125,000 t/y)
BENZENE
B (199,000 t/y)
(64,000 t/y)
(50,000 t/y)
MALEIC ANHYDRIDE
26.6 %
B (74,000 t/y)
DEALKYLATION
(109,000 t/y)
TOLUENE
T (20,400 t/y)
(30,000 t/y)
T D I
24.7 %
B (19,000 t/y)
(46,600 t/y)
XYLENE
(39,600 t/y)
P-XYLENE
(52,800 t/y)
TEREPHTHALIC ACID
(61,400 t/y)
D M T
14.0 %
(17,700 t/y)
CAPROLACTAM
(50,000 t/y)
LINER ALKYL BENZENE
13.6 %

SECTION 2



(130,000 t/y)
LDPE
8.2 %
(70,000 t/y)
HDPE
18.4 %
(98,000 t/y)
V C M
(93,000 t/y)
P V C
31.8 %
(136,000 t/y)
STYRENE
(116,100 t/y)
(110,000 t/y)
POLYSTYRENE
11.4 %
(19,900 t/y)
(25,500 t/y)
P O
(30,000 t/y)
P G
9.7 %
(44,800 t/y)
ACRYLONITRILE
31.7 %
(100,000 t/y)
P P
32.6 %
(83,000 t/y)
S B R
20.7 %
(50,000 t/y)
MALEIC ANHYDRIDE
26.6 %
(30,000 t/y)
T D I
24.7 %
(61,400 t/y)
D M T
14.0 %
(17,700 t/y)
CAPROLACTAM
(18,000 t/y)
NYLON-6-F
15.1 %
(50,000 t/y)
LINER ALKYL BENZENE
13.6 %
Notes
(Annual Production Amount, t/y)
Rate of Return on Investment
NO
DATE
DESCRIPTION
ENG
CH D
APP D
REVISIONS
JOB NO.
REQ. NO.
JAPAN GASOLINE CO., LTD.
(NIHON KIHATSUYU KABUSHIKI KAISHA)
FIG. VII-1
THE RECOMMENDED COMPLEX FROM THE VIEW POINT OF RATE OF RETURN ON INVESTMENT
DATE
SCALE
ENG.
CH D
APP D
DWG NO.
-F
REV
FORM 100

SECTION 3

2778
(2 of 2)

MACROSCOPIC MARKET SURVEY AND EVALUATION OF EXPORT POSSIBILITIES FOR PETROCHEMICALS FROM TRINIDAD AND TOBAGO

ANNEXES

FEBRUARY 1971

JAPAN GASOLINE CO., LTD.

TOKYO, JAPAN

UNIDO CONTRACT NO. 70/36
SERIAL NO. 2 5

MACROSCOPIC MARKET SURVEY
AND
EVALUATION OF EXPORT POSSIBILITIES
FOR
PETROCHEMICALS FROM TRINIDAD AND TOBAGO
ANNEXES

Report prepared for the United Nations Industrial Development Organization acting as Participating and Executing Agency for the United Nations Development Program (Special Industrial Services).

FEBRUARY 1971

JAPAN GASOLINE CO., LTD.

TOKYO, JAPAN

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Annex A. Informations about Available Materials and Utilities provided by Industrial Development Corporation of Trinidad and Tobago.

1. Raw Materials

(1) Natural Gas

(a)	Quantity	300 - 500 MMSCF/D	(Prospective)
(b)	Composition Vol %	C_1 95	(Approx)
		C_2) C_3) 5	(Approx)
		H_2S, CO_2, N_2	Negligible
(c)	Pressure	300 PSIG	
(d)	Price *	15 US ¢/1000 SCF	

* Amoco has not as yet quoted a firm price for their natural gas to a petrochemical manufacture in Trinidad and Tobago. This price was advised by IDC at the Second Meeting between IDC and JGC Mission.

(2) # Naphtha from TEXACO

(a)	Quantity	Any Quantity available from Texaco	
(b)	Properties	S.G.	Not Specific
		Boiling Range	"
		S. Content	"
(c)	Price	33.30 TT $/ton	

Naphtha from Texaco Trinidad Inc (TTI) is produced as specialty naphthas for sale to various customers who would in turn utilise it for specific purposes. TTI does not at present produce naphtha for naphtha cracking hence any specification on this cannot be obtained. The price given in the study is an average export price of naphthas.

(3) Naphtha from TESORO

(a) Quantity 1,200,000 t/y (Prospective)

(b) Properties

Naphtha from the indigenous crude

Crude Quantity bbl/day	Naphtha Cut Boiling Range °C	Chemical Analysis P	O	N	A
		wt %			
60,000	100 - 150	39	0	42	19
	150 - 200	28	0	51	21
20,000	100 - 150	27	0	52	21
	150 - 200	5	0	71	24

IBP : The IBP of the naphtha will be determined by the IBP of the crude to be used.

EBP : Approx. 350°F

(c) Price : 6 - 6½ US ¢/gal
(22.02 $/t)

(d) Crude to be used (for reference) :
The imput to the refinery would be a combination of 80,000 bbl/day of local (indigenous) and 70,000 bbl/day of foreign-based crude which would possibly be imported from Nigeria.

The specification of the indigenous crude

Quantity bbl/day	Approx Chemical Analysis P	O	N	A	API Gravity	% light fraction	% gas oil D.I.53-57	% fuel oil
60,000	33	-	48	19	26	18.8	15.1	66.1
20,000	33	-	48	19	23	11.4	28.5	60.1

2. * Other Raw Materials from Texaco and Fedchem

	Quantity	Specification	Price
(1) Benzene	-	-	118.5 TT$/ton
(2) Toluene	-	-	-
(3) Xylenes	-	-	84.8 TT$/ton
(4) Cyclohexane	-	-	123.5 TT$/ton
(5) N-Paraffin	-	-	21.6 TT$/bbl
(6) Ammonia	-	-	-
(7) Urea	-	-	-

* The prices quoted in the study for these petrochemicals are based on the average f.o.b. price of the chemicals. With no idea of the quantity of each chemical to be demanded, the suppliers were not in a position to quote a selling price.

3. Utility Conditions

(1)	Steam	200 PSIA	0.044 TT¢/lb
(2)	Cooling Water		1 TT¢/1000 gal
(3)	Process Water	0 - 300,000 gal/D	30 TT¢/1000 gal
		300,000 - 650,000 gal/D	45 TT¢/1000 gal
(4)	Power	Shown in Page 13 - 14 of "IDC pre-Feasibility Studies"	
(5)	Fuel		TT 22.5¢/10^6 BTU

4. Labour Cost

(1)	Operator	2.8 TT$/Hr.
(2)	Chief and/or Supervisor	4.3 TT$/Hr.

5. Relative cost of complete process plant.

U.S. (Gulf Coast)	1.00
T.T.	1.05

6. Basis of Calculation.

The cost calculation is done by following the basis shown in "I.D.C. Pre-Feasibility Studies."

7. Fob. Price of Petrochemicals (U.S. $/Barrel)

(1)	Ammonia	n.a. **
(2)	Urea	n.a.
(3)	Ammonium Sulphate	n.a.
(4)	Benzene	$7.77 *
(5)	Toluene	$5.04 *
(6)	Xylene	$6.63 *

(7)	Nonene	n.a.
(8)	Dodecene	n.a.
(9)	Cyclohexane	$9.66 *
(10)	Di-isobutylene	$8.08 *
(11)	Naphtenic acids	$33.67 *
(12)	Normal paraffins	$10.80 *
(13)	Unfinished virgin Naphtha (Shell)	$7.98 *
(14)	Special Naphtha (Texaco)	$5.10 *
(15)	Middle Distillates	$2.54 *

* These are the average F.O.B. prices for the year 1969. These prices also take into consideration the variation that would exist in shipping to different countries and the various quantities shipped.

** n.a. - not available.

8. Condensate

(1) Quantity

(2) Properties

(3) Price

AMOCO has stated that the quantity of condensate associated with their natural gas is quite substantial. The Ministry of Petroleum and Mines, has calculated that this quantity could support an economic sized ethylene plant of approximately 200,000 tons/yr of ethylene. The condensate has a boiling range of approximately 60 - 100°. No price, not even some assumed or estimated value could be arrived at.

Annex B   Information from AMOCO International Oil Co.

AMOCO

AMOCO INTERNATIONAL OIL COMPANY

500 N. MICHIGAN AVENUE · P.O. BOX 8368 · CHICAGO, ILLINOIS 60680

September 9, 1970

File: ODG-422-414

Re: Gas Condensate Data
Trinidad

Mr. Hiroshi Yashiki, Managing Director
Japan Gasoline Company, Limited
New Ohtemachi Building
2-1, Ohtemachi 2-Chome, Chiyoda-ku
Tokyo, Japan

Dear Sir:

Your letter of August 20, 1970, addressed to our parent company, Standard Oil Company (Indiana), regarding operations offshore of Trinidad has been forwarded to this office for handling. Amoco International and its subsidiaries are responsible for oil and gas operations outside North America, including operations in Trinidad and Tobago.

Unfortunately, most of the questions raised in your letter cannot be answered at this time due to the comparatively early stage of our operation in Trinidad and Tobago. We are still involved in exploratory drilling and are unable to answer detailed questions concerning development plans.

We will not be in a position to predict output of natural gas and condensate nor their prices for quite some time. We are, however, furnishing you the attached tabulation reflecting a composite analysis of gas from two areas within the concession which have been found to be gas productive. The amount of condensate associated with the gas varies, but very roughly would be on the order of 25 barrels per million cubic feet of gas. The API gravity of conventionally separated condensate has ranged from 40° to 57°. We hasten to caution you that the ultimate make-up of a gas production stream will be a function of the relative amount of reserves discovered and placed on production from different areas in the concession. Therefore, gas composition could vary substantially from the data shown in the attachment. Nonetheless, this is the best information we have available.

Thank you for your interest in our company and its operations. Our Manager of Gas Sales, Mr. Robert M. Dunham, may be in contact with you in the future when such appears appropriate from the evolving situation in our operations.

Very truly yours,

COMPOSITE GAS ANALYSIS - TRINIDAD

COMPONENT	MOL PERCENT
H_2S	Nil
N_2	0.35
CO_2	0.36
C_1	94.48
C_2	2.92
C_3	1.08
iC_4	0.19
nC_4	0.28
C_5	0.16
C_6	0.07
C_7	0.11
	100.00

Weighted average of Southeast Galeota and Offshore Point Radix Analysis 9-16-69

JAPAN GASOLINE CO., LTD.

Subject: Memorandum
Talking with TEXACO

Date: 30-31 July 1970
Ch. H. Matsui

1) TEXACO is not, always, in a position to give anyone a long term assurance or guarantee of supplying raw materials such as naphtha because of existing commitments.

2) The quantity and price of raw materials are always subjects to be discussed with customer.

The supply of unlimited quantity of raw materials is not considered as a realistic matter.

However, it is TEXACO's policy to do everything possible to supply the oil and chemical raw material need of Trinidad Industry. The requirement of any potential customer would be carefully investigated and every effort made to supply on a commercial basis.

3) At present Trinidad and Tobago refinery's products are exported to United States, Puerto Rico (Union Carbide Corp.), Europe, etc.

4) TEXACO has no plan to expand the crude capacity of refinery plant in Trinidad and Tobago in near future.

CH Matsui 7.31.70

Annex D-1 Information about Naphtha from Trinidad and Tobago

Trinidad and Tobago
INDUSTRIAL DEVELOPMENT CORPORATION

P. O. Box 949, Port-of-Spain,
Trinidad, W.I.

Cables: IDCORP.

Telephones: 37291 - 37296

Please Quote Ref. No. when replying.

December 30, 1970.

Mr. Takayuki Iwaki,
Japan Gasoline Company Limited,
New Ohtemachi Building,
2-1 Ohtemachi 2-chome,
Chiyoda - Ku,
Tokyo, Japan.

Dear Sir,

Reference is made to your two previous letters of December 10 and 23, 1970.

We welcome the news that UNIDO has decided to revise the deadline for submission of the final report to late February 1971 and that you will now proceed to add a study of Naptha Utilization to the Interim Report.

Re your inquiry in your letter of December 10, we wish to advise that the following are the specifications of the crude to and Naphtha from Trinidad-Tesoro's proposed 150,000 bbl/day refinery:-

Naphtha — The IBP of the naphtha will be determined by the IBP of the crude to be used and will have an end point of approx. 350°F. The approx. price in Trinidad would be 6-6½ cents (US) per gallon (US) and this price should be assumed in your study.

Crude — The input to the refinery would be a combination of local (indigenous) and foreign-based (imported) crude in approx. a 1:1 ratio. The foreign crude would possibly be imported from Nigeria and the indigenous crude would possess the following specifications:

Quantity bbl/day	Approx. Chemical Analysis P	O	N	A	A.P.I. Gravity	% light fraction	% gas oil D.I.53-57	% fuel oil
60,000	53	-	48	19	26	18.8	15.1	66.1
20,000	33	-	48	19	23	11.4	28.5	60.1

We hope that the information provided would assist in the completion of the studies, and look forward to meeting with you to review progress.

With best wishes for 1971,

Yours sincerely,

Eldon G. Warner,
General Manager.

Annex D-2 Information about Naphtha from Trinidad and Tobago

Trinidad and Tobago
INDUSTRIAL DEVELOPMENT CORPORATION

P. O. Box 949, Port-of-Spain,
Trinidad, W.I.

Cables: IDCORP

Telephones: 37291 - 37296

Please Quote Ref. No. when replying.

TLT 4-

January 13, 1970

企画部
総務部
経理部
プロセス技術部
営業本部
原子力部
エンジニアリング本部
研究開発本部

Takayuki Iwaki,
Japan Gasoline Co. Ltd.,
New Ohtemachi Building,
2-1 Ohtemachi 2 - Chome,
Tokyo, Japan.

Dear Sir,

Subsequent to my letter dated December 30, 1970, wherein information on the chemical and physical properties of the crudes to be processed on, and naphtha from Trinidad - Tesoro's proposed refinery was provided, the following analyses on naphtha cuts are hereby detailed:

Crude quantity bbl per day	Naphtha Cut Boiling Range °C	Chemical Analysis P (Weight per cent)	O	N	A
60,000	100 - 150	39	0	42	19
	150 - 200	28	0	51	21
20,000	100 - 150	27	0	52	21
	150 - 200	5	0	71	24

We hope that this additional information would facilitate the completion of the studies.

Yours faithfully,

Earle C. Baccus,
for General Manager,
Industrial Development Corporation.

46. 1. 19

Annex E. Technological Base Data

1. General

In view of the stage of this study which is meant by UNIDO as a precusor to a major launching and marketing, the cost data have to coincide with the general standard of petrochemical industry in the world rather than to be selected from the most favorable ones that are inherent to the specific process.

The data used in this study were taken from the published literature and our data bank, and always were examined carefully not to be special data that are resulted from the specific process.

We used the same general assumptions as those used in "Pre-feasibility Studies on Petrochemical Plants For Trinidad and Tobago" supplied by Industrial Development Corporation of Trinidad and Tobago.

2. Utility Cost

The costs of utilities were given by Industrial Development Corporation of Trinidad and Tobago and are as follows:

(a)	Steam :	Pressure	200 PSIA
		Cost	0.48 $/t
(b)	Water :	Cooling Water	0.0013 $/t
		Sea Water	0.0007 $/t
		Process Water	0.040 $/t : 0 - 1136 t/day
			0.059 $/t: 1136 - 2460 t/day
(c)	Fuel :	Cost	0.446 $/$10^6$ Kcal
(d)	Power :		

Rate D1 (Less than 199 KVA at 230V)
(Less than 350 KVA at 400V)

Basic charge : $3.58 x Maximum KVA in a month

Supplementary charge : ¢0.8/Kwhr, less than 30,000 Kwhr/month
¢0.65/Kwhr, more than 30,000 Kwhr/month

Rate D2 (200 KVA - 3,999 KVA at 2.4, 4.16, 6.6, 12, 33, 66 KV)

Basic charge	:	\$3.58 x Maximum KVA in a month
Supplementary charge	:	¢0.75/Kwhr, less than 50,000 Kwhr/month
		¢0.60/Kwhr, 50,000 - 250,000 Kwhr/month
		¢0.50/Kwhr, 250,000 - 500,000 Kwhr/month
		¢0.38/Kwhr, more than 500,000 Kwhr/month

Rate D3 (More than 4,000 KVA at 33, 66, 132 KV)

Basic charge	:	\$3.45/KVA, 4,000 - 9,999 KVA
		\$2.82/KVA, 10,000 - 14,999 KVA
		\$2.45/KVA, 15,000 - 19,999 KVA
		\$2.07/KVA, 20,000 -
Supplementary charge	:	¢0.75/Kwhr, less than 50,000 Kwhr/month
		¢0.60/Kwhr, 50,000 - 200,000 Kwhr/month
		¢0.50/Kwhr, 200,000 - 500,000 Kwhr/month
		¢0.375/Kwhr, 500,000 - 1,000,000 Kwhr/month
		¢0.30/Kwhr, more than 1,000,000 Kwhr/month

As regards electricity the Trinidad and Tobago Electricity Corporation (T & TEC) quotes three rates for the large scale supply of electricity in the "Electricity Tariff Industrial Rate" as written above. In this study the electricity is assumed to be bought from T & TEC not by the individual plant but by the complex as a whole.

The petrochemical complexes proposed in this study use 74,013 Kw, 50,027 Kw and 119,391 Kw of electricity respectively and the average cost of this electricity is calculated 0.0065 \$/Kwh.

3. Chemical Cost

The cost of chemical used in this study is assumed equivalent to world market price.

4. Capital Investment

Capital investment consists of Process section and Utilities & General Service facilities.

The former is "battery limit", and the latter is set up at 20 per cent of "battery limit".

5. Labour Cost

The wage rates are as follows:

Operator	1.40 $/hr
Supervisor	2.15 $/hr

The payroll burden is taken at 5% of total labour costs.

6. Selling Price Calculation

The calculation was made on the assumption of net income of 10% C.I every year.

All capital is assumed to be financial through borrowing and a full 7 per cent interest payment is charged.

As special investment incentives, tax holiday provisions under the Aid to Pioneer Industries Ordinance is applied.

The selling price is a factory price or FOB Trinidad and Tobago (the inland transportation cost in Trinidad and Tobago is neglected).

Annex F. Processing of Natural Gas and Production of Basic Materials from Natural Gas and Condensate.

1. Capacity of the Plant of Natural Gas Processing:

This plant is designed to feed 400 MMSCFD of natural gas (2,731,000 t/y).

The basis for the above capacity is:

1 year = 330 days.

2. Condition and Composition of Feed Gas:

The inlet pressure of the natural gas is 300 psig.

The composition of the feed gas is as follows:

Component	Mole percent
H_2S	Nil
N_2	0.35
CO_2	0.36
C_1	94.48
C_2	2.92
C_3	1.08
iC_4	0.19
nC_4	0.28
C_5	0.16
C_6	0.07
C_7	0.11
	100.00

3. Products from Natural Gas Processing Plant:

The products given hereunder are assumed:

Ethane

(a) Product Specification

C_1	1.0 wt. %
C_2	96.0
C_3	3.0
	100.0

(b) Ethane Recovery Ratio

40% Minimum

(c) Product phase

Liquid or Gas

<u>Propane and Butane</u>

(a) Product Specification

C_2	3.5 wt. %
C_3) C_4)	96.0
C_5 +	0.5
	100.0

(b) Propane and Butane Recovery Ratio

95%

(c) Product phase

Liquid or Gas

Note:

Methane is assumed to be used for LNG and no specification of product.

Pentane plus product is assumed to be used with condensate for petrochemical feed.

4. Process of Natural Gas Processing:

The following processes are recommended as a method of recovery of ethane, propane, butane and pentane plus from the natural gas mentioned above. (refer to Fig F-1)

(a) Gas Washing Process

(b) Drying Process

(c) Pre-Flushing and Demethanizing Process

(d) Fractionation Process

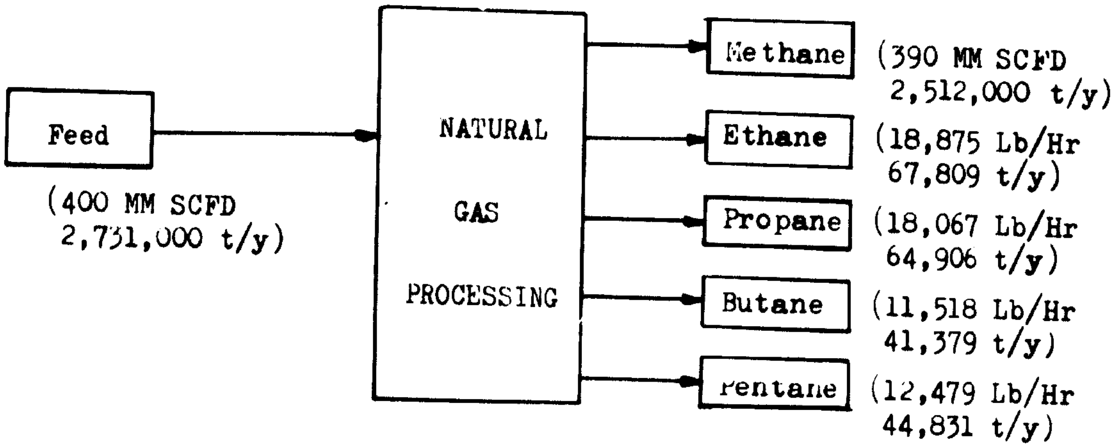
(e) Refrigeration Process

5. Estimated Investment Cost for Plant of Natural Gas Processing:

The preliminary investment cost for this natural gas processing plant is estimated as

Total cost $11,500,000.

6. Estimated Material Balance and Product Specification of Natural Gas Processing:



Stream Name	Feed Gas	Methane Product	Ethane Product	Propane Product	Butane Product	Pentane Plus
C_1	41.548	41,539.0	9.0	-	-	-
C_2	1,284	669.0	605.0	10.0	-	-
C_3	475	58.1	11.8	400.0	5.1	-
iC_4	84	4.8	-	2.0	77.1	0.1
nC_4	123	5.1	-	0.2	116.7	1.0
C_5	70	1.1	-	-	0.7	68.2
C_6	31	0.1	-	-	-	30.9
C_7	48	-	-	-	-	48.0
N_2	154	154.0	-	-	-	-
CO_2	158	-	-	-	-	-
H_2S	-	-	-	-	-	-
Total (Lb-MOL/Hr)	43,975	42,431.2	625.8	412.2	199.6	148.2
Lb/Hr	760,219	699,280	18,875	18,067	11,518	12,479
MMSCFD	400	390	5.7	-	-	-
MW	17.30	16.32	30.16	43.83	57.70	84.20

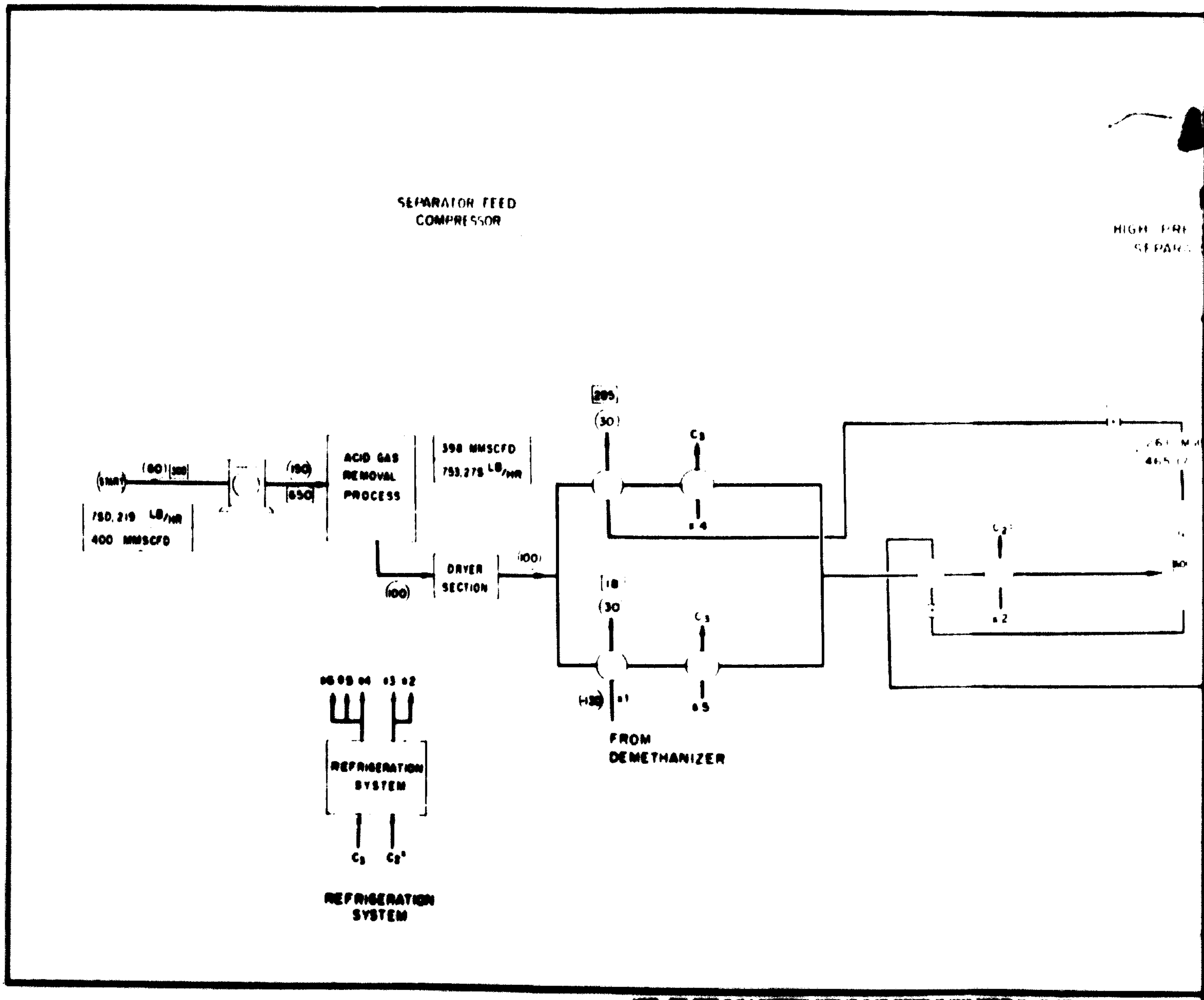
7. Estimated Utility Requirements of Natural Gas Processing:

	Elec. Power (Kw)	Steam (10^3 Lb/h)			Cooling Water (GPM)	Fuel (10^6 BTU/Hr)
		900 psig	200 psig	45 psig		
Acid Gas Removal & reclaimer	415		29.8		4,100	
Separator, Fractionation & Refrigeration	1,900	399	49.0	12.8	38,400	
Dryer	50				1,200	12.0
Total	2,365	399	78.8	12.8	43,700	12.0

8. Estimated Production Costs of Ethylene Propylene, B-B fraction and Cracked Gasoline.

Shown in Table F-1.

Ethane, Propane and Butane are recovered first by Natural Gas Processing and feeded into the respective cracker. The streams from these crackers are combined with the stream from Condensate - Pentane plus Cracker to be treated by the same equipment of Compression, Purification and Refrigeration.


SEPARATOR FEED
COMPRESSOR
ACID GAS
REMOVAL
PROCESS
398 MMSCFD
753,278 LB/HR
750,219 LB/HR
400 MMSCFD
DRYER
SECTION
FROM
DEMETHANIZER
REFRIGERATION
SYSTEM
REFRIGERATION
SYSTEM

SECTION 1

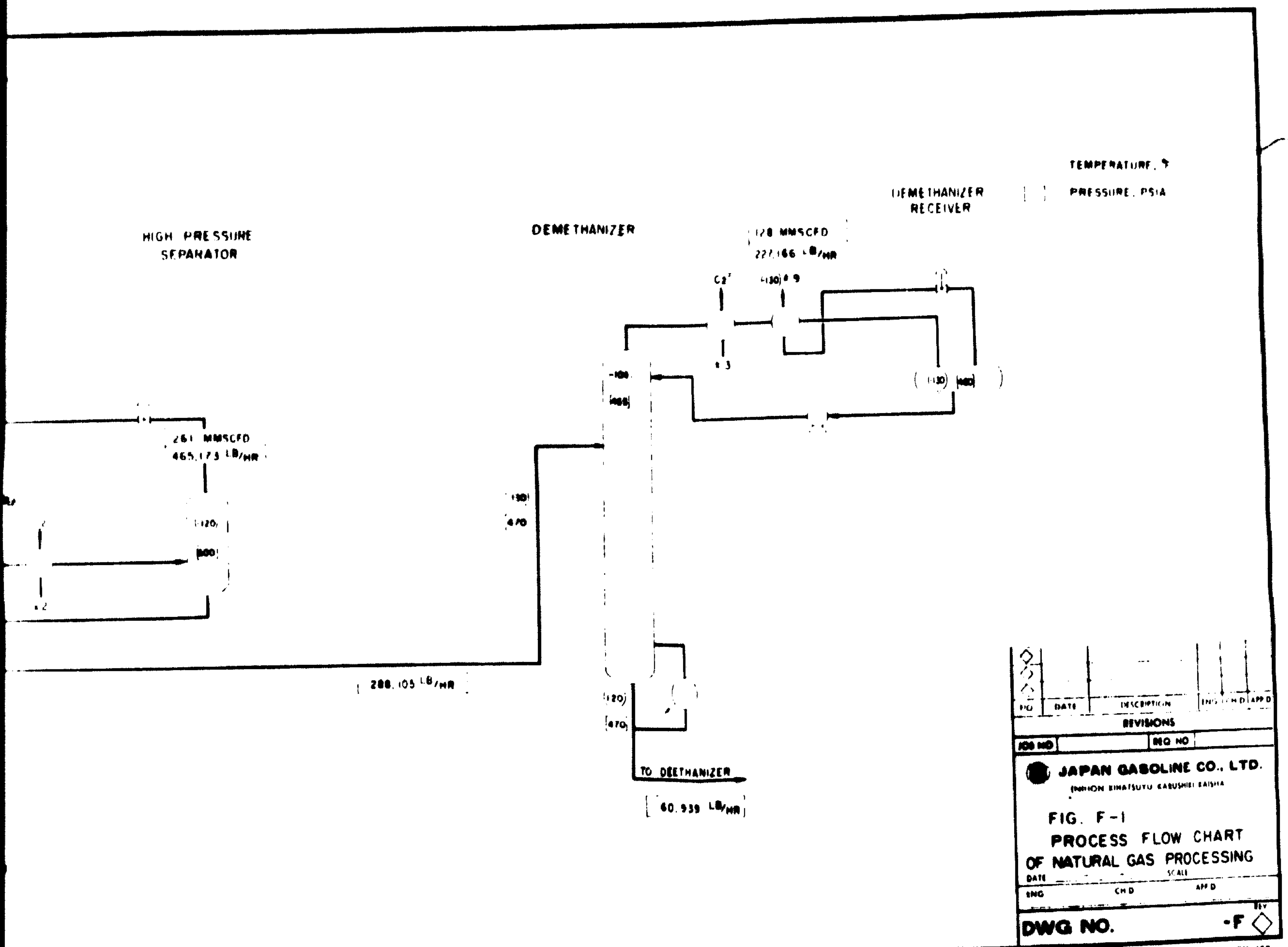
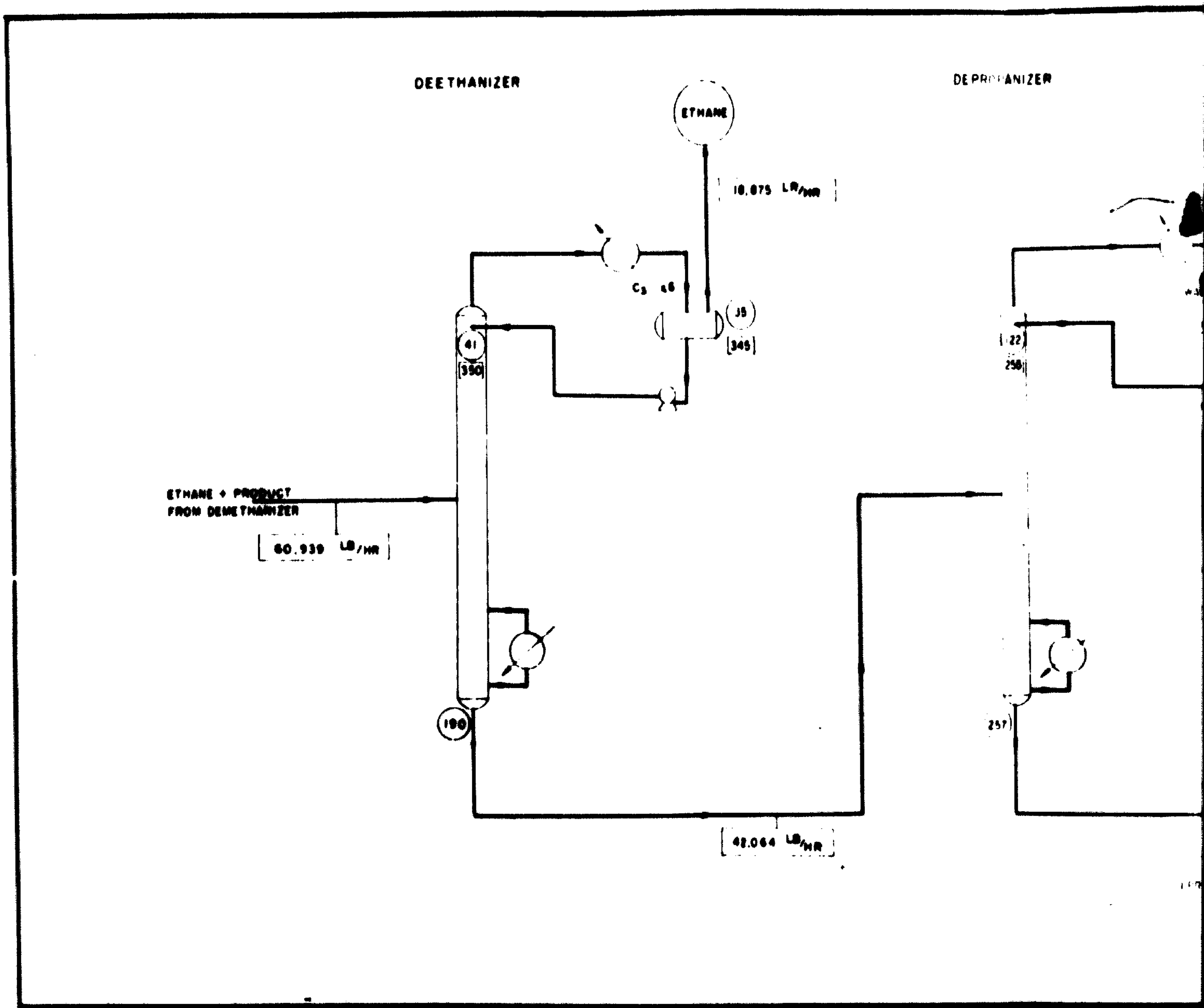
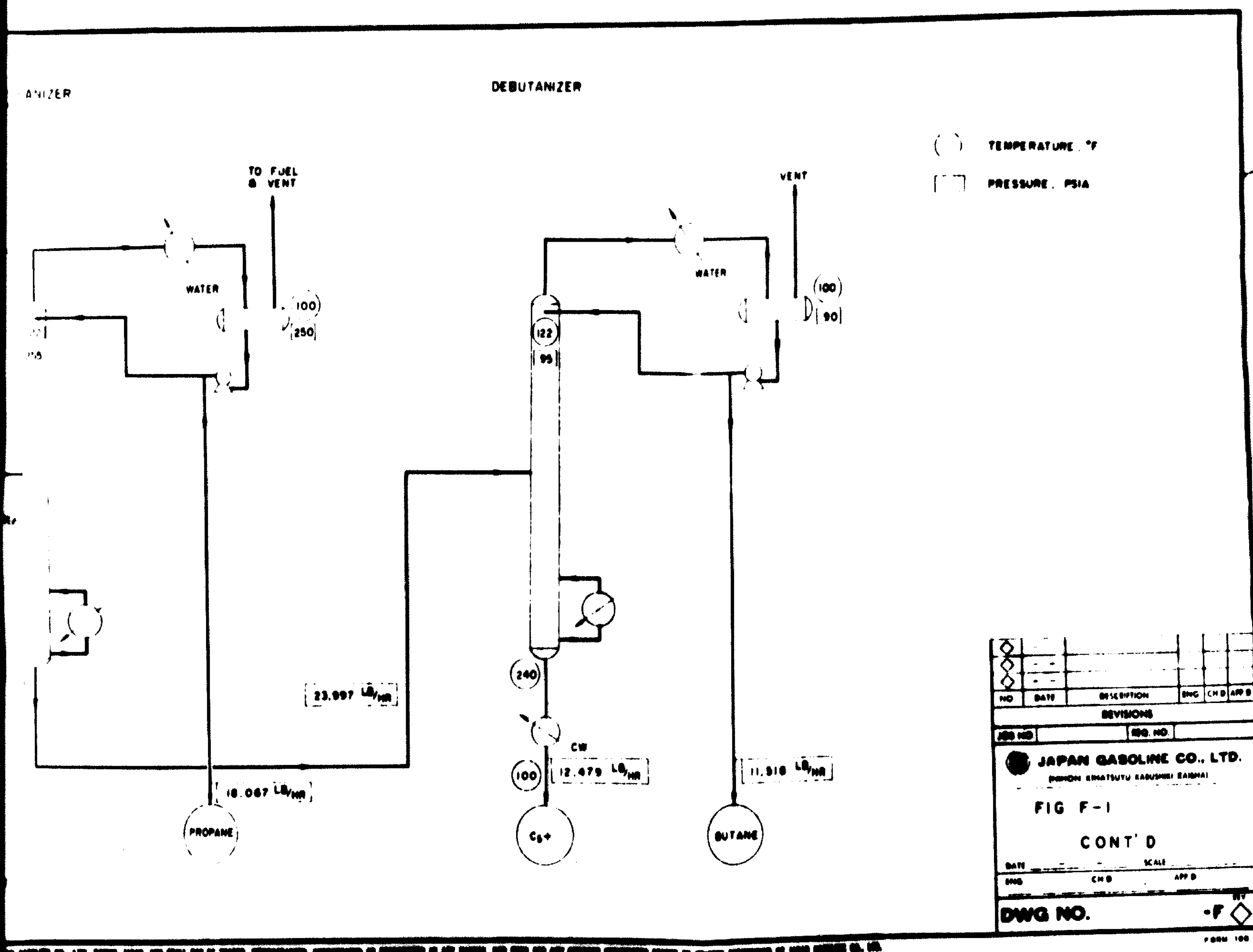


FIG. F-1
PROCESS FLOW CHART
OF NATURAL GAS PROCESSING

SECTION 2


DEETHANIZER
ETHANE
41
350
35
345
ETHANE + PRODUCT
FROM DEMETHANIZER
60,939 LB/HR
190
42,064 LB/HR

SECTION 1


ANIZER
DEBUTANIZER
( ) TEMPERATURE, °F
[ ] PRESSURE, PSIA
TO FUEL & VENT
WATER
(100)
[250]
VENT
WATER
(100)
[90]
(122)
[95]
(240)
CW
(100)
23,997 LB/HR
18,067 LB/HR
12,479 LB/HR
11,518 LB/HR
PROPANE
C_5+
BUTANE
NO
DATE
DESCRIPTION
REVISIONS
JOB NO
JAPAN GASOLINE CO., LTD.
FIG F-1
CONT'D
DATE
SCALE
DWG NO.
FORM 100

SECTION 2

Table F-1 **Processing and Cracking of Natural Gas and Associated Condensate**

			Natural Gas Processing
Capacity (t/y)			174,000 [a] (400 MMSCFD [b])
Capital Investment (1,000 $)	Process Section		11,500
	Utilities & General Service Facilities @ 20% of above		2,300
Item	**Unit Cost**	**Basis (1/t)**	**Total Cost ($/t)**
Raw Material			
Natural Gas	7.25 $/t	15.69 t	113.75
By-Product			
Methane	7.25 [c] $/t	- 14.44 t	- 104.69
Pentane Plus	16.65 $/t	- 0.26 t	- 4.33
Utilities			
Power	0.0065 $/kwh	107.6 kwh	0.70
Steam 900 psig	0.62 $/t	8.23 t	5.10
200 psig	0.48 $/t	1.63 t	0.78
45 psig	0.35 $/t	0.26 t	0.09
Cooling Water	0.0013 $/t	451.5 t	0.59
Fuel	0.446 $/$10^6$ kcal	0.138 10^6 kcal	0.06
Labour			
Operator	1.40 $/m.h.	8/shift	0.51
Supervisor	2.15 $/m.h.	1/shift	0.10
Payroll Burden	5% of Labour		0.03
Interim Production Cost of Ethane, Propane, Butane			12.69

a. Annual production amount of ethane, propane and butane

b. Amount of feed gas

c. The price of methane recovered in this process is assumed same as that of natural gas for LNG feed stock

Table F-1 (cont'd)

Item	Unit Cost	Basis (1/t)	Ethane, Propane Butane Cracking	Condensate, Pentane Plus Cracking
		Capacity (t/y)	99,000 d	142,000 d.
Capital Investment (1,000 $)	Thermal Cracking Section		3,270	[illegible],360
	Compression, Purification, Refrigeration Section		17,400 i	
	Utilities & General Facilities @20% of above		5,406	
	Total		46,236 j	
Item	Unit Cost	Basis (1/t)	Total Cost ($/t)	
Material				
Ethane, Propane, Butan	12.69 h $/t	1.76 t	22.33	
Condensate, pentane plue	16.65 h $/t	3.2 t		53.28
By-Product				
Propylene	50 e $/t	(- 0.18 t	- 9.00	
		- 0.59 t		- 29.50
B-B fraction	50 f $/t	(- 0.07 t	- 3.50	
		- 0.41 t		- 20.50
Cracked Gasoline	13.54 g $/t	- 0.52 t		- 7.04
Fuel Oil	0.446 $/$10^6$ kcal	- 0.2 10^6 kcal		- 0.09
Fuel Gas	0.446 $/$10^6$ kcal	- 1.0 10^6 kcal	- 0.45	
		- 0.5 10^6 kcal		- 0.22
Utilties				
Power	0.0065 $/kwh	(39.7 kwh	0.26	
		80 kwh		0.52
Steam	0.48 $/t	(4.86 t	2.33	
		3.3 t		1.58
Colling Water	0.0013 $/t	(420 t	0.55	
		480 t		0.62
Calalyst & Chemicals		0.99 $	0.99	
		0.8 $		0.80
(SUM)			(13.51)	(- 0.55)
(MIXED SUM)			(5.23)	
Labour				
Operator	1.40 $/m.h.	18/shift	0.83	
Supervisor	2.15 $/m.h.	3/shift	0.21	
Payroll Burden		5% of Labour	0.05	
Maintenance		3% of C.I.	5.76	
Depreciation		10% of C.I.	14.[illegible]0	
Interest		7% of C.I.	13.43	
Tax and Insurance		2% of C.I.	3.84	
Overheads		2% of C.I.	3.84	
(Net Manufacturing Cost)			[illegible]	
Net Cash Flow @20% of C.I.		$	9,247,[illegible]00	
Depreciation		$	4,623,600	
Net Income		$	4,623,600	
Total Manufacturing Cost		$	12,626,000	
Total Sales		$	17,249,600	
Selling Price of Ethylene		$/t	71.[illegible]6	

d. Annual production amount of ethylene accordingly total amount of ethylene is 241,000 t/y

e. The price of propylene is set up 50 $/t (cost allocation)

f. The price of B-B fraction is set up 50 $/t (cost allocation)

g. As regards the price of cracked gasoline, refer to Appendix "Aromatics Recovery"

h. The price of pentane plus is set up 16.65 $/t same as that of condensate.

i. The same equipments of Compression, Purification and Refrigeration are used for both of the streams fr. Ethane, Propane and Butane Crackers and Condensate - Pentane Plus Cracker.

j. Total Investment is the [illegible] of C.I's of Natural Gas Processing, Ethane, Propan Butane Cracking and Condensate - Pentane plus Cra[illegible]

Annex G. Production of Basic Materials from Condensate Pyrolysis

1. Capacity of Plant of Condensate Pyrolysis:

   This plant is designed to feed 410,000 t/y of condensate.

   The basis for the above capacity is:

   1 year = 330 days

2. Property of Condensate:

   The API gravity of condensate is 49°.

3. Estimated Production Costs of Ethylene, Propylene, B-B fraction and Cracked Gasoline.

   Shown in Table G-1.

TABLE G-1 CONDENSATE CRACKING

Item	Unit Cost	Basis (1/t)	Total Cost ($/t)
Capacity (t/y)			130,000 a
Capital Investment (1,000 $)	Process Section		17,500
	Utilities & General Service Facilities		3,500
	Total Capital Investment (1,000 $)		21,000
Raw Material			
Condensate	16.65 $/t	3.2 t	53.28
Catalyste Chemicals		0.8 $	0.80
By-Product			
Propylene	50 b $/t	- 0.59 t	- 29.50
B-B fraction	50 c $/t	- 0.41	- 20.50
Cracked Gasoline	12.67 $/t	- 0.52	- 6.59
Fuel Oil	0.446 $/$10^6$ kcal	- 0.2 10^6 kcal	- 0.09
Fuel Gas	0.446 $/$10^6$ kcal	- 0.5 10^6 kcal	- 0.22
Utilities			
Power	0.0065 $/kwh	80 kwh	0.52
Steam	0.48 $/t	3.3 t	1.58
Cooling Water	0.0013 $/t	480 t	0.62
Labour			
Operator	1.40 $/m.h.	15/shift	1.45
Supervisor	2.15 $/m.h.	2/shift	0.29
Payroll Burden	5% of Labour		0.08
Maintenance	3% of C.I.		4.85
Depreciation	10% of C.I.		16.15
Interest	7% of C.I.		11.31
Tax and Insurance	2% of C.I.		3.23
Overheads	2% of C.I.		3.23
Net Manufacturing Cost			40.49
Capital Investment (1,000 $)			21,000
Net Cash Flow @ 20% of C.I.	$		4,200,000
Depreciation	$		2,100,000
Net Income	$		2,100,000
Total Manufacturing Cost	$		5,263,700
Total Sales	$		7,363,700
Selling Price of Ethylene	$/t		56.64

a. Annual production amount of ethylene

b. The price of propylene is set up 50 $/t (cost allocation)

c. The price of B-B fraction is set up 50 $/t (cost allocation)

d. As regards the price of cracked gasoline, refer to Appendix "Aromatics Recovery".

Annex H. **Naphtha Cracking**

			Case 3
Capacity (t/y)			300,000 [a]
Capital Investment (1,000 $)	Process Section		28,800
	Utilities & General Service Facilities		5,800
	Total Capital Investment (1,000 $)		34,600
Item	**Unit Cost**	**Basis (1/t)**	**Total Cost ($/t)**
Materials			
Naphtha	22.02 $/t	4.00 t	88.08
Catalyst & Chemicals		0.8 $/t	0.80
By-Product			
Propylene	44.0 [b] $/t	- 0.67 t	- 29.48
B-B Fraction	75.0 [c] $/t	- 0.47 t	- 35.25
Cracked Gasoline	18.53 [d] $/t	- 1.13 t	- 20.94
Fuel Oil	0.446 $/$10^6$ kcal	- 0.06 x 10^6 kcal	- 0.03
Fuel Gas	0.446 $/$10^6$ kcal	- 0.59 x 10^6 kcal	- 0.26
Utilities			
Power	0.0065 $/kwh	80 kwh	0.52
Steam	0.48 $/t	3.3 t	1.58
Cooling Water	0.0013 $/t	480 t	0.62
Fuel	0.446 $/$10^6$ kcal	— 10^6 kcal	
Process Water	0.040 $/t	— t	
Labour			
Operator	1.40 $/m.h.	15 /Shift	0.55
Superviser	2.15 $/m.h.	2 /Shift	0.11
Payroll Burden	5% of Labour		
Maintenance	3% of Capital Investment		3.46
Depreciation	10% "		11.53
Interest	7% "		8.07
Tax & Insurance	2% "		2.31
Overheads	2% "		2.31
Net Production Cost			34.01
Capital Investment (1,000 $)			34,600
Net Cash Flow @ 20% of C.I.	$		6,920,000
Depreciation	$		3,460,000
Net Income	$		3,460,000
Total Manufacturing Cost	$		10,203,000
Total Sales	$		13,663,000
Selling Price	$/t		45.54

a. Annual production amount of ethylene.

b. The price of propylene is set up 44.0 $/t (cost allocation)

c. The price of B-B fraction is set up 75.0 $/t (cost allocation)

d. As regards the price of cracked gasoline, refer to Appendix "Aromatic Recovery"

Annex I. Cost Calculation of Aromatics

Table I-1. Aromatics Recovery

							Case 1	Case 2	Case 3
Capacity (t/y)							53,000	48,000	199,000
Capital Investment (1,000 $)	Process Section						3,210	3,020	7,180
	Utilities & General Service Facilities						640	604	1,440
	Total Capital Investment (1,000 $)						3,850	3,624	8,620
Item	Unit Cost			Basis (1/t)			Total Cost ($/t)		
	Case 1	Case 2	Case 3	Case 1	Case 2	Case 3			
Materials									
Cracked Gasoline	13.54 $/t	12.67 $/t	18.53 $/t	1.40 t		1.70 t	18.96	17.74	31.50
Hydrogen	0.0186 $/Nm3	0.0187 $/Nm3	0.0132 $/Nm3	67 Nm3		189 Nm3	1.25	1.25	2.50
By-Product									
Fuel Gas	0.0184 $/Nm3	0.0184 $/Nm3	0.0184 $/Nm3	- 3.2 Nm3		- 8.6 Nm3	- 0.06	- 0.06	- 0.16
Fuel Oil	5.1 $/t	5.1 $/t	5.1 $/t	- 0.40 t		- 0.70 t	- 2.04	- 2.04	- 3.57
Catalyst & Chemicals				0.85 $/t		0.85 $/t	0.85	0.85	0.85
Utilities									
Powers	0.0065 $/kwh			53 kwh			0.35	0.35	0.35
Steam	0.48 $/t			2.6 t			1.25	1.25	1.25
Cooling Water	0.0013 $/t			91 t			0.12	0.12	0.12
Fuel	0.446 $/$10^6$ kcal			0.12 x 10^6 kcal			0.05	0.05	0.05
Process Water	0.040 $/t			___ t					
				Men / Shift					
				Case 1	Case 2	Case 3			
Labour									
Operator	1.40 $/m.h.			9	9	9	1.88	2.08	0.50
Superviser	2.15 $/m.h.			1	1	1	0.32	0.35	0.09
Payroll Burden	5% of Labour						0.11	0.12	0.03
Maintenance	3% of Total Capital Investment						2.18	2.27	1.30
Depreciation	10% "						7.26	7.55	4.33
Interest	7% "						5.08	5.28	3.03
Tax & Insurance	2% "						1.45	1.51	0.87
Overheads	2% "						1.45	1.51	0.87
Net Manufacturing Cost							40.46	40.18	43.91
Total Capital Investment (1,000 $)							3,900	3,670	8,620
Net Cash Flow	@ 20% of T.C.I.	$					770,000	724,800	1,724,000
Depreciation		$					385,000	362,400	862,000
Net Income		$					385,000	362,400	862,000
Total Manufacturing Cost		$					2,144,000	1,928,600	8,737,760
Total Sales		$					2,529,000	2,291,000	9,599,760
Selling Price		$/t					47.71	47.73	48.24

Table I-2 Dealkylation (Toluene - Benzene)

					Case 1	Case 2	Case 3
Capacity (t/y)					55,400[a]	54,000[a]	74,000[a]
Capital Investment (1,000 $)				Process Section	1,320	1,300	1,570
				Utilities & General Service Facilities	264	260	310
				Total Capital Investment (1,000 $)	1,584	1,560	1,880
Item	**Unit Cost Case 1**	**Unit Cost Case 2**	**Unit Cost Case 3**	**Basis (1/t)**	**Total Cost ($/t) Case 1**	**Total Cost ($/t) Case 2**	**Total Cost ($/t) Case 3**
Materials							
Toluene	36.6 $/t	36.6 $/t	36.6 $/t	1.2 t	43.92	43.92	43.92
Hydrogen	0.0186 $/Nm^3	0.0187 $/Nm^3	0.0132 $/Nm^3	385 Nm^3	7.16	7.20	5.08
Catalyst & Chemicals				0.80 $/t	0.80	0.80	0.80
Utilities							
Powers		0.0065 $/kwh		150 kwh	0.98	0.98	0.98
Steam		0.48 $/t		0.57 t	0.27	0.27	0.27
Cooling Water		0.0013 $/t		570 t	0.74	0.74	0.74
Fuel		0.446 $/10^6 kcal		- 1.3 x 10^6 kcal	- 0.58	- 0.58	- 0.58
Process Water		0.040 $/t		— t			
				Men / Shift (Case 1 / Case 2 / Case 3)			
Labour							
Operator		1.40 $/m.h.		3 / 3 / 3	0.60	0.61	0.45
Superviser		2.15 $/m.h.		1 / 1 / 1	0.31	0.32	0.23
Payroll Burden		5% of Labour			0.05	0.05	0.03
Maintenance		3% of Total Capital Investment			0.86	0.87	0.76
Depreciation		10% "			2.86	2.89	2.54
Interest		7% "			2.00	2.02	1.78
Tax & Insurance		2% "			0.57	0.58	0.51
Overheads		2% "			0.57	0.58	0.51
Net Manufacturing Cost					59.88	59.99	58.02
Total Capital Investment (1,000 $)					1,584	1,560	1,880
Net Cash Flow	@ 20% of T.C.I.	$			316,800	312,000	376,000
Depreciation		$			158,400	156,000	188,000
Net Income		$			158,400	156,000	188,000
Total Manufacturing Cost		$			3,317,352	3,239,460	4,293,480
Total Sales		$			3,475,752	3,395,460	4,481,480
Selling Price		$/t			62.74	62.88	60.56

a. Annual Production Amount of Benzene.

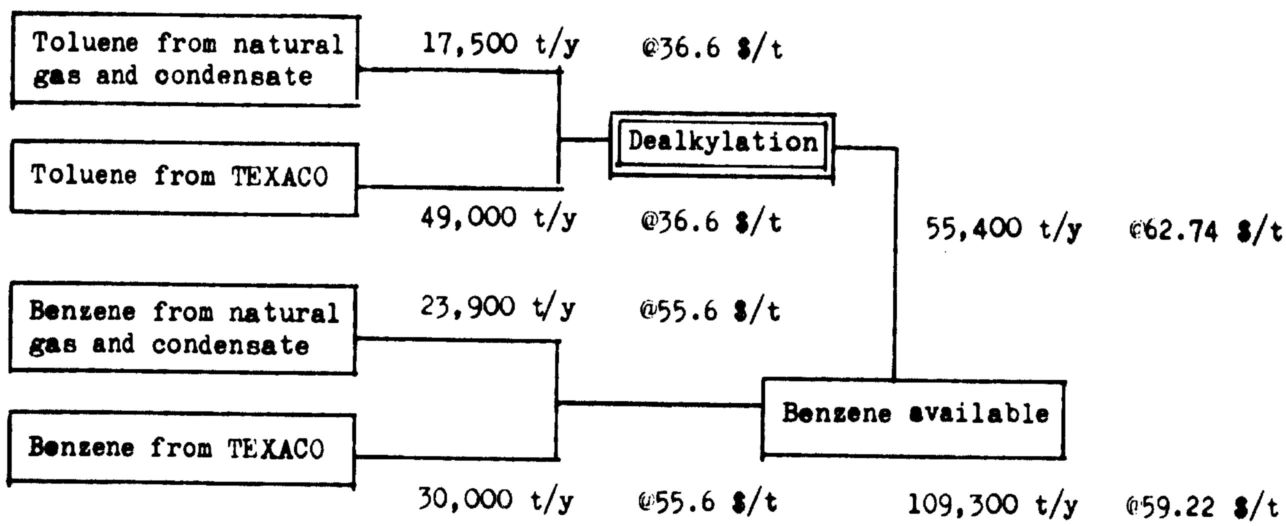
Presently TEXACO is producing:

Benzene	:	30,000 t/y	@ 55.6 $/t
Toluene	:	49,000	@ 36.6

(Case 1)

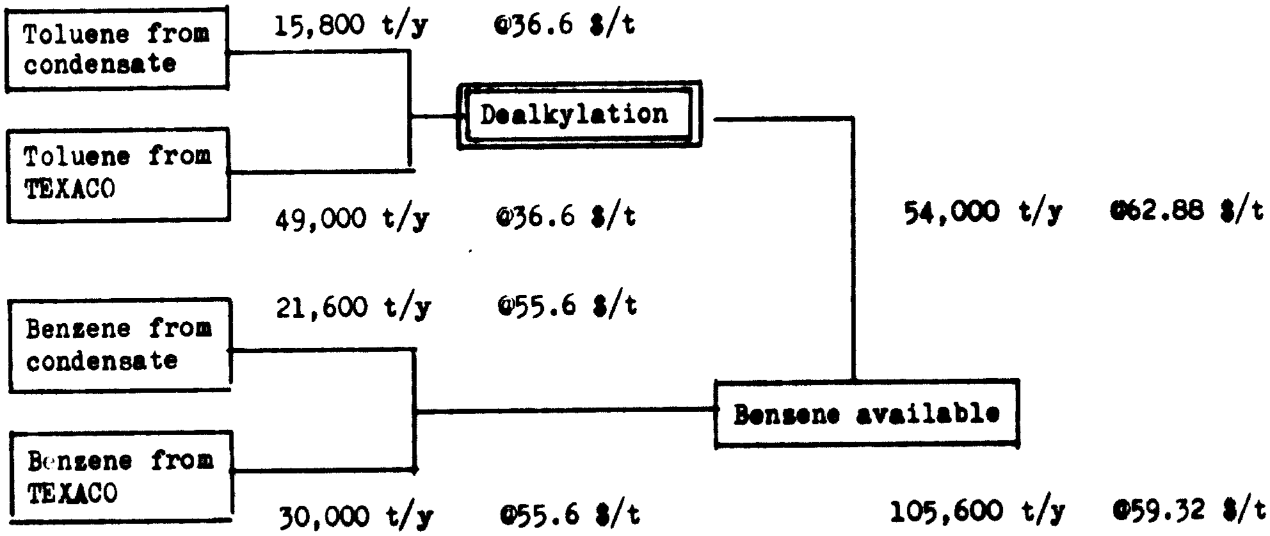
23,900 t/y of benzene is recovered from natural gas and condensate so that we have total 53,900 t/y of benzene. On the other hand 17,500 t/y of toluene is produced from natural gas and condensate so that we have total 66,500 t/y of toluene.

Considering the general trend of scale-up of capacity in petrochemical industry, it is preferable to convert toluene into benzene by dealkylation to scale-up the amount of benzene when the amounts of benzene and toluene are not large enough.



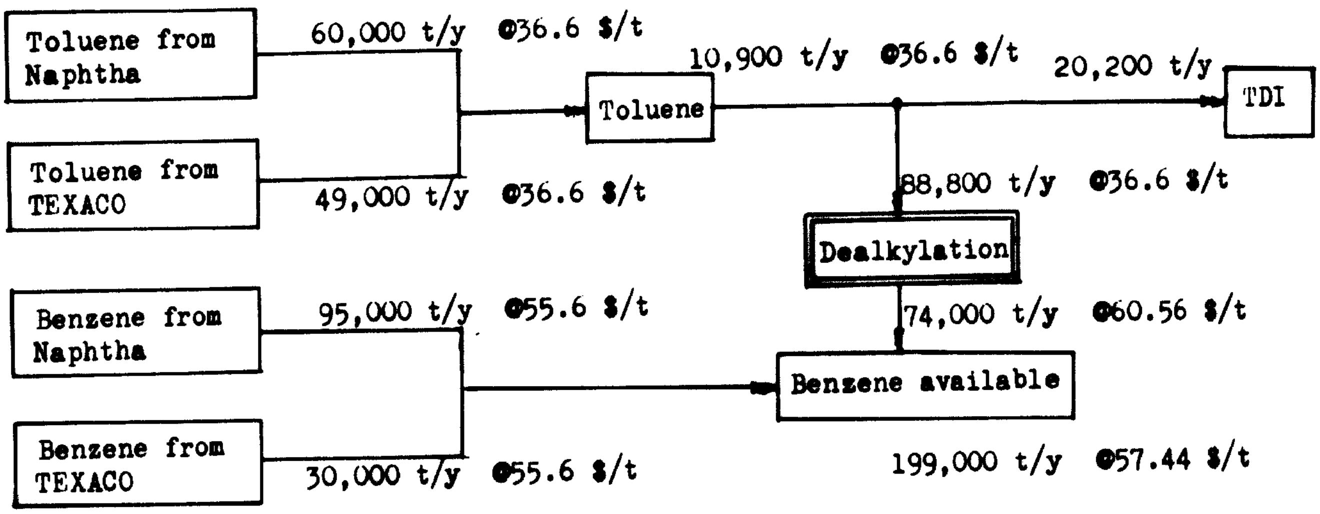
As regards benzene we have 55,400 t/y @62.74 $/t by dealkylation of toluene and 53,900 t/y @55.6 $/t. This gives us 109,300 t/y of benzene @59.22 $/t.

(Case 2)   Toluene is converted into benzene.



As regards benzene we have 54,000 t/y @62.88 $/t by dealkylation of toluene and 51,600 t/y @55.6 $/t. This gives us 105,600 t/y of benzene @59.32 $/t.

(Case 3) Toluene of 88,800 t/y out of total 109,000 t/y is dealkylated to benzene. (The balance of 20,200 t/y is used to produce TDI)



As regards benzene we have 74,000 t/y @60.56 $/t by dealkylation of toluene and 125,000 t/y @55.6 $/t. This gives us 199,000 t/y of benzene @57.44 $/t.

Annex J. **Butadiene Extraction**

			Case 1	Case 2	Case 3
Capacity (t/y)			30,000	24,000	65,000
Capital Investment (1,000 $)	Process Section		2,230	1,950	3,540
	Utilities & General Service Facilities		446	390	710
	Total Capital Investment (1,000 $)		2,676	2,340	4,250

Item	Unit Cost Case 1	Unit Cost Case 2	Unit Cost Case 3	Basis (1/t)	Total Cost ($/t) Case 1	Total Cost ($/t) Case 2	Total Cost ($/t) Case 3
Materials							
B-B Fraction a	50 $/t	50 $/t	75 $/t	2.18 t	109.00	109.00	163.50
By-Product							
Spent B-B b	27 $/t	27 $/t	27 $/t	- 1.18 t	- 31.86	- 31.86	- 31.86
Catalyst & Chemicals				1.2 $/t	1.20	1.20	1.20
Utilities							
Powers	0.0065 $/kwh			150 kwh	0.98	0.98	0.98
Steam	0.48 $/t			3.5 t	1.68	1.68	1.68
Cooling Water	0.0013 $/t			200 t	0.26	0.26	0.26
Fuel	0.446 $/$10^6$ kcal			— 10^6 kcal			
Process Water	0.040 $/t			— t			

Item	Unit Cost	Men / Shift Case 1	Men / Shift Case 2	Men / Shift Case 3	Case 1	Case 2	Case 3
Labour							
Operator	1.40 $/m.h.	3	3	3	1.11	1.39	0.51
Superviser	2.15 $/m.h.	1	1	1	0.57	0.71	0.26
Payroll Burden	5% of Labour				0.08	0.11	0.24
Maintenance	3% of Total Capital Investment				2.68	2.93	1.96
Depreciation	10% "				8.92	9.75	6.54
Interest	7% "				6.24	6.83	4.58
Tax & Insurance	2% "				1.78	1.95	1.31
Overheads	2% "				1.78	1.95	1.31
Net Manufacturing Cost					104.42	106.88	152.27

			Case 1	Case 2	Case 3
Total Capital Investment (1,000 $)			2,676	2,340	4,250
Net Cash Flow	@ 20% of T.C.I.	$	535,200	468,000	850,000
Depreciation		$	267,600	234,000	425,000
Net Income		$	267,600	234,000	425,000
Total Manufacturing Cost		$	3,132,600	2,565,100	9,897,600
Total Sales		$	3,400,200	2,799,100	10,322,000
Selling Price		$/t	113.34	116.63	158.81

a. The prices of B-B fraction are set up as written cost allocation.

b. The price of Spent B-B is equivalent to international price.

Annex K. __**Hydrogen Production**__

				Case 1	Case 2	Case 3
Capacity (Nm^3/hr)				3,200	3,000	8,300
Capital Investment (1,000 $)	Process Section			809	760	1,440
	Utilities & General Service Facilities			161	152	288
	Total Capital Investment (1,000 $)			970	912	1,728
Item	**Unit Cost**		**Basis** ($1/Nm^3$)	**Total Cost** ($\$/Nm^3$)		
Materials						
OFF Gas	0.005179	$\$/Nm^3$	0.3147 Nm^3	0.00163	0.00163	0.00163
Catalyst & Chemicals			0.000725 $\$/Nm^3$	0.00073	0.00073	0.00073
Utilities						
Power	0.0065	$/kwh	0.0466 kw	0.00030	0.00030	0.00030
Steam	0.48	$/t	——— t/hr			
Cooling Water	0.0013	$/t	0.0267 t/hr	0.00004	0.00004	0.00004
Fuel	0.446	$\$/10^6$ kcal	0.001670 x 10^6 kcal/hr	0.00075	0.00075	0.00075
Process Water	0.040	$/t	0.00133 t/hr	0.00005	0.00005	0.00005
Labour						
Operator	1.40	$/m.h.	3	0.00131	0.00140	0.00051
Superviser	2.15	$/m.h.	1	0.00067	0.00070	0.00026
Payroll Burden	5%	of Labour		0.00010	0.00011	0.00004
Maintenance	3%	of Capital Investment		0.00115	0.00115	0.00079
Depreciation	10%	"		0.00383	0.00384	0.00263
Interest	7%	"		0.00268	0.00269	0.00184
Tax & Insurance	2%	"		0.00077	0.00077	0.00053
Overheads	2%	"		0.00077	0.00077	0.00053
Net Production Cost				0.0148	0.0149	0.0106
Capital Investment (1,000 $)				970	912	1,728
Net Cash Flow @ 20% of C.I.		$		194,000	182,400	345,600
Depreciation		$		97,000	91,200	172,800
Net Income		$		97,000	91,200	172,800
Total **Manufacturing** Cost		$		375,091	354,024	696,802
Total Sales		$		472,091	445,224	869,[illegible]
Selling Price		$\$/Nm^3$		0.0186	0.0187	0.0132

Annex L. Calculation of Manufacturing Costs and Selling Prices of Petrochemicals

The method of calculation of manufacturing cost and selling price is that executed in "Pre-feasibility Study" prepared by I.D.C. with exception of adopting the Tax holiday provisions.

1. LDPE
2. HDPE
3. VCM
4. PVC
5. STYRENE
6. POLYSTYRENE
7-1. PO
7-2. PG
8. ACRYLONITRILE
9. POLYACRYLONITRILE-F
10. PP
11. SBR
12. MALEIC ANHYDRIDE
13. LINEAR ALKYLBENZENE
14. CAPROLACTAM
15-1. NYLON-6 (CHIP)
15-2. NYLON-6 -F
16. TDI
17-1. P-XYLENE
17-2. TEREPHTHALIC ACID
17-3. DMT
18. POLYESTER-F

1. L D P E

Capacity (t/y)		Case 1	Case 2	Case 3
		100,000	60,000	130,000
Capital Investment (1,000 $)	Process Section	22,180	16,300	25,920
	Utilities & General Service Facilities	4,440	3,270	5,180
	Total Capital Investment (1,000 $)	26,620	19,570	31,100

Item	Unit Cost Case 1	Unit Cost Case 2	Unit Cost Case 3	Basis (1/t)	Total Cost ($/t) Case 1	Total Cost ($/t) Case 2	Total Cost ($/t) Case 3
Materials							
Ethylene	71.58 $/t	56.64 $/t	45.54 $/t	1.05 t	75.16	59.47	47.82
Catalyst & Chemicals				18.90 $/t	18.90	18.90	18.90
Utilities							
Powers	0.0065 $/kwh			2,000 kwh	13.00	13.00	13.00
Steam	0.46 $/t			1.5 t	0.72	0.72	0.72
Cooling Water	0.0013 $/t			260 t	0.34	0.34	0.34
Fuel	0.446 $/$10^6$ kcal			— 10^6 kcal			
Process Water	0.040 $/t			— t			

Item	Unit Cost	Men / Shift Case 1	Men / Shift Case 2	Men / Shift Case 3	Case 1	Case 2	Case 3
Labour							
Operator	1.40 $/m.h.	65	60	65	7.21	11.09	5.54
Superviser	2.15 $/m.h.	4	3	4	0.51	0.85	0.52
Payroll Burden	5% of Labour				0.39	0.60	0.30
Maintenance	3% of Total Capital Investment				7.99	9.79	7.18
Depreciation	10% "				26.62	32.62	23.92
Interest	7% "				18.63	22.83	16.75
Tax & Insurance	2% "				5.32	6.52	4.78
Overheads	2% "				5.32	6.52	4.78
Net Manufacturing Cost					180.11	183.25	144.55

			Case 1	Case 2	Case 3
Capacity (t/y)			100,000	60,000	130,000
Total Capital Investment (1,000 $)			26,620	19,570	31,100
Net Cash Flow	@ 20% of T.C.I.	$	5,324,000	3,914,000	6,220,000
Depreciation		$	2,662,000	1,957,000	3,110,000
Net Income		$	2,662,000	1,957,000	3,110,000
Total Manufacturing Cost		$	18,011,000	10,995,000	18,791,500
Total Sales		$	20,673,000	12,952,000	21,901,500
Selling Price		$/t	206.73	215.87	168.47

2. H D P E

Capacity (t/y)		Case 1	Case 2	Case 3
		70,000	20,000	70,000
Capital Investment (1,000 $)	Process Section	22,620	10,400	22,620
	Utilities & General Service Facilities	4,520	2,080	4,520
	Total Capital Investment (1,000 $)	27,140	12,480	27,140

Item	Unit Cost Case 1	Unit Cost Case 2	Unit Cost Case 3	Basis (1/t)	Total Cost ($/t) Case 1	Total Cost ($/t) Case 2	Total Cost ($/t) Case 3
Materials							
Ethylene	71.58 $/t	56.64 $/t	45.54 $/t	1.06 t	75.87	60.04	48.27
Catalyst & Chemicals				30 $/t	30.00	30.00	30.00
Utilities							
Powers	0.0065 $/kwh			900 kwh	5.85	5.85	5.85
Steam	0.48 $/t			7 t	3.36	3.36	3.36
Cooling Water	0.0013 $/t			700 t	0.91	0.91	0.91
Fuel	0.446 $/$10^6$ kcal			— 10^6 kcal			
Process Water	0.040 $/t			— t			

Item	Unit Cost	Men / Shift Case 1	Men / Shift Case 2	Men / Shift Case 3	Case 1	Case 2	Case 3
Labour							
Operator	1.40 $/m.h.	50	30	50	7.92	16.63	7.92
Superviser	2.15 $/m.h.	5	3	5	1.22	2.55	1.22
Payroll Burden	5% of Labour				0.46	0.96	0.46
Maintenance	3% of Total Capital Investment				11.63	18.72	11.63
Depreciation	10% "				38.77	62.40	38.77
Interest	7% "				27.14	43.68	27.14
Tax & Insurance	2% "				7.75	12.48	7.75
Overheads	2% "				7.75	12.48	7.75
Net Manufacturing Cost					218.63	270.06	191.03

Capacity (t/y)			Case 1	Case 2	Case 3
			70,000	20,000	70,000
Total Capital Investment (1,000 $)			27,140	12,480	27,140
Net Cash Flow	@ 20% of T.C.I.	$	5,428,000	2,496,000	5,428,000
Depreciation		$	2,714,000	1,248,000	2,714,000
Net Income		$	2,714,000	1,248,000	2,714,000
Total Manufacturing Cost		$	15,304,100	5,401,200	13,372,100
Total Sales		$	18,018,100	6,649,200	16,086,100
Selling Price		$/t	257.40	332.46	229.80

3. V C M

			Case 1	Case 2	Case 3
Capacity (t/y)			88,300	53,800	98,000
Capital Investment (1,000 $)	Process Section		6,260	4,650	6,660
	Utilities & General Service Facilities		1,250	930	1,330
	Total Capital Investment (1,000 $)		7,510	5,580	7,990

Item	Unit Cost Case 1	Unit Cost Case 2	Unit Cost Case 3	Basis (1/t)	Total Cost ($/t) Case 1	Total Cost ($/t) Case 2	Total Cost ($/t) Case 3
Materials							
Ethylene	71.58 $/t	56.64 $/t	45.54 $/t	0.48 t	34.36	27.19	21.86
Chlorine	55.11 $/t	55.11 $/t	55.11 $/t	0.62	34.17	34.17	34.17
Catalyst & Chemicals				2.78 $/t	2.78	2.78	2.78
Utilities							
Powers	0.0065 $/kwh			280 kwh	1.82	1.82	1.82
Steam	0.48 $/t			2.5 t	1.20	1.20	1.20
Cooling Water	0.0013 $/t			200 t	0.26	0.26	0.26
Fuel	0.446 $/$10^6$ kcal			1.2 x 10^6 kcal	0.54	0.54	0.54
Process Water	0.040 $/t			— t			
				Men / Shift (Case 1 / Case 2 / Case 3)			
Labour							
Operator	1.40 $/m.h.			20 / 20 / 20	2.51	4.12	2.26
Superviser	2.15 $/m.h.			3 / 3 / 3	0.58	0.95	0.52
Payroll Burden	5% of Labour				0.15	0.25	0.14
Maintenance	3% of Total Capital Investment				2.55	3.11	2.45
Depreciation	10% "				8.51	10.37	8.15
Interest	7% "				5.95	7.26	5.71
Tax & Insurance	2% "				1.70	2.07	1.63
Overheads	2% "				1.70	2.07	1.63
Net Manufacturing Cost					98.78	98.16	85.12
Total Capital Investment (1,000 $)					7,510	5,580	7,990
Net Cash Flow	● 20% of T.C.I.	$			1,502,000	1,116,000	1,598,000
Depreciation		$			751,000	558,000	799,000
Net Income		$			751,000	558,000	799,000
Total Manufacturing Cost		$			8,722,300	5,281,000	8,341,760
Total Sales		$			9,473,300	5,839,000	9,140,760
Selling Price		$/t			107.29	108.53	93.27

4. P V C

		Case 1	Case 2	Case 3
Capacity (t/y)		84,100	51,200	93,000
Capital Investment (1,000 $)	Process Section	6,09[illegible]	4,520	6,470
	Utilities & General Service Facilities	1,220	900	1,290
	Total Capital Investment (1,000 $)	7,310	5,420	7,760

Item	Unit Cost Case 1	Unit Cost Case 2	Unit Cost Case 3	Basis (1/t)	Total Cost ($/t) Case 1	Total Cost ($/t) Case 2	Total Cost ($/t) Case 3
Materials							
VCM	107.29 $/t	108.53 $/t	93.27 $/t	1.05 t	112.65	113.96	97.93
Catalyst & Chemical				6.94 $/t	6.94	6.94	6.94
Utilities							
Powers	0.065 $/kwh			200 kwh	1.30	1.30	1.30
Steam	0.48 $/t			2 t	0.96	0.96	0.96
Cooling Water	0.0013 $/t			500 t	0.65	0.65	0.65
Fuel	0.446 $/$10^6$ kcal			— 10^6 kcal			
Process Water	0.040 $/t			— t			

Item	Unit Cost	Men / Shift Case 1	Men / Shift Case 2	Men / Shift Case 3	Total Cost ($/t) Case 1	Total Cost ($/t) Case 2	Total Cost ($/t) Case 3
Labour							
Operator	1.40 $/m.h.	18	16	20	2.37	3.47	2.38
Superviser	2.15 $/m.h.	4	3	4	0.81	1.00	0.73
Payroll Burden	5% of Labour				0.16	0.22	0.16
Maintenance	3% of Total Capital Investment				2.61	3.18	2.50
Depreciation	10% "				8.69	10.61	8.34
Interest	7% "				6.08	7.42	5.84
Tax & Insurance	2% "				1.74	2.12	1.67
Overheads	2% "				1.74	2.12	1.67
Net Manufacturing Cost					146.70	153.95	131.07
Total Capital Investment (1,000 $)					7,310	5,420	7,760

Item		Unit	Case 1	Case 2	Case 3
Net Cash Flow	@ 20% of T.C.I.	$	1,462,000	1,084,000	1,552,000
Depreciation		$	731,000	542,000	776,000
Net Income		$	731,000	542,000	776,000
Total Manufacturing Cost		$	12,337,500	7,882,240	12,189,510
Total Sales		$	13,068,500	8,424,240	12,965,510
Selling Price		$/t	155.39	164.54	139.41

5. S T Y R E N E

		Case 1	Case 2	Case 3
Capacity (t/y)		62,500	58,100	136,000
Capital Investment (1,000 $)	Process Section	7,245	6,910	11,530
	Utilities & General Service Facilities	1,450	1,380	2,300
	Total Capital Investment (1,000 $)	8,695	8,290	13,830

Item	Unit Cost Case 1	Unit Cost Case 2	Unit Cost Case 3	Basis (1/t)	Total Cost ($/t) Case 1	Total Cost ($/t) Case 2	Total Cost ($/t) Case 3
Materials							
Ethylene	71.58 $/t	56.64 $/t	45.54 $/t	0.31 t	22.19	19.56	14.12
Benzene	59.22 $/t	59.32 $/t	57.44 $/t	0.85 t	50.34	50.42	48.82
Catalyst & Chemicals				5.60 $/t	5.60	5.60	5.60
Utilities							
Powers	0.0065 $/kwh			150 kwh	0.98	0.98	0.98
Steam	0.48 $/t			12 t	5.76	5.76	5.76
Cooling Water	0.0013 $/t			150 t	0.20	0.20	0.20
Fuel	0.446 $/$10^6$ kcal			3.2 10^6 kcal	1.43	1.43	1.43
Process Water				- t			

Item	Unit Cost	Men / Shift Case 1	Men / Shift Case 2	Men / Shift Case 3	Case 1	Case 2	Case 3
Labour							
Operator	1.40 $/m.h.	4	4	5	0.71	0.76	0.41
Superviser	2.15 $/m.h.	1	1	1	0.27	0.29	0.13
Payroll Burden	5% of Labour				0.05	0.05	0.03
Maintenance	3% of Total Capital Investment				4.17	4.29	3.05
Depreciation	10% "				13.91	14.29	10.17
Interest	7% "				9.74	10.01	7.12
Tax & Insurance	2% "				2.78	2.86	2.03
Overheads	2% "				2.78	2.86	2.03
Net Manufacturing Cost					120.91	117.36	101.88

			Case 1	Case 2	Case 3
Capacity (t/y)			62,500	58,100	136,000
Total Capital Investment (1,000 $)			8,695	8,290	13,830
Net Cash Flow	@ 2% of T.C.I.	$	1,739,000	1,658,000	2,766,000
Depreciation		$	869,500	829,000	1,383,000
Net Income		$	869,500	829,000	1,383,000
Total Manufacturing Cost		$	7,556,900	6,818,600	13,855,680
Total Sales		$	8,426,400	7,647,600	15,238,680
Selling Price		$/t	134.82	131.63	112.05

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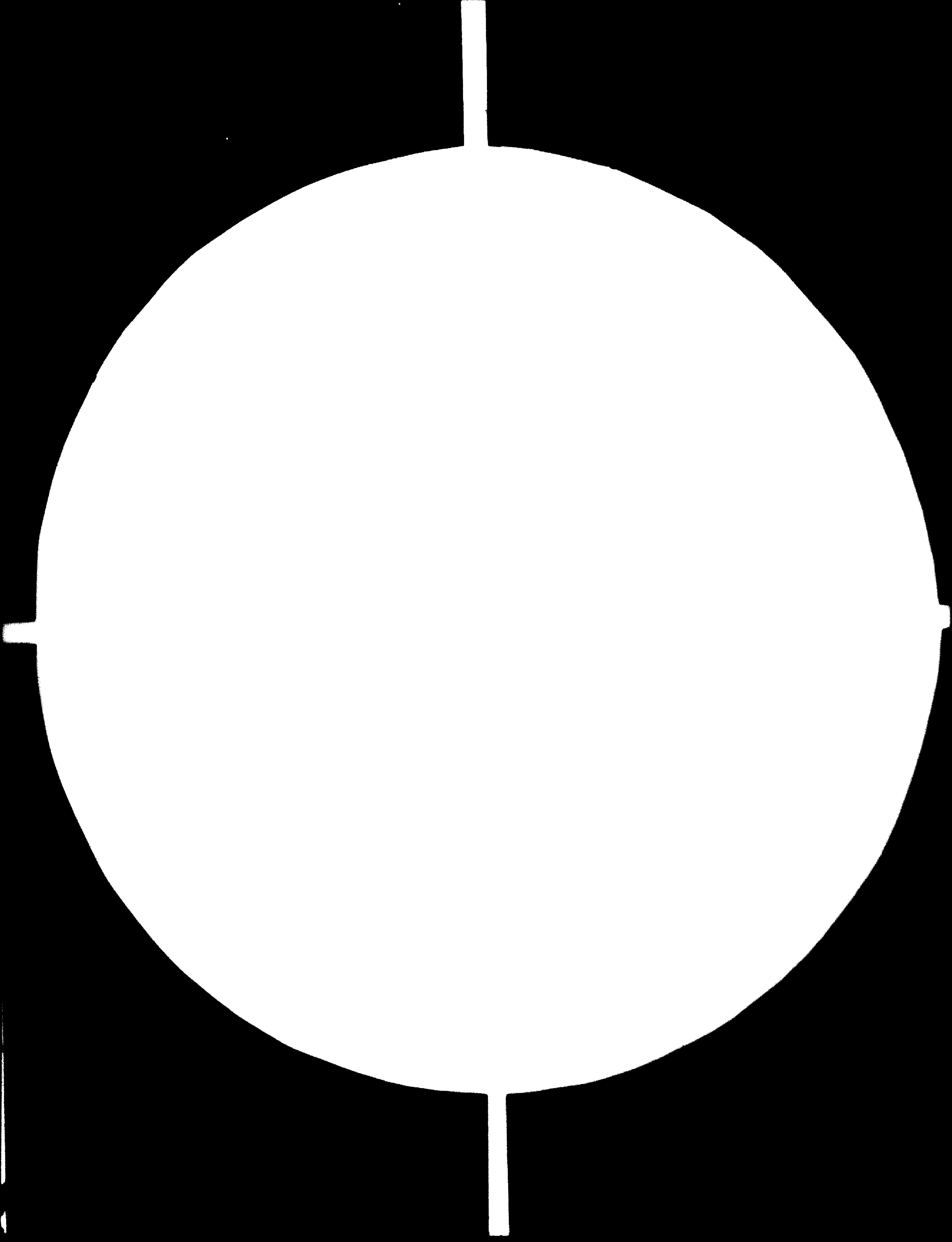

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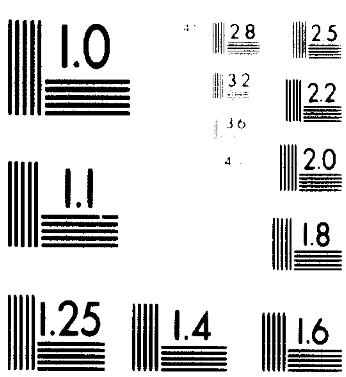

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS
STANDARD REFERENCE MATERIAL 1010a
(ANSI and ISO TEST CHART No. 2)

24x

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6. Polyetyrene (Suspension)

		Case 1	Case 2	Case 3
Capacity (t/y)		50,700	48,300	110,000
Capital Investment (1,000 $)	Process Section	10,300	10,000	16,400
	Utilities & General Service Facilities	2,060	2,000	3,280
	Total Capital Investment (1,000 $)	12,360	12,000	19,680

Item	Unit Cost Case 1	Unit Cost Case 2	Unit Cost Case 3	Basis (1/t)	Total Cost ($/t) Case 1	Total Cost ($/t) Case 2	Total Cost ($/t) Case 3
Materials							
Styrene	134.82 $/t	131.63 $/t	112.05 $/t	1.053 t	141.97	138.61	117.99
Catalyst & Chemicals				7.72 $/t	7.72	7.72	7.72
Utilities							
Powers	0.0065 $/kwh			245 kwh	1.59	1.59	1.59
Steam	0.48 $/t			0.632 t	0.30	0.30	0.30
Cooling Water	0.0013 $/t			20.4 t	0.03	0.03	0.03
Fuel	0.446 $/$10^6$ kcal			___ 10^6 kcal			
Process Water	0.040 $/t			1.8 t	0.07	0.07	0.07

Item	Unit Cost	Men / Shift Case 1	Men / Shift Case 2	Men / Shift Case 3	Total Cost ($/t) Case 1	Total Cost ($/t) Case 2	Total Cost ($/t) Case 3
Labour							
Operator	1.40 $/m.h.	14	13	20	3.06	2.98	2.02
Superviser	2.15 $/m.h.	2	2	3	0.67	0.71	0.46
Payroll Burden	5% of Labour				0.18	0.18	0.12
Maintenance	3% of Total Capital Investment				7.31	7.45	5.37
Depreciation	10% "				24.38	24.84	17.89
Interest	7% "				17.07	17.39	12.52
Tax & Insurance	2% "				4.88	4.97	3.58
Overheads	2% "				4.88	4.97	3.58
Net Manufacturing Cost					214.11	211.81	173.24

			Case 1	Case 2	Case 3
Capacity (t/y)			50,700	48,300	110,000
Total Capital Investment (1,000 $)			12,360	12,000	19,680
Net Cash Flow	@ 20% of T.C.I.	$	2,472,000	2,400,000	3,936,000
Depreciation		$	1,236,000	1,200,000	1,968,000
Net Income		$	1,236,000	1,200,000	1,968,000
Total Manufacturing Cost		$	10,855,000	10,230,000	19,056,400
Total Sales		$	12,091,000	11,430,000	21,024,400
Selling Price		$/t	238.49	236.65	191.13

7-1. P O

	Case 1	Case 2	Case 3
Capacity (t/y)			25,500
Capital Investment (1,000 $) — Process Section			2,920
Capital Investment (1,000 $) — Utilities & General Service Facilities			580
Total Capital Investment (1,000 $)			3,500

Item	Unit Cost Case 1	Unit Cost Case 2	Unit Cost Case 3	Basis (1/t) / Men / Shift (Case 1, Case 2, Case 3)	Total Cost ($/t) Case 1	Total Cost ($/t) Case 2	Total Cost ($/t) Case 3
Materials							
Propylene			44 $/t	0.92 t			40.48
Chlorine			55.11 $/t	1.43 t			78.81
Lime			13.75 $/t	1.14 t			15.68
Catalyst & Chemicals				1.06 $/t			1.06
Utilities							
Powers	0.0065 $/kwh			200 kwh			1.30
Steam	0.48 $/t			9.1 t			4.37
Cooling Water	0.0013 $/t			400 t			0.52
Fuel	0.446 $/$10^6$ kcal			— 10^6 kcal			
Process Water	0.040 $/t			— t			
Labour				Men / Shift: Case 1 / Case 2 / Case 3			
Operator	1.40 $/m.h.			Case 3: 20			8.70
Superviser	2.15 $/m.h.			Case 3: 3			2.00
Payroll Burden	5% of Labour						0.54
Maintenance	3% of Total Capital Investment						4.12
Depreciation	10% "						13.73
Interest	7% "						9.61
Tax & Insurance	2% "						2.75
Overheads	2% "						2.75
Net Manufacturing Cost							186.42

			Case 3
Capacity (t/y)			25,500
Total Capital Investment (1,000 $)			3,500
Net Cash Flow	@ 20% of T.C.I.	$	700,000
Depreciation		$	350,000
Net Income		$	350,000
Total Manufacturing Cost		$	4,753,700
Total Sales		$	5,103,700
Selling Price		$/t	200.15

7-2. [illegible]

					Case 1	Case 2	Case 3
Capacity (t/y)							30,000
Capital Investment (1,000 $)	Process Section						1,580
	Utilities & General Service Facilities						320
Total Capital Investment (1,000 $)							1,900

Item	Unit Cost Case 1	Unit Cost Case 2	Unit Cost Case 3	Basis (1/t)	Total Cost ($/t) Case 1	Total Cost ($/t) Case 2	Total Cost ($/t) Case 3
Materials							
Propylene Oxide			200.15 $/t	0.85 t			170.13
Catalyst & Chemicals				1.78 $/t			1.78
Utilities							
Powers	0.0065 $/kwh			200 kwh			1.30
Steam	0.48 $/t			5 t			2.40
Cooling Water	0.0013 $/t			200 t			0.26
Fuel	0.446 $/$10^6$ kcal			— 10^6 kcal			
Process Water	0.040 $/t			— t			

Item	Unit Cost	Men/Shift Case 1	Men/Shift Case 2	Men/Shift Case 3	Total Cost ($/t) Case 1	Total Cost ($/t) Case 2	Total Cost ($/t) Case 3
Labour							
Operator	1.40 $/m.h.			12			4.44
Superviser	2.15 $/m.h.			2			1.14
Payroll Burden	5% of Labour						0.28
Maintenance	3% of Total Capital Investment						1.90
Depreciation	10% "						6.33
Interest	7% "						4.43
Tax & Insurance	2% "						1.27
Overheads	2% "						1.27
Net Manufacturing Cost							196.93
Capacity (t/y)							30,000
Total Capital Investment (1,000 $)							1,900
Net Cash Flow @ 20% of T.C.I.	$						380,000
Depreciation	$						190,000
Net Income	$						190,000
Total Manufacturing Cost	$						5,907,900
Total Sales	$						6,097,900
Selling Price	$/t						203.26

8. ACRYLONITRILE

Item	Unit Cost Case 1	Unit Cost Case 2	Unit Cost Case 3	Basis (1/t)	Total Cost ($/t) Case 1	Case 2	Case 3
Capacity (t/y)					34,000	22,000	44,800
Capital Investment (1,000 $) — Process Section					8,060	6,200	9,510
Capital Investment (1,000 $) — Utilities & General Service Facilities					1,612	1,240	1,900
Total Capital Investment (1,000 $)					9,672	7,440	11,410
Materials							
Propylene	50 $/t	50 $/t	44 $/t	1.15 t	57.50	57.50	50.60
Ammonia	40 $/t	40 $/t	40 $/t	0.37 t	14.80	14.80	14.80
Catalyst & Chemicals				13.90 $/t	13.90	13.90	13.90
Utilities							
Powers	0.0065 $/kwh			600 kwh	3.90	3.90	3.90
Steam	0.48 $/t			8 t	3.84	3.84	3.84
Cooling Water	0.0013 $/t			500 t	0.54	0.54	0.54
Fuel	0.446 $/$10^6$ kcal			— 10^6 kcal			
Process Water	0.040 $/t			— t			
				Men / Shift (Case 1 / Case 2 / Case 3)			
Labour							
Operator	1.40 $/m.h.			12 / 9 / 12	3.91	4.54	2.97
Superviser	2.15 $/m.h.			1 / 1 / 1	0.50	0.77	0.38
Payroll Burden	5% of Labour				0.22	0.27	0.17
Maintenance	3% of Total Capital Investment				8.53	10.15	7.64
Depreciation	10% "				28.45	33.82	25.47
Interest	7% "				19.91	23.67	17.83
Tax & Insurance	2% "				5.69	6.76	5.09
Overheads	2% "				5.69	6.76	5.09
Net Manufacturing Cost					167.38	181.22	152.22
Capacity (t/y)					34,000	22,000	44,800
Total Capital Investment (1,000 $)					9,672	7,440	11,410
Net Cash Flow @ 20% of T.C.I.	$				1,934,400	1,488,000	2,282,000
Depreciation	$				967,200	744,000	1,141,000
Net Income	$				967,200	744,000	1,141,000
Total Manufacturing Cost	$				5,690,900	3,986,800	6,819,460
Total Sales	$				6,658,100	4,730,800	7,960,460
Selling Price	$/t				195.83	215.04	177.69

9. POLYACRYLONITRILE - F

		Case 1	Case 2	Case 3
Capacity (t/y)		12,000	12,000	12,000
Capital Investment (1,000 $)	Process Section	21,290	21,290	21,290
	Utilities & General Service Facilities	4,260	4,260	4,260
	Total Capital Investment (1,000 $)	25,550	25,550	25,550

Item	Unit Cost Case 1	Unit Cost Case 2	Unit Cost Case 3	Basis (1/t)	Total Cost ($/t) Case 1	Total Cost ($/t) Case 2	Total Cost ($/t) Case 3
Materials							
Acrylonitrile	195.83 $/t	215.04 $/t	177.69 $/t	1.006 t	197.[illegible]	216.33	178.76
Catalyst & Chemicals				125 $/t	125.00	125.00	125.00
Utilities							
Powers	0.0065 $/kwh			1,400 kwh	9.10	9.10	9.10
Steam	0.48 $/t			2.5 t	1.20	1.20	1.20
Cooling Water	0.0013 $/t			300 t	0.39	0.39	0.39
Fuel	0.446 $/$10^6$ kcal			— 10^6 kcal			
Process Water	0.040 $/t			10 t	0.40	0.40	0.40

Item	Unit Cost	Men / Shift Case 1	Men / Shift Case 2	Men / Shift Case 3	Total Cost ($/t) Case 1	Total Cost ($/t) Case 2	Total Cost ($/t) Case 3
Labour							
Operator	1.40 $/m.h.	63	63	63	58.21	58.21	58.21
Superviser	2.15 $/m.h.	4	4	4	5.68	5.68	5.68
Payroll Burden	5% of Labour				3.19	3.19	3.19
Maintenance	3% of Total Capital Investment				63.87	63.87	63.87
Depreciation	10% "				212.92	212.92	212.92
Interest	7% "				149.04	149.04	149.04
Tax & Insurance	2% "				42.58	42.58	42.58
Overheads	2% "				42.58	42.58	42.58
Net Manufacturing Cost					911.96	930.49	892.92

			Case 1	Case 2	Case 3
Capacity (t/y)			12,000	12,000	12,000
Total Capital Investment (1,000 $)			25,550	25,550	25,550
Net Cash Flow	@ 20% of T.C.I.	$	5,110,000	5,110,000	5,110,000
Depreciation		$	2,555,000	2,555,000	2,555,000
Net Income		$	2,555,000	2,555,000	2,555,000
Total Manufacturing Cost		$	10,933,920	11,165,880	10,715,000
Total Sales		$	13,488,920	13,720,880	13,270,000
Selling Price		$/t	1,124.08	1,143.41	1,105.83

10. P P

		Case 1	Case 2	Case 3
Capacity (t/y)		50,000	40,000	100,000
Capital Investment (1,000 $)	Process Section	17,150	15,000	26,000
	Utilities & General Service Facilities	3,430	3,000	5,200
	Total Capital Investment (1,000 $)	20,580	18,000	31,200

Item	Unit Cost Case 1	Unit Cost Case 2	Unit Cost Case 3	Basis (1/t)	Total Cost ($/t) Case 1	Total Cost ($/t) Case 2	Total Cost ($/t) Case 3
Materials							
Propylene	50 $/t	50 $/t	44 $/t	1.25 t	62.50	62.50	55.00
Catalyst & Chemicals				30.2 $/t	30.20	30.20	30.20
Utilities							
Powers	0.0065 $/kwh			1,100 kwh	7.15	7.15	7.15
Steam	0.48 $/t			8.3 t	3.98	3.98	3.98
Cooling Water	0.0013 $/t			800 t	1.04	1.04	1.04
Fuel	0.446 $/$10^6$ kcal			— 10^6 kcal			
Process Water	0.040 $/t						

Item	Unit Cost	Men / Shift Case 1	Men / Shift Case 2	Men / Shift Case 3	Total Cost ($/t) Case 1	Total Cost ($/t) Case 2	Total Cost ($/t) Case 3
Labour							
Operator	1.40 $/m.h.	16	15	19	3.55	4.16	2.11
Supervisor	2.15 $/m.h.	2	2	2	0.68	0.85	0.34
Payroll Burden	5% of Labour				0.21	0.25	0.12
Maintenance	3% of Total Capital Investment				12.35	13.50	9.30
Depreciation	10% "				41.16	45.00	31.20
Interest	7% "				28.81	31.50	21.84
Tax & Insurance	2% "				8.23	9.00	6.24
Overheads	2% "				8.23	9.00	6.24
Net Manufacturing Cost					208.09	218.13	174.82

			Case 1	Case 2	Case 3
Capacity (t/y)			50,000	40,000	100,000
Total Capital Investment (1,000 $)			20,580	18,000	31,200
Net Cash Flow	@ 20% of T.C.I.	$	4,116,000	3,600,000	6,240,000
Depreciation		$	2,058,000	1,800,000	3,120,000
Net Income		$	2,058,000	1,800,000	3,120,000
Total Manufacturing Cost		$	10,404,500	8,725,200	17,482,000
Total Sales		$	12,462,500	10,525,200	20,602,000
Selling Price		$/t	249.25	263.13	206.02

11. S B R

		Case 1	Case 2	Case 3
Capacity (t/y)		38,000	30,000	83,000
Capital Investment (1,000 $)	Process Section	8,530	7,400	13,550
	Utilities & General Service Facilities	1,706	1,480	2,710
	Total Capital Investment (1,000 $)	10,236	8,880	16,260

Item	Unit Cost Case 1	Unit Cost Case 2	Unit Cost Case 3	Basis (1/t)	Total Cost ($/t) Case 1	Total Cost ($/t) Case 2	Total Cost ($/t) Case 3
Materials							
Butadiene	113.34 $/t	116.63 $/t	158.81 $/t	0.78 t	88.41	90.97	123.87
Styrene	134.82 $/t	131.63 $/t	112.05 $/t	0.24 t	32.36	31.59	26.89
Catalyst & Chemicals				8.33 $/t	8.33	8.33	8.33
Utilities							
Powers	0.0065 $/kwh			537 kwh	3.49	3.49	3.49
Steam	0.48. $/t			3.3 t	1.58	1.58	1.58
Cooling Water	0.0013 $/t			290 t	0.38	0.38	0.38
Fuel	0.446 $/$10^6$ kcal			— 10^6 kcal			
Process Water	0.040 $/t			1.6 t	0.10	0.10	0.10

Item	Unit Cost	Men / Shift Case 1	Men / Shift Case 2	Men / Shift Case 3	Case 1	Case 2	Case 3
Labour							
Operator	1.40 $/m.h.	30	25	45	8.75	9.24	6.01
Superviser	2.15 $/m.h.	3	3	5	1.34	1.70	1.03
Payroll Burden	5% of Labour				0.50	0.55	0.35
Maintenance	3% of Total Capital Investment				8.08	8.88	5.88
Depreciation	10% "				26.94	29.60	19.59
Interest	7% "				18.86	20.72	13.71
Tax & Insurance	2% "				5.39	5.92	3.92
Overheads	2% "				5.39	5.92	3.92
Net Manufacturing Cost					209.90	218.97	219.05

			Case 1	Case 2	Case 3
Capacity (t/y)			38,000	30,000	83,000
Total Capital Investment (1,000 $)			10,236	8,880	16,260
Net Cash Flow	@ 2% of T.C.I.	$	2,047,200	1,776,000	3,252,000
Depreciation		$	1,023,600	888,000	1,626,000
Net Income		$	1,023,600	888,000	1,626,000
Total Manufacturing Cost		$	7,976,200	6,569,100	18,181,150
Total Sales		$	8,999,800	7,457,100	19,807,150
Selling Price		$/t	236.84	248.57	238.64

12. MALEIC ANHYDRIDE

		Case 1	Case 2	Case 3
Capacity (t/y)		35,000	35,000	50,000
Capital Investment (1,000 $)	Process Section	6,490	6,490	8,040
	Utilities & General Service Facilities	1,292	1,292	1,610
	Total Capital Investment (1,000 $)	7,782	7,782	9,650

Item	Unit Cost Case 1	Unit Cost Case 2	Unit Cost Case 3	Basis (1/t)	Total Cost ($/t) Case 1	Total Cost ($/t) Case 2	Total Cost ($/t) Case 3
Materials					75.80	75.93	73.52
Benzene	59.22 $/t	59.32 $/t	57.44 $/t	1.28 t			
Catalyst & Chemicals				4.21 $/t	4.21	4.21	4.21
Utilities							
Powers	0.0065 $/kwh			1,730 kwh	11.25	11.25	11.25
Steam	0.48 $/t			- 6.6 t	- 3.17	- 3.17	- 3.17
Cooling Water	0.0013 $/t			180 t	0.24	0.24	0.24
Fuel	0.446 $/10⁶ kcal			— 10⁶ kcal			
Process Water	0.040 $/t			— t			
				Men / Shift: Case 1 / Case 2 / Case 3			
Labour							
Operator	1.40 $/m.h.			10 / 10 / 10	3.17	3.17	2.22
Superviser	2.15 $/m.h.			2 / 2 / 2	0.97	0.97	0.68
Payroll Burden	5% of Labour				0.24	0.24	0.15
Maintenance	3% of Total Capital Investment				6.67	6.67	5.79
Depreciation	10% "				22.23	22.23	19.30
Interest	7% "				15.56	15.56	13.51
Tax & Insurance	2% "				4.45	4.45	3.86
Overheads	2% "				4.45	4.45	3.86
Net Manufacturing Cost					141.88	142.01	135.42
Total Capital Investment (1,000 $)					7,782	7,782	9,650
Net Cash Flow @ 20% of T.C.I.	$				1,556,400	1,556,400	1,930,000
Depreciation	$				778,200	778,200	965,000
Net Income	$				778,200	778,200	965,000
Total Manufacturing Cost	$				4,965,800	4,970,400	6,771,000
Total Sales	$				5,774,000	5,748,600	7,736,000
Selling Price	$/t				164.11	164.24	154.72

13. LINEAR ALKYLBENZENE

		Case 1	Case 2	Case 3
Capacity (t/y)		30,000	30,000	50,000
Capital Investment (1,000 $)	Process Section	4,400	4,400	6,000
	Utilities & General Service Facilities	880	880	1,200
	Total Capital Investment (1,000 $)	5,280	5,280	7,200

Item	Unit Cost Case 1	Unit Cost Case 2	Unit Cost Case 3	Basis (1/t)	Total Cost ($/t) Case 1	Total Cost ($/t) Case 2	Total Cost ($/t) Case 3
Materials							
N-Paraffins	90.57 $/t	90.57 $/t	90.57 $/t	1.02 t	92.38	92.38	92.38
Benzene	59.22 $/t	59.32 $/t	57.44 $/t	0.38 t	22.50	22.54	21.83
By-Product							
Heavy N-Paraffin	110 $/t	110 $/t	110 $/t	- 0.24 t	- 26.40	- 26.40	- 26.40
Utilities							
Powers	0.0065 $/kwh			344 kwh	2.24	2.24	2.24
Steam	0.48 $/t			0.67 t	0.32	0.32	0.34
Cooling Water	0.0013 $/t			504 t	0.66	0.66	0.66
Fuel	0.446 $/$10^6$ kcal			5.4 x 10^6 kcal	2.40	2.40	2.40
Process Water	0.040 $/t			t			
				Men / Shift: Case 1 / Case 2 / Case 3			
Labour					1.48	1.48	1.11
Operator	1.40 $/m.h.			4 / 4 / 5	0.57	0.57	0.34
Superviser	2.15 $/m.h.			1 / 1 / 1	0.10	0.10	0.07
Payroll Burden	5% of Labour						
Maintenance	3% of Total Capital Investment				5.28	5.28	4.32
Depreciation	10% "				17.60	17.60	14.40
Interest	7% "				12.32	12.32	10.08
Tax & Insurance	2% "				3.52	3.52	2.88
Overheads	2% "				3.52	3.52	2.88
Net Manufacturing Cost					138.49	138.53	129.53
Capacity (t/y)					30,000	30,000	50,000
Total Capital Investment (1,000 $)					5,280	5,280	7,200
Net Cash Flow	@ 20% of T.C.I.	$			1,056,000	1,056,000	1,440,000
Depreciation		$			528,000	528,000	720,000
Net Income		$			528,000	528,000	720,000
Total Manufacturing Cost		$			4,155,000	4,156,000	6,476,500
Total Sales		$			4,683,000	4,684,000	7,196,500
Selling Price		$/t			156.09	156.13	143.93

14. CAPROLACTAM

			Case 1	Case 2	Case 3
Capacity (t/y)			17,700	17,700	17,700
Capital Investment (1,000 $)	Process Section		[illegible]	9,550	9,550
	Utilities & General Service Facilities		[illegible]	1,910	1,910
	Total Capital Investment (1,000 $)		11,460	11,460	11,460

Item	Unit Cost Case 1	Unit Cost Case 2	Unit Cost Case 3	Basis (1/t)	Total Cost ($/t) Case 1	Total Cost ($/t) Case 2	Total Cost ($/t) Case 3
Materials							
Cyclohexane	61.75 $/t	61.75 $/t	61.75 $/t	1.1 t	67.93	67.93	67.93
Ammonia	40.00 $/t	40.00 $/t	40.00 $/t	1.0 t	40.00	40.00	40.00
Oleum & Sulfuric Acid	20.00 $/t	20.00 $/t	20.00 $/t	1.8 t	36.00	36.00	36.00
Catalyst & Chemicals				14.3 $/t	14.30	14.30	14.30
By-Product							
Ammonium Sulfate	30.67 $/t	30.67 $/t	30.67 $/t	- 2.6 t	- 79.73	- 79.73	- 79.73
Utilities							
Powers	0.0065 $/kwh			900 kwh	5.85	5.85	5.85
Steam	0.48 $/t			12 t	5.76	5.76	5.76
Cooling Water	0.0013 $/t			140 t	1.34	1.34	1.34
Fuel	0.446 $/$10^6$ kcal			3.0 x 10^6 kcal	0.18	0.18	0.18
Process Water				— t			
				Men / Shift: Case 1 / Case 2 / Case 3			
Labour							
Operator	1.40 $/m.h.			8 / 8 / 8	5.01	5.01	5.01
Superviser	2.15 $/m.h.			2 / 2 / 2	1.92	1.92	1.92
Payroll Burden	5% of Labour				0.35	0.35	0.35
Maintenance	3% of Total Capital Investment				19.42	19.42	19.42
Depreciation	10% "				64.75	64.75	64.75
Interest	7% "				45.32	45.32	45.32
Tax & Insurance	2% "				12.95	12.95	12.95
Overheads	2% "				12.95	12.95	12.95
Net Manufacturing Cost					254.30	254.30	254.30
Total Capital Investment (1,000 $)					11,460	11,460	11,460
Net Cash Flow @ 20% of T.C.I.	$				2,292,000	2,292,000	2,292,000
Depreciation	$				1,146,000	1,146,000	1,146,000
Net Income	$				1,146,000	1,146,000	1,146,000
Total Manufacturing Cost	$				4,501,110	4,501,110	4,501,110
Total Sales	$				5,647,110	5,647,110	5,647,110
Selling Price	$/t				319.05	319.05	319.05

15-1. NYLON 6 (CHIP)

		Case 1	Case 2	Case 3
Capacity (t/y)		18,500	18,500	18,500
Capital Investment (1,000 $)	Process Section	1,490	1,490	1,490
	Utilities & General Service Facilities	300	300	300
	Total Capital Investment (1,000 $)	1,790	1,790	1,790

Item	Unit Cost Case 1	Unit Cost Case 2	Unit Cost Case 3	Basis (1/t)	Total Cost ($/t) Case 1	Total Cost ($/t) Case 2	Total Cost ($/t) Case 3
Materials							
Caprolactam	319.05 $/t	319.05 $/t	319.05 $/t	0.955 t	304.69	304.69	304.69
Waste Nylon 6	300 $/t	300 $/t	300 $/t	0.04 t	12.00	12.00	12.00
Catalyst & Chemicals				23.19 $/t	23.19	23.19	23.19
Utilities							
Powers	0.0065 $/kwh			270 kwh	1.76	1.76	1.76
Steam	0.48 $/t			2.6 t	1.25	1.25	1.25
Cooling Water	0.0013 $/t			91 t	0.12	0.12	0.12
Fuel	0.446 $/$10^6$ kcal			0.35 x 10^6 kcal	0.16	0.16	0.16
Process Water	0.040 $/t			— t			

Item	Unit Cost	Men / Shift Case 1	Men / Shift Case 2	Men / Shift Case 3	Total Cost Case 1	Total Cost Case 2	Total Cost Case 3
Labour							
Operator	1.40 $/m.h.	9	9	9	5.39	5.39	5.39
Superviser	2.15 $/m.h.	1	1	1	0.92	0.92	0.92
Payroll Burden	5% of Labour				0.32	0.32	0.32
Maintenance	3% of Total Capital Investment				2.90	2.90	2.90
Depreciation	10% "				9.68	9.68	9.68
Interest	7% "				6.77	6.77	6.77
Tax & Insurance	2% "				1.94	1.94	1.94
Overheads	2% "				1.94	1.94	1.94
Net Manufacturing Cost					373.03	373.03	373.03

			Case 1	Case 2	Case 3
Capacity (t/y)			18,500	18,500	18,500
Total Capital Investment (1,000 $)			1,790	1,790	1,790
Net Cash Flow	@ 20% of T.C.I.	$	358,000	358,000	358,000
Depreciation		$	179,000	179,000	179,000
Net Income		$	179,000	179,000	179,000
Total Manufacturing Cost		$	6,901,060	6,901,060	6,901,060
Total Sales		$	7,080,060	7,080,060	7,080,060
Selling Price		$/t	382.71	382.71	382.71

15-2. NYLON 6 - F

		Case 1	Case 2	Case 3
Capacity (t/y)		18,000	18,000	18,000
Capital Investment (1,000 $)	Process Section	19,820	19,820	19,820
	Utilities & General Service Facilities	3,960	3,960	3,960
	Total Capital Investment (1,000 $)	23,780	23,780	23,780

Item	Unit Cost Case 1	Unit Cost Case 2	Unit Cost Case 3	Basis (1/t)	Men / Shift Case 1	Men / Shift Case 2	Men / Shift Case 3	Total Cost ($/t) Case 1	Total Cost ($/t) Case 2	Total Cost ($/t) Case 3
Materials										
Nylon 6 Chip	382.71 $/t	382.71 $/t	382.71 $/t	1.042 t				398.78	398.78	398.78
Utilities										
Powers	0.0065 $/kwh			189.3 kwh				1.23	1.23	1.23
Steam	0.48 $/t			— t						
Cooling Water	0.0013 $/t			8.0 t				0.01	0.01	0.01
Fuel	0.446 $/ 10^6 kcal			— 10^6 kcal						
Process Water										
Labour										
Operator	1.40 $/m.h.				300	300	300	184.80	184.80	184.80
Superviser	2.15 $/m.h.				30	30	30	28.38	28.38	28.38
Payroll Burden	5% of Labour							10.66	10.66	10.66
Maintenance	3% of Total Capital Investment							39.63	39.63	39.63
Depreciation	10% "							132.11	132.11	132.11
Interest	7% "							92.48	92.48	92.48
Tax & Insurance	2% "							26.42	26.42	26.42
Overheads	2% "							26.42	26.42	26.42
Net Manufacturing Cost								940.92	940.92	940.92

			Case 1	Case 2	Case 3
Capacity (t/y)			18,000	18,000	18,000
Total Capital Investment (1,000 $)			23,780	23,780	23,780
Net Cash Flow	@ 20% of T.C.I.	$	4,756,000	4,756,000	4,756,000
Depreciation		$	2,378,000	2,378,000	2,378,000
Net Income		$	2,378,000	2,378,000	2,378,000
Total Manufacturing Cost		$	16,936,560	16,936,560	16,936,560
Total Sales		$	19,314,560	19,314,560	19,314,560
Selling Price		$/t	1,073.03	1,073.03	1,073.03

16. T D I

	Case 1	Case 2	Case 3
Capacity (t/y)			30,000
Capital Investment (1,000 $) — Process Section			17,840
Capital Investment (1,000 $) — Utilities & General Service Facilities			3,570
Total Capital Investment (1,000 $)			21,410

Item	Unit Cost Case 1	Unit Cost Case 2	Unit Cost Case 3	Basis (1/t)	Total Cost ($/t)
Materials					
Toluene			36.6 $/t	0.679 t	24.85
Chlorine			55.11 $/t	0.947 t	52.19
Nitric Acid			103.4 $/t	0.970 t	100.30
Natural Gas			5.3 $/$10^3$ Nm^3	340 Nm^3	1.80
Catalyst & Chemicals				30 $/t	30.00
Utilities					
Powers	0.0065 $/kwh			1,283 kwh	8.34
Steam	0.48 $/t			7.92 t	3.80
Cooling Water	0.0013 $/t			945 t	1.23
Fuel	0.446 $/$10^6$ kcal			— 10^6 kcal	
Process Water	0.040 $/t			— t	

Item	Unit Cost	Men / Shift Case 1	Men / Shift Case 2	Men / Shift Case 3	Total Cost ($/t)
Labour					
Operator	1.40 $/m.h.			8	2.96
Superviser	2.15 $/m.h.			2	1.14
Payroll Burden	5% of Labour				0.21
Maintenance	3% of Total Capital Investment				21.41
Depreciation	10% "				71.37
Interest	7% "				49.96
Tax & Insurance	2% "				14.27
Overheads	2% "				14.27
Net Manufacturing Cost					398.10

			Case 3
Capacity (t/y)			30,000
Total Capital Investment (1,000 $)			21,410
Net Cash Flow	@ 20% of T.C.I.	$	4,282,000
Depreciation		$	2,141,000
Net Income		$	2,141,000
Total Manufacturing Cost		$	11,943,000
Total Sales		$	14,084,000
Selling Price		$/t	469.47

17-1. P-XYLENE

	Case 1	Case 2	Case 3
Capacity (t/y)			39,600
Capital Investment (1,000 $) — Process Section			3,330
Capital Investment (1,000 $) — Utilities & General Service Facilities			670
Total Capital Investment (1,000 $)			4,000

Item	Unit Cost Case 1	Unit Cost Case 2	Unit Cost Case 3	Basis (1/t)	Total Cost ($/t)
Materials					
Xylene			48.2 $/t	1.177 t	56.73
Catalyst & Chemicals				1.35 $/t	1.35
Utilities					
Powers	0.0065 $/kwh			373 kwh	2.42
Steam	0.48 $/t			— t	
Cooling Water	0.0013 $/t			40 t	0.05
Fuel	0.446 $/$10^6$ kcal			0.0029 x 10^6 kcal	-
Process Water	0.040 $/t			— t	

Item	Unit Cost	Men / Shift Case 1	Men / Shift Case 2	Men / Shift Case 3	Total Cost ($/t)
Labour					
Operator	1.40 $/m.h.			5	1.40
Superviser	2.15 $/m.h.			1	0.43
Payroll Burden	5% of Labour				0.09
Maintenance	3% of Total Capital Investment				3.03
Depreciation	10% "				10.10
Interest	7% "				7.07
Tax & Insurance	2% "				2.02
Overheads	2% "				2.02
Net Manufacturing Cost					86.71

Capacity (t/y)			39,600
Total Capital Investment (1,000 $)			4,000
Net Cash Flow	@ 20% of T.C.I.	$	800,000
Depreciation		$	400,000
Net Income		$	400,000
Total Manufacturing Cost		$	3,433,720
Total Sales		$	3,833,720
Selling Price		$/t	96.81

17-2. TEREPHTHALIC ACID

	Case 1	Case 2	Case 3
Capacity (t/y)			52,800
Capital Investment (1,000 $) — Process Section			12,050
Capital Investment (1,000 $) — Utilities & General Service Facilities			2,410
Total Capital Investment (1,000 $)			14,460

Item	Unit Cost Case 1	Unit Cost Case 2	Unit Cost Case 3	Basis (1/t)	Total Cost ($/t) Case 1	Total Cost ($/t) Case 2	Total Cost ($/t) Case 3
Materials							
P-Xylene			96.81 $/t	0.75 t			72.61
Catalyst & Chemicals				45.2 $/t			45.20
Utilities							
Powers	0.0065 $/kwh			617.2 kwh			4.01
Steam	0.48 $/t			4.5 t			2.16
Cooling Water	0.0013 $/t			333.48 t			0.43
Fuel	0.446 $/$10^6$ kcal			0.980 x 10^6 kcal			0.44
Process Water	0.040 $/t			30.57 t			1.22

Item	Unit Cost	Men / Shift Case 1	Men / Shift Case 2	Men / Shift Case 3	Total Cost ($/t) Case 1	Total Cost ($/t) Case 2	Total Cost ($/t) Case 3
Labour							
Operator	1.40 $/m.h.			10			2.10
Superviser	2.15 $/m.h.			2			0.65
Payroll Burden	5% of Labour						0.14
Maintenance	3% of Total Capital Investment						8.22
Depreciation	10% "						27.39
Interest	7% "						19.17
Tax & Insurance	2% "						5.48
Overheads	2% "						5.48
Net Manufacturing Cost							194.70

			Case 1	Case 2	Case 3
Capacity (t/y)					52,800
Total Capital Investment (1,000 $)					14,460
Net Cash Flow	@ 20% of T.C.I.	$			2,892,000
Depreciation		$			1,446,000
Net Income		$			1,446,000
Total Manufacturing Cost		$			10,280,160
Total Sales		$			11,726,160
Selling Price		$/t			222.09

17-3. DMT

			Case 1	Case 2	Case 3
Capacity (t/y)					61,400
Capital Investment (1,000 $)	Process Section				8,730
	Utilities & General Service Facilities				1,750
	Total Capital Investment (1,000 $)				10,480

Item	Unit Cost Case 1	Unit Cost Case 2	Unit Cost Case 3	Basis (1/t)	Men / Shift Case 1	Men / Shift Case 2	Men / Shift Case 3	Total Cost ($/t)
Materials								
Terephthalic Acid			222.09 $/t	0.86 t				191.00
Methanol			88.00 $/t	0.33 t				29.04
Catalyst & Chemicals				1.77 $/t				1.77
Utilities								
Powers	0.0065 $/kwh			88.18 kwh				0.57
Steam	0.48 $/t			8.545 t				4.10
Cooling Water	0.0013 $/t			250 t				0.33
Fuel	0.446 $/$10^6$ kcal			0.817 x 10^6 kcal				0.36
Process Water	0.040 $/t			5.558 t				0.22
Labour								
Operator	1.40 $/m.h.						8	1.44
Superviser	2.15 $/m.h.						1	0.28
Payroll Burden	5% of Labour							0.09
Maintenance	3% of Total Capital Investment							5.12
Depreciation	10%	"						17.07
Interest	7%	"						11.95
Tax & Insurance	2%	"						3.41
Overheads	2%	"						3.41
Net Manufacturing Cost								270.16

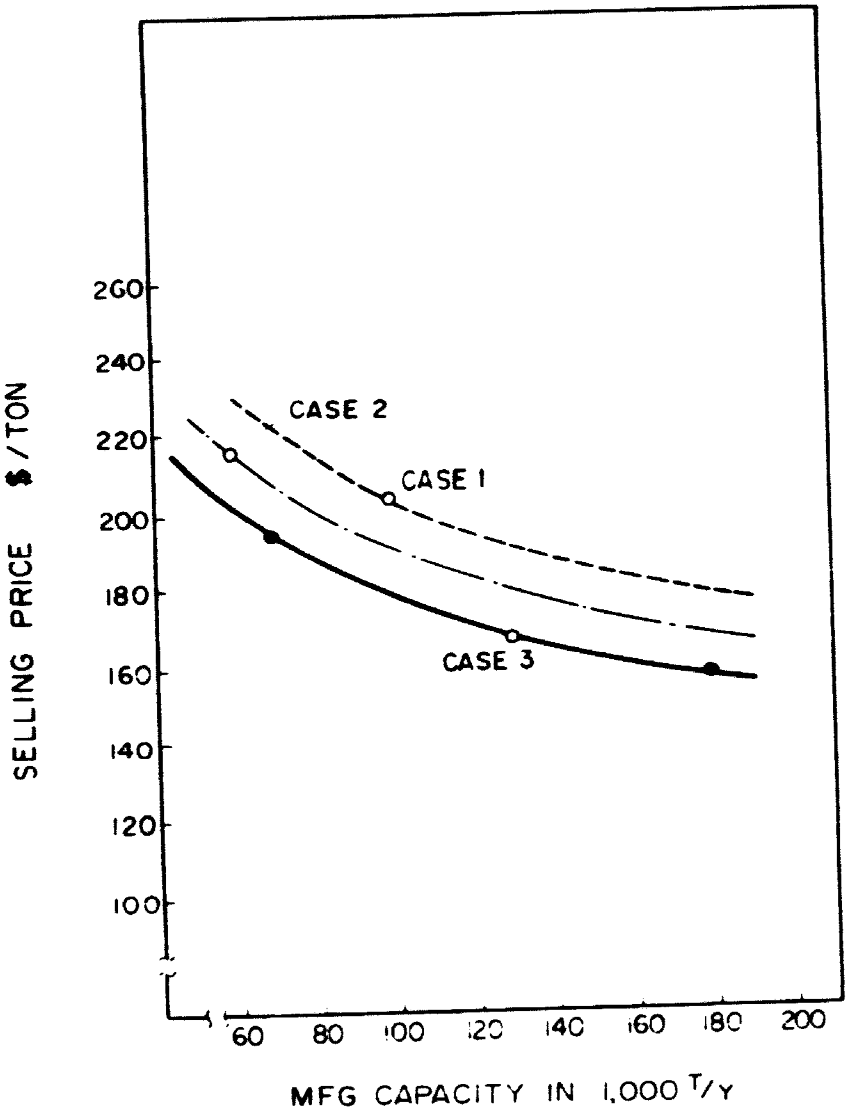
			Case 1	Case 2	Case 3
Capacity (t/y)					61,400
Total Capital Investment (1,000 $)					10,480
Net Cash Flow	@ 20% of T.C.I.	$			2,096,000
Depreciation		$			1,048,000
Net Income		$			1,048,000
Total Manufacturing Cost		$			16,587,820
Total Sales		$			17,635,820
Selling Price		$/t			287.23

18. POLY ESTER - F

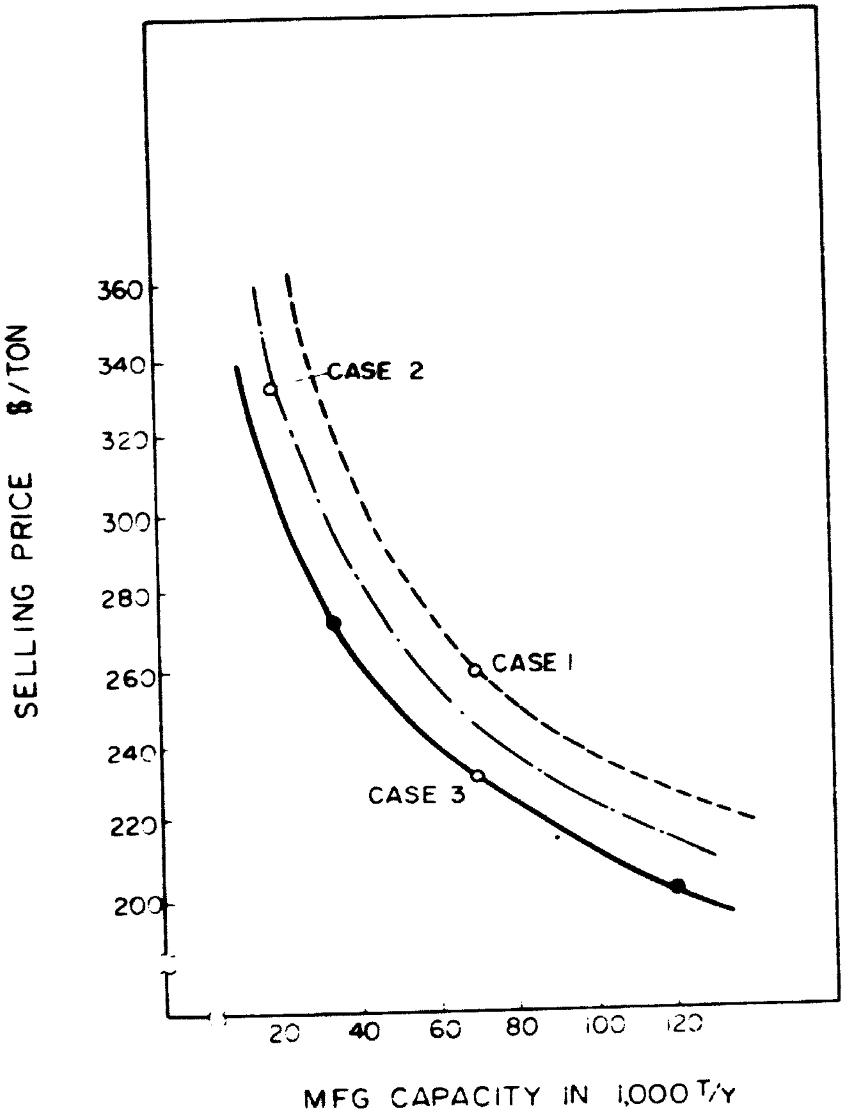
Item	Unit Cost Case 1	Unit Cost Case 2	Unit Cost Case 3	Basis (1/t)	Total Cost ($/t) Case 1	Total Cost ($/t) Case 2	Total Cost ($/t) Case 3
Capacity (t/y)							12,000
Capital Investment (1,000 $) — Process Section							14,160
Capital Investment (1,000 $) — Utilities & General Service Facilities							2,840
Total Capital Investment (1,000 $)							17,000
Materials							
DMT			287.23 $/t	1.15 t			330.31
Ethylene Glycol			204.6 $/t	0.36 t			73.66
Catalyst & Chemicals				29.4 $/t			29.40
Utilities							
Powers	0.0065 $/kwh			2,900 kwh			18.85
Steam	0.48 $/t			2.5 t			1.20
Cooling Water	0.0013 $/t			1,750 t			2.28
Fuel	0.446 $/$10^6$ kcal			— 10^6 kcal			
Process Water	0.040 $/t			— t			
Labour				Men / Shift: Case 1 / Case 2 / Case 3			
Operator	1.40 $/m.h.			Case 3: 80			73.92
Superviser	2.15 $/m.h.			Case 3: 5			7.10
Payroll Burden	5% of Labour						4.05
Maintenance	3% of Total Capital Investment						42.50
Depreciation	10% "						141.67
Interest	7% "						99.17
Tax & Insurance	2% "						28.33
Overheads	2% "						28.33
Net Manufacturing Cost							880.77
Capacity (t/y)							12,000
Total Capital Investment (1,000 $)							17,000
Net Cash Flow @ 20% of T.C.I.	$						3,400,000
Depreciation	$						1,700,000
Net Income	$						1,700,000
Total Manufacturing Cost	$						10,569,240
Total Sales	$						12,269,240
Selling Price	$/t						1,022.44

Annex M. Figure of Selling price of Petrochemicals VS Manufacturing Capacity

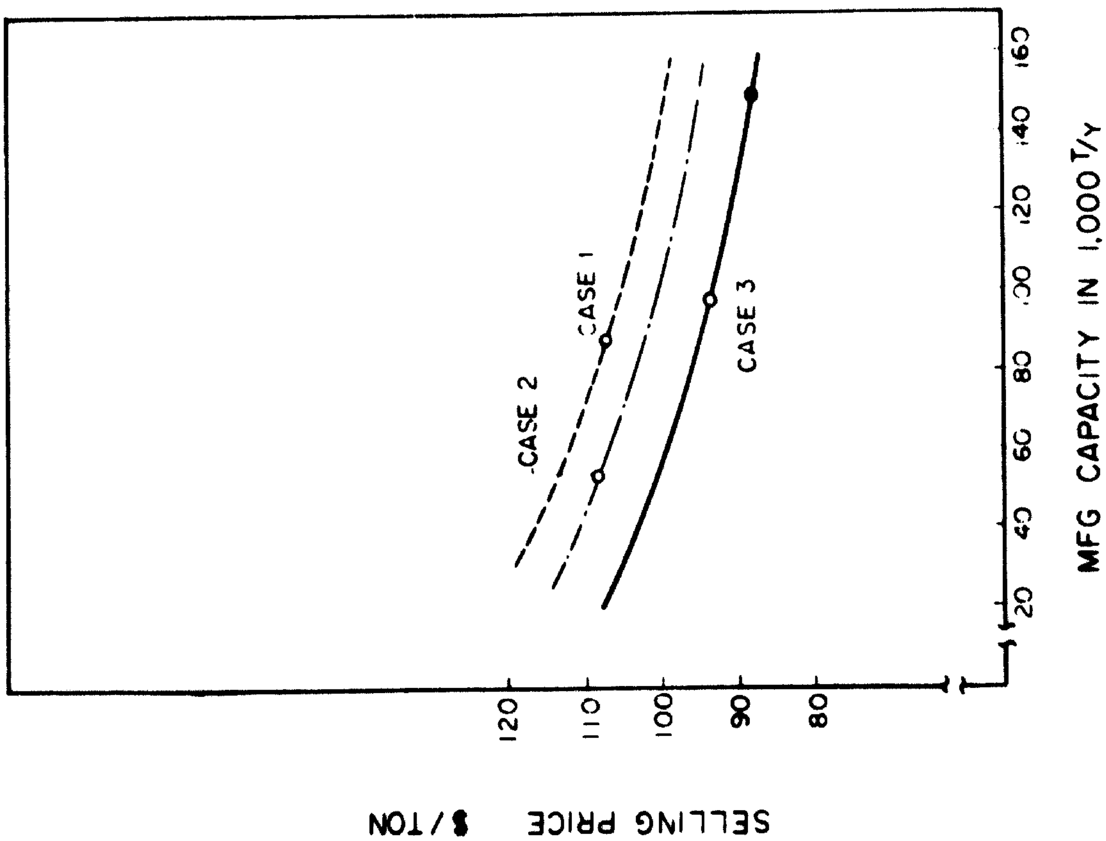
1 LDPE


SELLING PRICE $/TON
260
240
220
200
180
160
140
120
100
CASE 2
CASE 1
CASE 3
60
80
100
120
140
160
180
200
MFG CAPACITY IN 1,000 T/Y

2 HDPE

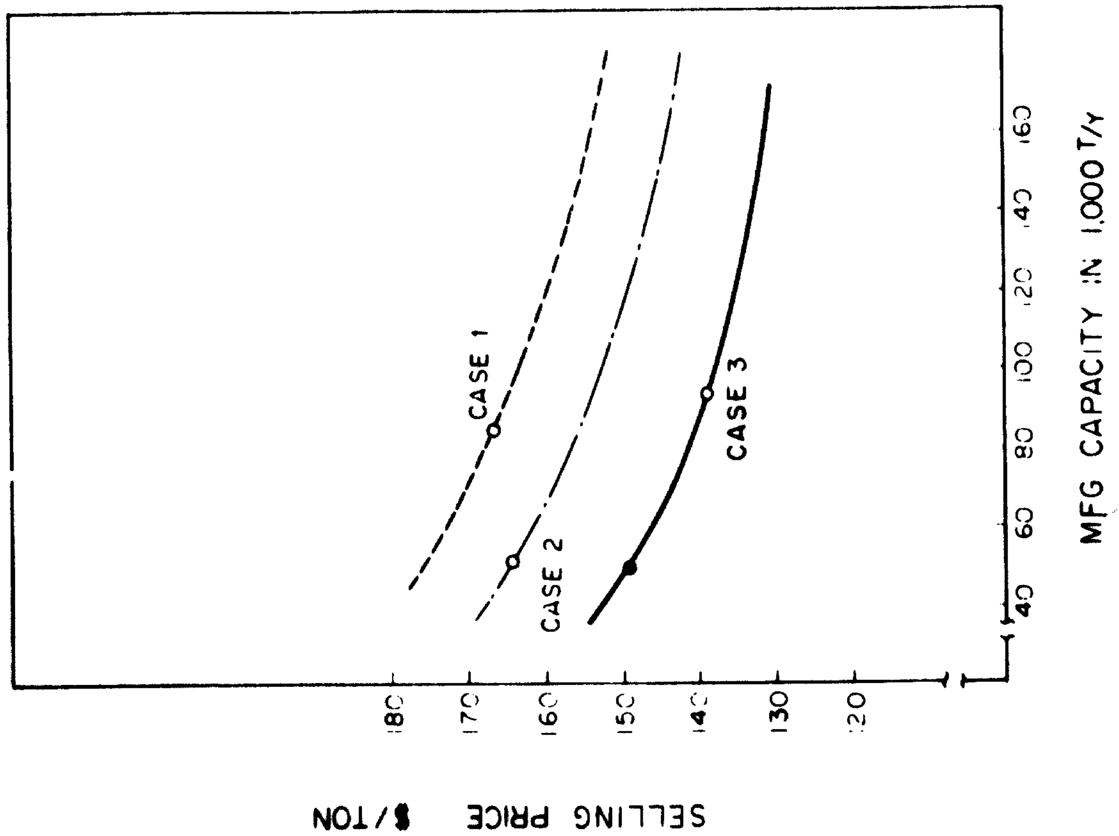

SELLING PRICE $/TON
360
340
320
300
280
260
240
220
200
CASE 2
CASE 1
CASE 3
20
40
60
80
100
120
MFG CAPACITY IN 1,000 T/Y

3 VCM



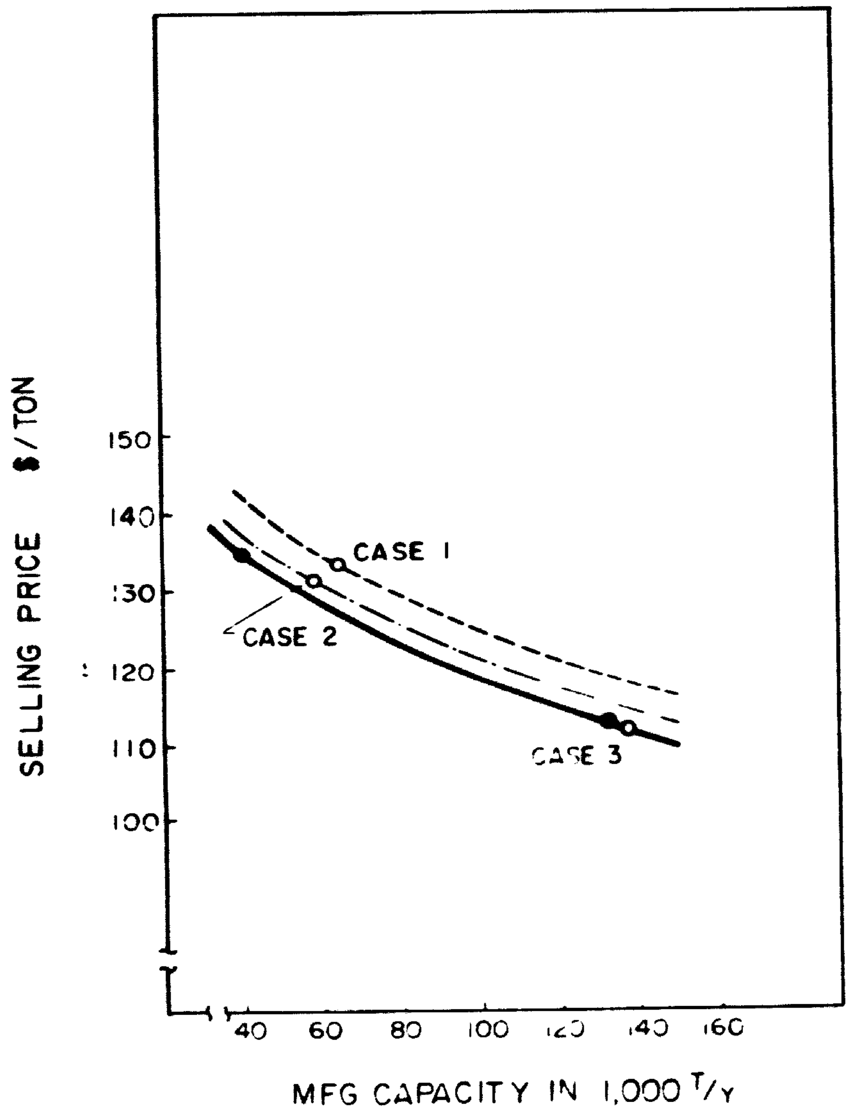
SELLING PRICE $/TON
120
110
100
90
80
MFG CAPACITY IN 1,000 T/Y
20
40
60
80
100
120
140
160
CASE 1
CASE 2
CASE 3

4 PVC

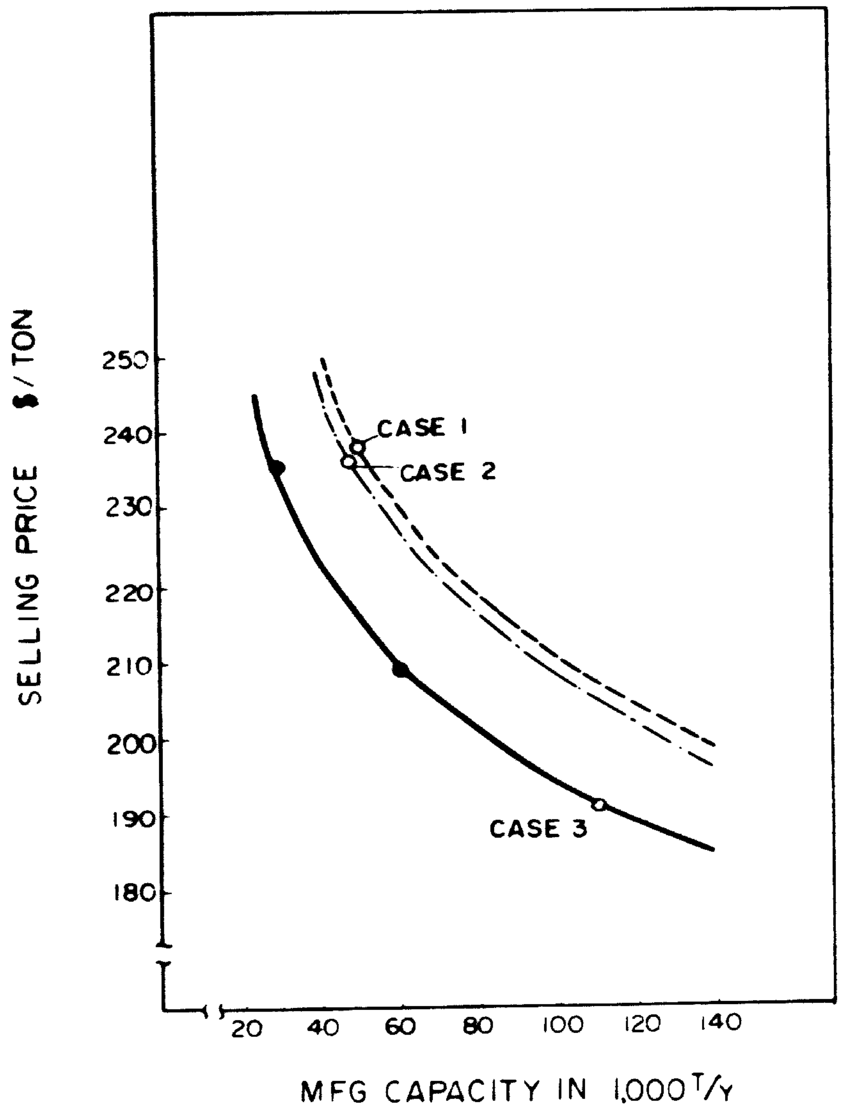


SELLING PRICE $/TON
180
170
160
150
140
130
120
MFG CAPACITY IN 1,000 T/Y
40
60
80
100
120
140
160
CASE 1
CASE 2
CASE 3

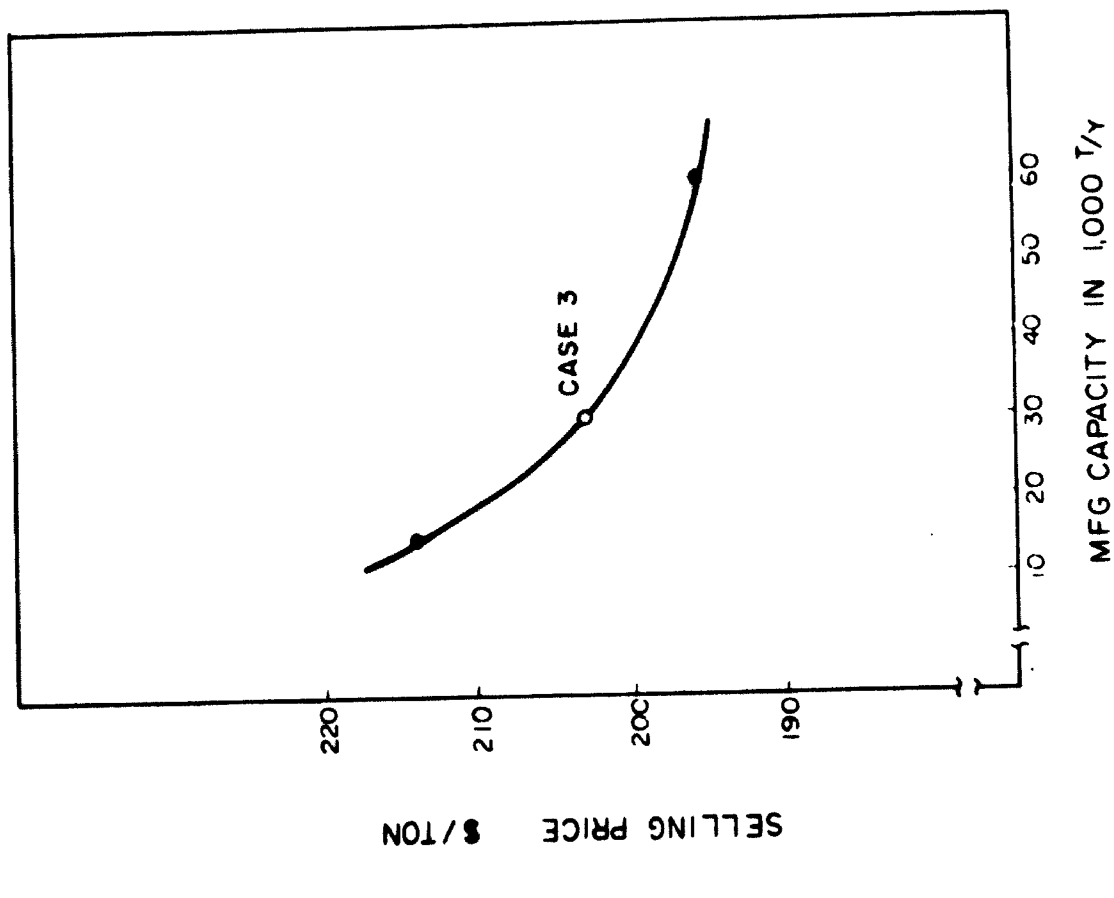
5 STYRENE



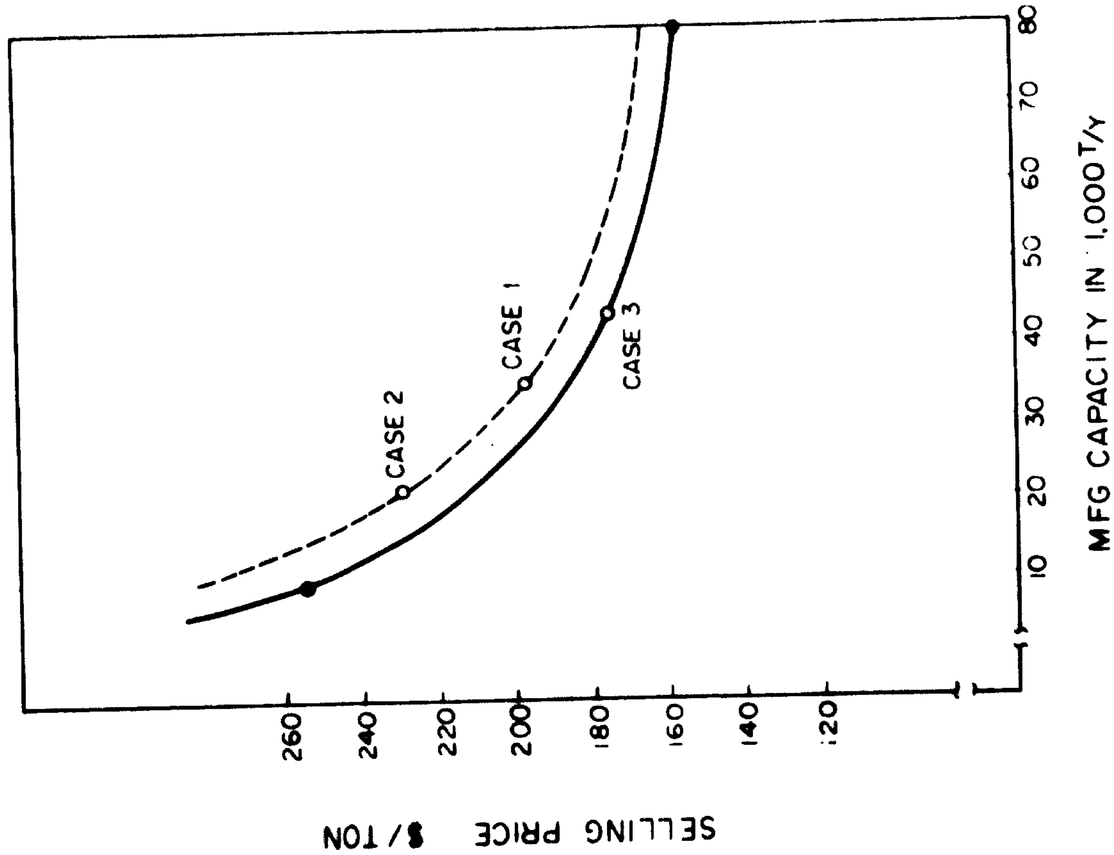
6 POLYSTYRENE



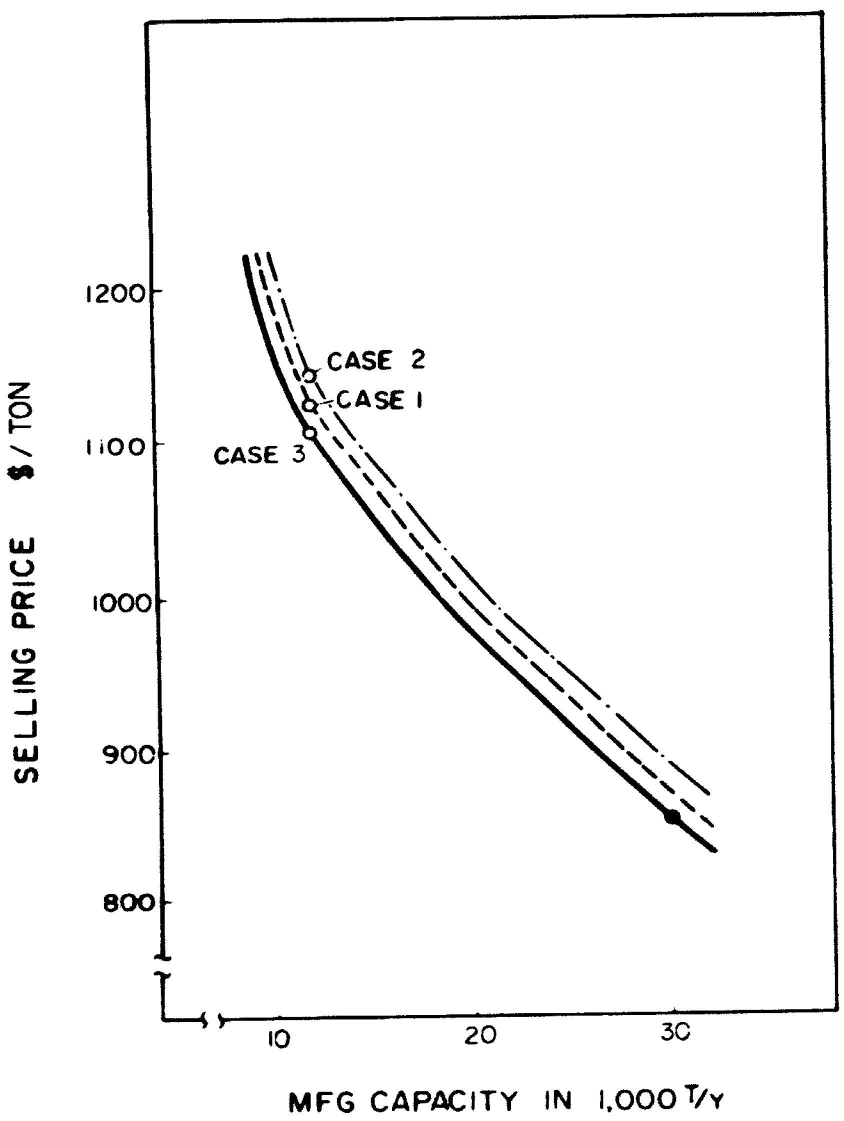
7 P G



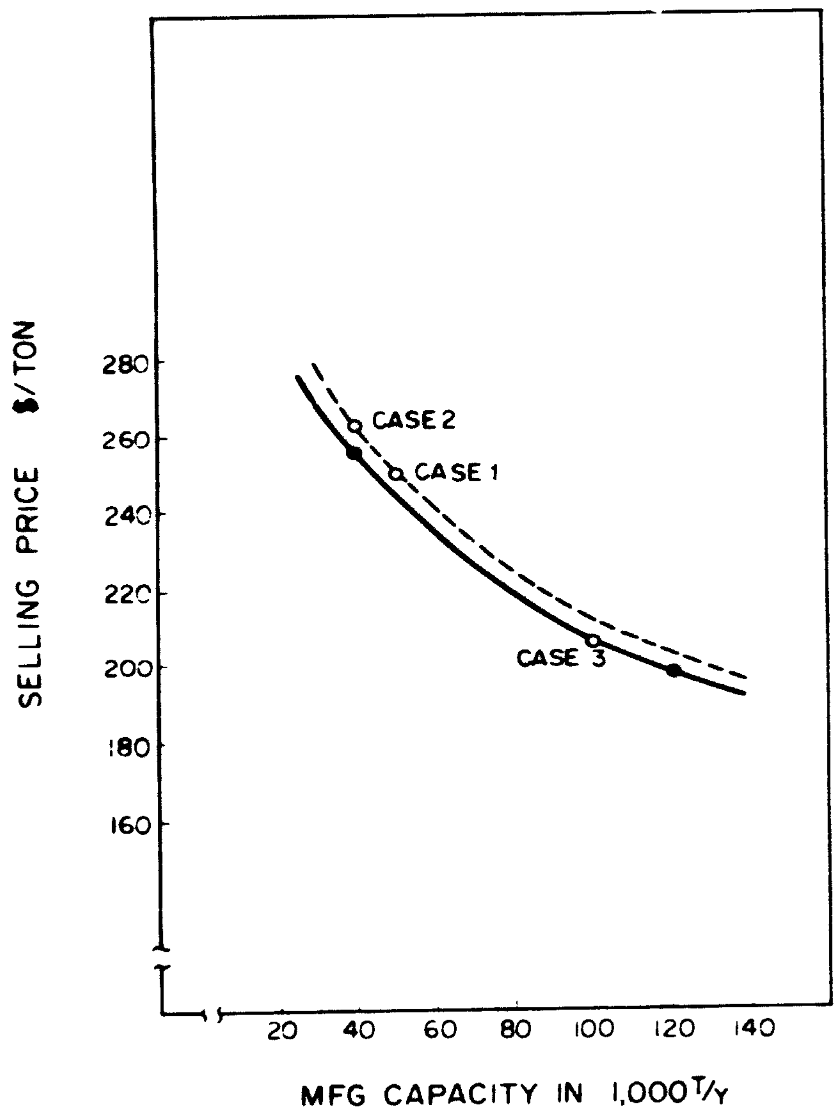
8 ACRYLONITRILE



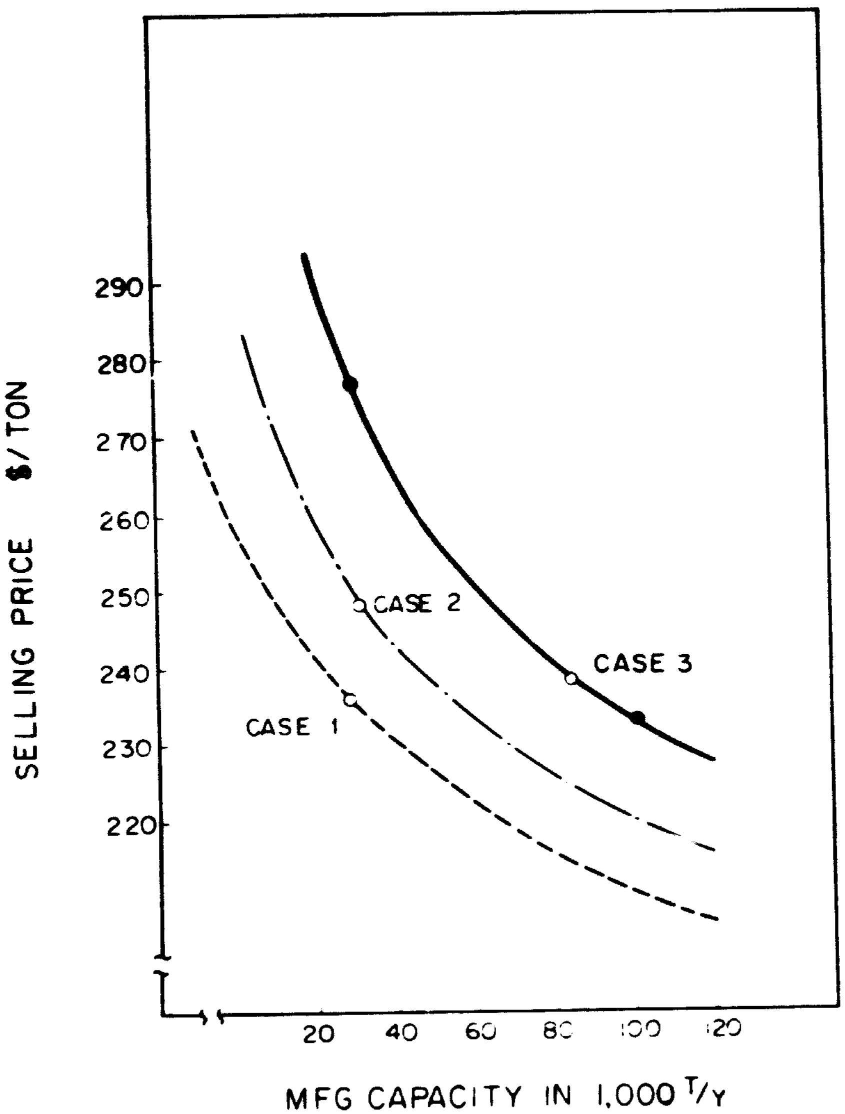
9 POLYACRYLONITRILE – F



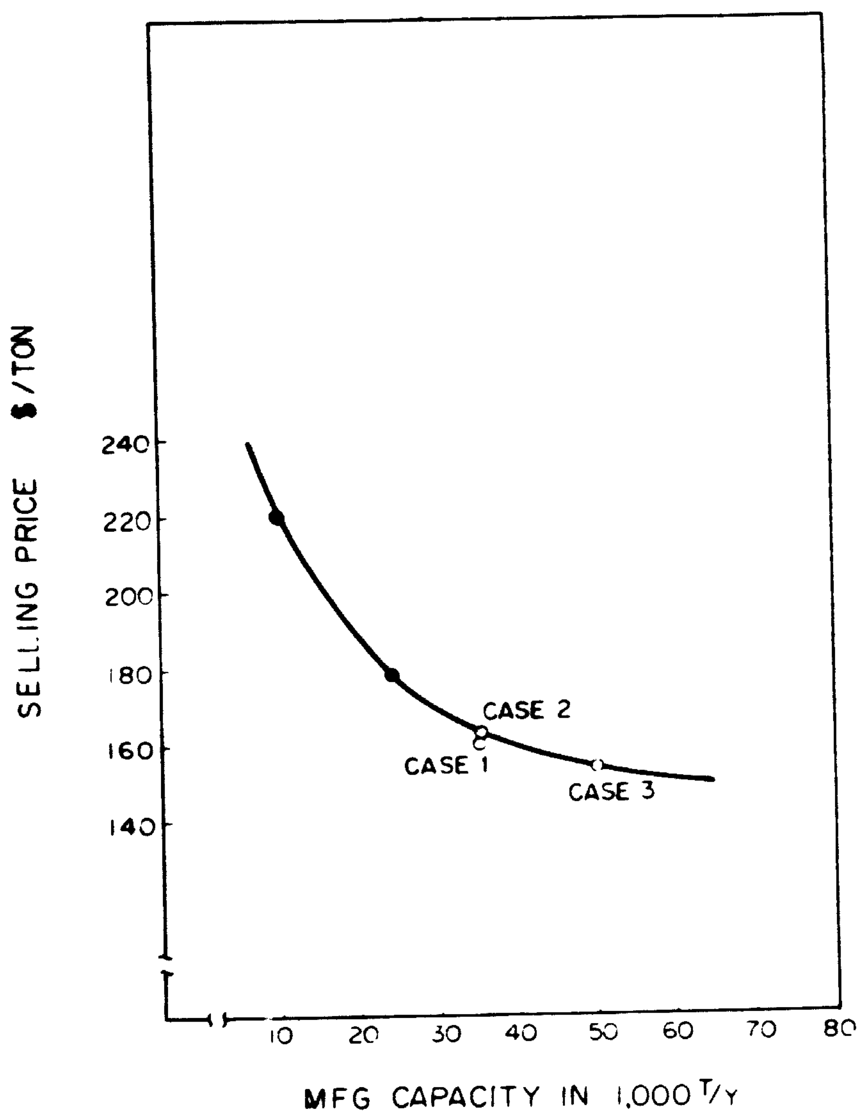
10 PP



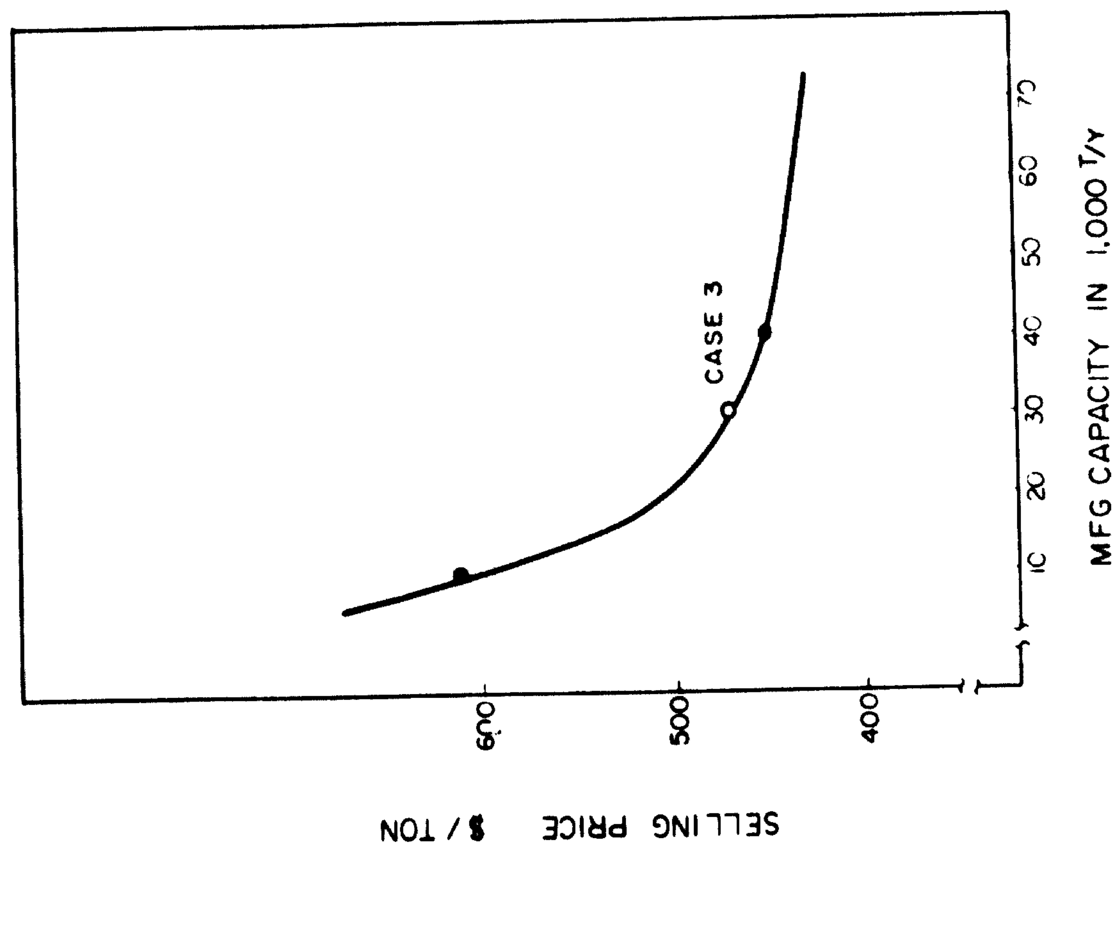
11 SBR



12 MALEIC ANHYDRIDE

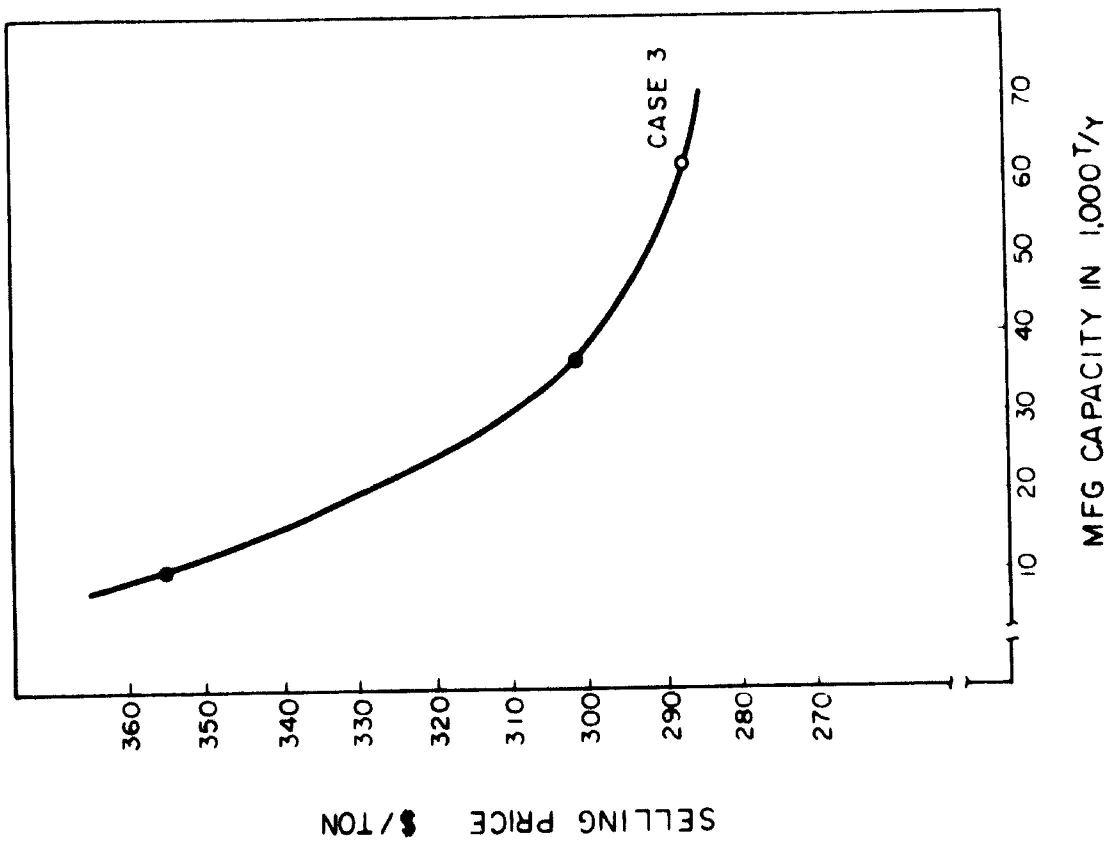


13 TDI



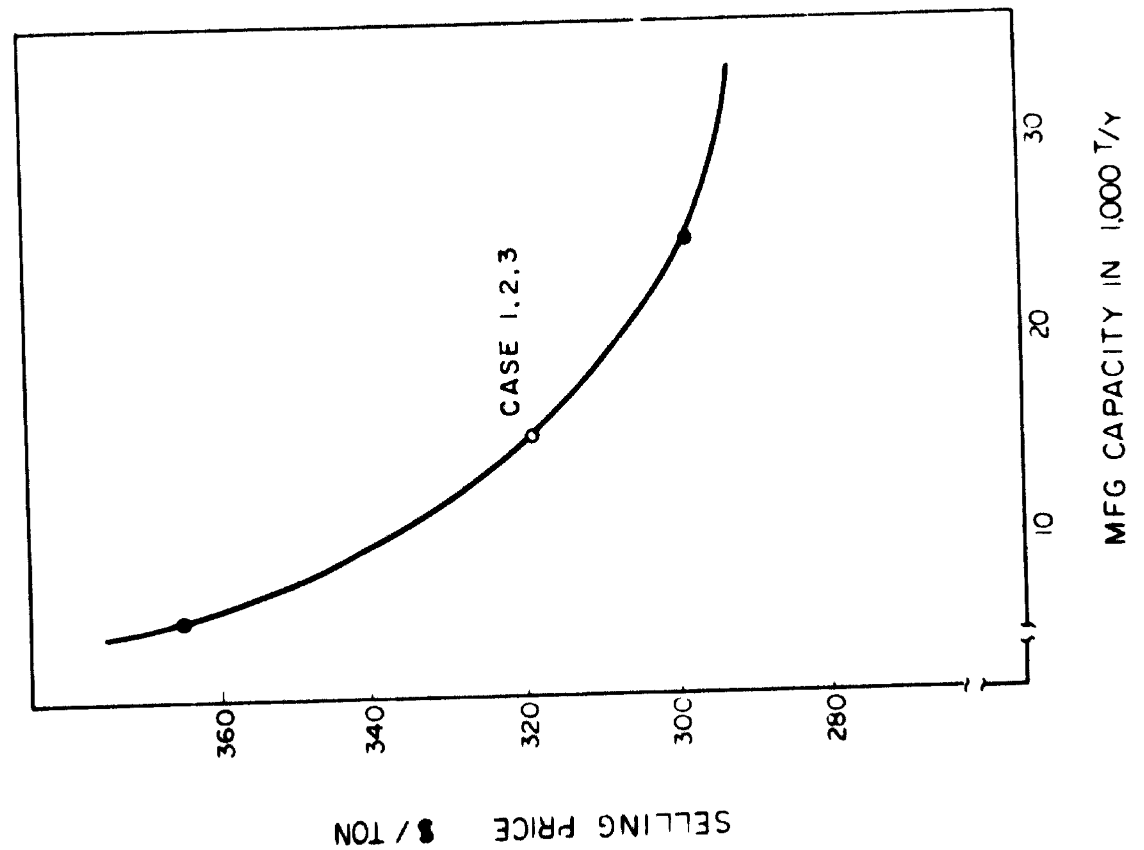
SELLING PRICE $/TON
600
500
400
CASE 3
10
20
30
40
50
60
70
MFG CAPACITY IN 1,000 T/Y

14 DMT

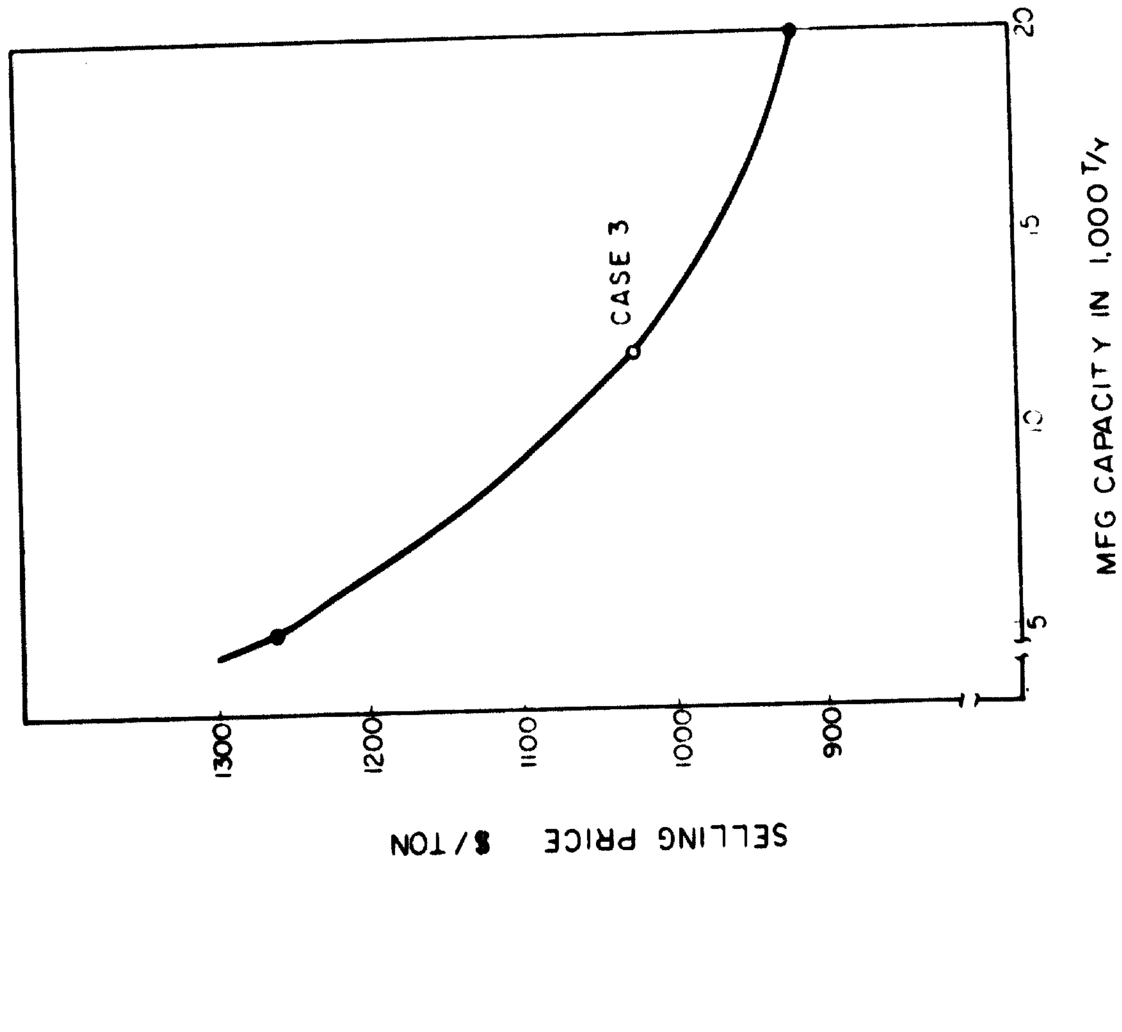


SELLING PRICE $/TON
360
350
340
330
320
310
300
290
280
270
CASE 3
10
20
30
40
50
60
70
MFG CAPACITY IN 1,000 T/Y

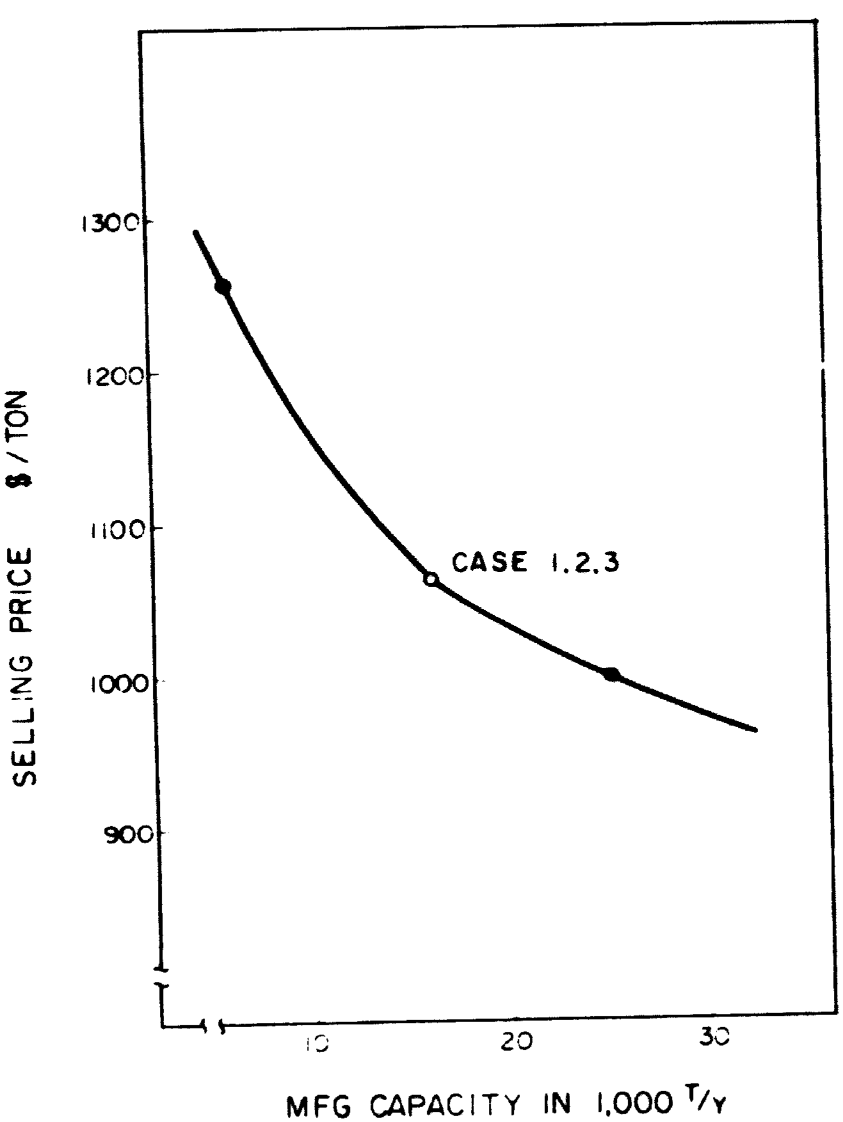
16 CAPROLACTAM



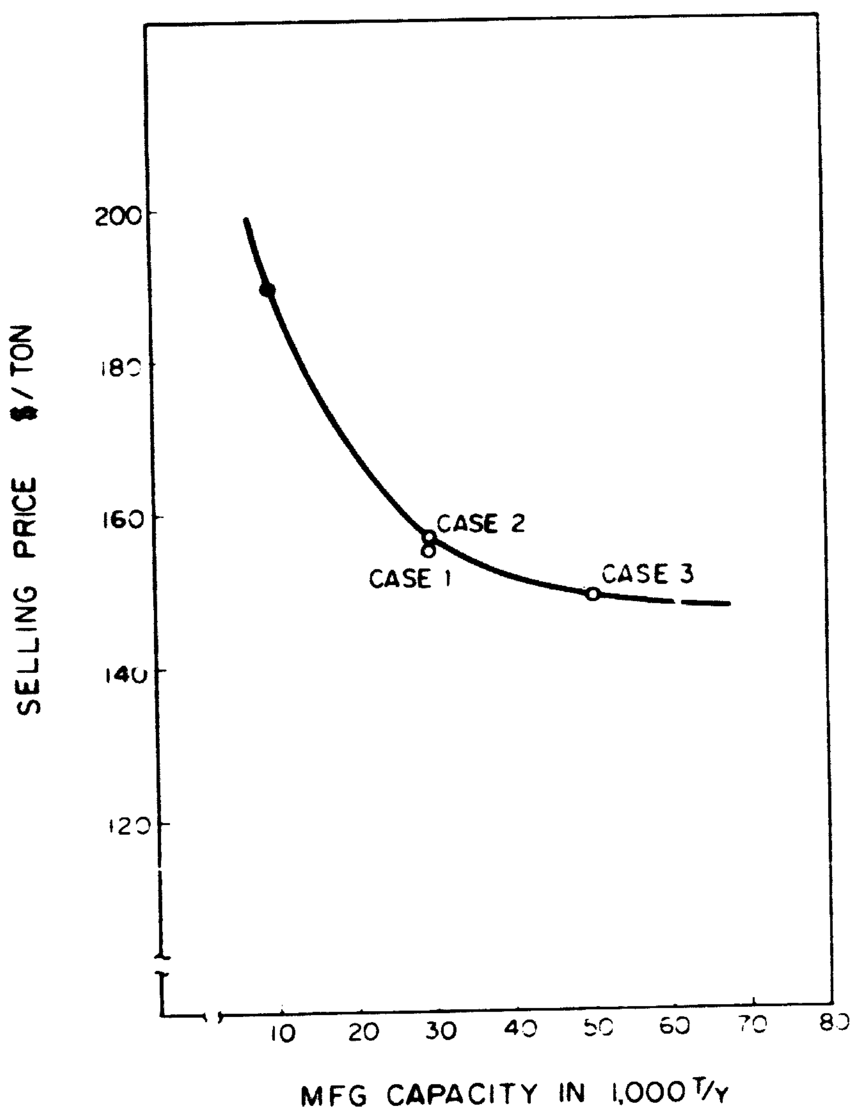
15 POLYESTER – F



17 NYLON 6-F



18 LINEAR ALKYLBENZENE



Annex N. Calculation of Consolidated Manufacturing Cost of the End Product

In Annex L, the manufacturing cost of the end product is derived from the selling price of the intermediate product. (In this case, the profit is taken as 10% of C.I in every year with every product disregarding the end or the intermediate. In other words the rate of return on investment is taken as the uniform value of 10.3% with every product).

In this Annex N, the consolidated manufacturing costs of the end products were calculated. Namely, when the intermediate product is converted to the end product, the profit obtained by selling the end product must cover the both of the capital investments of the intermediate and the end product. So the manufacturing cost of the end product is calculated by consolidating the intermediate product.

- C-1. VCM - PVC
- C-2. STYRENE - POLYSTYRENE
- C-3. STYRENE - SBR
- C-4. ACRYLONITRILE - POLYACRYLONITRILE-F
- C-5. PO - PG
- C-6. TEREPHTHALIC ACID - DMT
- C-7. TEREPHTHALIC ACID - DMT - POLYESTER-F
- C-8. CAPROLACTAM - NYLON 6 (CHIP - FIBER)

C-1. VCM - PVC

Capacity (t/y)			93,000 *
Capital Investment (1,000 $)	Process Section		13,130 **
	Utilities & General Service Facilities		2,620 **
Total Capital Investment (1,000 $)			15,750 **

Item	Unit Cost	Basis (1/t)	Total Cost ($/t)
Materials			
Ethylene	45.54 $/t	0.50 t	22.77
Chlorine	55.11 $/t	0.65 t	35.82
Catalyst & Chemicals		9.86 $/t	9.86
Utilities			
Power	0.0065 $/kwh	494 kwh	3.21
Steam	0.48 $/t	4.625 t	2.22
Cooling Water	0.0013 $/t	710 t	0.92
Fuel	0.446 $/$10^6$ kcal	1.26 x 10^6 kcal	0.56
Process Water	0.040 $/t	— t	
Labour			
Operator	1.40 $/m.h.	40 ***	4.77
Superviser	2.15 $/m.h.	7 ****	1.28
Payroll Burden	5% of Labour		0.30
Maintenance	3% of Capital Investment		5.08
Depreciation	10% "		16.94
Interest	7% "		11.85
Tax & Insurance	2% "		3.39
Overheads	2% "		3.39
Net Production Cost			122.36

* Annual Production Amount of PVC

** The Sum of C.I's of VCM and PVC Plants

*** 20 persons are allocated to VCM Plant

**** 3 persons are allocated to VCM Plant

C-2. Styrene - Polystyrene

Capacity (t/y)				110,000 *
Capital Investment (1,000 $)	Process Section			26,235 **
	Utilities & General Service Facilities			5,240 **
Total Capital Investment (1,000 $)				31,475 **
Item	**Unit Cost**		**Basis (1/t)**	**Total Cost ($/t)**
Materials				
Ethylene	45.54 $/t		0.33 t	15.03
Benzene	57.44 $/t		0.90 t	51.70
Catalyst & Chemicals			13.62 $	13.62
Utilities				
Power	0.0065 $/kwh		403 kwh	2.62
Steam	0.48 $/t		13.27 t	6.37
Cooling Water	0.0013 $/t		178.4 t	0.23
Fuel	0.446 $/$10^6$ kcal		3.37 x 10^6 kcal	1.50
Process Water	0.040 $/t		1.8 t	0.07
Labour				
Operator	1.40 $/m.h.		24 ***	2.42
Superviser	2.15 $/m.h.		4 ****	0.62
Payroll Burden	5% of Labour			0.15
Maintenance	3% of Capital Investment			8.58
Depreciation	10%	"		28.61
Interest	7%	"		20.03
Tax & Insurance	2%	"		5.72
Overheads	2%	"		5.72
Net Production Cost				162.99

* Annual Production Amount of Polystyrene

** C.I is the sum of C.I of Polystyrene and the allocation of C.I of styrene between Polystyrene and SBR according to the amount of Styrene used for each product.

*** 4 persons are allocated to Styrene Plant.

**** 1 person is allocated to Styrene Plant.

C-3. Styrene - SBR

Capacity (t/y)			83,000 *
Capital Investment (1,000 $)	Process Section		15,245 **
	Utilities & General Service Facilities		3,050 **
	Total Capital Investment (1,000 $)		18,295 **
Item	**Unit Cost**	**Basis (1/t)**	**Total Cost ($/t)**
Materials			
Butadiene	158.81 $/t	0.78 t	123.87
Ethylene	45.54	0.07 t	3.19
Benzene	57.44	0.20 t	11.49
Catalyst & Chemicals		9.67 $	9.67
Utilities			
Power	0.0065 $/kwh	573 kwh	3.72
Steam	0.48 $/t	3.59 t	1.72
Cooling Water	0.0013 $/t	326 t	0.42
Fuel	0.446 $/$10^6$ kcal	0.77 10^6 kcal	0.34
Process Water	0.040 $/t	1.6 t	0.06
Labour			
Operator	1.40 $/m.h.	46 ***	6.15
Superviser	2.15 $/m.h.	5	1.03
Payroll Burden	5% of Labour		0.36
Maintenance	3% of Capital Investment		6.61
Depreciation	10% "		22.04
Interest	7% "		15.43
Tax & Insurance	2% "		4.41
Overheads	2% "		4.41
Net Production Cost			214.92

* Annual Production Amount of SBR.

** The sum of C.I. of SBR and the allocation of C.I of Styrene between Polystyrene and SBR according to the amount of Styrene used for each product.

*** 1 person is allocated to Styrene Plant.

C-4. ACN - Polyacrylonitrile-F

Capacity (t/y)			12,000 *
Capital Investment (1,000 $)	Process Section		23,860 **
	Utilities & General Service Facilities		4,770 **
	Total Capital Investment (1,000 $)		28,630 **

Item	Unit Cost	Basis (1/t)	Total Cost ($/t)
Materials			
Propylene	44 $/t	1.16	51.04
Ammonia	40 $/t	0.37	14.80
Catalyst & Chemicals		139.00	139.00
Utilities			
Power	0.0065 $/kwh	2,004 kwh	13.03
Steam	0.48 $/t	10.5 t	5.04
Cooling Water	0.0013 $/t	803 t	1.04
Fuel	0.446 $/$10^6$ kcal	— 10^6 kcal	-
Process Water	0.040 $/t	10 t	0.40
Labour			
Operator	1.40 $/m.h.	66 ***	55.44
Superviser	2.15 $/m.h.	4	5.68
Payroll Burden	5% of Labour		3.06
Maintenance	3% of Capital Investment		71.58
Depreciation	10% "		238.58
Interest	7% "		167.01
Tax & Insurance	2% "		47.72
Overheads	2% "		47.72
Net Production Cost			861.14

* Annual Production Amount of Polyacrylonitrile-F

** The Sum of C.I of Polyacrylonitrile Plant and the C.I allocation of ACN Plant taking account of the amount used for Polyacrylonitrile

*** 3 persons are allocated to ACN Plant

C-5. PO - PG

Item	Unit Cost	Basis (1/t)	Total Cost ($/t)
Capacity (t/y)			30,000 *
Capital Investment (1,000 $) — Process Section			4,500 **
Capital Investment (1,000 $) — Utilities & General Service Facilities			900 **
Total Capital Investment (1,000 $)			5,400 **
Materials			
Propylene	44 $/t	0.78 t	34.32
Chlorine	55.11 $/t	1.22 t	67.23
Lime	13.75 $/t	0.97 t	13.34
Catalyst & Chemicals		2.68 $	2.68
Utilities			
Power	0.0065 $/kwh	370 kwh	2.41
Steam	0.48 $/t	12.7 t	6.10
Cooling Water	0.0013 $/t	540 t	0.70
Fuel	0.446 $/$10^6$ kcal	— 10^6 kcal	
Process Water	0.040 $/t	— t	
Labour			
Operator	1.40 $/m.h.	32 ***	11.83
Superviser	2.15 $/m.h.	5 ****	2.84
Payroll Burden	5% of Labour		0.73
Maintenance	3% of Capital Investment		5.40
Depreciation	10% "		18.00
Interest	7% "		12.60
Tax & Insurance	2% "		3.60
Overheads	2% "		3.60
Net Production Cost			185.38

* Annual Production Amount of PG

** The Sum of C.I of PG Plant and C.I of PO Plant

*** 20 persons are allocated to PO Plant

**** 3 persons are allocated to PO Plant

C-6. Terephthalic Acid - DMT

		Case 3
Capacity (t/y)		61,400 *
Capital Investment (1,000 $)	Process Section	20,780 **
	Utilities & General Service Facilities	4,160 **
	Total Capital Investment (1,000 $)	24,940 **

Item	Unit Cost	Basis (1/t)	Total Cost ($/t)
Materials			
P-Xylene	96.81	0.65 t	62.93
Methanol	88.00	0.33 t	29.04
Catalyst & Chemicals		40.64 $/t	40.64
Utilities			
Power	0.0065 $/kwh	619 kwh	4.02
Steam	0.48 $/t	12.4 t	5.95
Cooling Water	0.0013 $/t	536.8 t	0.70
Fuel	0.446 $/$10^6$ kcal	1.66 10^6 kcal	0.74
Process Water	0.040 $/t	31.85 t	1.27
Labour			
Operator	1.40 $/m.h.	18 ***	3.25
Superviser	2.15 $/m.h.	3 ****	0.83
Payroll Burden	5% of Labour		0.20
Maintenance	3% of Capital Investment		12.19
Depreciation	10% "		40.62
Interest	7% "		28.43
Tax & Insurance	2% "		8.12
Overheads	2% "		8.12
Net Production Cost			247.05

* Annual Production Amount of DMT

** The sum of C.I of DMT Plant and C.I of Terephtharic acid Plant

*** 8 persons are allocated to Terephtharic acid Plant

**** 1 person is allocated to Terephtharic acid Plant

C-7. Terephthalic Acid - DMT - Polyester-F

			Total Cost ($/t)
Capacity (t/y)			12,000 *
Capital Investment (1,000 $)	Process Section		18,828 **
	Utilities & General Service Facilities		3,772 **
Total Capital Investment (1,000 $)			22,600 **
Item	**Unit Cost**	**Basis** (1/t)	**Total Cost** ($/t)
Materials			
P-Xylene	96.81 $/t	0.74 t	71.64
Methanol	88.00 $/t	0.38 t	33.44
Ethylene Glycol	204.6 $/t	0.36 t	73.66
Catalyst & Chemicals		76.14 $/t	76.14
Utilities			
Power	0.0065 $/kwh	3,611.4 kwh	23.47
Steam	0.48 $/t	16.8 t	8.06
Cooling Water	0.0013 $/t	2,367.3 t	3.08
Fuel	0.446 $/$10^6$ kcal	1.9 10^6 kcal	0.85
Process Water	0.040 $/t	36.6 t	1.46
Labour			
Operator	1.40 $/m.h.	84 ***	77.62
Superviser	2.15 $/m.h.	5	7.10
Payroll Burden	5% of Labour		4.24
Maintenance	3% of Capital Investment		56.50
Depreciation	10% "		188.33
Interest	7% "		131.83
Tax & Insurance	2% "		37.67
Overheads	2% "		37.67
Net Production Cost			832.76

* Annual Production Amount of Polyester

** The sum of C.I of Polyester Plant and the allocation of C.I's of DMT and Terephthalic acid plants calculated by taking account of the amount used for raw materials only for production of Polyester

*** 2 persons are allocated to DMT Plant and 2 persons are allocated to Terephtharic acid Plant

C-8. Caprolactam - Nylon 6 Chip - Nylon 6-F

Capacity (t/y)				15,000 *
Capital Investment (1,000 $)	Process Section			30,860 **
	Utilities & General Service Facilities			6,170 **
	Total Capital Investment (1,000 $)			37,030 **

Item	Unit Cost		Basis (1/t)		Total Cost ($/t)
Materials					
Cyclohexane	61.75	$/t	1.09	t	67.31
Waste Nylon 6	300	$/t	0.04	t	12.00
Oleum & Sulfaric Acid	20.00	$/t	1.79	t	35.80
By-Product					
Ammonium Sulfate	30.67	$/t	- 2.56	t	- 78.52
Catalyst & Chemicals			38.40	$	38.40
Utilities					
Power	0.0065	$/kwh	1,366.3	kwh	8.88
Steam	0.48	$/t	14.6	t	7.01
Cooling Water	0.0013	$/t	241.8	t	0.31
Fuel	0.446	$/$10^6$ kcal	3.36	10^6 kcal	1.50
Process Water	0.040	$/t	—	t	
Labour					
Operator	1.40	$/m.h.	317	***	195.27
Superviser	2.15	$/m.h.	33	****	31.22
Payroll Burden	5% of Labour				11.32
Maintenance	3% of Capital Investment				61.72
Depreciation	10%	"			205.72
Interest	7%	"			144.01
Tax & Insurance	2%	"			41.14
Overheads	2%	"			41.14
Net Production Cost					864.43

* Annual Production Amount of Nylon 6 F

** The Sum of C.I's of Nylon 6 -F, Nylon 6 CHIP and Caprolactam Plants

*** 8 persons and 9 persons are allocated to Caprolactam and Nylon 6 CHIP Plant respectively

**** 2 persons are and 1 person is allocated to Caprolactam and Nylon 6 CHIP Plant respectively

Annex C Calculation of Rate of Return on Investment

(Discounted Cash Flow Calculation Results Sheet of Computer)

OVERALL RATE OF RETURN ON INVESTMENT WITH THE MOST RECOMMENDABLE COMPLEX

DISCOUNTED CASH FLOW CHALCULATION RESULTS

END OF YEAR		INVESTMENT	TOTAL SALES VALUE	TOTAL PRODUCT COST	INCOME BEFORE TAX	CORPORATE TAX	INCOME AFTER TAX	DEPRECIATION	CASH FLOW BACK	DISCOUNT RATE R = 19.9%	PRESENT VALUE	PRESENT VALUE AT PROJ. START-UP
ENG. + CONST	-1	323351. *1	0.	0.	0.	0.	0.	0.	0.	0.0	0.	0.
OPERATION START-UP	1	0. *2	261562.	199078.	62484.	0.	62484.	32335.	94819.	0.83403	79082.	364870.
	2	0.	261562.	199078.	62484.	0.	62484.	32335.	94819.	0.69561	65957.	
	3	0.	261562.	199078.	62484.	0.	62484.	32335.	94819.	0.58015	55009.	
	4	0.	6902.	199078.	62484.	0.	62484	32335.	94819	0.48386	45879.	
	5	0.	261562.	199078.	62484.	0.	62484.	32335.	94819.	0.40356	38265.	
	6	0.	261562.	199078.	62484.	28118.	34366.	32335.	66701.	0.33658	22450.	
	7	0.	261562.	199078.	62484.	28118.	34366.	32335.	66701.	0.28072	18724.	
	8	0.	261562.	199078.	62484.	28118.	34366.	32335.	66701.	0.23412	15616.	
	9	0.	261562.	199078.	62484.	28118.	34366.	32335.	66701.	0.19527	13025.	
	10	0. *3	261562.	2491.	62484.	28118.	34366.	32335.	66701.	0.16286	10863.	
											364870.	

*1) TOTAL INVESTMENT COSTS
*2) WORKING CAPITAL
*3) SALVAGE VALUE

RATE OF RETURN ON INVESTMENT 19.9 %

1. L D P E

DISCOUNTED CASH FLOW CALCULATION RESULTS

END OF YEAR		INVESTMENT	TOTAL SALES VALUE	TOTAL PRODUCT COST	INCOME BEFORE TAX	CORPORATE TAX	INCOME AFTER TAX	DEPRECIATION	CASH FLOW BACK	DISCOUNT RATE	PRESENT VALUE	PRESENT VALUE AT PROJ. START-UP
										R = 8.2%		
ENG. + CONST	-1	31100. *1	0.	0.	0.	0.	0.	0.	0.	0.0	0.	0.
OPERATION	1	0. *2	21190.	18793.	2397.	0.	2397.	3110.	5507.	0.92330	5088.	33665.
START-UP	2	0.	21190.	18793.	2397.	0.	2397.	3110.	5507.	0.85342	4700.	
	3	0.	21190.	18793.	2397.	0.	2397.	3110.	5507.	0.78839	4342.	
	4	0.	21190.	18793.	2397.	0.	2397.	3110.	5507.	0.72832	4011.	
	5	0.	21190.	18793.	2397.	0.	2397.	3110.	5507.	0.67282	3705.	
	6	0.	21190.	18793.	2397.	1079.	1318.	3110.	4428.	0.62156	2753.	
	7	0.	21190.	18793.	2397.	1079.	1318.	3110.	4428.	0.57420	2543.	
	8	0.	21190.	18793.	2397.	1079.	1318.	3110.	4428.	0.53045	2349.	
	9	0.	21190.	18793.	2397.	1079.	1318.	3110.	4428.	0.49003	2170.	
	10	0. *3	21190.	18793.	2397.	1079.	1318.	3110.	4428.	0.45269	2005.	
											33665.	

*1) TOTAL INVESTMENT COSTS
*2) WORKING CAPITAL
*3) SALVAGE VALUE

RATE OF RETURN ON INVESTMENT 8.2 %

2. H D P E

DISCOUNTED CASH FLOW CALCULATION RESULTS

END OF YEAR		INVESTMENT	TOTAL SALES VALUE	TOTAL PRODUCT COST	INCOME BEFORE TAX	CORPORATE TAX	INCOME AFTER TAX	DEPRECIATION	CASH FLOW BACK	DISCOUNT RATE	PRESENT VALUE	PRESENT VALUE AT PROJ. START-UP
										R = 16.4%		
ENG. + CONST	-1	27140. *1	0.	0.	0.	0.	0.	0.	0.	0.0	0.	0.
OPERATION	1	0. *2	18620.	13372.	5248.	0.	5248.	2714.	7962.	0.84460	6725.	32134.
START-UP	2	0.	18620.	13372.	5248.	0.	5248.	2714.	7962.	0.71334	5680.	
	3	0.	18620.	13372.	5248.	0.	5248.	2714.	7962.	0.60249	4797.	
	4	0.	18620.	13372.	5248.	0.	5248.	2714.	7962.	0.50886	4051.	
	5	0.	18620.	13372.	5248.	0.	5248.	2714.	7962.	0.42978	3422.	
	6	0.	18620.	13372.	5248.	2362.	2886.	2714.	5600.	0.36299	2033.	
	7	0.	18620.	13372.	5248.	2362.	2886.	2714.	5600.	0.30658	1717.	
	8	0.	18620.	13372.	5248.	2362.	2886.	2714.	5600.	0.25894	1450.	
	9	0.	18620.	13372.	5248.	2362.	2886.	2714.	5600.	0.21870	1225.	
	10	0. *3	18620.	13372.	5248.	2362.	2886.	2714.	5600.	0.18471	1034.	
											32134.	

*1) TOTAL INVESTMENT COSTS
*2) WORKING CAPITAL
*3) SALVAGE VALUE

RATE OF RETURN ON INVESTMENT 13.4 %

3. V C M

DISCOUNTED CASH FLOW CALCULATION RESULTS

END OF YEAR		INVESTMENT	TOTAL SALES VALUE	TOTAL PRODUCT COST	INCOME BEFORE TAX	CORPORATE TAX	INCOME AFTER TAX	DEPRECIATION	CASH FLOW BACK	DISCOUNT RATE	PRESENT VALUE	PRESENT VALUE AT PROJ. START-UP
										R = 2.6%		
ENG. + CONST	-1	7990. *1	0.	0.	0.	0.	0.	0.	0.	0.0	0.	0.
OPERATION	1	0. *2	8526.	8346.	180.	0.	180.	799.	979.	0.97467	955.	8198.
START-UP	2	0.	8526.	8346.	180.	0.	180.	799.	979.	0.94998	930.	
	3	0.	8526.	8346.	180.	0.	180.	799.	979.	0.92592	907.	
	4	0.	8526.	8346.	180.	0.	180.	799.	979.	0.90247	884.	
	5	0.	8526.	8346.	180.	0.	180.	799.	979.	0.87961	862.	
	6	0.	8526.	8346.	180.	81.	99.	799.	898.	0.85733	770.	
	7	0.	8526.	8346.	180.	81.	99.	799.	898.	0.83561	751.	
	8	0.	8526.	8346.	180.	81.	99.	799.	898.	0.81445	732.	
	9	0.	8526.	8346.	180.	81.	99.	799.	898.	0.79382	713.	
	10	0. *3	8526.	8346.	180.	81.	99.	799.	898.	0.77371	695.	
											8198.	

*1) TOTAL INVESTMENT COSTS
*2) WORKING CAPITAL
*3) SALVAGE VALUE

RATE OF RETURN ON INVESTMENT 2.6 %

4. V C M - P V C

DISCOUNTED CASH FLOW CALCULATION RESULTS

END OF YEAR		INVESTMENT	TOTAL SALES VALUE	TOTAL PRODUCT COST	INCOME BEFORE TAX	CORPORATE TAX	INCOME AFTER TAX	DEPRECIATION	CASH FLOW BACK	DISCOUNT RATE	PRESENT VALUE	PRESENT VALUE AT PROJ. START-UP
										R = 31.6%		
ENG. + CONST	-1	15750. *1	0.	0.	0.	0.	0.	0.	0.	0.0	0.	0.
OPERATION	1	0. *2	17391.	11381.	6010.	0.	6010.	1575.	7585.	0.75885	5756.	20755.
START-UP	2	0.	17391.	11381.	6010.	0.	6010.	1575.	7585.	0.57586	4368.	
	3	0.	17391.	11381.	6010.	0.	6010.	1575.	7585.	0.43699	3315.	
	4	0.	17391.	11381.	6010.	0.	6010.	1575.	7585.	0.33161	2515.	
	5	0.	17391.	11381.	6010.	0.	6010.	1575.	7585.	0.25164	1909.	
	6	0.	17391.	11381.	6010.	2705.	3306.	1575.	4881.	0.19096	932.	
	7	0.	17391.	11381.	6010.	2705.	3306.	1575.	4881.	0.14491	707.	
	8	0.	17391.	11381.	6010.	2705.	3306.	1575.	4881.	0.10997	537.	
	9	0.	17391.	11381.	6010.	2705.	3306.	1575.	4881.	0.08345	407.	
	10	0. *3	17391.	11381.	6010.	2705.	3306.	1575.	4881.	0.06332	309.	
											20755.	

*1) TOTAL INVESTMENT COSTS
*2) WORKING CAPITAL
*3) SALVAGE VALUE

RATE OF RETURN ON INVESTMENT 31.9 %

5. STYRENE

DISCOUNTED CASH FLOW CALCULATION RESULTS

END OF YEAR		INVESTMENT	TOTAL SALES VALUE	TOTAL PRODUCT COST	INCOME BEFORE TAX	CORPORATE TAX	INCOME AFTER TAX	DEPRECIATION	CASH FLOW BACK	DISCOUNT RATE (R = 10.2%)	PRESENT VALUE	PRESENT VALUE AT PROJ. START-UP
ENG. + CONST	-1	13830. *1	0.	0.	0.	0.	0.	0.	0.	0.0	0.	0.
OPERATION	1	0. *2	15232.	13877.	1355.	0.	1355.	1383.	2738.	0.90718	2484.	15245.
START-UP	2	0.	15232.	13877.	1355.	0.	1355.	1383.	2738.	0.82298	2253.	
	3	0.	15232.	13877.	1355.	0.	1355.	1383.	2738.	0.74660	2044.	
	4	0.	15232.	13877.	1355.	0.	1355.	1383.	2738.	0.67730	1854.	
	5	0.	15232.	13877.	1355.	0.	1355.	1383.	2738.	0.61444	1682.	
	6	0.	15232.	13877.	1355.	610.	745.	1383.	2128.	0.55741	1186.	
	7	0.	15232.	13877.	1355.	610.	745.	1383.	2128.	0.50567	1076.	
	8	0.	15232.	13877.	1355.	610.	745.	1383.	2128.	0.45874	976.	
	9	0.	15232.	13877.	1355.	610.	745.	1383.	2128.	0.41616	886.	
	10	0. *3	15232.	13877.	1355.	610.	745.	1383.	2128.	0.37754	803.	
											15245.	

*1) TOTAL INVESTMENT COSTS
*2) WORKING CAPITAL
*3) SALVAGE VALUE

RATE OF RETURN ON INVESTMENT 10.2 %

6. STYRENE - POLYSTYRENE

DISCOUNTED CASH FLOW CALCULATION RESULTS

END OF YEAR		INVESTMENT	TOTAL SALES VALUE	TOTAL PRODUCT COST	INCOME BEFORE TAX	CORPORATE TAX	INCOME AFTER TAX	DEPRECIATION	CASH FLOW BACK	DISCOUNT RATE (R = 11.4%)	PRESENT VALUE	PRESENT VALUE AT PROJ. START-UP
ENG. + CONST	-1	31475. *1	0.	0.	0.	0.	0.	0.	0.	0.0	0.	0.
OPERATION	1	0. *2	21450.	17956.	3494.	0.	3494.	3148.	6642.	0.89767	5962.	35115.
START-UP	2	0.	21450.	17956.	3494.	0.	3494.	3148.	6642.	0.80580	5352.	
	3	0.	21450.	17956.	3494.	0.	3494.	3148.	6642.	0.72334	4804.	
	4	0.	21450.	17956.	3494.	0.	3494.	3148.	6642.	0.64932	4313.	
	5	0.	21450.	17956.	3494.	0.	3494.	3148.	6642.	0.58287	3871.	
	6	0.	21450.	17956.	3494.	1572.	1922.	3148.	5070.	0.52323	2653.	
	7	0.	21450.	17956.	3494.	1572.	1922.	3148.	5070.	0.46968	2381.	
	8	0.	21450.	17956.	3494.	1572.	1922.	3148.	5070.	0.42162	2138.	
	9	0.	21450.	17956.	3494.	1572.	1922.	3148.	5070.	0.37847	1919.	
	10	0. *3	21450.	17956.	3494.	1572.	1922.	3148.	5070.	0.33974	1722.	
											35115.	

*1) TOTAL INVESTMENT COSTS
*2) WORKING CAPITAL
*3) SALVAGE VALUE

RATE OF RETURN ON INVESTMENT 37.3 %

7. PO - PG

DISCOUNTED CASH FLOW CALCULATION RESULTS

	END OF YEAR	INVESTMENT	TOTAL SALES VALUE	TOTAL PRODUCT COST	INCOME BEFORE TAX	CORPORATE TAX	INCOME AFTER TAX	DEPRECIATION	CASH FLOW BACK	DISCOUNT RATE R = 9.7%	PRESENT VALUE	PRESENT VALUE AT PROJ. START-UP
ENG. + CONST	-1	5400. *1	0.	0.	0.	0.	0.	0.	0.	0.0	0.	0.
OPERATION START-UP	1	0. *2	6060.	5561.	499.	0.	499.	540.	1039.	0.91150	947.	5924.
	2	0.	6060.	5561.	499.	0.	499.	540.	1039.	0.83083	863.	
	3	0.	6060.	5561.	499.	0.	499.	540.	1039.	0.75731	787.	
	4	0.	6060.	5561.	499.	0.	499.	540.	1039.	0.69029	717.	
	5	0.	6060.	5561.	499.	0.	499.	540.	1039.	0.62920	654.	
	6	0.	6060.	5561.	499.	224.	274.	540.	814.	0.57351	467.	
	7	0.	6060.	5561.	499.	224.	274.	540.	814.	0.52276	426.	
	8	0.	6060.	5561.	499.	224.	274.	540.	814.	0.47649	388.	
	9	0.	6060.	5561.	499.	224.	274.	540.	814.	0.43433	354.	
	10	0. *3	6060.	5561.	499.	224.	274.	540.	814.	0.39589	322.	
											5924.	

*1) TOTAL INVESTMENT COSTS
*2) WORKING CAPITAL
*3) SALVAGE VALUE

RATE OF RETURN ON INVESTMENT 9.7 %

8. ACRYLONITRILE

DISCOUNTED CASH FLOW CALCULATION RESULTS

	END OF YEAR	INVESTMENT	TOTAL SALES VALUE	TOTAL PRODUCT COST	INCOME BEFORE TAX	CORPORATE TAX	INCOME AFTER TAX	DEPRECIATION	CASH FLOW BACK	DISCOUNT RATE R = 31.7%	PRESENT VALUE	PRESENT VALUE AT PROJ. START-UP
ENG. + CONST	-1	11410. *1	0.	0.	0.	0.	0.	0.	0.	0.0	0.	0.
OPERATION START-UP	1	0. *2	11155.	6823.	4332.	0.	4332.	1141.	5473.	0.75957	4157.	15022.
	2	0.	11155.	6823.	4332.	0.	4332.	1141.	5473.	0.57695	3158.	
	3	0.	11155.	6823.	4332.	0.	4332.	1141.	5473.	0.43824	2398.	
	4	0.	11155.	6823.	4332.	0.	4332.	1141.	5473.	0.33287	1822.	
	5	0.	11155.	6823.	4332.	0.	4332.	1141.	5473.	0.25284	1384.	
	6	0.	11155.	6823.	4332.	1949.	2383.	1141.	3524.	0.19205	677.	
	7	0.	11155.	6823.	4332.	1949.	2383.	1141.	3524.	0.14588	514.	
	8	0.	11155.	6823.	4332.	1949.	2383.	1141.	3524.	0.11081	390.	
	9	0.	11155.	6823.	4332.	1949.	2383.	1141.	3524.	0.08416	297.	
	10	0. *3	11155.	6823.	4332.	1949.	2383.	1141.	3524.	0.06393	225.	
											15022.	

*1) TOTAL INVESTMENT COSTS
*2) WORKING CAPITAL
*3) SALVAGE VALUE

RATE OF RETURN ON INVESTMENT 31.7 %

9. **ACRYLONITRILE - POLYACRYLONITRILE-F**

DISCOUNTED CASH FLOW CALCULATION RESULTS

	END OF YEAR	INVESTMENT	TOTAL SALES VALUE	TOTAL PRODUCT COST	INCOME BEFORE TAX	CORPORATE TAX	INCOME AFTER TAX	DEPRECIATION	CASH FLOW BACK	DISCOUNT RATE R = 14.4%	PRESENT VALUE	PRESENT VALUE AT PROJ. START-UP
ENG. + CONST	-1	28630. *1	0.	0.	0.	0.	0.	0.	0.	0.0	0.	0.
OPERATION	1	0. *2	14568.	10429.	4139.	0.	4139.	2863.	7002.	0.87425	6122.	32748.
START-UP	2	0.	14568.	10429.	4139.	0.	4139.	2863.	7002.	0.76431	5352.	
	3	0.	14568.	10429.	4139.	0.	4139.	2863.	7002.	0.66819	4679.	
	4	0.	14568.	10429.	4139.	0.	4139.	2863.	7002.	0.58416	4091.	
	5	0.	14568.	10429.	4139.	0.	4139.	2863.	7002.	0.51070	3576.	
	6	0.	14568.	10429.	4139.	1863.	2277.	2863.	5140.	0.44648	2295.	
	7	0.	14568.	10429.	4139.	1863.	2277.	2863.	5140.	0.39033	2006.	
	8	0.	14568.	10429.	4139.	1863.	2277.	2863.	5140.	0.34125	1754.	
	9	0.	14568.	10429.	4139.	1863.	2277.	2863.	5140.	0.29834	1533.	
	10	0. *3	14568.	10429.	4139.	1863.	2277.	2863.	5140.	0.26082	1341.	
											32748.	

*1) TOTAL INVESTMENT COSTS
*2) WORKING CAPITAL
*3) SALVAGE VALUE

RATE OF RETURN ON INVESTMENT 14.4 %

10. **P P**

DISCOUNTED CASH FLOW CALCULATION RESULTS

	END OF YEAR	INVESTMENT	TOTAL SALES VALUE	TOTAL PRODUCT COST	INCOME BEFORE TAX	CORPORATE TAX	INCOME AFTER TAX	DEPRECIATION	CASH FLOW BACK	DISCOUNT RATE R = 32.6%	PRESENT VALUE	PRESENT VALUE AT PROJ. START-UP
ENG. + CONST	-1	31200. *1	0.	0.	0.	0.	0.	0.	0.	0.0	0.	0.
OPERATION	1	0. *2	29800.	17482.	12318.	0.	12318.	3120.	15438.	0.75402	11640.	41378.
START-UP	2	0.	29800.	17482.	12318.	0.	12318.	3120.	15438.	0.56854	8777.	
	3	0.	29800.	17482.	12318.	0.	12318.	3120.	15438.	0.42869	6618.	
	4	0.	29800.	17482.	12318.	0.	12318.	3120.	15438.	0.32324	4990.	
	5	0.	29800.	17482.	12318.	0.	12318.	3120.	15438.	0.24373	3763.	
	6	0.	29800.	17482.	12318.	5543.	6775.	3120.	9895.	0.18377	1818.	
	7	0.	29800.	17482.	12318.	5543.	6775.	3120.	9895.	0.13857	1371.	
	8	0.	29800.	17482.	12318.	5543.	6775.	3120.	9895.	0.10448	1034.	
	9	0.	29800.	17482.	12318.	5543.	6775.	3120.	9895.	0.07878	780.	
	10	0. *3	29800.	17482.	12318.	5543.	6775.	3120.	9895.	0.05940	588.	
											41378.	

*1) TOTAL INVESTMENT COSTS
*2) WORKING CAPITAL
*3) SALVAGE VALUE

RATE OF RETURN ON INVESTMENT 32.6 %

11. STYRENE - SBR

DISCOUNTED CASH FLOW CALCULATION RESULTS

END OF YEAR		INVESTMENT	TOTAL SALES VALUE	TOTAL PRODUCT COST	INCOME BEFORE TAX	CORPORATE TAX	INCOME AFTER TAX	DEPRECIATION	CASH FLOW BACK	DISCOUNT RATE R = 20.7%	PRESENT VALUE	PRESENT VALUE AT PROJ. START-UP
ENG. + CONST	-1	19295. *1	0.	0.	0.	0.	0.	0.	0.	0.0	0.	0.
OPERATION	1	0. *2	21912.	17839.	4073.	0.	4073.	1830.	5902.	0.82866	4891.	22078.
START-UP	2	0.	21912.	17839.	4073.	0.	4073.	1830.	5902.	0.68669	4053.	
	3	0.	21912.	17839.	4073.	0.	4073.	1830.	5902.	0.56903	3359.	
	4	0.	21912.	17839.	4073.	0.	4073.	1830.	5902.	0.47153	2783.	
	5	0.	21912.	17839.	4073.	0.	4073.	1830.	5902.	0.39074	2306.	
	6	0.	21912.	17839.	4073.	1833.	2240.	1830.	4070.	0.32379	1318.	
	7	0.	21912.	17839.	4073.	1833.	2240.	1830.	4070.	0.26832	1092.	
	8	0.	21912.	17839.	4073.	1833.	2240.	1830.	4070.	0.22234	905.	
	9	0.	21912.	17839.	4073.	1833.	2240.	1830.	4070.	0.18425	750.	
	10	0. *3	21912.	17839.	4073.	1833.	2240.	1830.	4070.	0.15268	621.	
											22078.	

*1) TOTAL INVESTMENT COSTS
*2) WORKING CAPITAL
*3) SALVAGE VALUE

RATE OF RETURN ON INVESTMENT 20.7 %

12. MALEIC ANHYDRIDE

DISCOUNTED CASH FLOW CALCULATION RESULTS

END OF YEAR		INVESTMENT	TOTAL SALES VALUE	TOTAL PRODUCT COST	INCOME BEFORE TAX	CORPORATE TAX	INCOME AFTER TAX	DEPRECIATION	CASH FLOW BACK	DISCOUNT RATE R = 26.6%	PRESENT VALUE	PRESENT VALUE AT PROJ. START-UP
ENG. + CONST	-1	9650. *1	0.	0.	0.	0.	0.	0.	0.	0.0	0.	0.
OPERATION	1	0. *2	9850.	6913.	2937.	0.	2937.	965.	3902.	0.78978	3082.	12219.
START-UP	2	0.	9850.	6913.	2937.	0.	2937.	965.	3902.	0.62375	2434.	
	3	0.	9850.	6913.	2937.	0.	2937.	965.	3902.	0.49263	1922.	
	4	0.	9850.	6913.	2937.	0.	2937.	965.	3902.	0.38907	1518.	
	5	0.	9850.	6913.	2937.	0.	2937.	965.	3902.	0.30728	1199.	
	6	0.	9850.	6913.	2937.	1322.	1615.	965.	2580.	0.24268	626.	
	7	0.	9850.	6913.	2937.	1322.	1615.	965.	2580.	0.19167	495.	
	8	0.	9850.	6913.	2937.	1322.	1615.	965.	2580.	0.15137	391.	
	9	0.	9850.	6913.	2937.	1322.	1615.	965.	2580.	0.11955	308.	
	10	0. *3	9850.	6913.	2937.	1322.	1615.	965.	2580.	0.09442	244.	
											12219.	

*1) TOTAL INVESTMENT COSTS
*2) WORKING CAPITAL
*3) SALVAGE VALUE

RATE OF RETURN ON INVESTMENT 26.6 %

13. L - ALKYLBENZENE

DISCOUNTED CASH FLOW CALCULATION RESULTS

	END OF YEAR	INVESTMENT	TOTAL SALES VALUE	TOTAL PRODUCT COST	INCOME BEFORE TAX	CORPORATE TAX	INCOME AFTER TAX	DEPRECIATION	CASH FLOW BACK	DISCOUNT RATE R = 13.6%	PRESENT VALUE	PRESENT VALUE AT PROJ. START-UP
ENG. + CONST	-1	7200. *1	0.	0.	0.	0.	0.	0.	0.	0.0	0.	0.
OPERATION	1	0. *2	7450.	6476.	974.	0.	974.	720.	1694.	0.88041	1491.	8178.
START-UP	2	0.	7450.	6476.	974.	0.	974.	720.	1694.	0.77512	1313.	
	3	0.	7450.	6476.	974.	0.	974.	720.	1694.	0.68242	1156.	
	4	0.	7450.	6476.	974.	0.	974.	720.	1694.	0.60081	1018.	
	5	0.	7450.	6476.	974.	0.	974.	720.	1694.	0.52896	896.	
	6	0.	7450.	6476.	974.	438.	536.	720.	1256.	0.46570	585.	
	7	0.	7450.	6476.	974.	438.	536.	720.	1256.	0.41001	515.	
	8	0.	7450.	6476.	974.	438.	536.	720.	1256.	0.36097	453.	
	9	0.	7450.	6476.	974.	438.	536.	720.	1256.	0.31781	399.	
	10	0. *3	7450.	6476.	974.	438.	536.	720.	1256.	0.27980	351.	
											8178.	

*1) TOTAL INVESTMENT COSTS
*2) WORKING CAPITAL
*3) SALVAGE VALUE

RATE OF RETURN ON INVESTMENT 13.6 %

14. CAPROLACTAM

DISCOUNTED CASH FLOW CALCULATION RESULTS

	END OF YEAR	INVESTMENT	TOTAL SALES VALUE	TOTAL PRODUCT COST	INCOME BEFORE TAX	CORPORATE TAX	INCOME AFTER TAX	DEPRECIATION	CASH FLOW BACK	DISCOUNT RATE R = 9.3%	PRESENT VALUE	PRESENT VALUE AT PROJ. START-UP
ENG. + CONST	-1	11460. *1	0.	0.	0.	0.	0.	0.	0.	0.0	0.	0.
OPERATION	1	0. *2	5505.	4501.	1004.	0.	1004.	1146.	2150.	0.91528	1968.	12521.
START-UP	2	0.	5505.	4501.	1004.	0.	1004.	1146.	2150.	0.83774	1801.	
	3	0.	5505.	4501.	1004.	0.	1004.	1146.	2150.	0.76677	1648.	
	4	0.	5505.	4501.	1004.	0.	1004.	1146.	2150.	0.70181	1509.	
	5	0.	5505.	4501.	1004.	0.	1004.	1146.	2150.	0.64235	1381.	
	6	0.	5505.	4501.	1004.	452.	552.	1146.	1698.	0.58793	998.	
	7	0.	5505.	4501.	1004.	452.	552.	1146.	1698.	0.53812	914.	
	8	0.	5505.	4501.	1004.	452.	552.	1146.	1698.	0.49253	836.	
	9	0.	5505.	4501.	1004.	452.	552.	1146.	1698.	0.45080	765.	
	10	0. *3	5505.	4501.	1004.	452.	552.	1146.	1698.	0.41261	701.	
											12521.	

*1) TOTAL INVESTMENT COSTS
*2) WORKING CAPITAL
*3) SALVAGE VALUE

RATE OF RETURN ON INVESTMENT 9.3 %

15. CAPROLACTAM - NYLON 6-F

DISCOUNTED CASH FLOW CALCULATION RESULTS

	END OF YEAR	INVESTMENT	TOTAL SALES VALUE	TOTAL PRODUCT COST	INCOME BEFORE TAX	CORPORATE TAX	INCOME AFTER TAX	DEPRECIATION	CASH FLOW BACK	DISCOUNT RATE R = 15.1%	PRESENT VALUE	PRESENT VALUE AT PROJ. START-UP
ENG. + CONST	-1	37030. *1	0.	0.	0.	0.	0.	0.	0.	0.0	0.	0.
OPERATION START-UP	1	0. *2	21204.	15554.	5650.	0.	5650.	3703.	9353.	0.86909	8128.	42608.
	2	0.	21204.	15554.	5650.	0.	5650.	3703.	9353.	0.75532	7064.	
	3	0.	21204.	15554.	5650.	0.	5650.	3703.	9353.	0.65644	6140.	
	4	0.	21204.	15554.	5650.	0.	5650.	3703.	9353.	0.57050	5336.	
	5	0.	21204.	15554.	5650.	0.	5650.	3703.	9353.	0.49582	4637.	
	6	0.	21204.	15554.	5650.	2542.	3107.	3703.	6810.	0.43091	2935.	
	7	0.	21204.	15554.	5650.	2542.	3107.	3703.	6810.	0.37450	2550.	
	8	0.	21204.	15554.	5650.	2542.	3107.	3703.	6810.	0.32547	2217.	
	9	0.	21204.	15554.	5650.	2542.	3107.	3703.	6810.	0.28287	1926.	
	10	0. *3	21204.	15554.	5650.	2542.	3107.	3703.	6810.	0.24584	1674.	
											42608.	

*1) TOTAL INVESTMENT COSTS
*2) WORKING CAPITAL
*3) SALVAGE VALUE

RATE OF RETURN ON INVESTMENT 15.1 %

16. T D I

DISCOUNTED CASH FLOW CALCULATION RESULTS

	END OF YEAR	INVESTMENT	TOTAL SALES VALUE	TOTAL PRODUCT COST	INCOME BEFORE TAX	CORPORATE TAX	INCOME AFTER TAX	DEPRECIATION	CASH FLOW BACK	DISCOUNT RATE R = 24.7%	PRESENT VALUE	PRESENT VALUE AT PROJ. START-UP
ENG. + CONST	-1	21410. *1	0.	0.	0.	0.	0.	0.	0.	0.0	0.	0.
OPERATION START-UP	1	0. *2	17880.	11942.	5938.	0.	5938.	2141.	8079.	0.80183	6478.	26701.
	2	0.	17880.	11942.	5938.	0.	5938.	2141.	8079.	0.64293	5194.	
	3	0.	17880.	11942.	5938.	0.	5938.	2141.	8079.	0.51553	4165.	
	4	0.	17880.	11942.	5938.	0.	5938.	2141.	8079.	0.41337	3339.	
	5	0.	17880.	11942.	5938.	0.	5938.	2141.	8079.	0.33145	2678.	
	6	0.	17880.	11942.	5938.	2672.	3265.	2141.	5407.	0.26577	1437.	
	7	0.	17880.	11942.	5938.	2672.	3265.	2141.	5407.	0.21310	1152.	
	8	0.	17880.	11942.	5938.	2672.	3266.	2141.	5407.	0.17087	924.	
	9	0.	17880.	11942.	5938.	2672.	3266.	2141.	5407.	0.13701	741.	
	10	0. *3	17880.	11942.	5938.	2672.	3266.	2141.	5407.	0.10986	594.	
											26701.	

*1) TOTAL INVESTMENT COSTS
*2) WORKING CAPITAL
*3) SALVAGE VALUE

RATE OF RETURN ON INVESTMENT 24.7 %

17. TEREPHTHALIC ACID - DMT

DISCOUNTED CASH FLOW CALCULATION RESULTS

	END OF YEAR	INVESTMENT	TOTAL SALES VALUE	TOTAL PRODUCT COST	INCOME BEFORE TAX	CORPORATE TAX	INCOME AFTER TAX	DEPRECIATION	CASH FLOW BACK	DISCOUNT RATE R = 14.0%	PRESENT VALUE	PRESENT VALUE AT PROJ. START-UP
ENG. + CONST	-1	24940. *1	0.	0.	0.	0.	0.	0.	0.	0.0	0.	0.
OPERATION START-UP	1	0. *2	18666.	15170.	3496.	0.	3496.	2494.	5990.	0.87715	5254.	28433.
	2	0.	18666.	15170.	3496.	0.	3496.	2494.	5990.	0.76939	4609.	
	3	0.	18666.	15170.	3496.	0.	3496.	2494.	5990.	0.67487	4042.	
	4	0.	18666.	15170.	3496.	0.	3496.	2494.	5990.	0.59196	3546.	
	5	0.	18666.	15170.	3496.	0.	3496.	2494.	5990.	0.51923	3110.	
	6	0.	18666.	15170.	3496.	1573.	1923.	2494.	4417.	0.45544	2012.	
	7	0.	18666.	15170.	3496.	1573.	1923.	2494.	4417.	0.39949	1764.	
	8	0.	18666.	15170.	3496.	1573.	1923.	2494.	4417.	0.35041	1548.	
	9	0.	18666.	15170.	3496.	1573.	1923.	2494.	4417.	0.30736	1358.	
	10	0. *3	18666.	15170.	3496.	1573.	1923.	2494.	4417.	0.26960	1191.	
											28433.	

*1) TOTAL INVESTMENT COSTS
*2) WORKING CAPITAL
*3) SALVAGE VALUE

RATE OF RETURN ON INVESTMENT 14.0 %

18. TEREPHTHALIC ACID - DMT - POLYESTER-F

DISCOUNTED CASH FLOW CALCULATION RESULTS

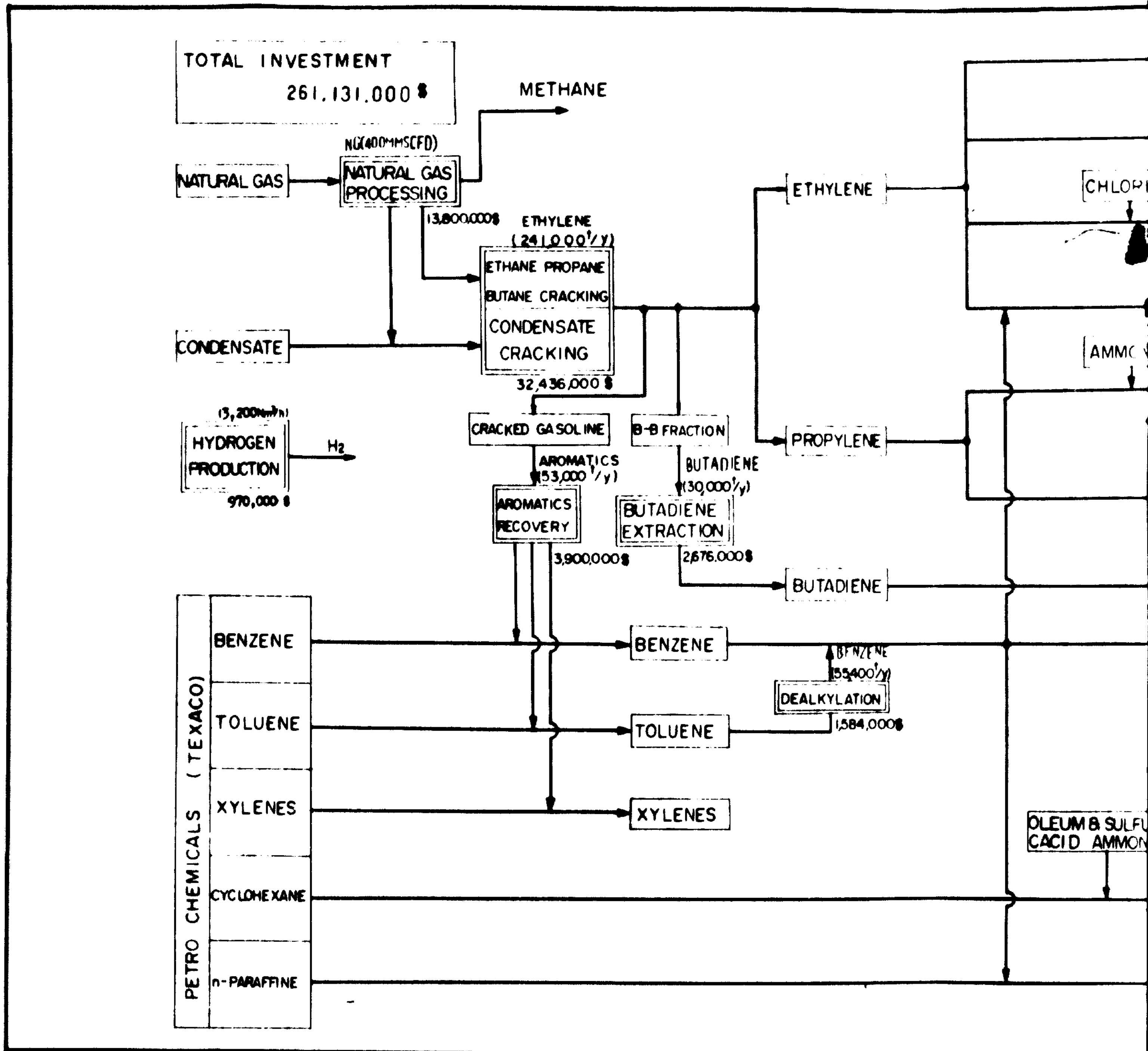
	END OF YEAR	INVESTMENT	TOTAL SALES VALUE	TOTAL PRODUCT COST	INCOME BEFORE TAX	CORPORATE TAX	INCOME AFTER TAX	DEPRECIATION	CASH FLOW BACK	DISCOUNT RATE R = 12.1%	PRESENT VALUE	PRESENT VALUE AT PROJ. START-UP
ENG. + CONST	-1	22600. *1	0.	0.	0.	0.	0.	0.	0.	0.0	0.	0.
OPERATION START-UP	1	0. *2	12672.	9993.	2679.	0.	2679.	2260.	4939.	0.89200	4406.	25336.
	2	0.	12672.	9993.	2679.	0.	2679.	2260.	4939.	0.79567	3930.	
	3	0.	12672.	9993.	2679.	0.	2679.	2260.	4939.	0.70973	3505.	
	4	0.	12672.	9993.	2679.	0.	2679.	2260.	4939.	0.63308	3127.	
	5	0.	12672.	9993.	2679.	0.	2679.	2260.	4939.	0.56471	2789.	
	6	0.	12672.	9993.	2679.	1206.	1473.	2260.	3733.	0.50372	1881.	
	7	0.	12672.	9993.	2679.	1206.	1473.	2260.	3733.	0.44932	1678.	
	8	0.	12672.	9993.	2679.	1206.	1473.	2260.	3733.	0.40079	1496.	
	9	0.	12672.	9993.	2679.	1206.	1473.	2260.	3733.	0.35751	1335.	
	10	0. *3	12672.	9993.	2679.	1206.	1473.	2260.	3733.	0.31890	1191.	
											25336.	

*1) TOTAL INVESTMENT COSTS
*2) WORKING CAPITAL
*3) SALVAGE VALUE

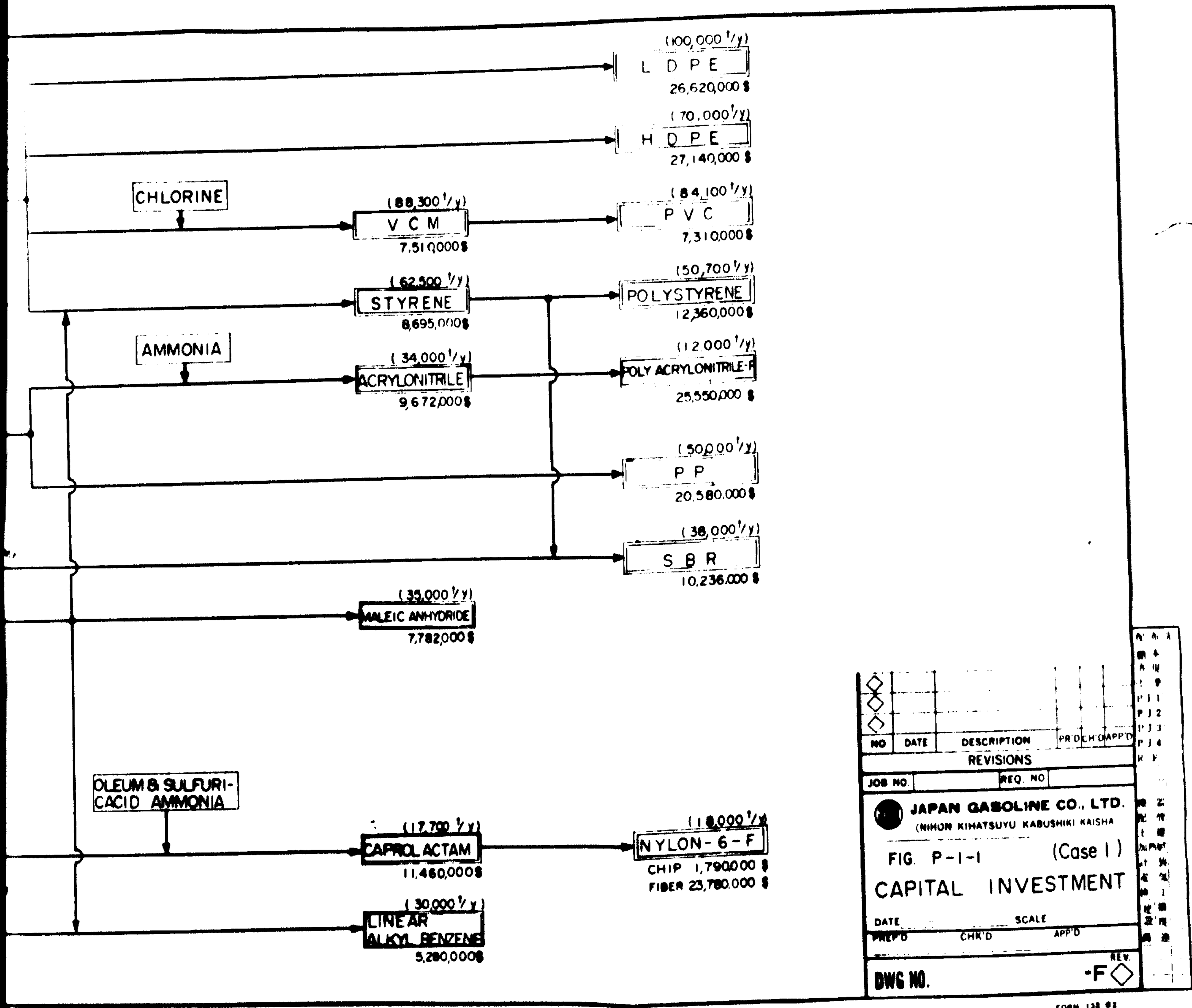
RATE OF RETURN ON INVESTMENT 12.1 %

Annex P. Capital Investment, Utilities and Labour of Complex.

1. Capital Investment
2. Electric Power
3. Steam
4. Cooling Water
5. Fuel
6. Labour

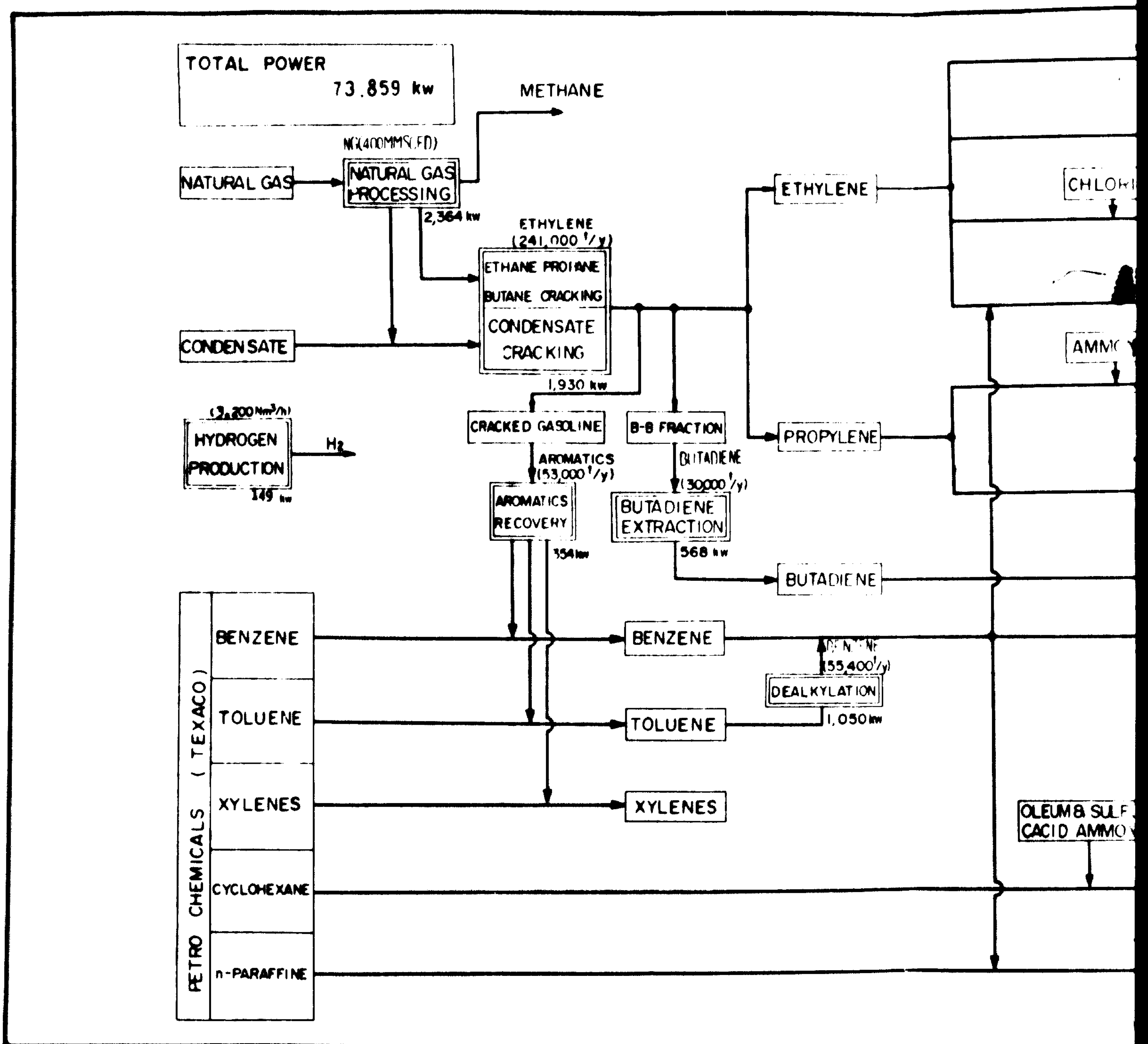

TOTAL INVESTMENT
261,131,000 $
METHANE
NG(400MMSCFD)
NATURAL GAS
NATURAL GAS PROCESSING
13,800,000$
ETHYLENE
(241,000 t/y)
ETHANE PROPANE
BUTANE CRACKING
CONDENSATE CRACKING
CONDENSATE
32,436,000 $
(3,200Nm³/h)
HYDROGEN PRODUCTION
H2
970,000 $
CRACKED GASOLINE
B-B FRACTION
AROMATICS
(53,000 t/y)
AROMATICS RECOVERY
3,900,000$
BUTADIENE
(30,000 t/y)
BUTADIENE EXTRACTION
2,676,000$
ETHYLENE
PROPYLENE
BUTADIENE
CHLOR
AMMO
PETRO CHEMICALS (TEXACO)
BENZENE
TOLUENE
XYLENES
CYCLOHEXANE
n-PARAFFINE
BENZENE
(55,400 t/y)
DEALKYLATION
1,584,000$
BENZENE
TOLUENE
XYLENES
OLEUM & SULFU
CACID AMMON

SECTION 1

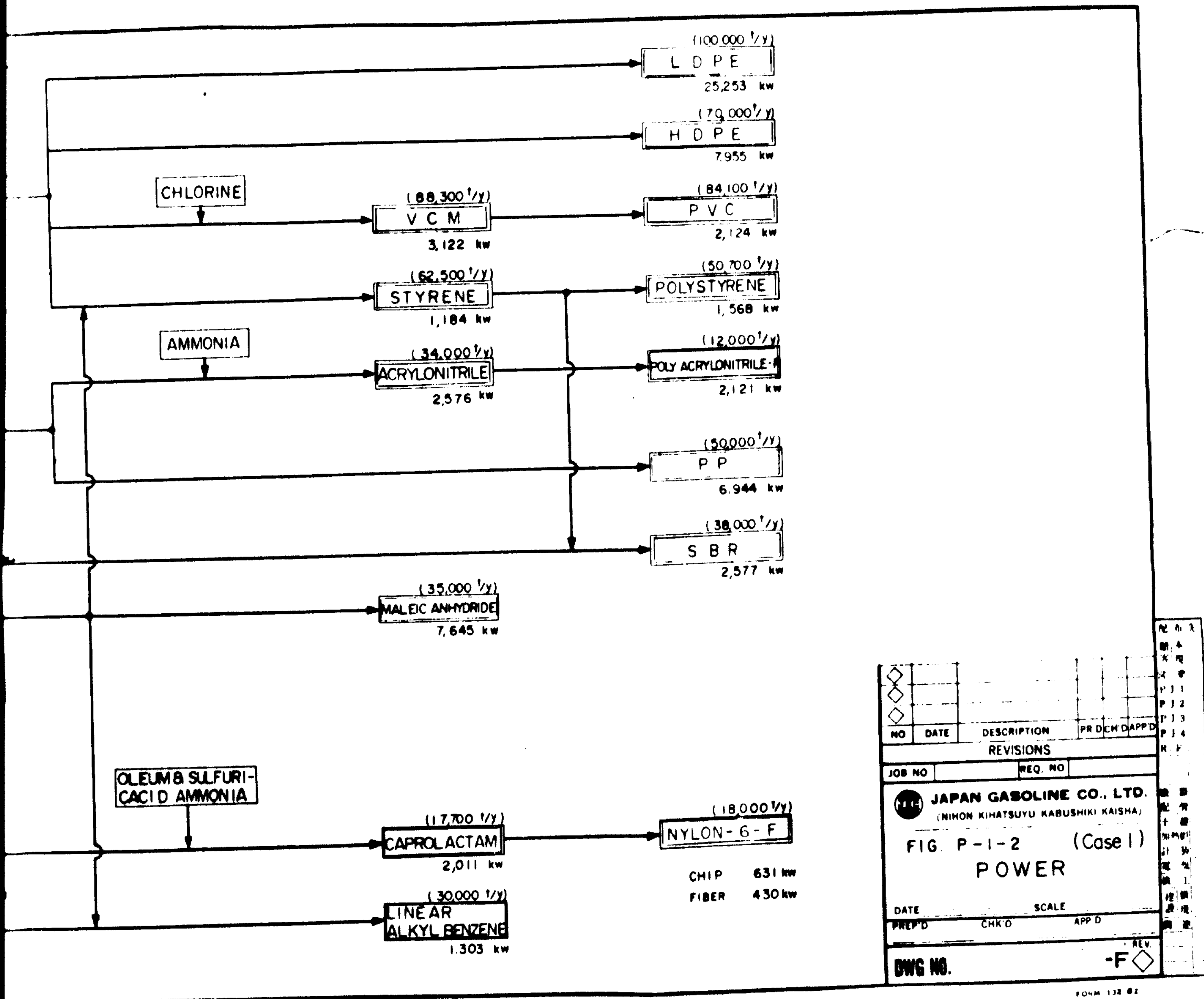


(100,000 t/y)
L D P E
26,620,000 $
(70,000 t/y)
H D P E
27,140,000 $
CHLORINE
(88,300 t/y)
V C M
7,510,000 $
(84,100 t/y)
P V C
7,310,000 $
(62,500 t/y)
STYRENE
8,695,000 $
(50,700 t/y)
POLYSTYRENE
12,360,000 $
AMMONIA
(34,000 t/y)
ACRYLONITRILE
9,672,000 $
(12,000 t/y)
POLY ACRYLONITRILE-F
25,550,000 $
(50,000 t/y)
P P
20,580,000 $
(38,000 t/y)
S B R
10,236,000 $
(35,000 t/y)
MALEIC ANHYDRIDE
7,782,000 $
OLEUM & SULFURI-CACID AMMONIA
(17,700 t/y)
CAPROLACTAM
11,460,000 $
(18,000 t/y)
NYLON-6-F
CHIP 1,790,000 $
FIBER 23,780,000 $
(30,000 t/y)
LINEAR ALKYL BENZENE
5,280,000 $
NO
DATE
DESCRIPTION
PR'D
CH'D
APP'D
REVISIONS
JOB NO.
REQ. NO
JAPAN GASOLINE CO., LTD.
(NIHON KIHATSUYU KABUSHIKI KAISHA)
FIG. P-1-1
(Case 1)
CAPITAL INVESTMENT
DATE
SCALE
PREP'D
CHK'D
APP'D
DWG NO.
-F
REV.
FORM 138 02

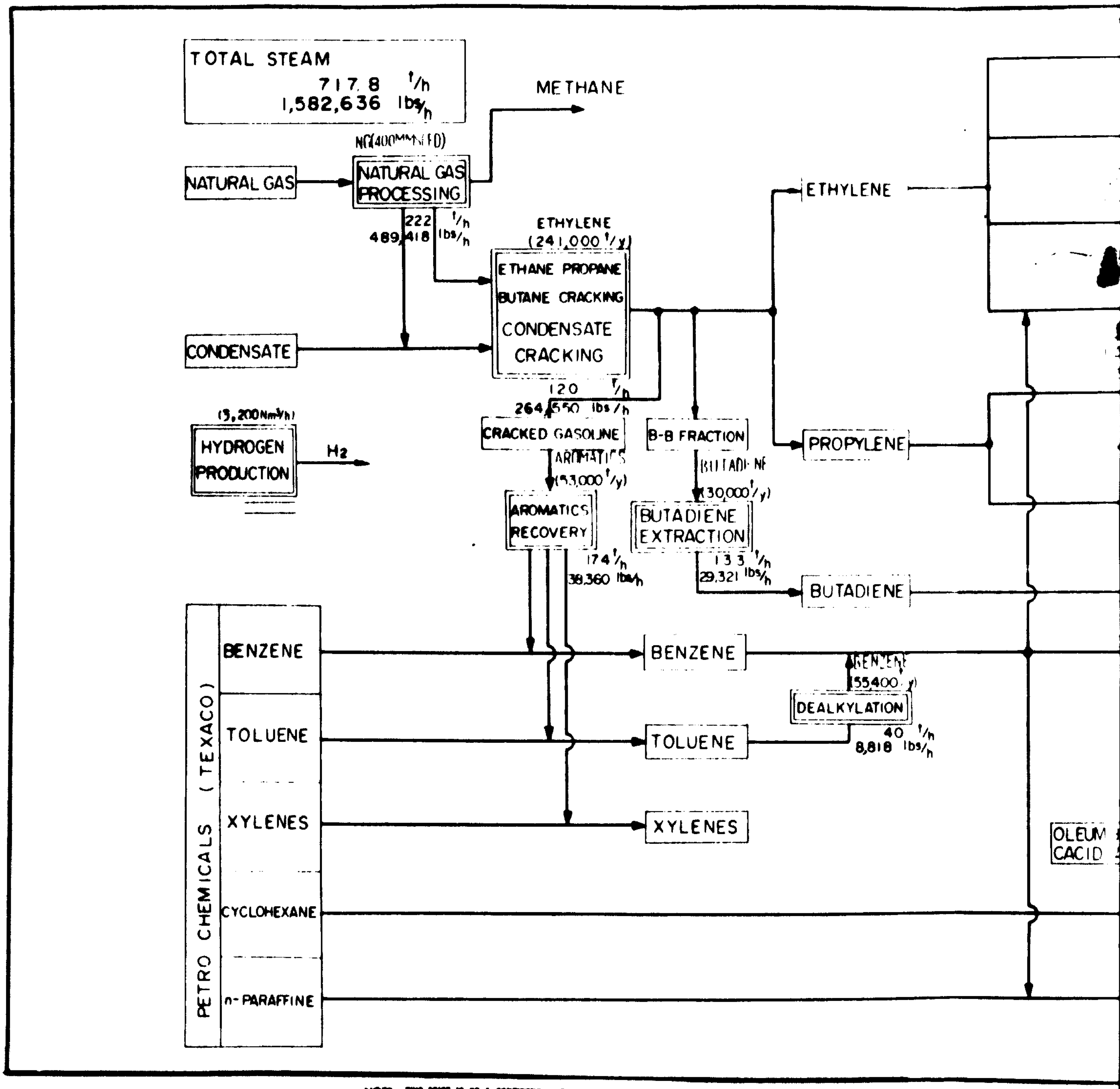
SECTION 2


TOTAL POWER
73,859 kw
METHANE
NG(400MMSCFD)
NATURAL GAS
NATURAL GAS PROCESSING
2,364 kw
ETHYLENE
(241,000 t/y)
ETHANE PROPANE
BUTANE CRACKING
CONDENSATE CRACKING
CONDENSATE
1,930 kw
(3,200 Nm³/h)
HYDROGEN PRODUCTION
H2
149 kw
CRACKED GASOLINE
B-B FRACTION
AROMATICS
(53,000 t/y)
BUTADIENE
(30,000 t/y)
AROMATICS RECOVERY
354 kw
BUTADIENE EXTRACTION
568 kw
ETHYLENE
PROPYLENE
BUTADIENE
BENZENE
TOLUENE
XYLENES
(55,400 t/y)
DEALKYLATION
1,050 kw
PETRO CHEMICALS (TEXACO)
BENZENE
TOLUENE
XYLENES
CYCLOHEXANE
n-PARAFFINE
CHLORI
AMMO
OLEUM & SULF
CACID AMMO

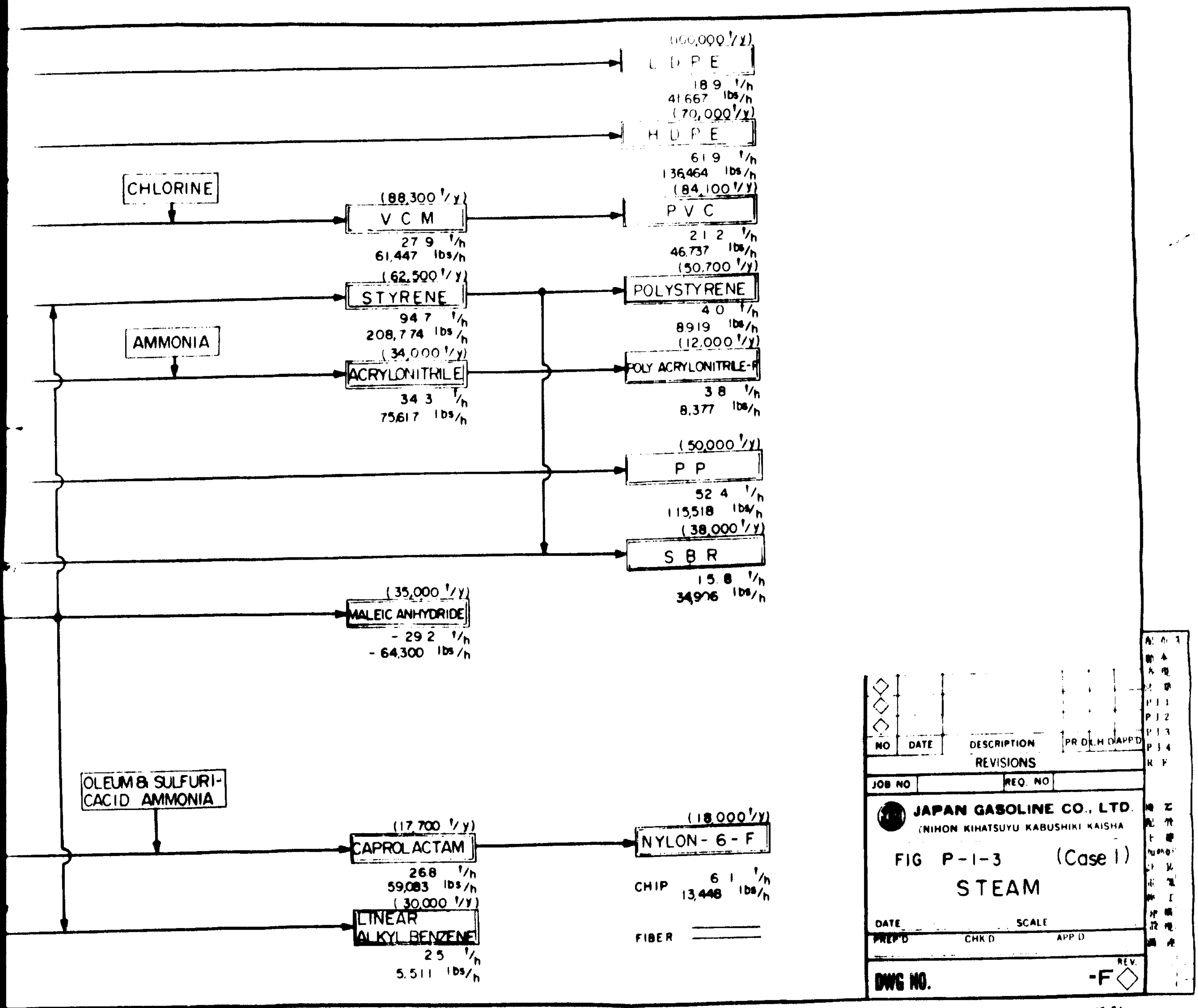
SECTION 1


(100,000 t/y)
L D P E
25,253 kw
(70,000 t/y)
H D P E
7,955 kw
CHLORINE
(88,300 t/y)
V C M
3,122 kw
(84,100 t/y)
P V C
2,124 kw
(62,500 t/y)
STYRENE
1,184 kw
(50,700 t/y)
POLYSTYRENE
1,568 kw
AMMONIA
(34,000 t/y)
ACRYLONITRILE
2,576 kw
(12,000 t/y)
POLY ACRYLONITRILE-F
2,121 kw
(50,000 t/y)
P P
6,944 kw
(38,000 t/y)
S B R
2,577 kw
(35,000 t/y)
MALEIC ANHYDRIDE
7,645 kw
OLEUM & SULFURIC ACID AMMONIA
(17,700 t/y)
CAPROLACTAM
2,011 kw
(18,000 t/y)
NYLON-6-F
CHIP 631 kw
FIBER 430 kw
(30,000 t/y)
LINEAR ALKYL BENZENE
1,303 kw
NO
DATE
DESCRIPTION
PR'D
CH'D
APP'D
REVISIONS
JOB NO
REQ. NO
JAPAN GASOLINE CO., LTD.
(NIHON KIHATSUYU KABUSHIKI KAISHA)
FIG. P-1-2 (Case 1)
POWER
DATE
SCALE
PREP'D
CHK'D
APP'D
REV.
DWG NO.
-F

SECTION 2

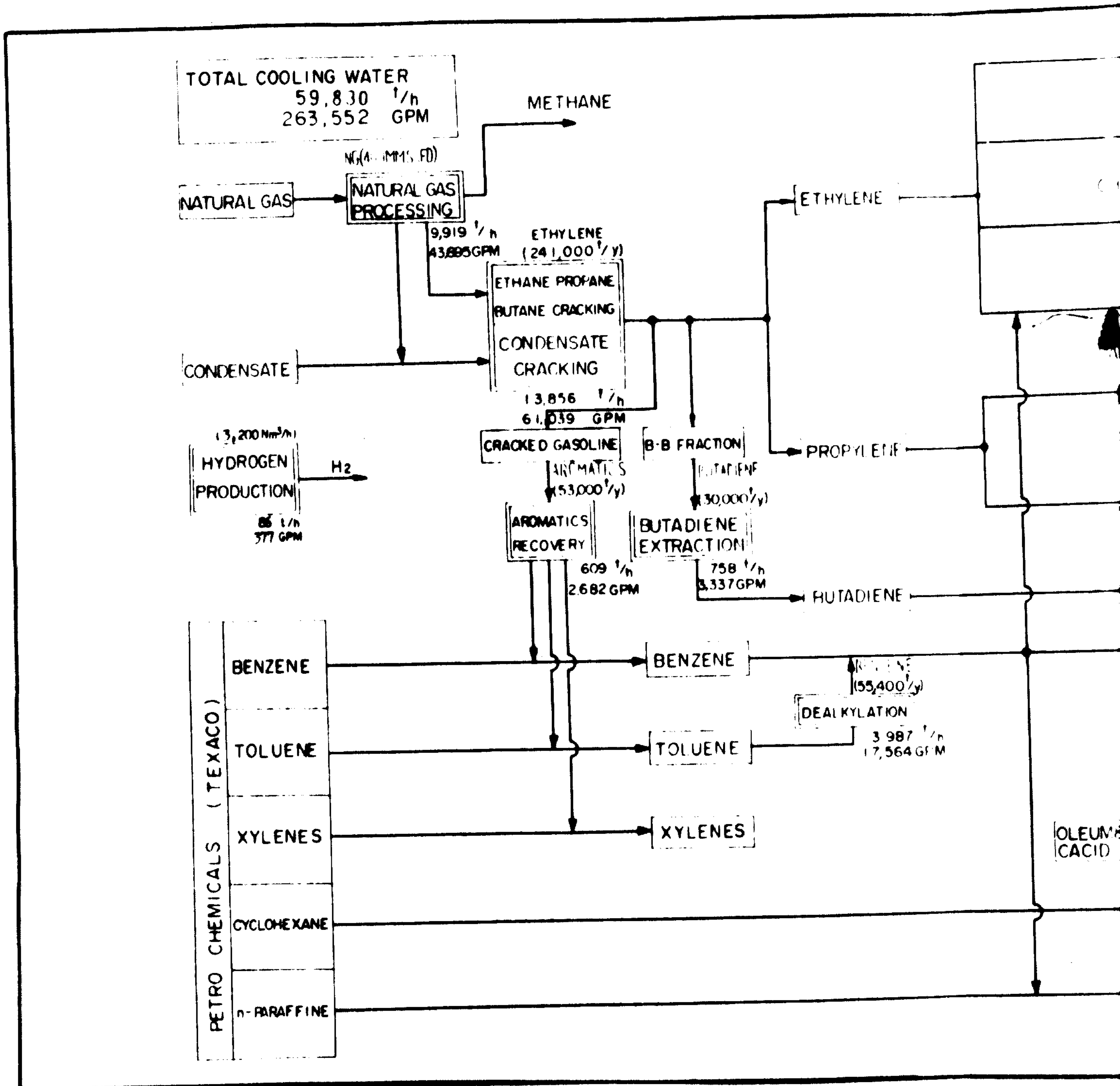

TOTAL STEAM
717.8 t/h
1,582,636 lbs/h
METHANE
NATURAL GAS
NATURAL GAS PROCESSING
222 t/h
489,418 lbs/h
ETHYLENE
(241,000 t/y)
ETHANE PROPANE
BUTANE CRACKING
CONDENSATE CRACKING
CONDENSATE
ETHYLENE
120 t/h
264,550 lbs/h
CRACKED GASOLINE
B-B FRACTION
PROPYLENE
(3,200Nm³/h)
HYDROGEN PRODUCTION
H2
(53,000 t/y)
AROMATICS RECOVERY
(30,000 t/y)
BUTADIENE EXTRACTION
174 t/h
38,360 lbs/h
13.3 t/h
29,321 lbs/h
BUTADIENE
PETRO CHEMICALS (TEXACO)
BENZENE
TOLUENE
XYLENES
CYCLOHEXANE
n-PARAFFINE
BENZENE
(55400 t/y)
DEALKYLATION
40 t/h
8,818 lbs/h
TOLUENE
XYLENES
OLEUM
CACID

SECTION 1



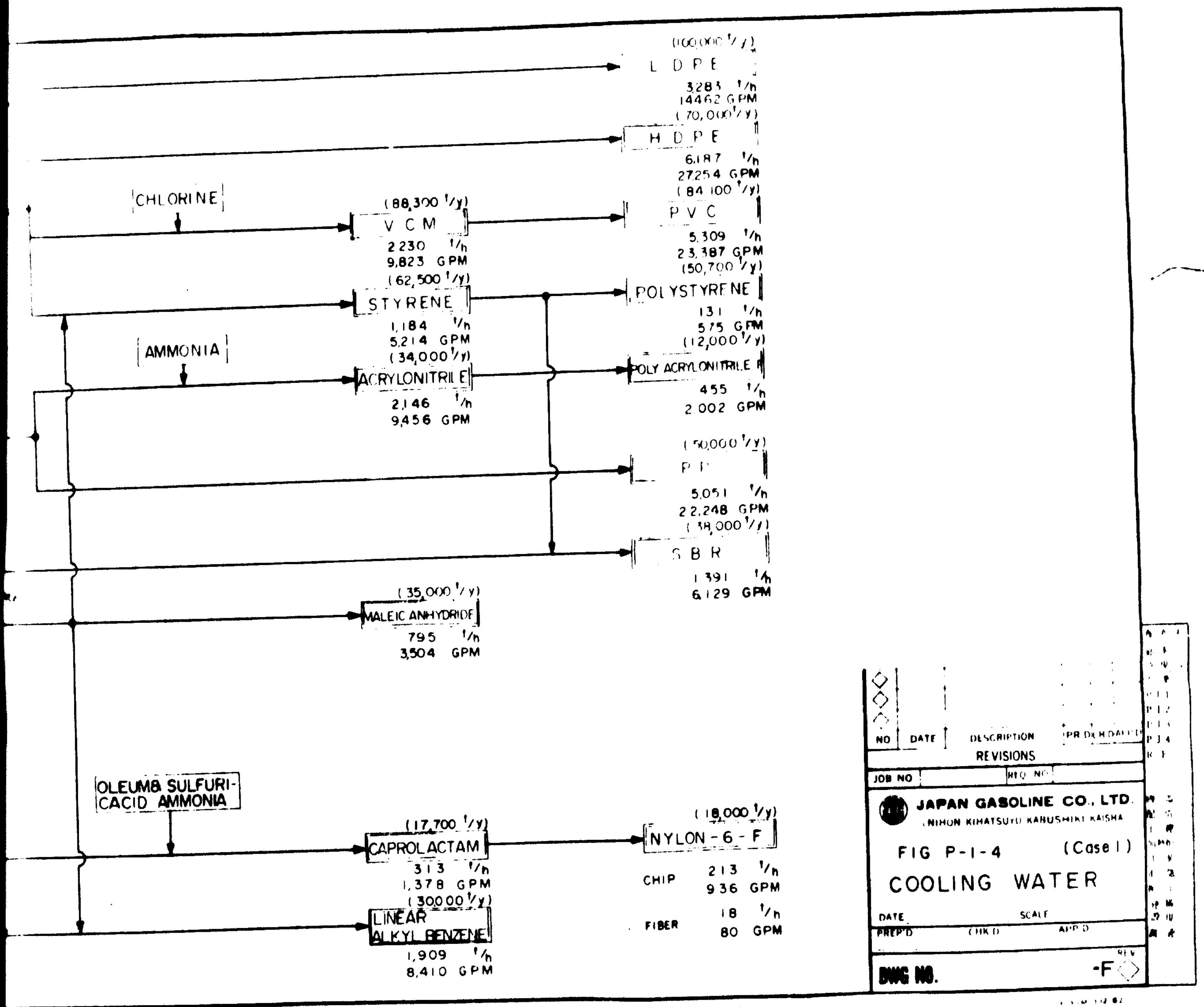
(100,000 t/y)
L D P E
18.9 t/h
41,667 lbs/h
(70,000 t/y)
H D P E
61.9 t/h
136,464 lbs/h
CHLORINE
(88,300 t/y)
V C M
27.9 t/h
61,447 lbs/h
(84,100 t/y)
P V C
21.2 t/h
46,737 lbs/h
(62,500 t/y)
STYRENE
94.7 t/h
208,774 lbs/h
(50,700 t/y)
POLYSTYRENE
4.0 t/h
8,919 lbs/h
AMMONIA
(34,000 t/y)
ACRYLONITRILE
34.3 t/h
75,617 lbs/h
(12,000 t/y)
POLY ACRYLONITRILE-F
3.8 t/h
8,377 lbs/h
(50,000 t/y)
P P
52.4 t/h
115,518 lbs/h
(38,000 t/y)
S B R
15.8 t/h
34,906 lbs/h
(35,000 t/y)
MALEIC ANHYDRIDE
- 29.2 t/h
- 64,300 lbs/h
OLEUM & SULFURIC ACID AMMONIA
(17,700 t/y)
CAPROLACTAM
26.8 t/h
59,083 lbs/h
(18,000 t/y)
NYLON-6-F
CHIP 6.1 t/h
13,448 lbs/h
FIBER
(30,000 t/y)
LINEAR ALKYL BENZENE
2.5 t/h
5,511 lbs/h
NO DATE DESCRIPTION PR'D CH'D APP'D
REVISIONS
JOB NO REQ. NO
JAPAN GASOLINE CO., LTD.
(NIHON KIHATSUYU KABUSHIKI KAISHA
FIG P-1-3 (Case 1)
STEAM
DATE SCALE
PREP'D CHK'D APP'D
DWG NO. -F
REV.

SECTION 2

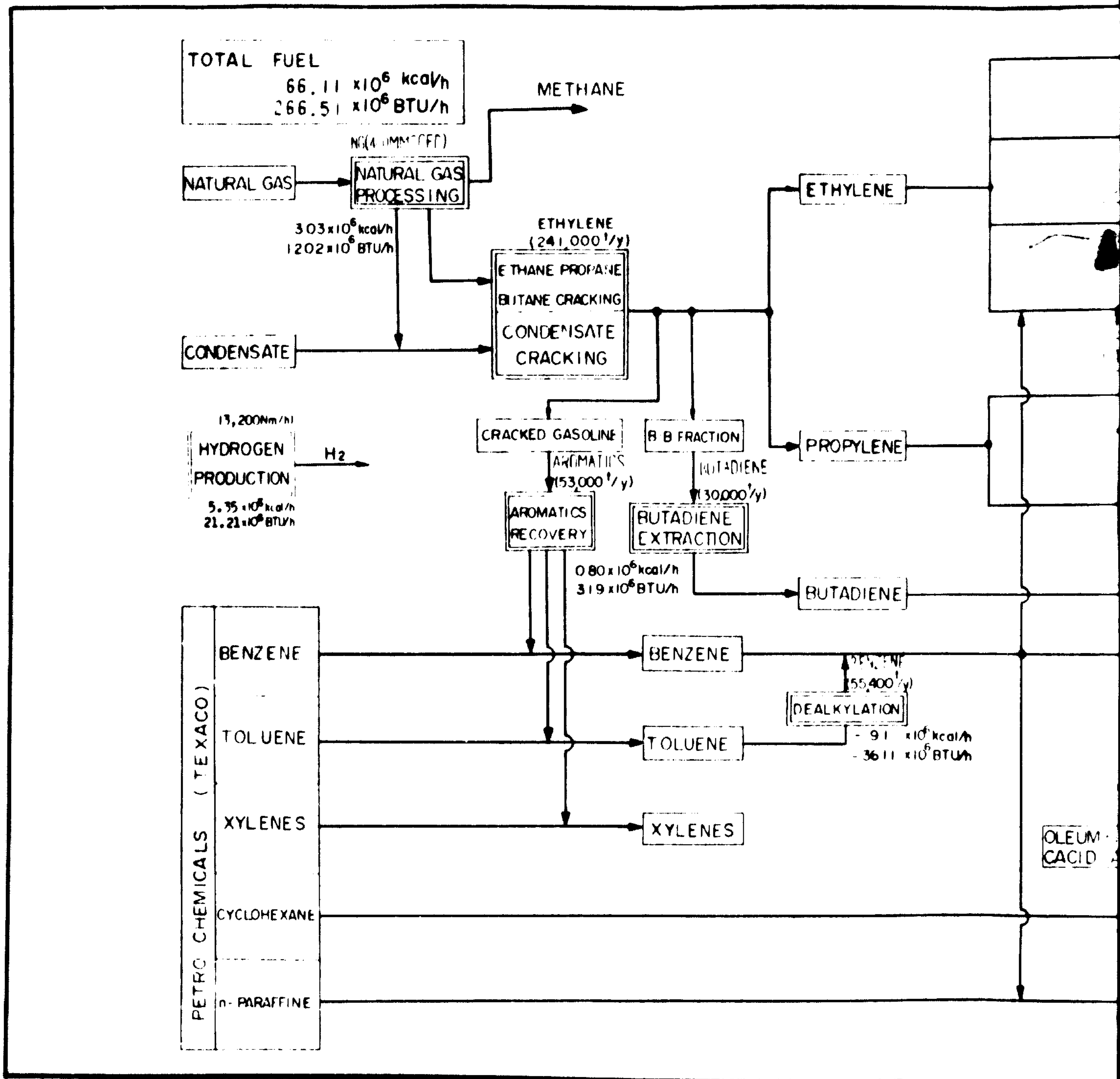


TOTAL COOLING WATER
59,830 t/h
263,552 GPM
METHANE
NATURAL GAS
NATURAL GAS PROCESSING
9,919 t/h
43,695 GPM
ETHYLENE
(241,000 t/y)
ETHANE PROPANE
BUTANE CRACKING
CONDENSATE
CRACKING
CONDENSATE
13,856 t/h
61,039 GPM
CRACKED GASOLINE
B-B FRACTION
ETHYLENE
PROPYLENE
(3,200 Nm³/h)
HYDROGEN
PRODUCTION
H2
85 t/h
377 GPM
(53,000 t/y)
(30,000 t/y)
AROMATICS
RECOVERY
BUTADIENE
EXTRACTION
609 t/h
2,682 GPM
758 t/h
3,337 GPM
BUTADIENE
PETRO CHEMICALS (TEXACO)
BENZENE
TOLUENE
XYLENES
CYCLOHEXANE
n-PARAFFINE
BENZENE
(55,400 t/y)
DEALKYLATION
TOLUENE
3,987 t/h
17,564 GPM
XYLENES
OLEUM
CACID

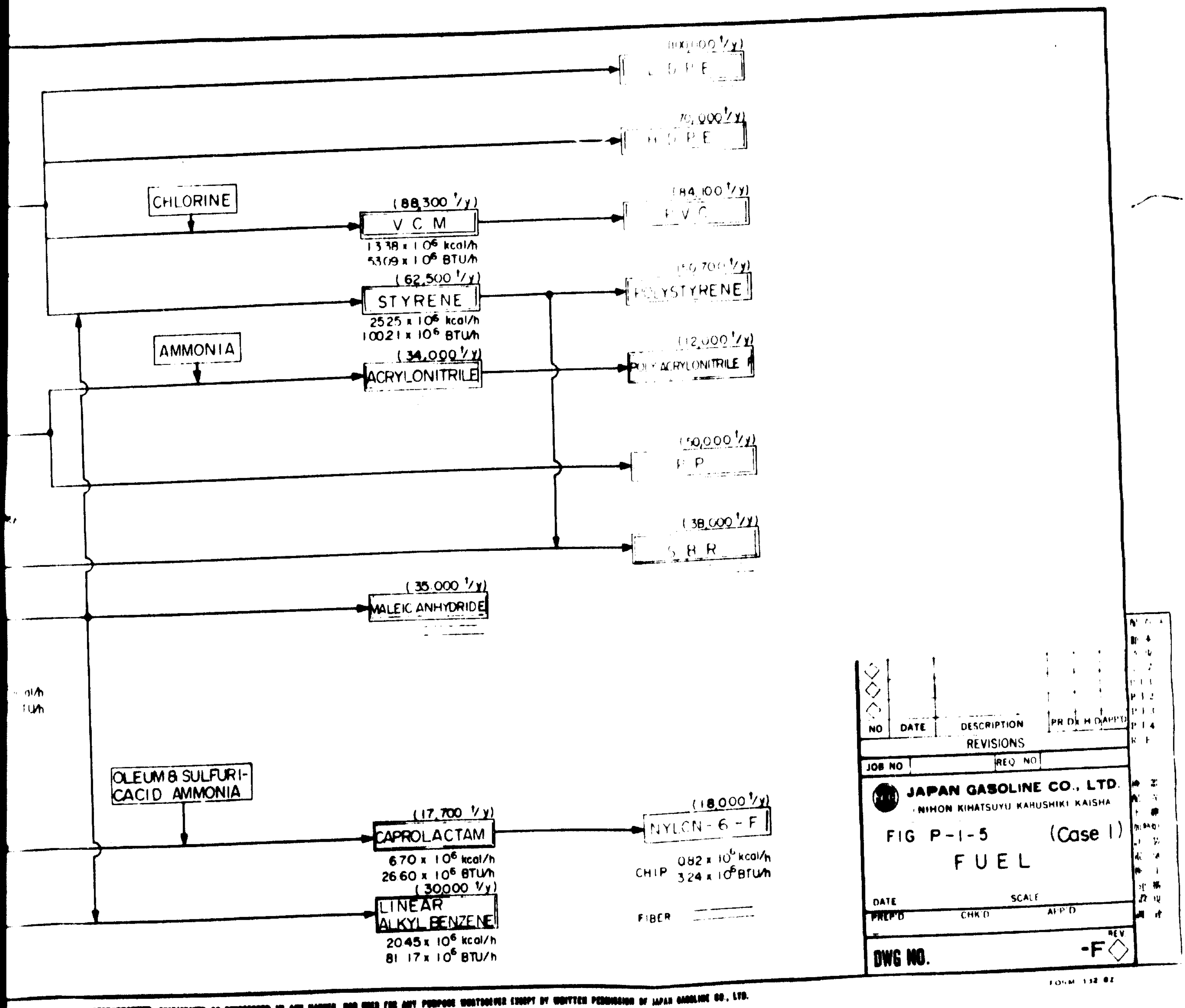
SECTION 1


(100,000 t/y)
L D P E
3,283 t/h
14,462 GPM
(70,000 t/y)
H D P E
6,187 t/h
27,254 GPM
CHLORINE
(88,300 t/y)
V C M
2,230 t/h
9,823 GPM
(84,100 t/y)
P V C
5,309 t/h
23,387 GPM
(62,500 t/y)
STYRENE
1,184 t/h
5,214 GPM
(50,700 t/y)
POLYSTYRENE
131 t/h
575 GPM
AMMONIA
(34,000 t/y)
ACRYLONITRILE
2,146 t/h
9,456 GPM
(12,000 t/y)
POLY ACRYLONITRILE
455 t/h
2,002 GPM
(50,000 t/y)
P P
5,051 t/h
22,248 GPM
(38,000 t/y)
S B R
1,391 t/h
6,129 GPM
(35,000 t/y)
MALEIC ANHYDRIDE
795 t/h
3,504 GPM
OLEUM& SULFURICACID AMMONIA
(17,700 t/y)
CAPROLACTAM
313 t/h
1,378 GPM
(18,000 t/y)
NYLON - 6 - F
CHIP 213 t/h 936 GPM
FIBER 18 t/h 80 GPM
(30,000 t/y)
LINEAR ALKYL BENZENE
1,909 t/h
8,410 GPM
NO DATE DESCRIPTION
REVISIONS
JOB NO
REQ NO
JAPAN GASOLINE CO., LTD.
(NIHON KIHATSUYU KABUSHIKI KAISHA)
FIG P-1-4 (Case I)
COOLING WATER
DATE SCALE
PREP'D CHK'D APP'D
DWG NO. -F

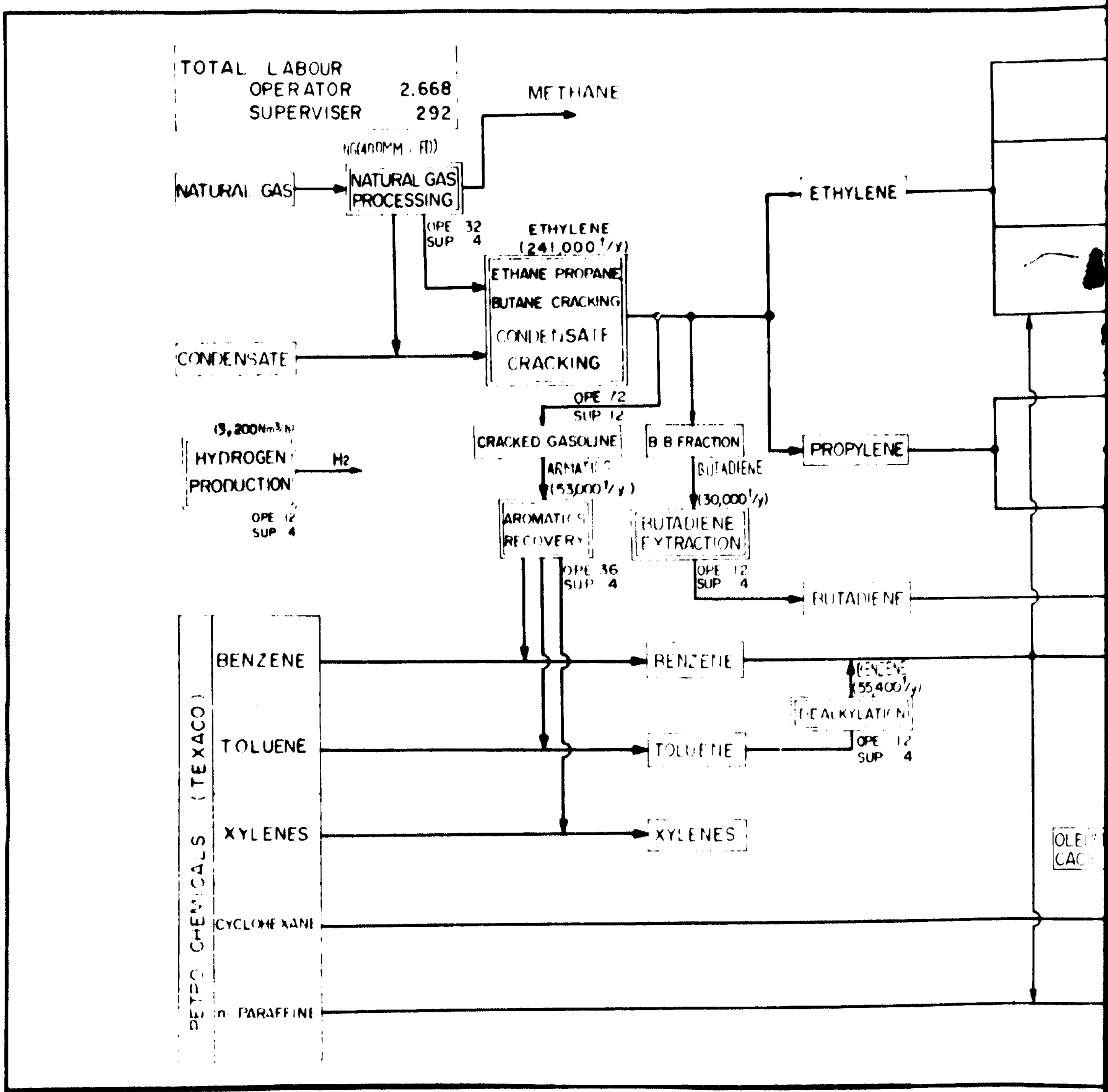
SECTION 2


TOTAL FUEL
66.11 x10^6 kcal/h
266.51 x10^6 BTU/h
METHANE
NATURAL GAS
NATURAL GAS PROCESSING
3.03x10^6 kcal/h
12.02x10^6 BTU/h
ETHYLENE
(241,000 t/y)
ETHANE PROPANE
BUTANE CRACKING
CONDENSATE CRACKING
CONDENSATE
ETHYLENE
13,200Nm³/h
HYDROGEN PRODUCTION
H2
5.35 x10^6 kcal/h
21.21 x10^6 BTU/h
CRACKED GASOLINE
AROMATICS
(53,000 t/y)
B B FRACTION
BUTADIENE
(30,000 t/y)
PROPYLENE
AROMATICS RECOVERY
BUTADIENE EXTRACTION
0.80 x10^6 kcal/h
3.19 x10^6 BTU/h
BUTADIENE
PETRO CHEMICALS (TEXACO)
BENZENE
TOLUENE
XYLENES
CYCLOHEXANE
n- PARAFFINE
BENZENE
(55,400 t/y)
DEALKYLATION
- 9.1 x10^6 kcal/h
- 36.11 x10^6 BTU/h
TOLUENE
XYLENES
OLEUM
ACID

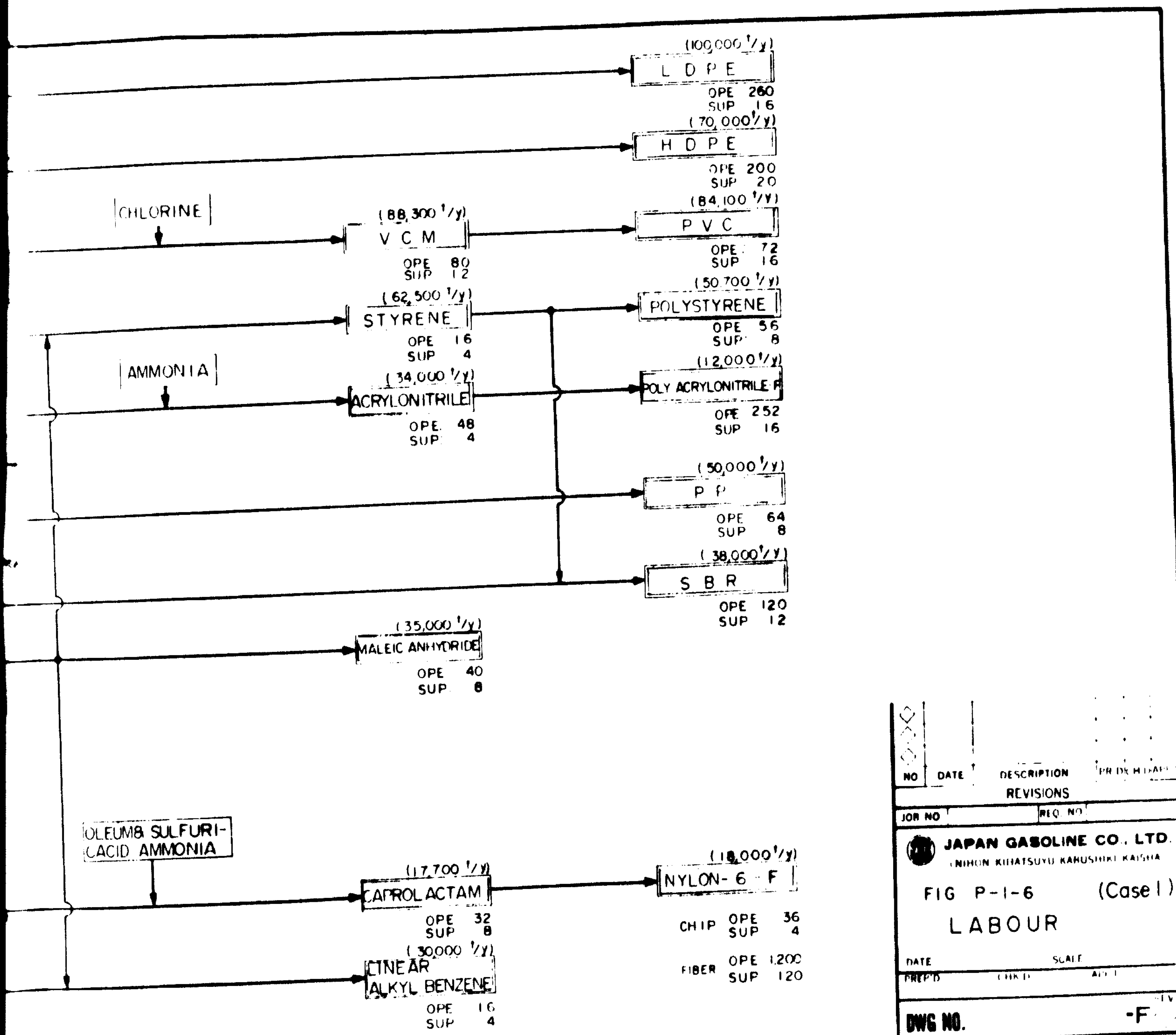
SECTION 1


(100,000 t/y)
L D P E
70,000 t/y
H D P E
CHLORINE
(88,300 t/y)
V C M
1338 x 10^6 kcal/h
5309 x 10^6 BTU/h
(84,100 t/y)
P V C
(62,500 t/y)
STYRENE
2525 x 10^6 kcal/h
10021 x 10^6 BTU/h
POLYSTYRENE
AMMONIA
(34,000 t/y)
ACRYLONITRILE
(12,000 t/y)
POLYACRYLONITRILE
(50,000 t/y)
P P
(38,000 t/y)
S B R
(35,000 t/y)
MALEIC ANHYDRIDE
OLEUM & SULFURIC ACID AMMONIA
(17,700 t/y)
CAPROLACTAM
670 x 10^6 kcal/h
2660 x 10^6 BTU/h
(18,000 t/y)
NYLON-6-F
CHIP
082 x 10^6 kcal/h
324 x 10^6 BTU/h
FIBER
(30,000 t/y)
LINEAR ALKYL BENZENE
2045 x 10^6 kcal/h
8117 x 10^6 BTU/h
NO
DATE
DESCRIPTION
REVISIONS
JOB NO
REQ NO
JAPAN GASOLINE CO., LTD.
NIHON KIHATSUYU KABUSHIKI KAISHA
FIG P-1-5
(Case I)
FUEL
DATE
SCALE
PREP'D
CHK'D
APP'D
DWG NO.
-F
REV

SECTION 2


TOTAL LABOUR
OPERATOR 2,668
SUPERVISER 292
METHANE
NATURAL GAS
NATURAL GAS PROCESSING
OPE 32
SUP 4
ETHYLENE
(241,000 t/y)
ETHANE PROPANE
BUTANE CRACKING
CONDENSATE CRACKING
CONDENSATE
OPE 72
SUP 12
ETHYLENE
PROPYLENE
HYDROGEN PRODUCTION
H2
OPE 12
SUP 4
CRACKED GASOLINE
B B FRACTION
(30,000 t/y)
AROMATICS RECOVERY
BUTADIENE EXTRACTION
OPE 36
SUP 4
OPE 12
SUP 4
BUTADIENE
BENZENE
(55,400 t/y)
OPE 12
SUP 4
TOLUENE
XYLENES
CYCLOHEXANE
n- PARAFFINE
PETRO CHEMICALS (TEXACO)

SECTION 1



NO | DATE | DESCRIPTION

REVISIONS

JOB NO | REQ NO

JAPAN GASOLINE CO., LTD.
(NIHON KIHATSUYU KABUSHIKI KAISHA)

FIG P-1-6 (Case I)

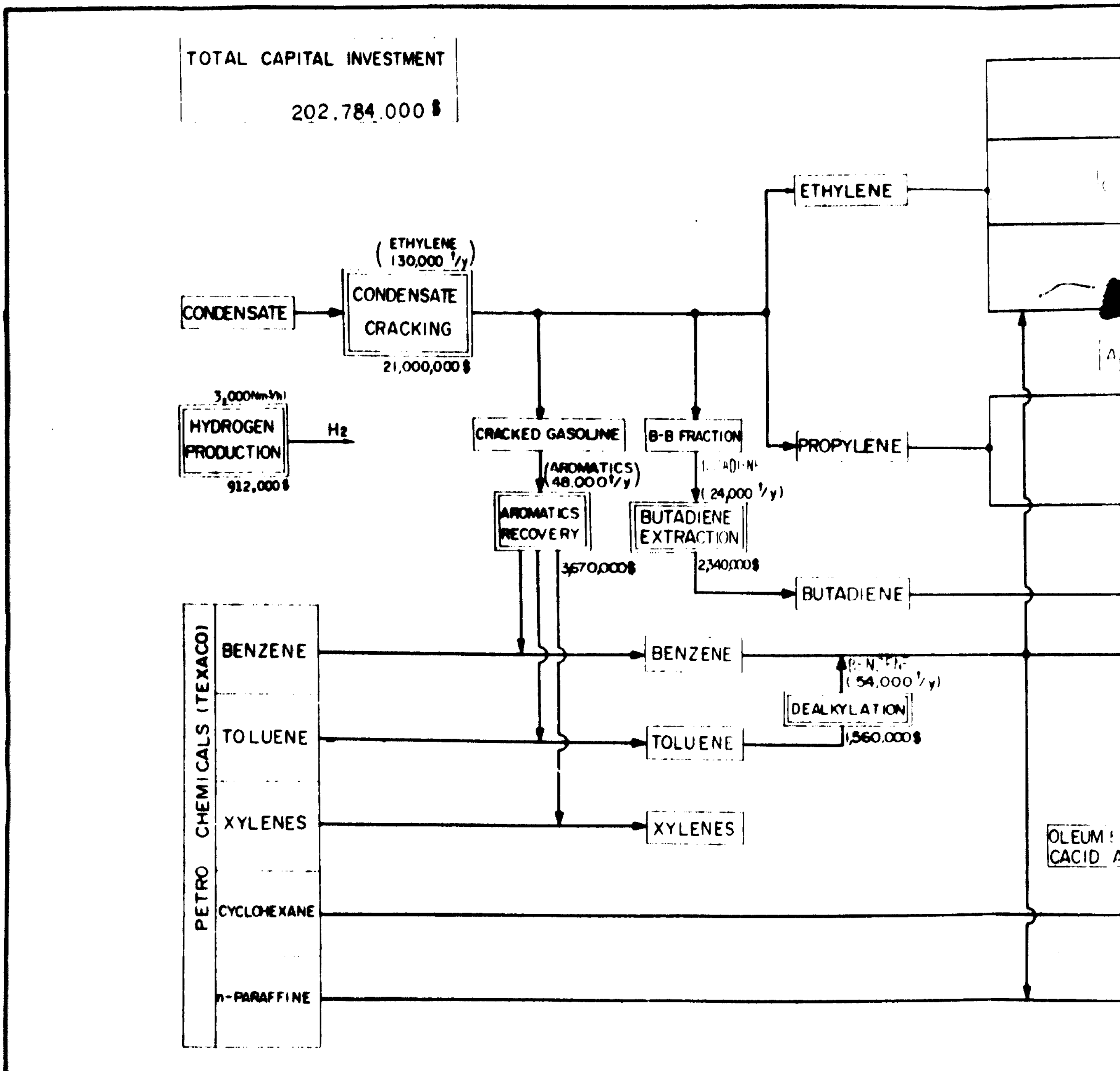
LABOUR

DATE SCALE

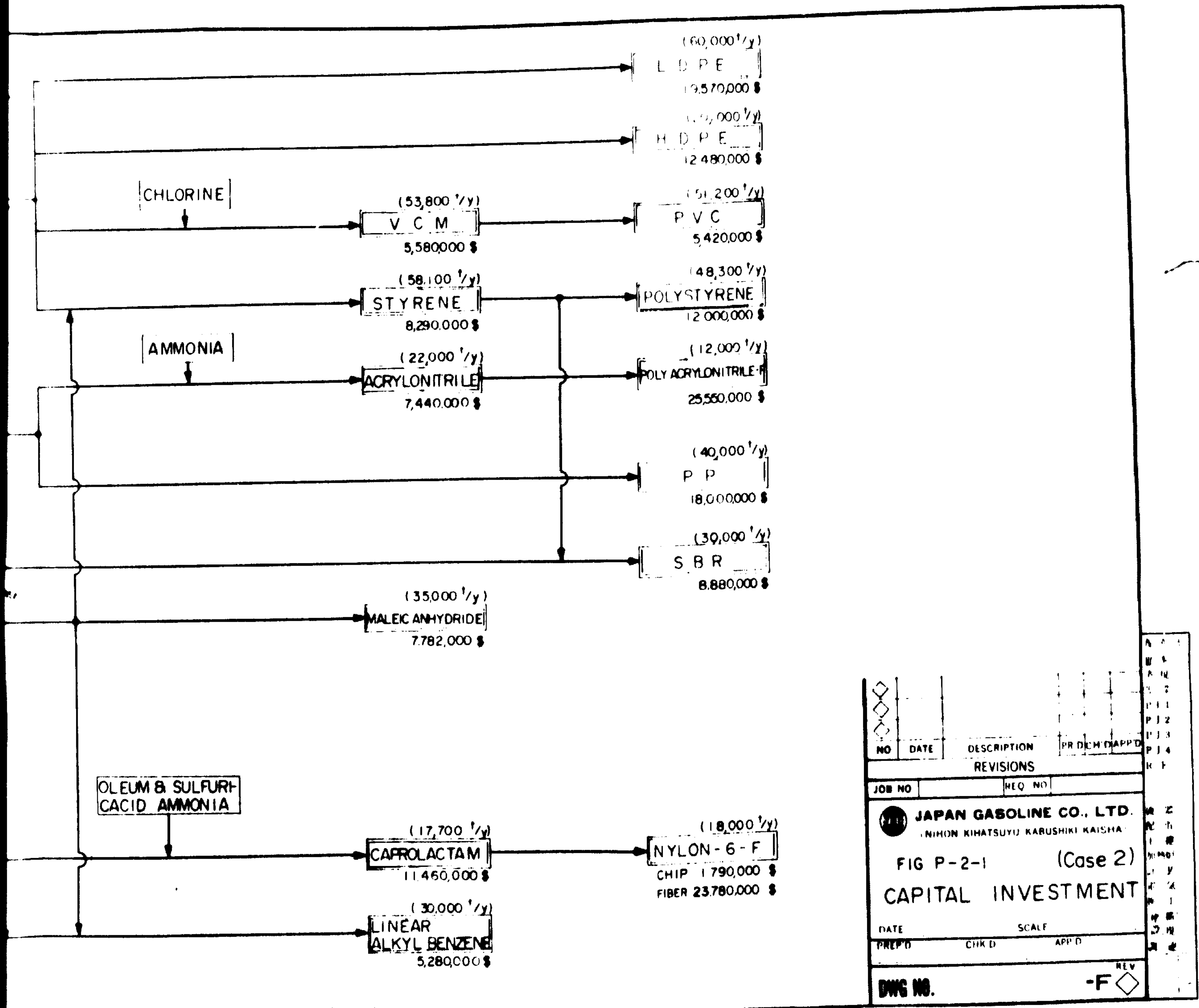
PREP'D CHK'D APP'D

DWG NO. -F

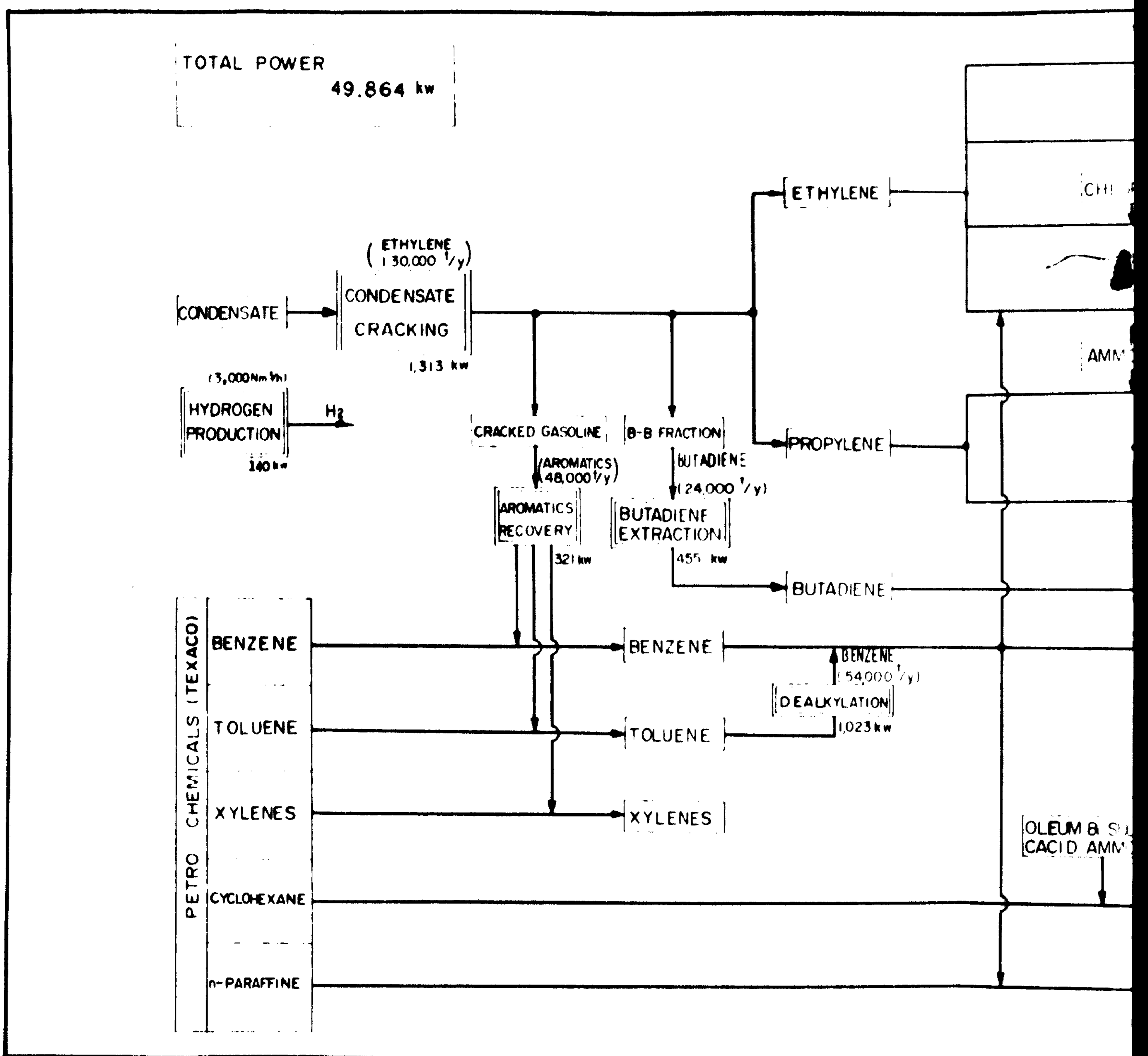
SECTION 2


TOTAL CAPITAL INVESTMENT
202,784,000 $
ETHYLENE
130,000 t/y
CONDENSATE
CONDENSATE CRACKING
21,000,000 $
3,000 Nm3/h
HYDROGEN PRODUCTION
H2
912,000 $
ETHYLENE
CRACKED GASOLINE
B-B FRACTION
PROPYLENE
AROMATICS
48,000 t/y
24,000 t/y
AROMATICS RECOVERY
3,670,000 $
BUTADIENE EXTRACTION
2,340,000 $
BUTADIENE
PETRO CHEMICALS (TEXACO)
BENZENE
TOLUENE
XYLENES
CYCLOHEXANE
n-PARAFFINE
BENZENE
54,000 t/y
DEALKYLATION
1,560,000 $
TOLUENE
XYLENES
OLEUM
CACID

SECTION 1

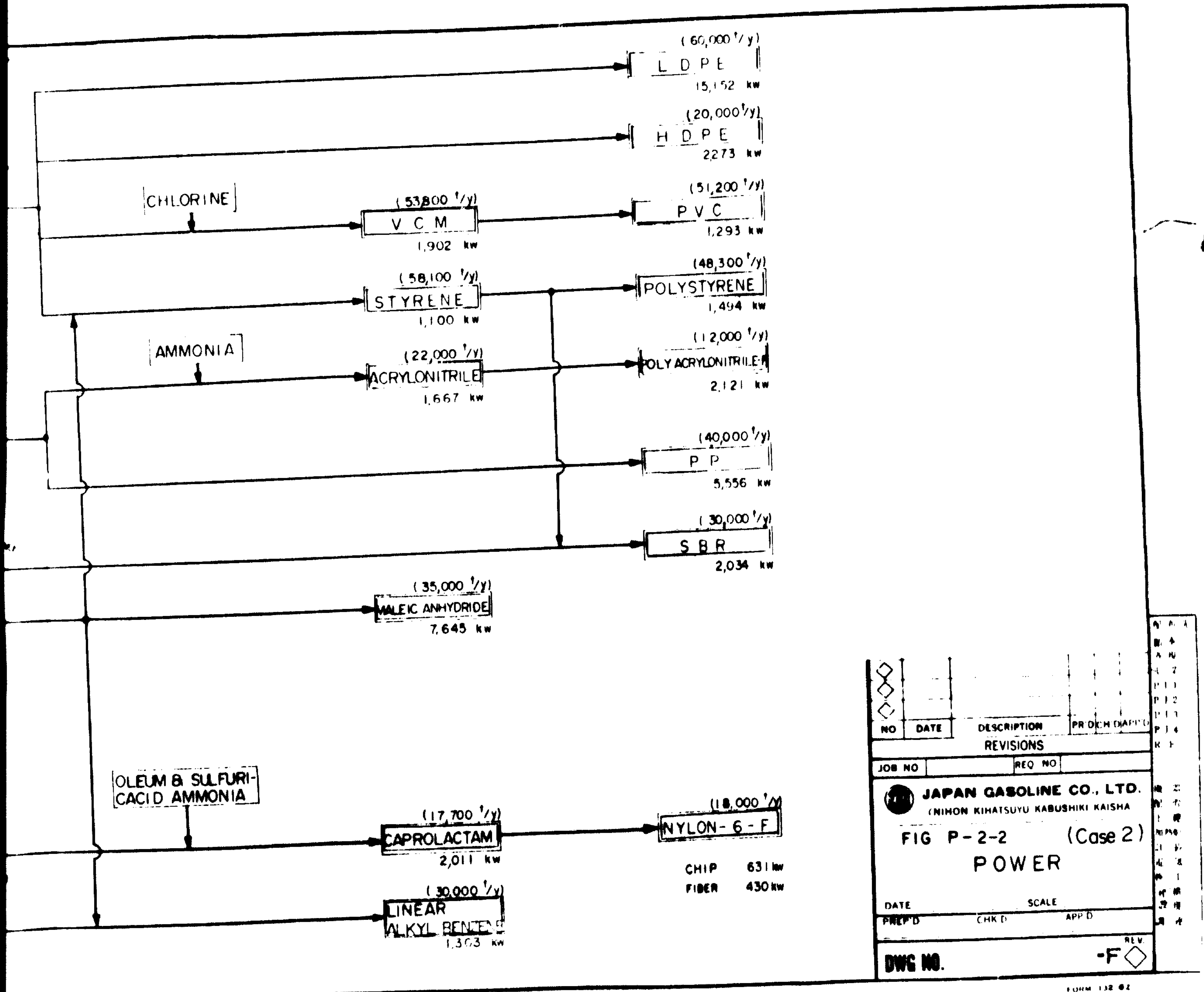

(60,000 t/y)
L D P E
19,570,000 $
H D P E
12,480,000 $
CHLORINE
(53,800 t/y)
V C M
5,580,000 $
(51,200 t/y)
P V C
5,420,000 $
(58,100 t/y)
STYRENE
8,290,000 $
(48,300 t/y)
POLYSTYRENE
12,000,000 $
AMMONIA
(22,000 t/y)
ACRYLONITRILE
7,440,000 $
(12,000 t/y)
POLY ACRYLONITRILE-F
25,550,000 $
(40,000 t/y)
P P
18,000,000 $
(30,000 t/y)
S B R
8,880,000 $
(35,000 t/y)
MALEIC ANHYDRIDE
7,782,000 $
OLEUM & SULFURIC ACID AMMONIA
(17,700 t/y)
CAPROLACTAM
11,460,000 $
(18,000 t/y)
NYLON-6-F
CHIP 1,790,000 $
FIBER 23,780,000 $
(30,000 t/y)
LINEAR ALKYL BENZENE
5,280,000 $
NO
DATE
DESCRIPTION
REVISIONS
JOB NO
REQ NO
JAPAN GASOLINE CO., LTD.
(NIHON KIHATSUYU KABUSHIKI KAISHA)
FIG P-2-1
(Case 2)
CAPITAL INVESTMENT
DATE
SCALE
PREP'D
CHK'D
APP'D
DWG NO.
-F
REV

SECTION 2



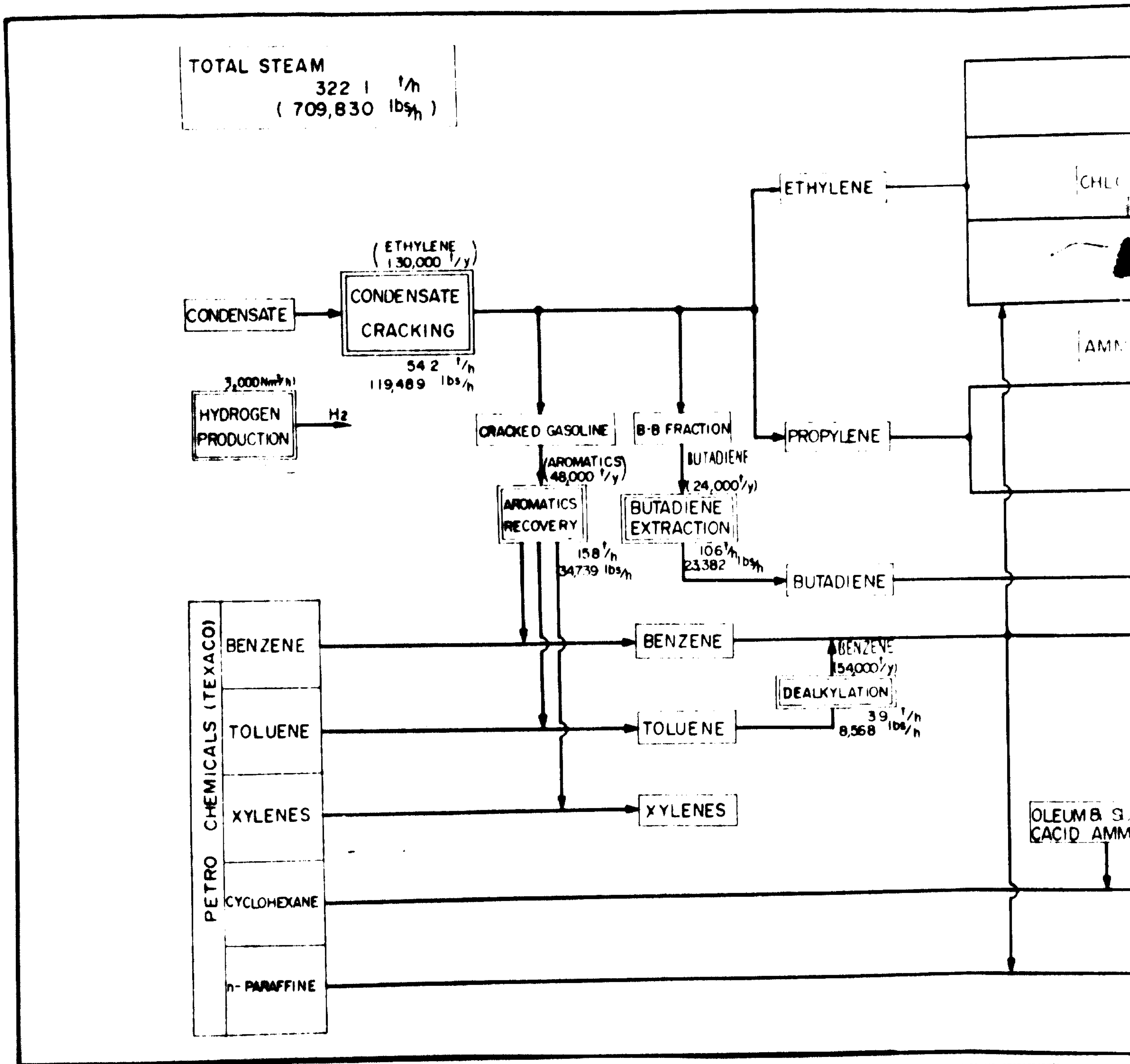
TOTAL POWER 49.864 kw
ETHYLENE 130,000 t/y
CONDENSATE
CONDENSATE CRACKING
1,313 kw
(3,000Nm³/h)
HYDROGEN PRODUCTION
140 kw
H2
ETHYLENE
PROPYLENE
CRACKED GASOLINE
B-B FRACTION
AROMATICS 48,000 t/y
BUTADIENE (24,000 t/y)
AROMATICS RECOVERY
321 kw
BUTADIENE EXTRACTION
455 kw
BUTADIENE
PETRO CHEMICALS (TEXACO)
BENZENE
TOLUENE
XYLENES
CYCLOHEXANE
n-PARAFFINE
BENZENE
BENZENE (54,000 t/y)
DEALKYLATION
1,023 kw
TOLUENE
XYLENES

SECTION 1

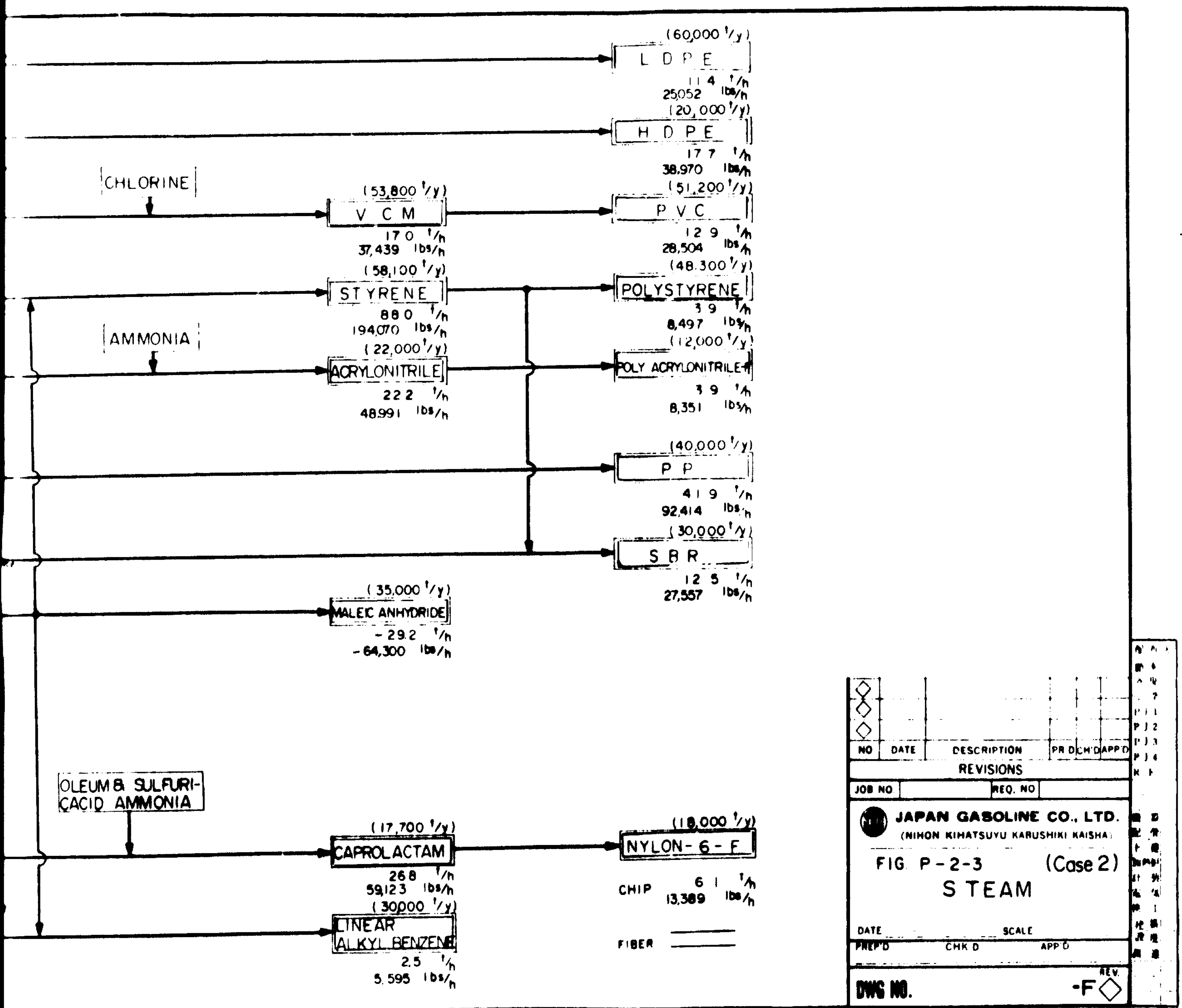


FORM 132 02

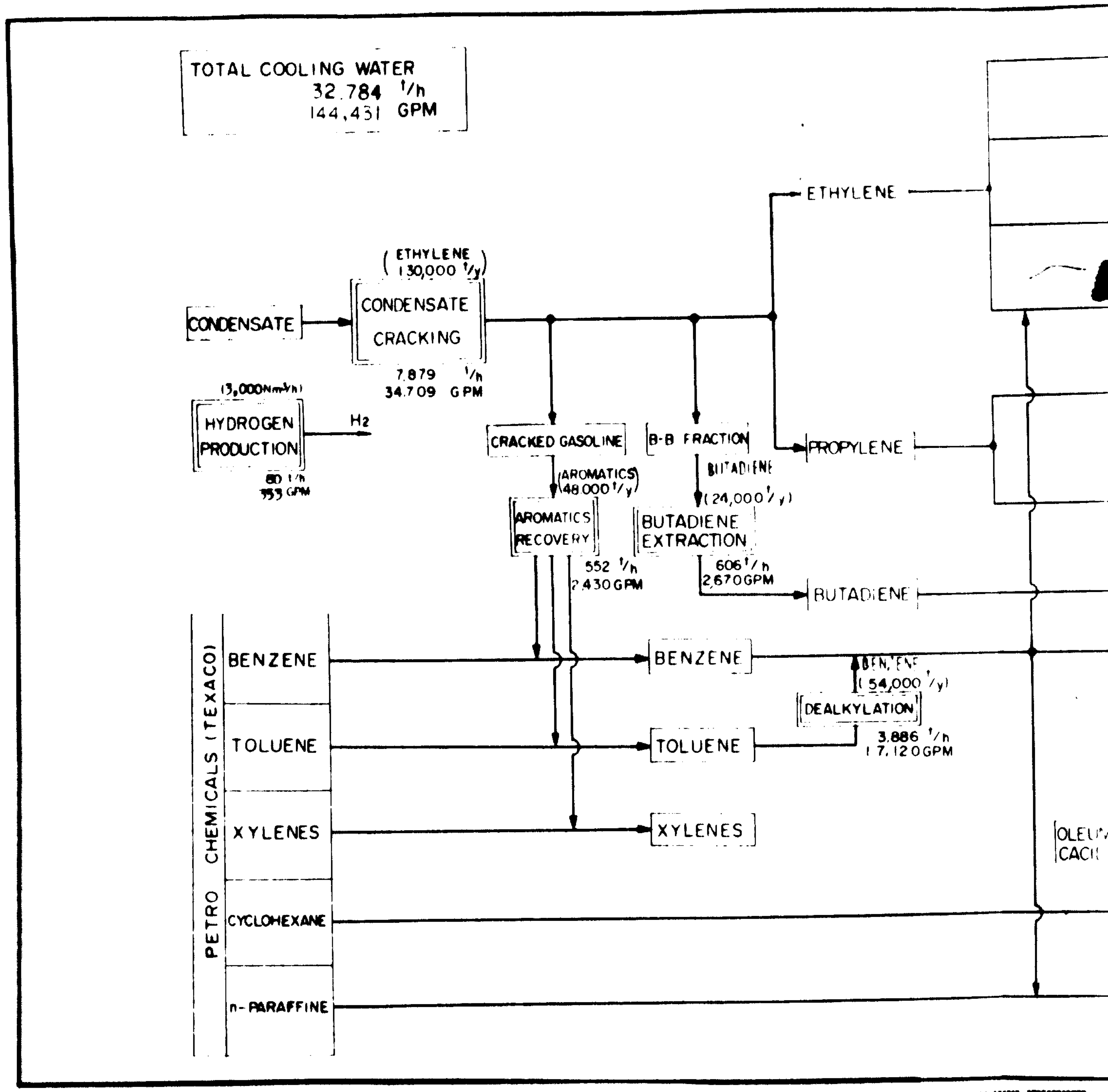
SECTION 2


TOTAL STEAM
322.1 t/h
(709,830 lbs/h)
ETHYLENE
(ETHYLENE 130,000 t/y)
CONDENSATE
CONDENSATE CRACKING
54.2 t/h
119,489 lbs/h
3,000Nm³/h
HYDROGEN PRODUCTION
H2
CRACKED GASOLINE
B-B FRACTION
PROPYLENE
(AROMATICS 48,000 t/y)
BUTADIENE
(24,000 t/y)
AROMATICS RECOVERY
BUTADIENE EXTRACTION
15.8 t/h
34,739 lbs/h
10.6 t/h
23,382 lbs/h
BUTADIENE
PETRO CHEMICALS (TEXACO)
BENZENE
TOLUENE
XYLENES
CYCLOHEXANE
n- PARAFFINE
BENZENE
BENZENE
(54,000 t/y)
DEALKYLATION
3.9 t/h
8,568 lbs/h
TOLUENE
XYLENES
CHL
AMM
OLEUM & S
ACID AMM

SECTION 1

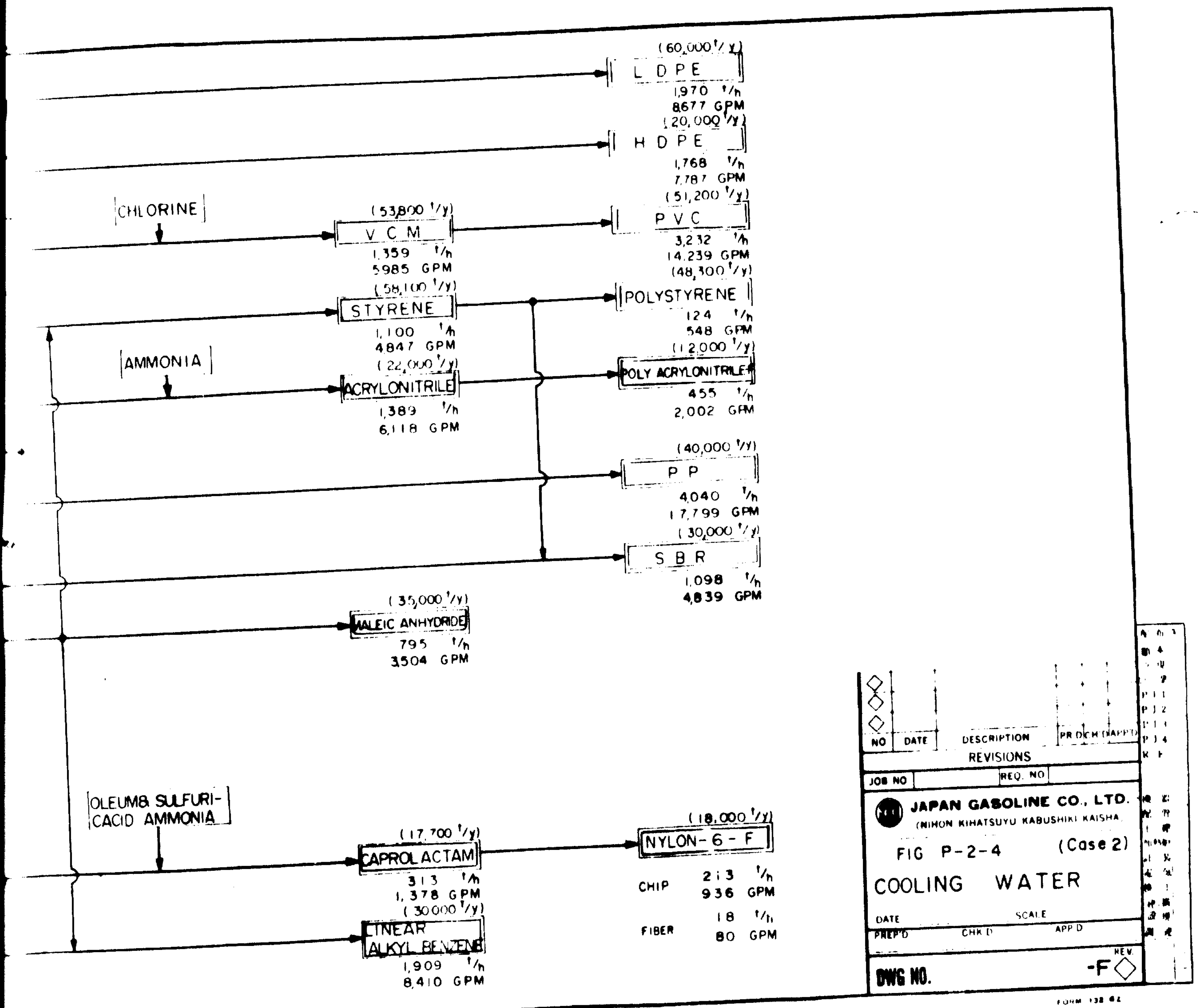

(60,000 t/y)
L D P E
11.4 t/h
25,052 lbs/h
(20,000 t/y)
H D P E
17.7 t/h
38,970 lbs/h
CHLORINE
(53,800 t/y)
V C M
17.0 t/h
37,439 lbs/h
(51,200 t/y)
P V C
12.9 t/h
28,504 lbs/h
(58,100 t/y)
STYRENE
88.0 t/h
194,070 lbs/h
(48,300 t/y)
POLYSTYRENE
3.9 t/h
8,497 lbs/h
AMMONIA
(22,000 t/y)
ACRYLONITRILE
22.2 t/h
48,991 lbs/h
(12,000 t/y)
POLY ACRYLONITRILE-F
3.9 t/h
8,351 lbs/h
(40,000 t/y)
P P
41.9 t/h
92,414 lbs/h
(30,000 t/y)
S B R
12.5 t/h
27,557 lbs/h
(35,000 t/y)
MALEIC ANHYDRIDE
-29.2 t/h
-64,300 lbs/h
OLEUM & SULFURIC ACID AMMONIA
(17,700 t/y)
CAPROLACTAM
26.8 t/h
59,123 lbs/h
(18,000 t/y)
NYLON-6-F
CHIP 6.1 t/h
13,389 lbs/h
FIBER
(30,000 t/y)
LINEAR ALKYL BENZENE
2.5 t/h
5,595 lbs/h
NO DATE DESCRIPTION PR'D CH'D APP'D
REVISIONS
JOB NO REQ. NO
JAPAN GASOLINE CO., LTD.
(NIHON KIHATSUYU KABUSHIKI KAISHA)
FIG. P-2-3 (Case 2)
S TEAM
DATE SCALE
PREP'D CHK'D APP'D
DWG NO. REV. -F

SECTION 2

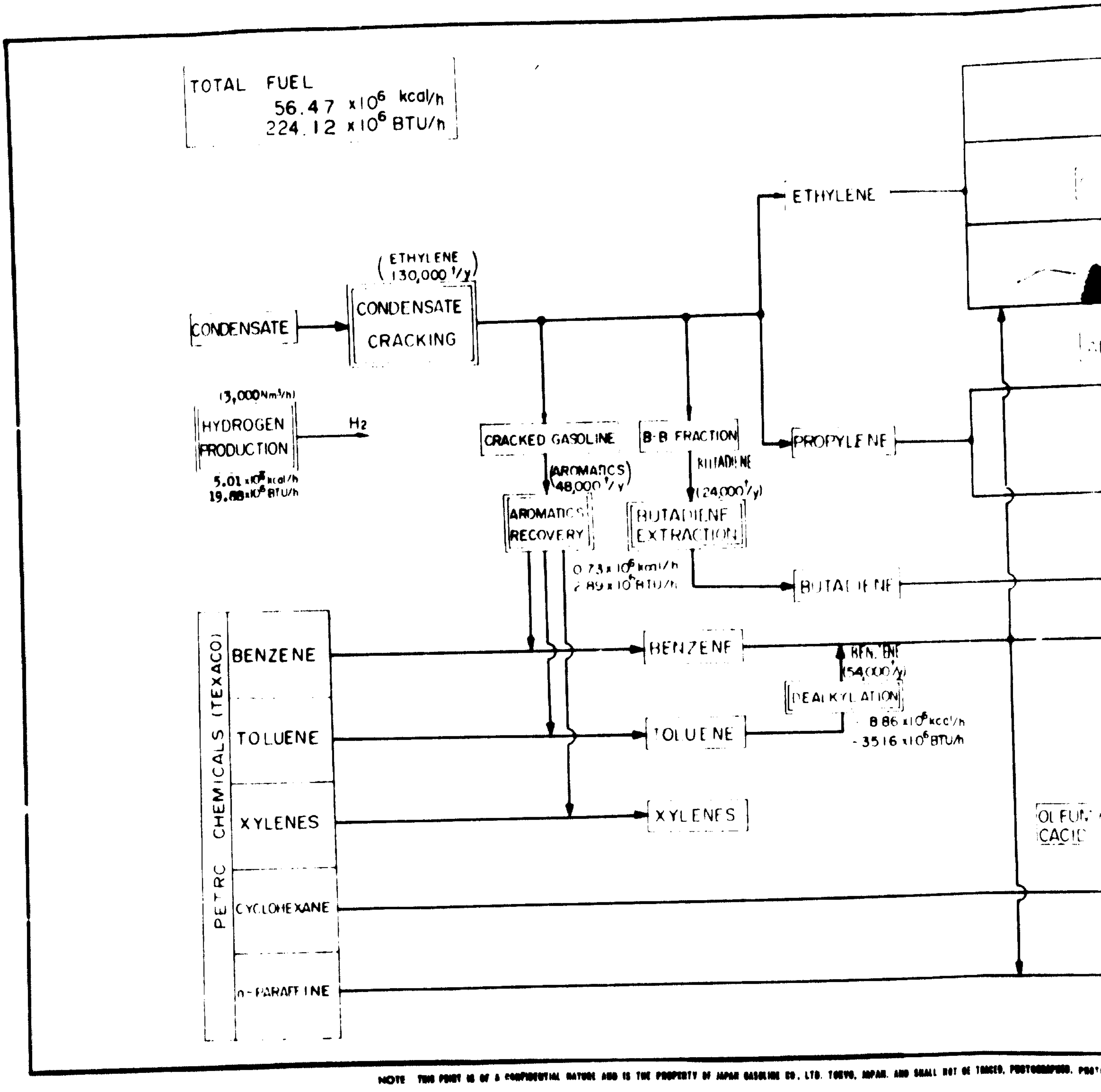


TOTAL COOLING WATER
32.784 t/h
144,431 GPM
ETHYLENE
(ETHYLENE 130,000 t/y)
CONDENSATE
CONDENSATE CRACKING
7.879 t/h
34.709 GPM
(3,000 Nm3/h)
HYDROGEN PRODUCTION
H2
80 t/h
353 GPM
CRACKED GASOLINE
B-B FRACTION
PROPYLENE
(AROMATICS 48,000 t/y)
(24,000 t/y)
AROMATICS RECOVERY
BUTADIENE EXTRACTION
552 t/h
2,430 GPM
606 t/h
2,670 GPM
BUTADIENE
PETRO CHEMICALS (TEXACO)
BENZENE
TOLUENE
XYLENES
CYCLOHEXANE
n-PARAFFINE
(54,000 t/y)
DEALKYLATION
3.886 t/h
17,120 GPM

SECTION 1

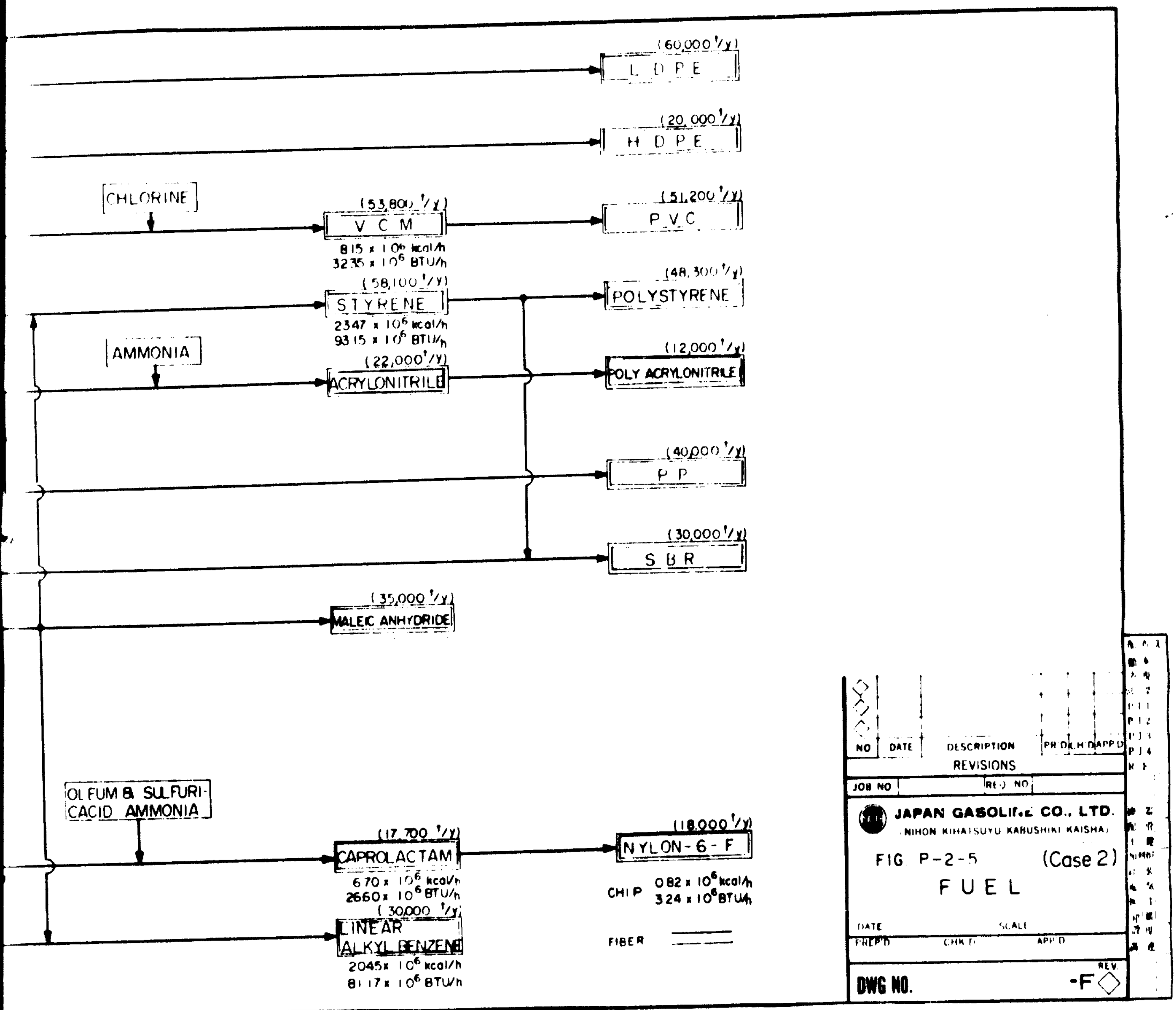

(60,000 t/y)
LDPE
1,970 t/h
8677 GPM
(20,000 t/y)
HDPE
1,768 t/h
7,787 GPM
CHLORINE
(53,800 t/y)
VCM
1,359 t/h
5985 GPM
(51,200 t/y)
PVC
3,232 t/h
14,239 GPM
(48,300 t/y)
(58,100 t/y)
STYRENE
1,100 t/h
4847 GPM
POLYSTYRENE
124 t/h
548 GPM
AMMONIA
(22,000 t/y)
ACRYLONITRILE
1,389 t/h
6,118 GPM
(12,000 t/y)
POLY ACRYLONITRILE
455 t/h
2,002 GPM
(40,000 t/y)
PP
4,040 t/h
17,799 GPM
(30,000 t/y)
SBR
1,098 t/h
4,839 GPM
(35,000 t/y)
MALEIC ANHYDRIDE
795 t/h
3504 GPM
OLEUM& SULFURIC ACID AMMONIA
(17,700 t/y)
CAPROLACTAM
313 t/h
1,378 GPM
(18,000 t/y)
NYLON-6-F
CHIP 213 t/h 936 GPM
FIBER 18 t/h 80 GPM
(30000 t/y)
LINEAR ALKYL BENZENE
1,909 t/h
8,410 GPM
NO
DATE
DESCRIPTION
PR'D CH'D APP'D
REVISIONS
JOB NO
REQ. NO
JAPAN GASOLINE CO., LTD.
(NIHON KIHATSUYU KABUSHIKI KAISHA)
FIG P-2-4 (Case 2)
COOLING WATER
DATE
SCALE
PREP'D
CHK'D
APP'D
DWG NO.
-F
REV.

SECTION 2



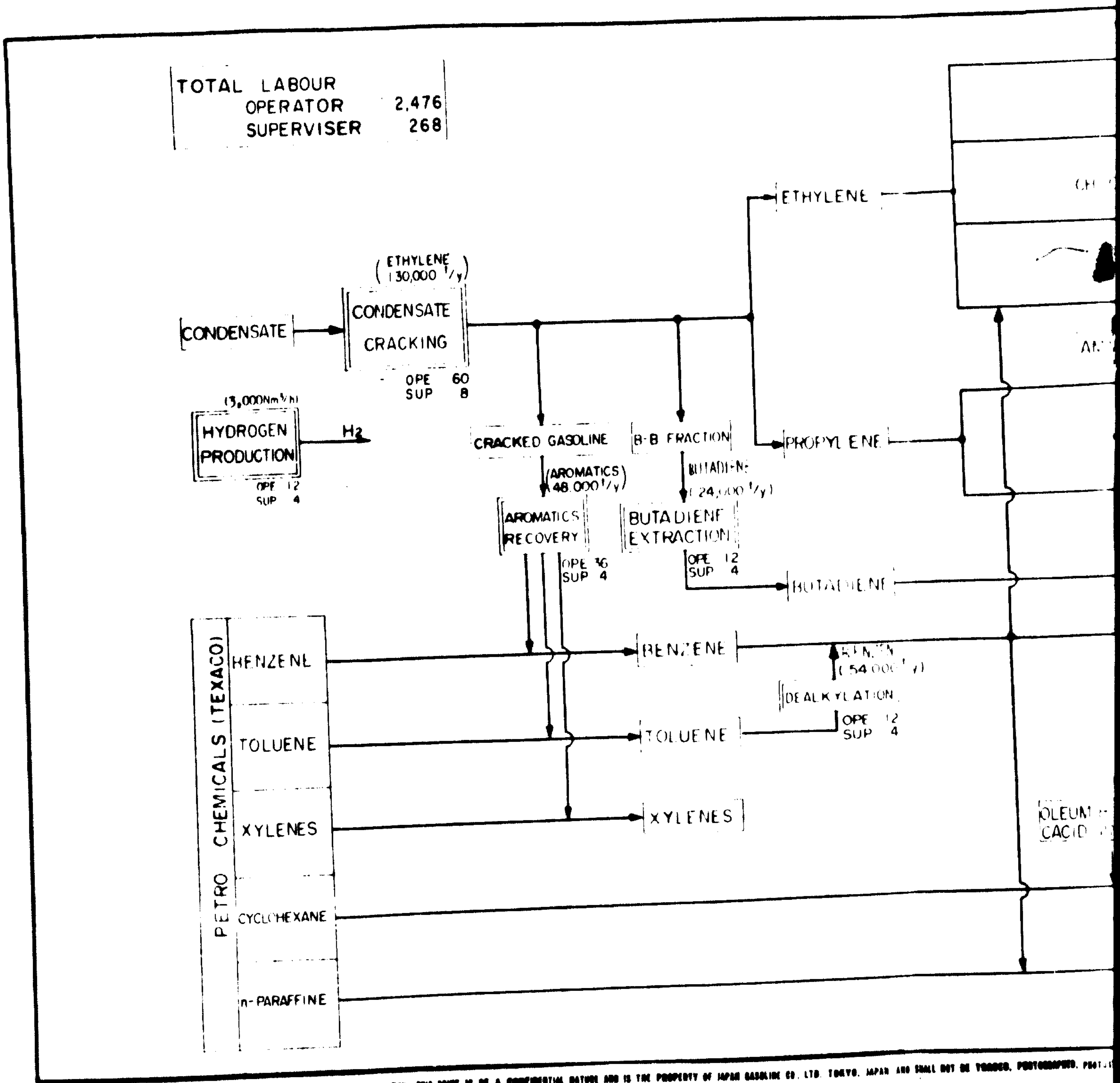
TOTAL FUEL
56.47 x10^6 kcal/h
224.12 x10^6 BTU/h
ETHYLENE
130,000 t/y
CONDENSATE
CONDENSATE CRACKING
ETHYLENE
(3,000 Nm³/h)
HYDROGEN PRODUCTION
H2
5.01 x10^6 kcal/h
CRACKED GASOLINE
B-B FRACTION
PROPYLENE
AROMATICS 48,000 t/y
BUTADIENE (24,000 t/y)
AROMATICS RECOVERY
BUTADIENE EXTRACTION
BUTADIENE
PETRO CHEMICALS (TEXACO)
BENZENE
TOLUENE
XYLENES
CYCLOHEXANE
n-PARAFFINE
BENZENE
TOLUENE
XYLENES
DEALKYLATION

SECTION 1



(60,000 t/y)
L D P E
(20,000 t/y)
H D P E
CHLORINE
(53,800 t/y)
V C M
815 x 10^6 kcal/h
3235 x 10^6 BTU/h
(51,200 t/y)
P V C
(58,100 t/y)
STYRENE
2347 x 10^6 kcal/h
9315 x 10^6 BTU/h
(48,300 t/y)
POLYSTYRENE
AMMONIA
(22,000 t/y)
ACRYLONITRILE
(12,000 t/y)
POLY ACRYLONITRILE
(40,000 t/y)
P P
(30,000 t/y)
S B R
(35,000 t/y)
MALEIC ANHYDRIDE
OLFUM & SULFURIC ACID AMMONIA
(17,700 t/y)
CAPROLACTAM
670 x 10^6 kcal/h
2660 x 10^6 BTU/h
(18,000 t/y)
NYLON-6-F
CHIP 0.82 x 10^6 kcal/h
3.24 x 10^6 BTU/h
FIBER
(30,000 t/y)
LINEAR ALKYL BENZENE
2045 x 10^6 kcal/h
8117 x 10^6 BTU/h
NO DATE DESCRIPTION PR'D CK'D APP'D
REVISIONS
JOB NO
REQ NO
JAPAN GASOLINE CO., LTD.
(NIHON KIHATSUYU KABUSHIKI KAISHA)
FIG. P-2-5 (Case 2)
FUEL
DATE SCALE
PREP'D CHK'D APP'D
DWG NO.
REV
-F

SECTION 2



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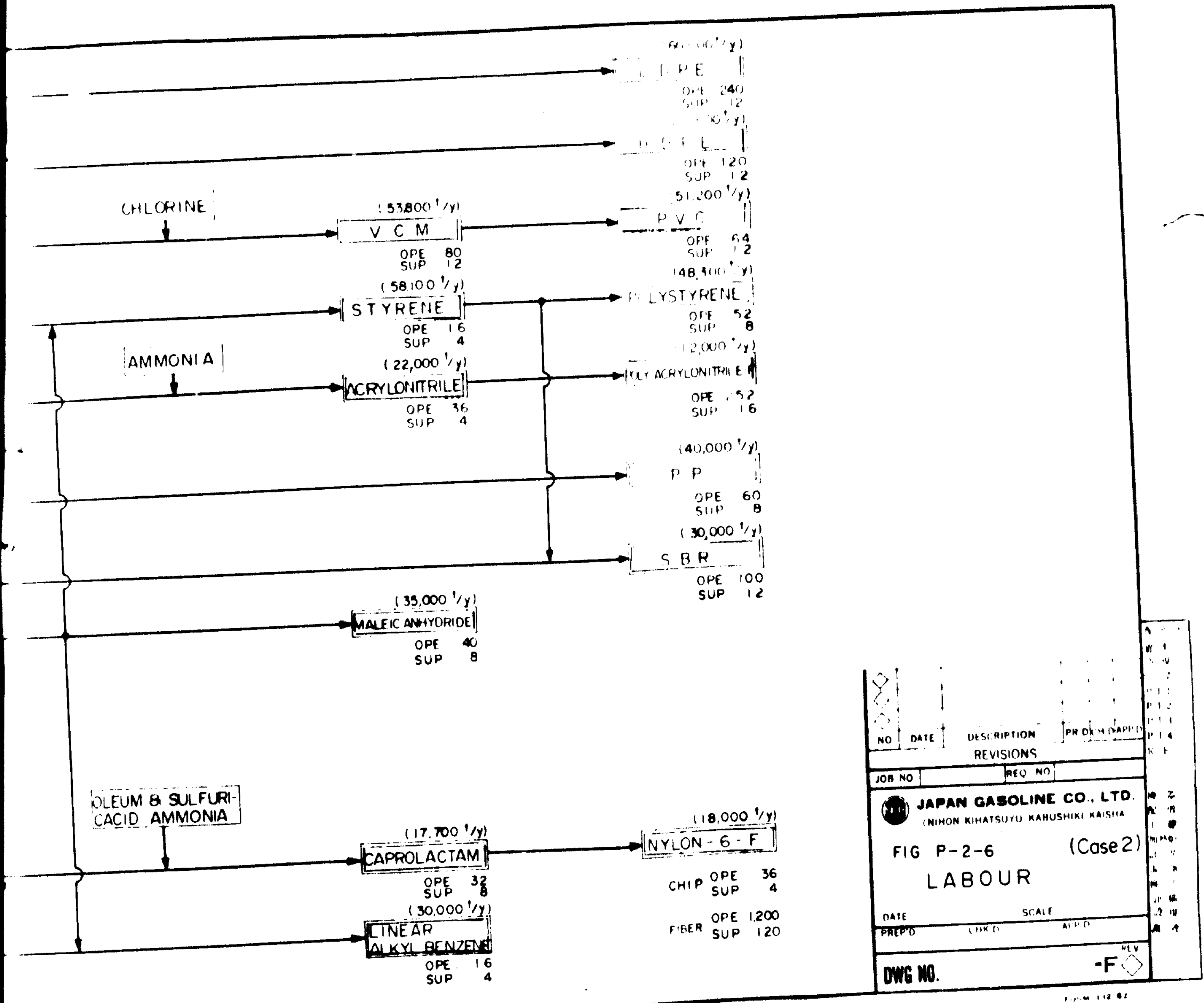
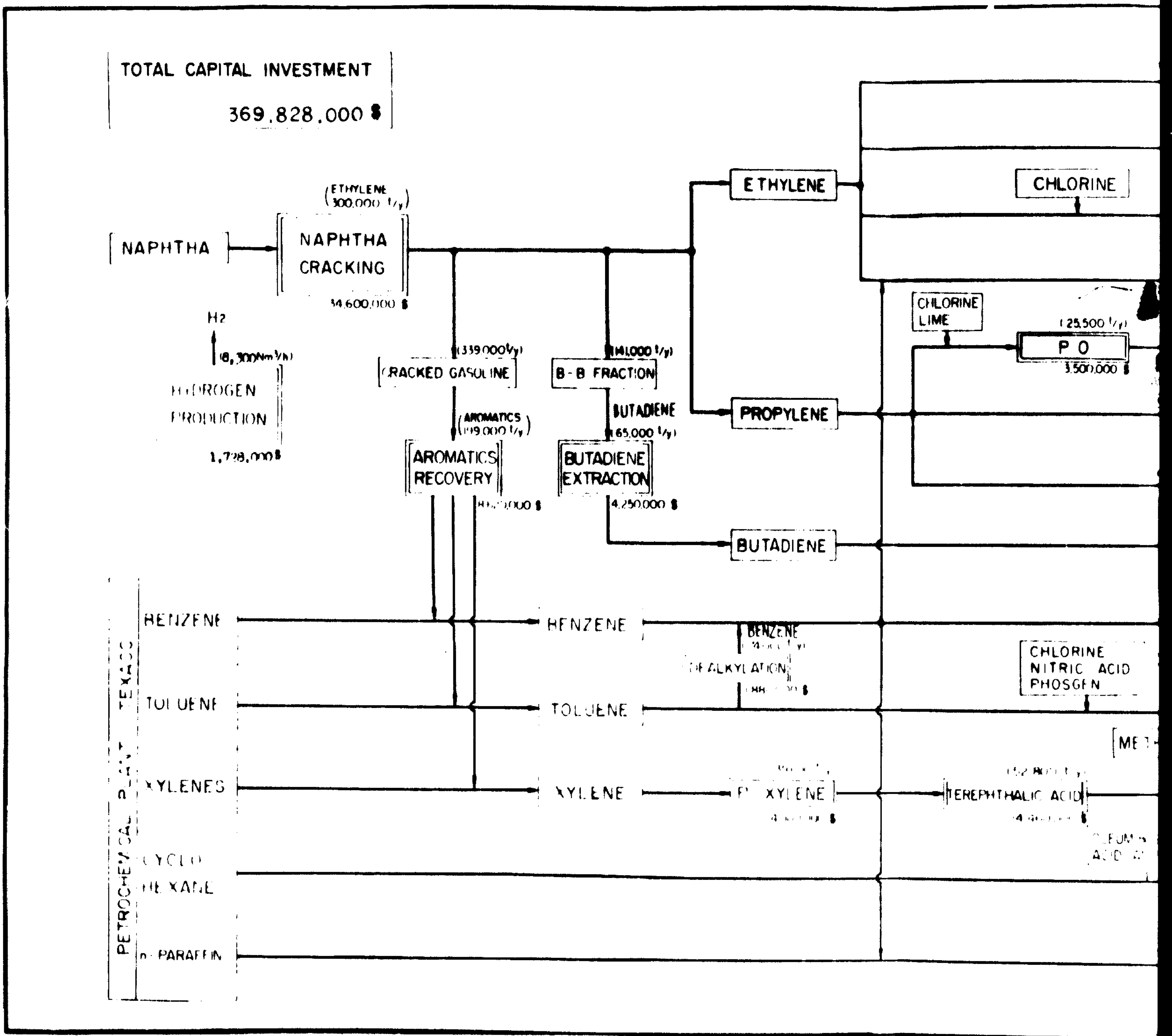
SECTION 1



OPE 240
OPE 120
SUP 12
CHLORINE
(53,800 t/y)
V C M
OPE 80
SUP 12
(51,200 t/y)
P V C
OPE 64
SUP 12
(58,100 t/y)
STYRENE
OPE 16
SUP 4
(48,300 t/y)
POLYSTYRENE
OPE 52
SUP 8
AMMONIA
(22,000 t/y)
ACRYLONITRILE
OPE 36
SUP 4
POLY ACRYLONITRILE
OPE 52
SUP 16
(40,000 t/y)
P P
OPE 60
SUP 8
(30,000 t/y)
S B R
OPE 100
SUP 12
(35,000 t/y)
MALEIC ANHYDRIDE
OPE 40
SUP 8
OLEUM & SULFURIC ACID AMMONIA
(17,700 t/y)
CAPROLACTAM
OPE 32
SUP 8
(18,000 t/y)
NYLON-6-F
CHIP OPE 36
SUP 4
FIBER OPE 1,200
SUP 120
(30,000 t/y)
LINEAR ALKYL BENZENE
OPE 16
SUP 4
NO
DATE
DESCRIPTION
PR'D
CH'K'D
APP'D
REVISIONS
JOB NO
REQ NO
JAPAN GASOLINE CO., LTD.
(NIHON KIHATSUYU KABUSHIKI KAISHA)
FIG P-2-6
(Case 2)
LABOUR
DATE
SCALE
PREP'D
CHK'D
APP'D
DWG NO.
-F
REV

SECTION 2



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SECTION 1

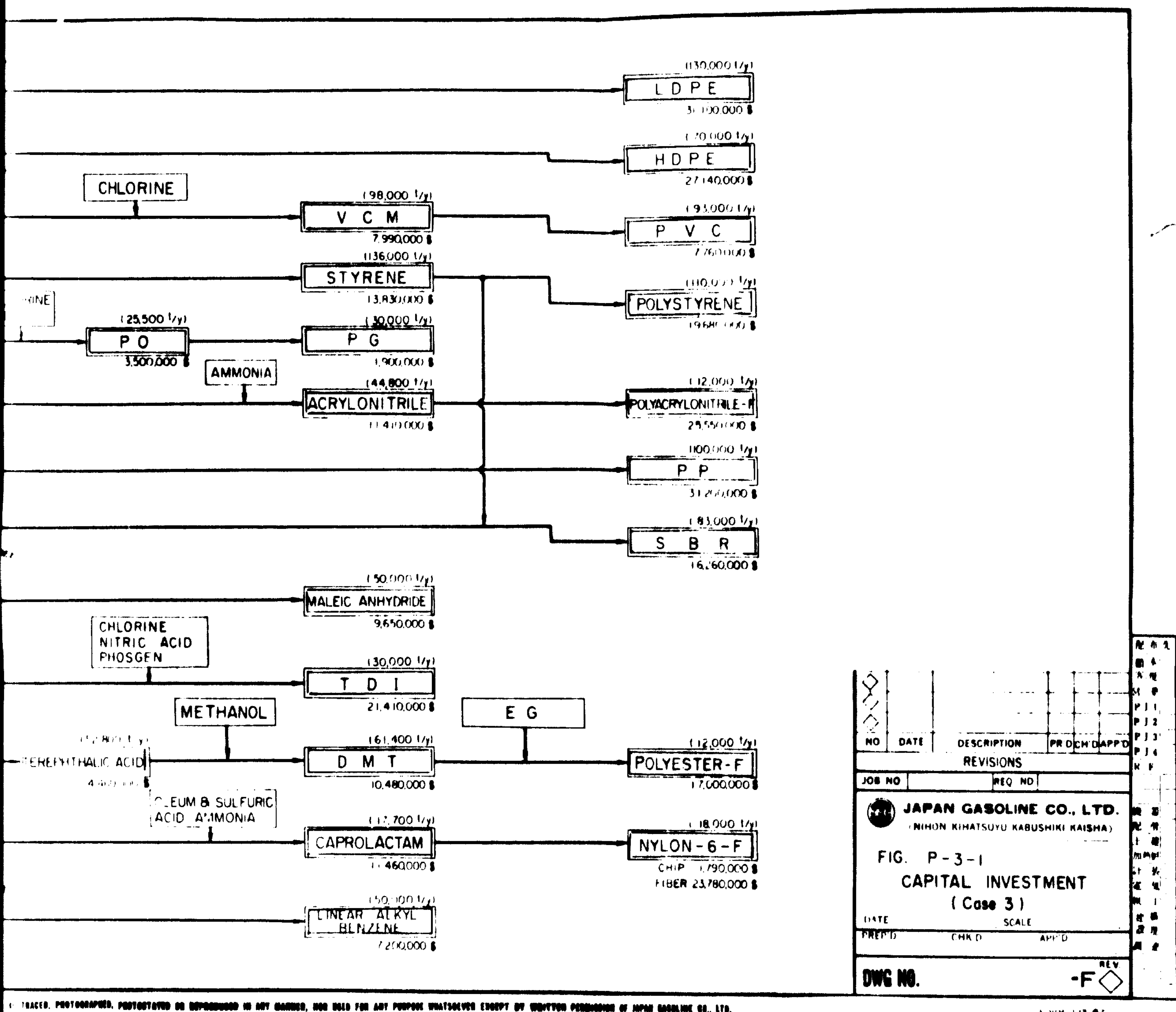
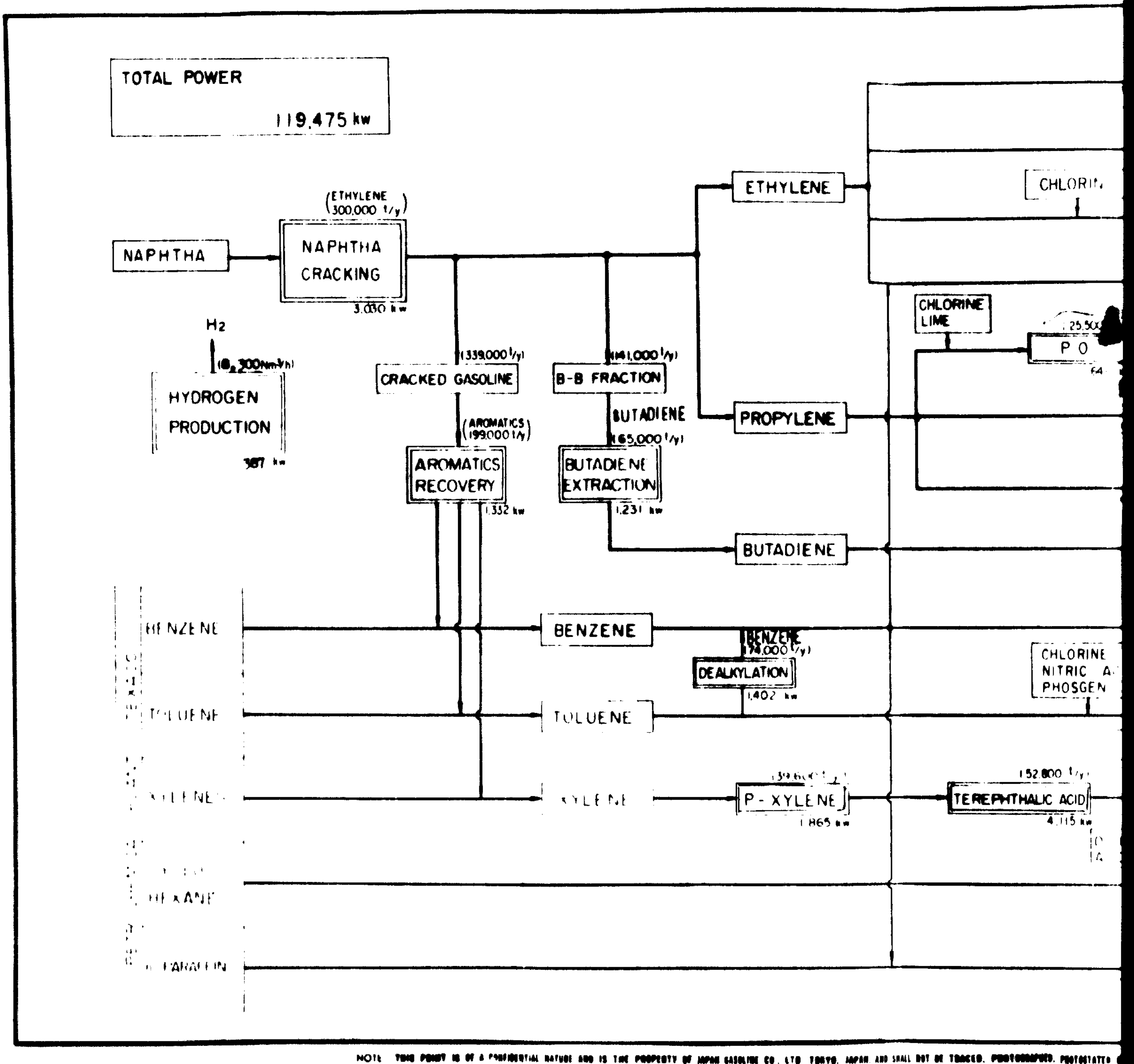
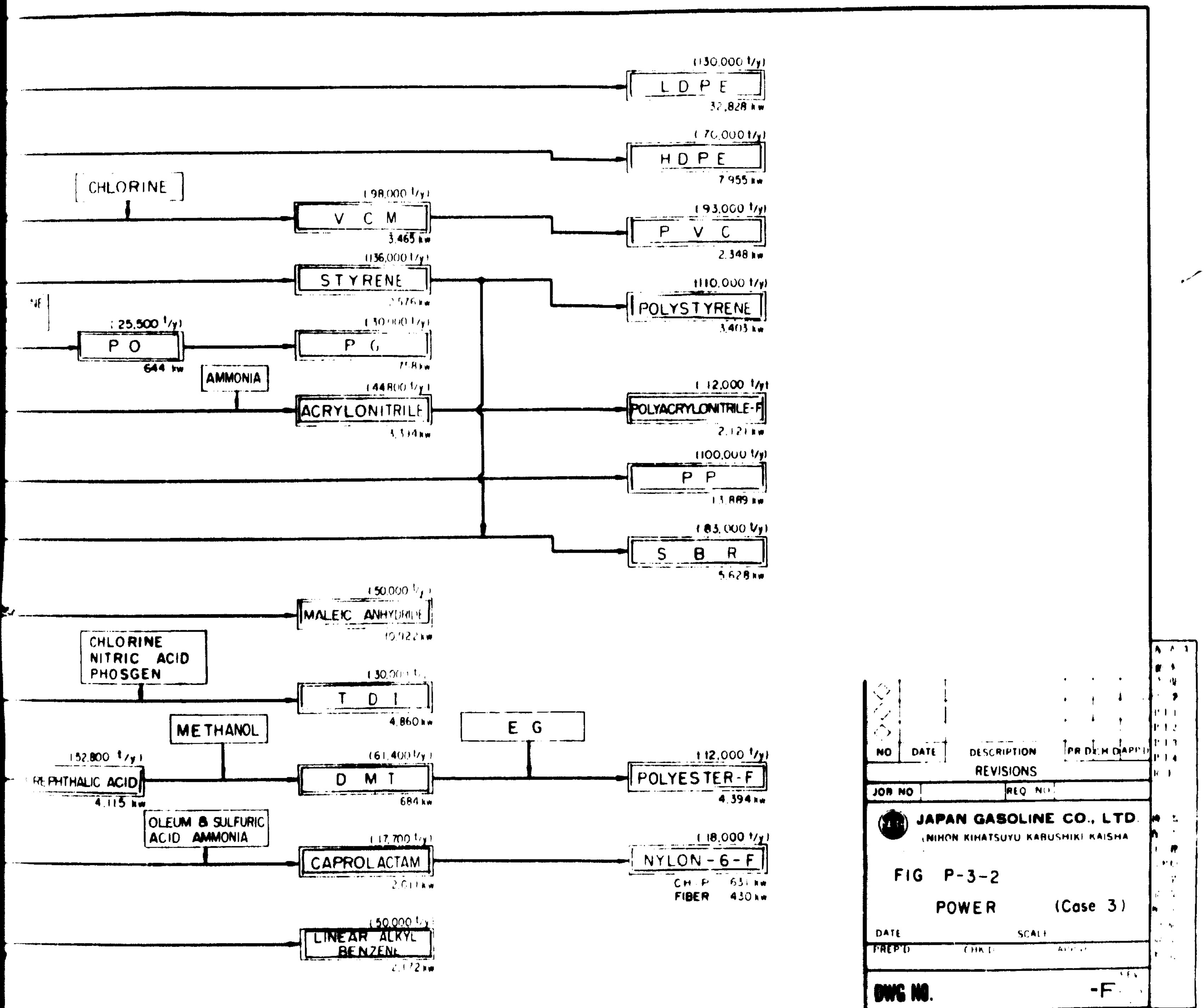


FIG. P-3-1 CAPITAL INVESTMENT (Case 3)

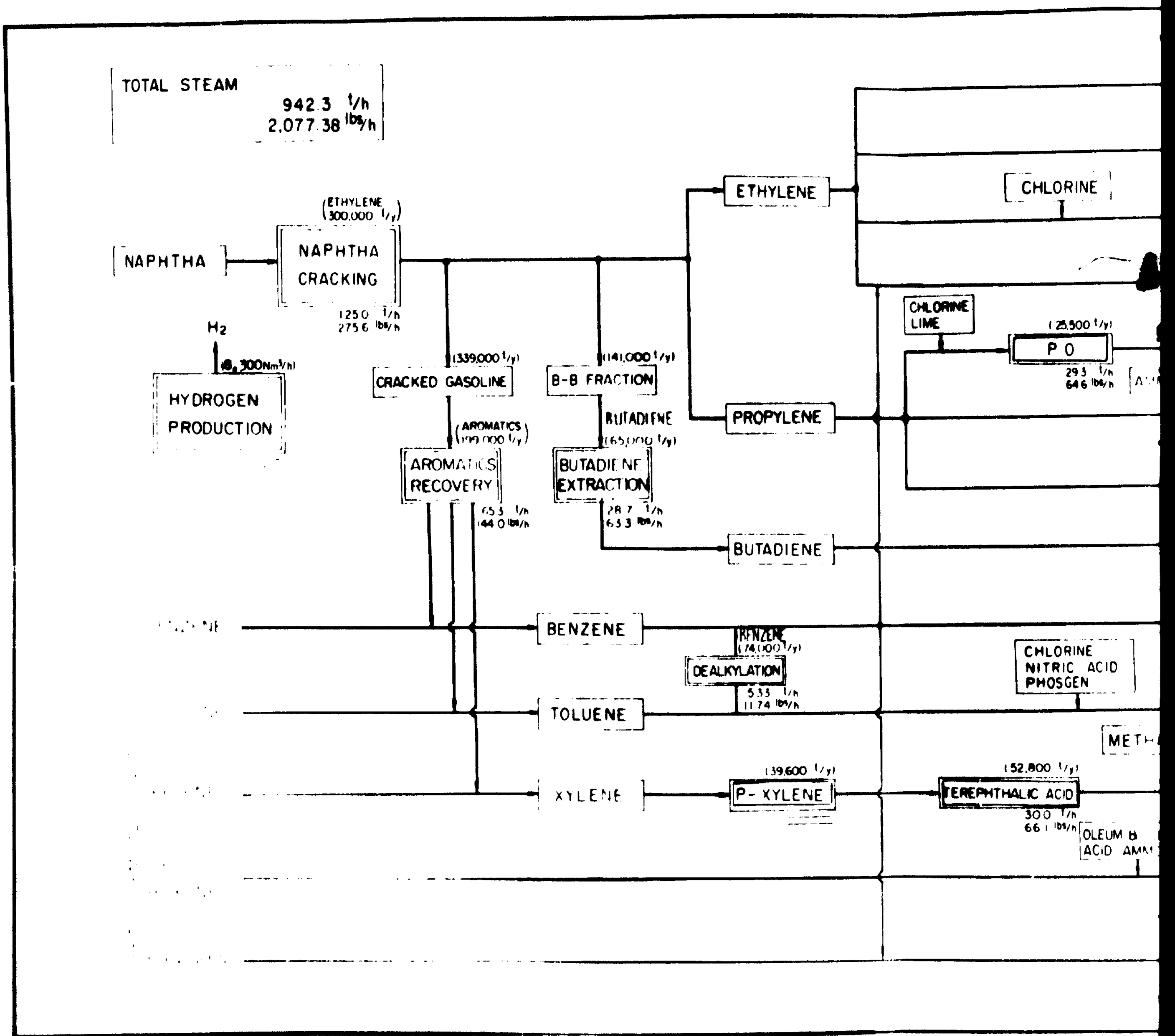
SECTION 2


TOTAL POWER
119,475 kw
NAPHTHA
(ETHYLENE 300,000 t/y)
NAPHTHA CRACKING
3,030 kw
H2
HYDROGEN PRODUCTION
CRACKED GASOLINE
(AROMATICS 199,000 t/y)
AROMATICS RECOVERY
1,332 kw
B-B FRACTION
BUTADIENE
BUTADIENE EXTRACTION
1,231 kw
ETHYLENE
PROPYLENE
BUTADIENE
BENZENE
DEALKYLATION
1,402 kw
TOLUENE
XYLENE
P-XYLENE
1,865 kw
TEREPHTHALIC ACID
4,115 kw
CHLORINE LIME
CHLORINE
NITRIC
PHOSGEN
HEXANE
PARAFFIN

SECTION 1


(130,000 t/y)
L D P E
32,828 kw
(70,000 t/y)
H D P E
7,955 kw
CHLORINE
(98,000 t/y)
V C M
3,465 kw
(93,000 t/y)
P V C
2,348 kw
(136,000 t/y)
STYRENE
(110,000 t/y)
POLYSTYRENE
3,403 kw
(25,500 t/y)
P O
644 kw
P G
AMMONIA
ACRYLONITRILE
(12,000 t/y)
POLYACRYLONITRILE-F
(100,000 t/y)
P P
(83,000 t/y)
S B R
5,628 kw
(50,000 t/y)
MALEIC ANHYDRIDE
CHLORINE
NITRIC ACID
PHOSGEN
T D I
4,860 kw
METHANOL
E G
(52,800 t/y)
TEREPHTHALIC ACID
4,115 kw
(61,400 t/y)
D M T
684 kw
(12,000 t/y)
POLYESTER-F
4,394 kw
OLEUM & SULFURIC ACID AMMONIA
(17,700 t/y)
CAPROLACTAM
(18,000 t/y)
NYLON-6-F
FIBER 430 kw
(50,000 t/y)
LINEAR ALKYL BENZENE
NO
DATE
DESCRIPTION
REVISIONS
JOB NO
REQ NO
JAPAN GASOLINE CO., LTD.
(NIHON KIHATSUYU KABUSHIKI KAISHA
FIG P-3-2
POWER (Case 3)
DATE
SCALE
DWG NO.
-F

SECTION 2



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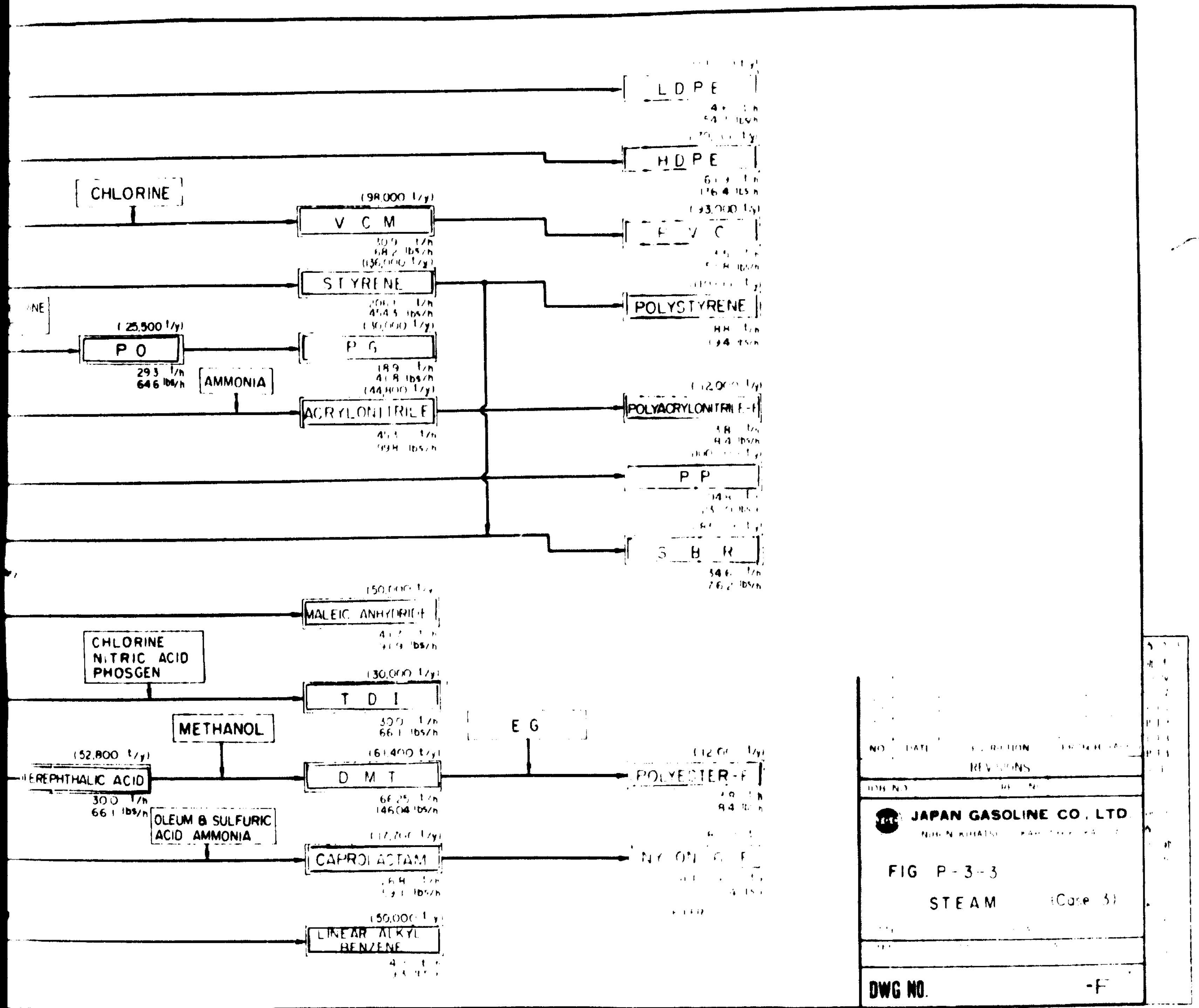
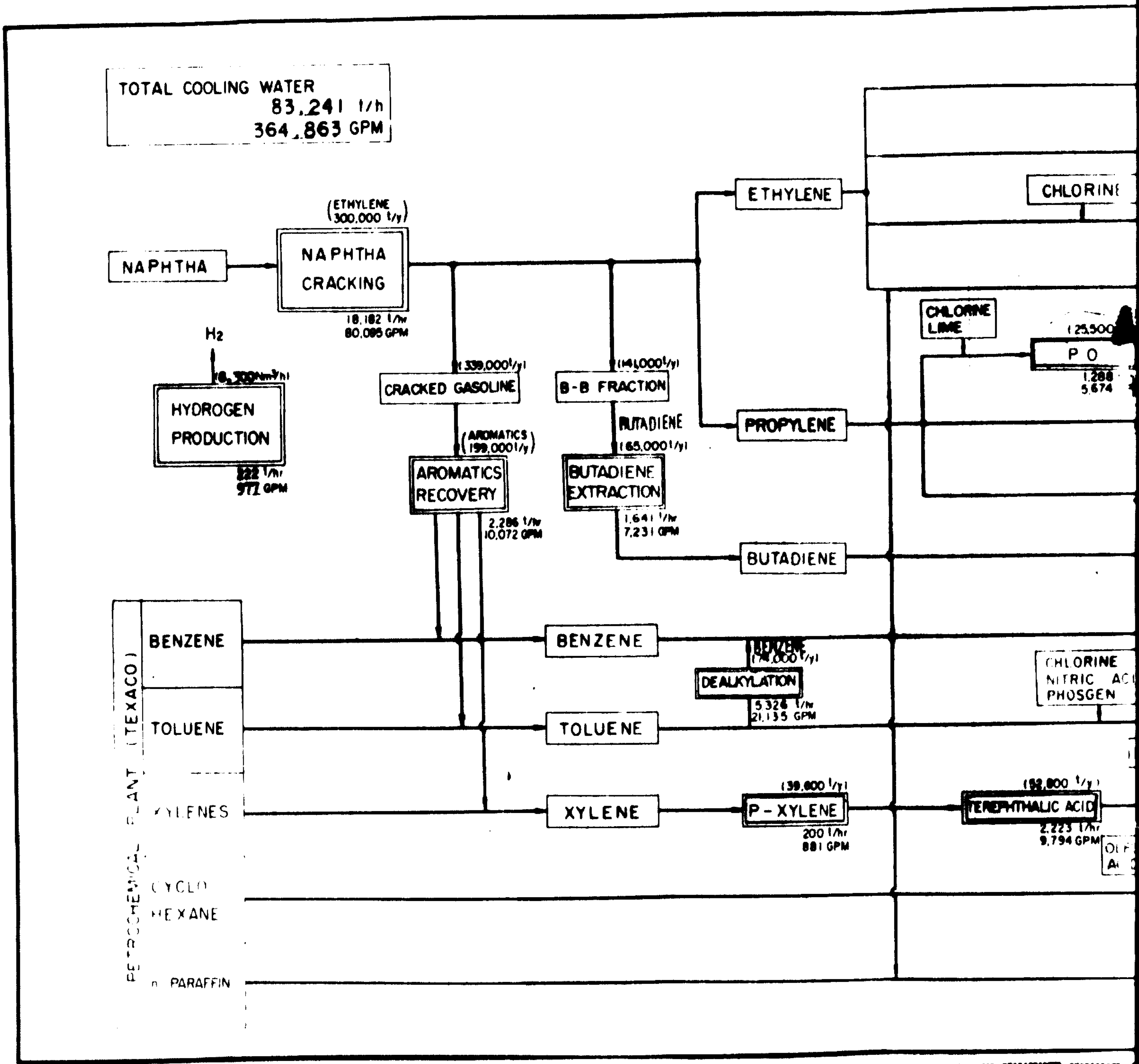
SECTION 1



LDPE
HDPE
CHLORINE
(98,000 t/y)
V C M
30.9 t/h
68.2 lbs/h
(136,000 t/y)
P V C
STYRENE
POLYSTYRENE
(25,500 t/y)
P O
29.3 t/h
64.6 lbs/h
(130,000 t/y)
P G
18.9 t/h
41.8 lbs/h
AMMONIA
(44,800 t/y)
ACRYLONITRILE
POLYACRYLONITRILE-F
P P
S B R
(50,000 t/y)
MALEIC ANHYDRIDE
CHLORINE
NITRIC ACID
PHOSGEN
(30,000 t/y)
T D I
30.0 t/h
66.1 lbs/h
METHANOL
E G
(52,800 t/y)
TEREPHTHALIC ACID
30.0 t/h
66.1 lbs/h
(61,400 t/y)
D M T
66.25 t/h
146.04 lbs/h
POLYESTER-F
OLEUM & SULFURIC ACID AMMONIA
CAPROLACTAM
(50,000 t/y)
LINEAR ALKYL BENZENE
NO. DATE REVISIONS
JAPAN GASOLINE CO., LTD
FIG P-3-3
STEAM (Case 3)
DWG NO.

SECTION 2



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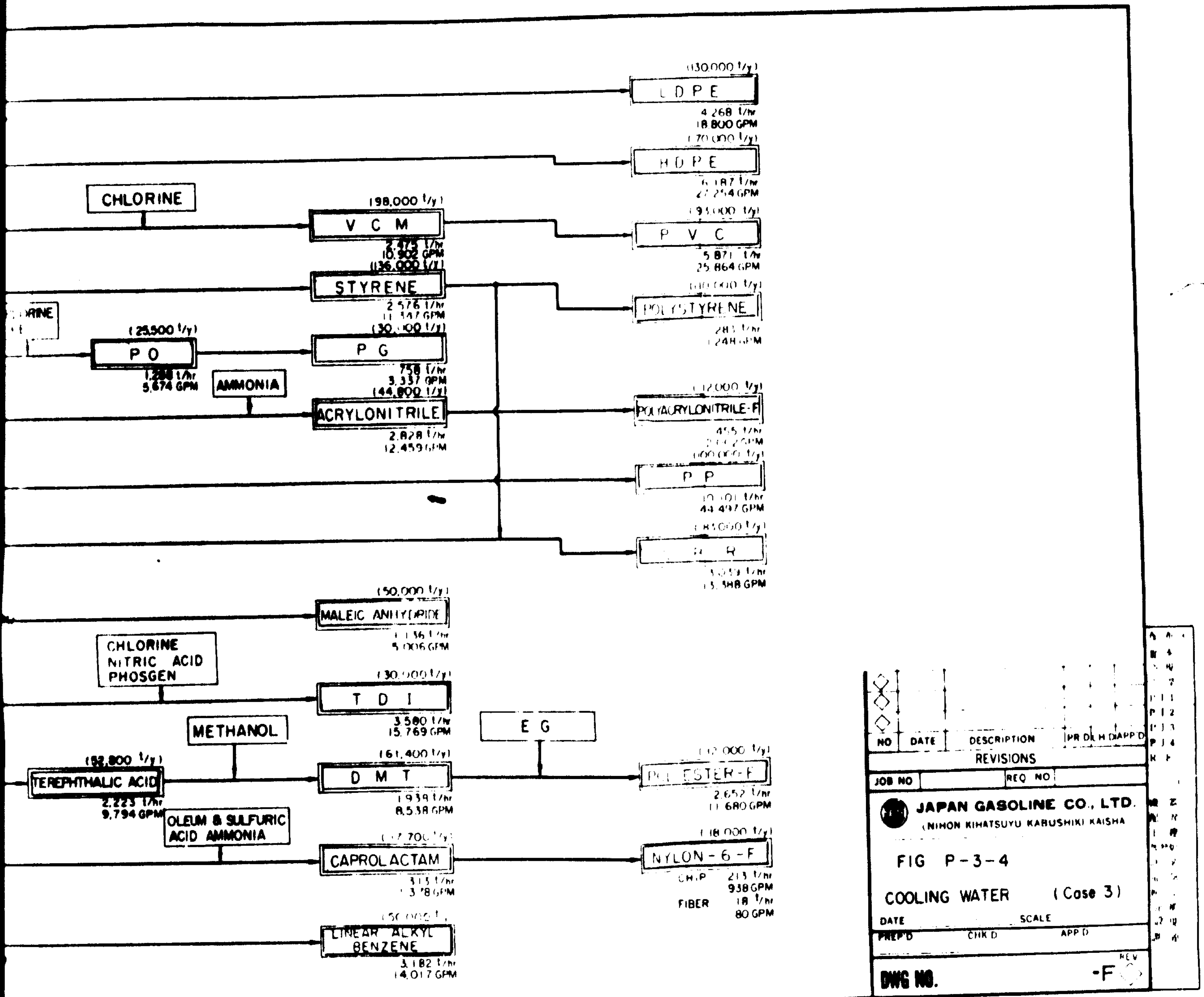
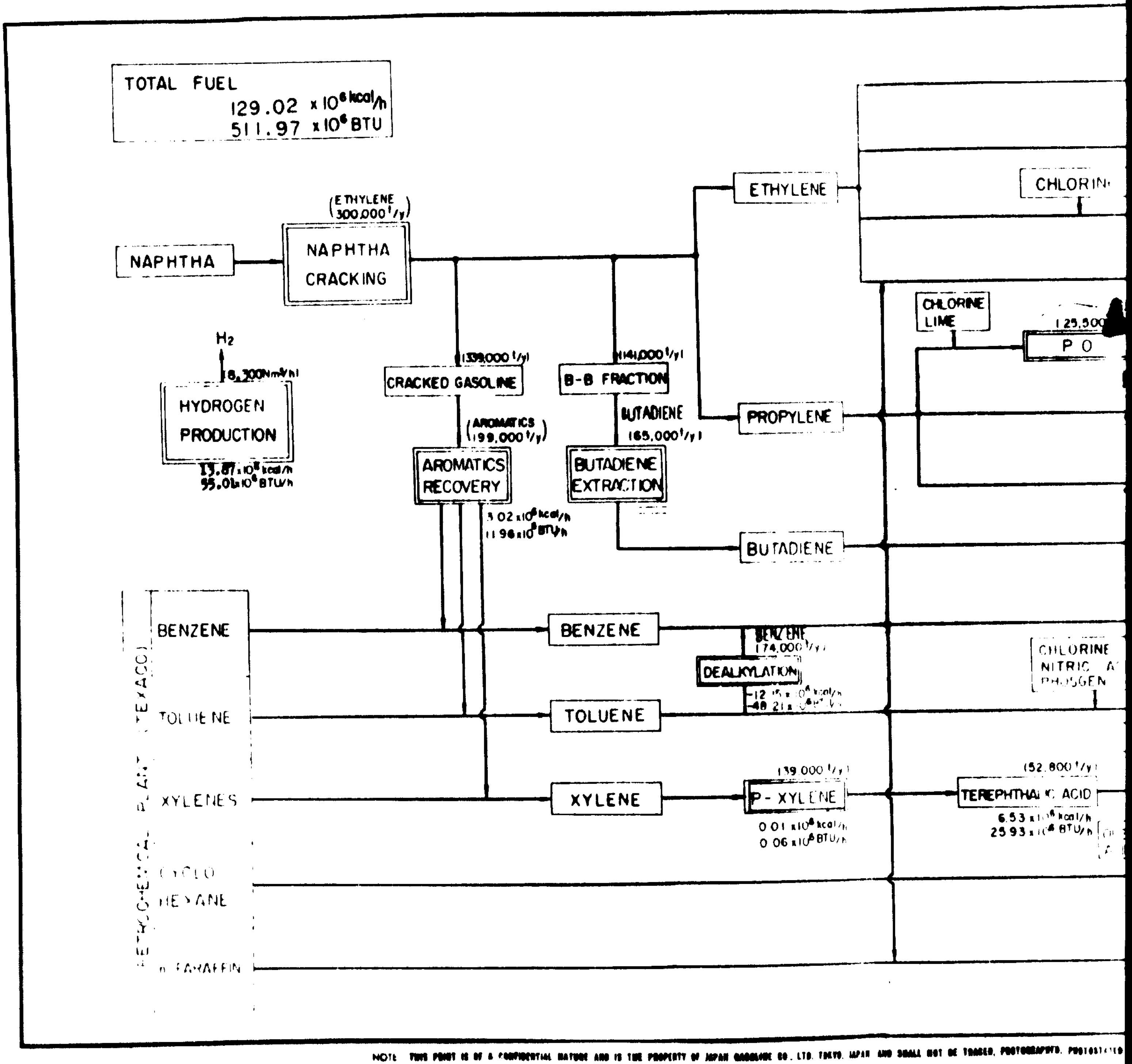
SECTION 1

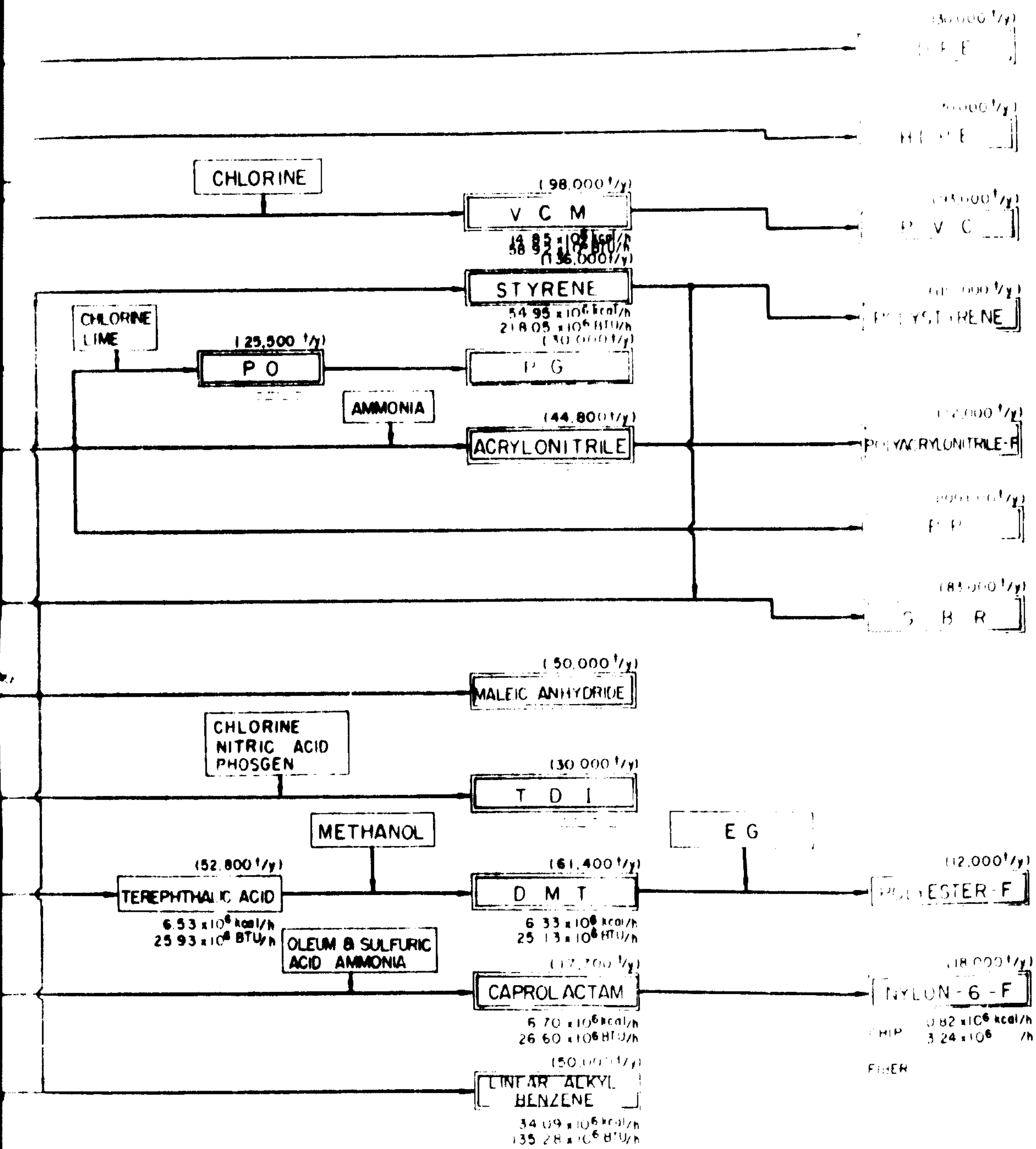


LDPE
(130,000 t/y)
4,268 t/hr
18,800 GPM
HDPE
CHLORINE
VCM
(198,000 t/y)
2,475 t/hr
10,902 GPM
PVC
5,871 t/hr
25,864 GPM
STYRENE
(136,000 t/y)
POLYSTYRENE
PO
(25,500 t/y)
5,674 GPM
PG
3,337 GPM
AMMONIA
ACRYLONITRILE
(44,800 t/y)
2,828 t/hr
12,459 GPM
POLYACRYLONITRILE-F
PP
44,497 GPM
MALEIC ANHYDRIDE
(50,000 t/y)
5,006 GPM
CHLORINE
NITRIC ACID
PHOSGEN
TDI
(30,000 t/y)
3,580 t/hr
15,769 GPM
METHANOL
EG
TEREPHTHALIC ACID
(52,800 t/y)
2,223 t/hr
9,794 GPM
DMT
(61,400 t/y)
1,939 t/hr
8,538 GPM
POLYESTER-F
2,652 t/hr
11,680 GPM
OLEUM & SULFURIC ACID AMMONIA
CAPROLACTAM
NYLON-6-F
(18,000 t/y)
CHIP 213 t/hr 938 GPM
FIBER 18 t/hr 80 GPM
LINEAR ALKYL BENZENE
3,182 t/hr
14,017 GPM
NO DATE DESCRIPTION
REVISIONS
JOB NO
REQ NO
JAPAN GASOLINE CO., LTD.
(NIHON KIHATSUYU KABUSHIKI KAISHA)
FIG P-3-4
COOLING WATER (Case 3)
DATE
SCALE
PREP'D
CHK'D
APP'D
DWG NO.
-F

SECTION 2


TOTAL FUEL
129.02 x10⁶ kcal/h
511.97 x10⁶ BTU
NAPHTHA
ETHYLENE 300,000 t/y
NAPHTHA CRACKING
H2
HYDROGEN PRODUCTION
CRACKED GASOLINE
B-B FRACTION
AROMATICS 199,000 t/y
AROMATICS RECOVERY
BUTADIENE 165,000 t/y
BUTADIENE EXTRACTION
ETHYLENE
PROPYLENE
BUTADIENE
CHLORINE LIME
BENZENE
TOLUENE
XYLENES
BENZENE
TOLUENE
XYLENE
DEALKYLATION
P-XYLENE
TEREPHTHALIC ACID
HEXANE

SECTION 1



NO	DATE	DESCRIPTION	PR'D	CH'D	APP'D

REVISIONS

JOB NO | REQ NO

JAPAN GASOLINE CO., LTD.
NIHON KIHATSUYU KABUSHIKI KAISHA

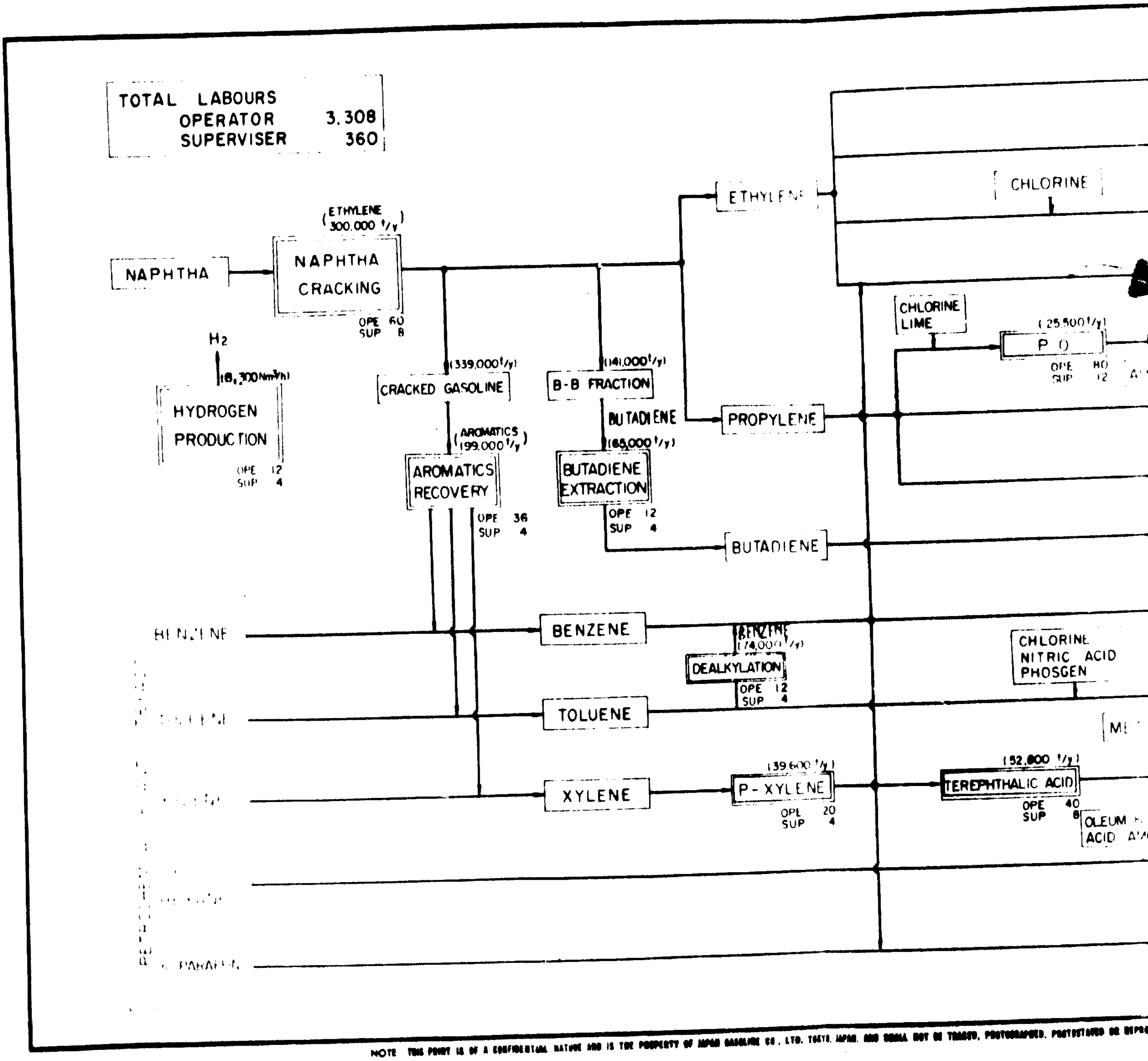
FIG P-3-5

FUEL (Case 3)

DATE | SCALE
PREP'D | CHK'D | APP'D

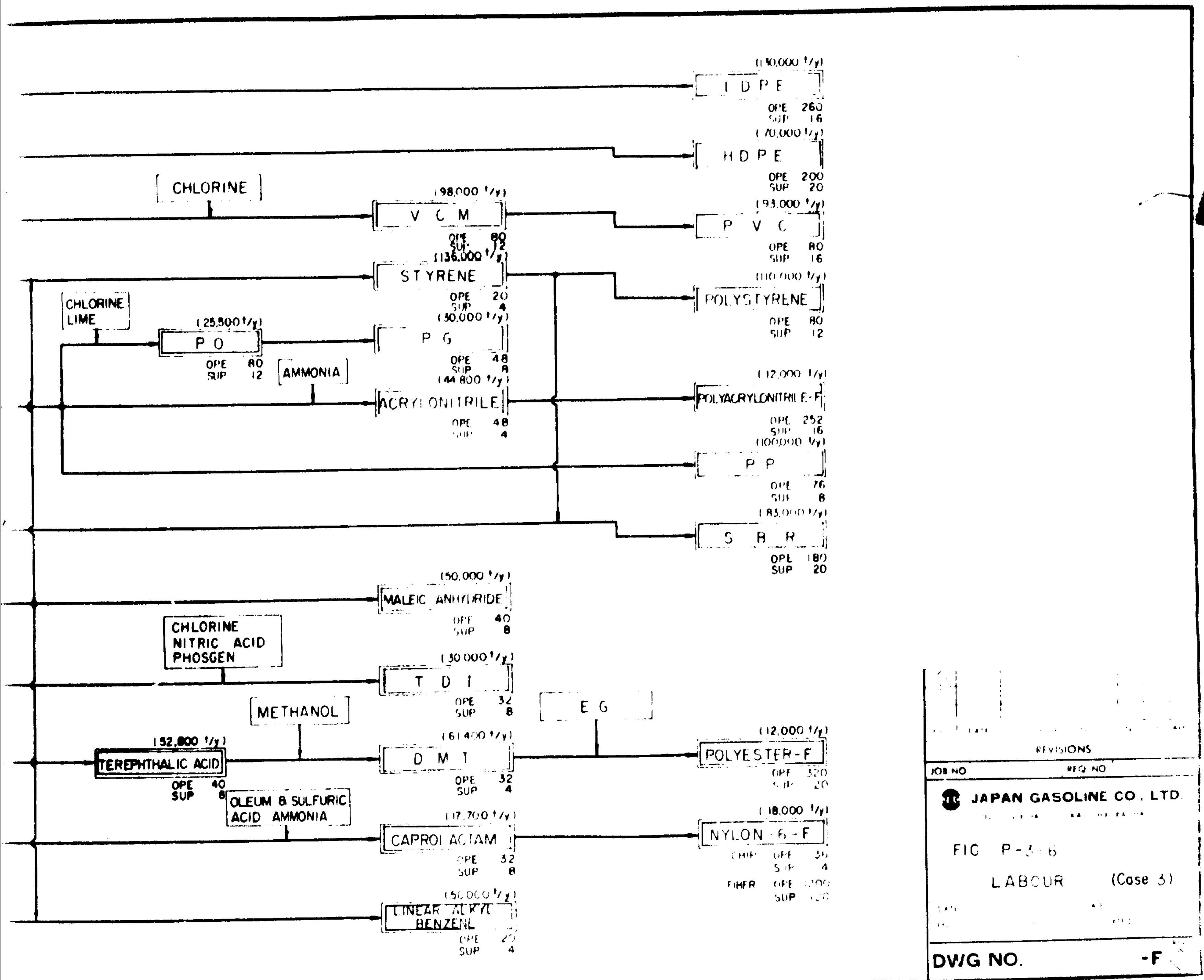
DWG NO. -F

SECTION 2



TOTAL LABOURS
OPERATOR 3,308
SUPERVISER 360
NAPHTHA
(ETHYLENE 300,000 t/y)
NAPHTHA CRACKING
OPE 60
SUP 8
H2
(8,300 Nm3/h)
HYDROGEN PRODUCTION
OPE 12
SUP 4
(339,000 t/y)
CRACKED GASOLINE
(AROMATICS 199,000 t/y)
AROMATICS RECOVERY
OPE 36
SUP 4
(141,000 t/y)
B-B FRACTION
BUTADIENE
(65,000 t/y)
BUTADIENE EXTRACTION
OPE 12
SUP 4
ETHYLENE
PROPYLENE
BUTADIENE
CHLORINE
CHLORINE LIME
(25,500 t/y)
P O
OPE 80
SUP 12
BENZENE
BENZENE
(74,000 t/y)
DEALKYLATION
OPE 12
SUP 4
TOLUENE
XYLENE
(139,600 t/y)
P-XYLENE
OPE 20
SUP 4
(52,800 t/y)
TEREPHTHALIC ACID
OPE 40
SUP 8
CHLORINE
NITRIC ACID
PHOSGEN
OLEUM
ACID
PARAFFIN

SECTION 1



(130,000 t/y)
L D P E
OPE 260
SUP 16
(70,000 t/y)
H D P E
OPE 200
SUP 20
CHLORINE
(98,000 t/y)
V C M
OPE 80
SUP 12
(93,000 t/y)
P V C
OPE 80
SUP 16
(136,000 t/y)
STYRENE
OPE 20
SUP 4
(110,000 t/y)
POLYSTYRENE
OPE 80
SUP 12
CHLORINE LIME
(25,500 t/y)
P O
OPE 80
SUP 12
(30,000 t/y)
P G
OPE 48
SUP 8
AMMONIA
(44,800 t/y)
ACRYLONITRILE
OPE 48
SUP 4
(12,000 t/y)
POLYACRYLONITRILE-F
OPE 252
SUP 16
(100,000 t/y)
P P
OPE 76
SUP 8
(83,000 t/y)
S B R
OPE 180
SUP 20
(50,000 t/y)
MALEIC ANHYDRIDE
OPE 40
SUP 8
CHLORINE
NITRIC ACID
PHOSGEN
(30,000 t/y)
T D I
OPE 32
SUP 8
METHANOL
E G
(52,800 t/y)
TEREPHTHALIC ACID
OPE 40
SUP 8
(61,400 t/y)
D M T
OPE 32
SUP 4
(12,000 t/y)
POLYESTER-F
OPE 320
SUP 20
OLEUM & SULFURIC ACID AMMONIA
(17,700 t/y)
CAPROLACTAM
OPE 32
SUP 8
(18,000 t/y)
NYLON-6-F
CHIP OPE 36
SUP 4
FIBER OPE 200
SUP 120
(50,000 t/y)
LINEAR ALKYL BENZENE
OPE 20
SUP 4
REVISIONS
JOB NO
REQ NO
JAPAN GASOLINE CO., LTD.
FIG P-3-6
LABOUR (Case 3)
DWG NO. -F

SECTION 2

Annex Q-1.

PRODUCERS OF METHANOL

(Unit : 1000 t/)

	Companies	Location	Present Capacity (end-1970)	Planned Capacity	Remarks
U S A	Air Products and Chems Inc.	Michaud, La	-	300	1971
		Pensacola, Fla	90	60	1971
	Allied Chem	South Point, Ohio	78		
	Borden Chem	Geismar, La.	490		
		West Coast	-	300	1972
	Celanese	Bishop, Tex.	246		
	Commercial Solvents	Sterington, La.	360	-	
	Du Pont	Belle, W. Va	120		
		Huron, Ohio	90		
		Orange, Tex.	400		
		Sobine, Tex.	-	600	1972
	Escambia Chem	Pensacola, Fla	346		
	Georgia Pacific	Plaquemine, La	307		
	Gulf Oil	Military, Ken.	31		
	Hercules	Hercules, Cal.	24		
		Louisiana, Mo	24		
		Plaquemine, La	240		
	Mercury Chem	Artesia	246		
	Methchem	First Mississippi		600	early 1973
	Petroleum Inc.	New Mexico	-		
	Monsanto	Texas City, Tex.	360		
	Rohm & Haas	Houston, Tex.	68		
	Tenneco Chem	Houston, Tex.	240		
	Union Carbide	S. Charleston, W. Va. } Texas City, Tex. }	166		
	Valley Nitrogen Producers Inc.		45		

	Companies	Location	Present Capacity (end-1970)	Planned Capacity	Remarks
CANADA	Chemcell	Clover Bar			
		Cornwall			
	Imperial Oil	Montreal,			
		Sarnia (Ont.)			
FRANCE	Methanolacq	Pardies	115		
	ONIA	Toulovse	25		
	Ste Chim des Charbonnages	Mazingarbe			
	Ugine Kuhlmann (a)	Harnes	23		
	" (b)	"	60		
	Ste des Produits Azotes	Lannemezan	41		
WEST GERMANY	BASF	Ludwigshafen	400		
	Union Rheinische Braunkohlen Kraftstoff	Wesseling	900		
	Elf Mineral Öl	Speyer	-		
	Erdölchemie GmbH	Dormagen	70	260	Planning
	Veba-Chemie	Gersenkirchen	-	200	Planning
ITALY	ANIC	Pisticci	60		
	Montecatini-Edison	Castellanza	100		
		Brindisi	60		
		Novare	65		
	Pozzi	Ferrandina	40		
	SIR	Porto Torres	40		
NETHERLANDS	Konam	Rotterdam	80		
BELGIUM	Ammoniaque Synthetique et Derives	Willebroeck	15		

	Companies	Location	Present Capacity (end-1970)	Planned Capacity	Remarks
U K	BP Chemicals	Grangemouth	65		
	ICI	Heysham	180		
		Billingham	100	310	end 1972
SWEDEN	AB Swonska Salpterverken	Kvantorp	28		
NORWAY	Norsk Hydro	Heroya	50		
AUSTRIA	Oesterreichisch Hiag Werke A.G.	Fischamend	20		
SPAIN	Abonos Sevilla	Sevilla	50		
BRAZIL	Alba SA	Cubatao	33		
	Metanor	Bahia	-	50	late 1972
ARGENTINA	Cia Gasco	Pilar	45		
MEXICO	Industria Petro-quimica National	Puebla	16		
	Pemex	San Martin Texmelucan	45		
TAIWAN	Chang Chun Petrochem	Hsinchu	16		
KOREA	Taesung Luber Ind.	Seoul	45		
	Taesung Ind. Corp.	Ulsan	50		
INDIA			40	60	1970/71
PAKISTAN			40		
AUSTRALIA	ICI	Botany, NSW	n.a.		
IRAN	National Petrochemical	Kharg Island		180	1970/71

	Companies	Location	Present Capacity (end-1970)	Planned Capacity	Remarks
ISRAEL	Chemicals Phosphates	Haifa		12	1971
	DOR Chemicals Ltd.	Haifa		50	1972
EGYPT	Egyptian General Petroleum	Alexandria		10	Planning
LIBYA	Occidental of Libya	Benghasi		330	1973

Annex Q-2.

PRODUCERS OF LDPE

(Unit : 1000 t/y)

	Companies	Location	Present Capacity (end-1970)	Planned Capacity	Remarks
U S A	Allied Chem	Orange, Tex.	11		
		Clinton, La.	45		
	Columbian Carbon	Lake Charles, La.	100		
	Dow Chemical	Freeport, Tex.	171		
		Plaquamine, La.	95		
	Du Pont	Orange, Tex.	193		
		Victoria, Tex.	95		
	Eastman Kodak	Longview, Tex.	113		
	Enjay Chemical	Baton Rouge, La.	95		
	Gulf Oil	Cedar Bayou, Tex.	95		
		Orange, Tex.	95	136	
	Monsanto	Texas City, Tex.	63		
	National Distillers & Chem Corp.	Houston, Tex.	136		
	U.S. Industrial Chem Co.	Tuscola, Ill.	68		
	Phillips Petroleum	Pasadena, Tex.	-	10	1972
	Rexall Drug & Chem and El Paso Products Co., j.v.	Odessa, Tex.	135		
	Sinclair-Koppers	Port Arthur, Tex.	79		
	UCC	Seadrift, Tex.	154		
		S. Charleston, W. Va.	54		
		Taft, La.	n.a.		
		Texas City, Tex.	100		
		Torrance, Calif.	n.a.		
		Whiting, Ind.	55		
		Penuelas, Puerto Rico	-	136	1971
	Chemplex	Clinton, Iowa	80		
	Cosden Oil & Chemical	Calumet City	10		
	Dart Industries	Odessa, Tex.	136		

	Companies	Location	Present Capacity (end-1970)	Planned Capacity	Remarks
CANADA	Canadian Ind.	Edmouton	30		
	Union Carbide of Canada	Montreal	45		
	Dow Chem of Canada	Sarnia, Ont.	n.a.		
	Thio-pet Chemical	Montreal East	1		
FRANCE	Cochime (BASF)	Berre l'Etang	65		
	Ethylene Plastique (ICI)	Carling	60		
		Lillebonne	100	60	1972
		Mont	50		
	SNPA	Mont	30		
		Balan	100	70	1972
	Soc Lorraine des Polyolefines	Carling	100	140	
	Aquitaine-Organico	Gonfreville	-	75	1971
		Balan	130	170	-
	Union Chimique Elf-Aquitaine	Balan	-	100	-
		Gonfreville	-	75	1971
WEST GERMANY	BASF AG	Ludwigshafen	18	12	1971
	Rheinische Olefin Werke GmbH (ROW)	Wesseling	500	240	1972
	Erdolchemie GmbH	Dormagen	100		
	Folienwerke Saar		-	30	1971
ITALY	ABCD (Astalti Bitumi Cementi Derivati SpA)	Ragusa	40	40	end 1971
	ANIC	Gela, Sicily	65	15	1971
	Sinoat	Priolo, Sicily	80		
	Montedison SpA	Brindisi	90	60	1971
		Ferrara	30		
		Cagriari	-	45	1971
			-	55	1973
	Rumianca SpA	Assemini	15	-	-
		Sardinia	36		
	Societa Italiana Resina (SIR)	Porto Torres	100	-	-

	Companies	Location	Present Capacity (end-1970)	Planned Capacity	Remarks
ITALY	Societa Italiana Resina (SIR)	Sardinia	80		
	Liquigas SpA	Sibari	-	50	1971
NETHER-LANDS	Dow Chem Europe	Terneusen	60		
	ICI (Holland) NV	Rozenburg	120		
	DSM	Beek-Geleen	140	60	1971
BELGIUM	BASF Antwerpern NV	Antwerp	33	33	1971
	Union Carbide Belgium NV	Antwerp	100	80	1971
	USI Europe NV	Antwerp	54	46	1971
		Zwijndrecht	-	40	1971
U K	BXL	Grangemouth	80	20	1971
	ICI	Wilton	180	20	
	Monsanto Chem	Fawley	50		
	Shell International Chem	Carrington	60	120	1974
	Bakelite Xylonite	Grangemouth	100		
SWEDEN	Unifos Kemi AB	Stenungsund	100	40	1971
	Union Carbide and Superfosfat Fabrivks Aktiebolag		-	20	
SWITZER-LAND	Unifos Kemi AB	Stenungsund	-	90	1971
DENMARK	Danbritkem A/S	Copenhagen	30		
FINLAND	Pekema Oy	Porvoo	-	80	1971
AUSTRIA	Danubia Olefinwerke	Schwechat	66	34	1972/1973
SPAIN	Alcudia SA	Puertollano	72	60	1972
			-	180	1974
	Aquitania-Iberia SA	Prat de Labregat	36		

	Companies	Location	Present Capacity (end-1970)	Planned Capacity	Remarks
SPAIN	Dow Unquinesa SA (Imhausen)	Tarragona	28	14	1972
			-	82	1973
	Calatrava SA	Puertollano	22		
VENEZUELA	Unicar Petroquimica CA	El Tablaso	-	50	1972
COLOMBIA	Poliolefinis Colombianas SA	Barrancabermeja	16		
CHILE	Empresa Nacional del Petroleo	Conception	20		
BRAZIL	Eletroteno Industrias Plasticas SA	Elclor	8	12	1971
			-	12	1975
	Union Carbide do Brazil SA	Cubatao	63		
	Poliolefinas LTDA		10		
ARGENTINA	Imperial Chem Ind	San Lorenso	14	6	1971
	Ipako	Ensenada	12	13	1972
	Indùstrias Quimicas Argentinas Duperial SAOC	San Lorenso	23	7	1972
MEXICO	Pemex	Poza Rica	46	10	1971
		Reynosa, Tam	26		
JAPAN	Idemitsu Petrochem Industry		-	30	1973
	Chisso Petrochemical/ Denka Petrochemical/ Maruzen Petrochemical	Chiba	30		
	Chisso Sekiyu Kagaku	Goi	20		
	Japan Polychemical	Tokuyama	64		
	Kasei Mizushima	Mizushima	30		
	Mitsubishi Yuka	Kashima	50		
		Yokkaichi	125		
	Mitsui Toatsu Kagaku	Sakai	30		
	Nihon Olefin Kagaku	Ohita	30		

	Companies	Location	Present Capacity (end-1970)	Planned Capacity	Remarks
JAPAN	Nihon Unicar	Kasumigaura	35		
		Kawasaki	110		
	Nippon Polychemicals	Tokuyama	64		
		Yokkaichi	-	30	1972
	Ube Kosan	Sakai	50	50	1972
		Goi	100		
	Japan Olefin Chem	Ohita	35		
	Mitsubishi Petro-chemical	Yokkaichi	125		
	Mitsui Polychemicals	Ichihara	60		
		Ohtake	56		
	Nippon Petrochemicals	Kawasaki	30	60	1971
	Sumitomo Chem	Ohe	125		
		Chiba	54		
	Sumitomo Chiba Chemical	Anegasaki	60	50	1971
		Sodegaura	30		
	Asahi Dow (Dow/Asahi Chem)	Kawasaki	35		
		Misushima	40		
	Mitsubishi Chemical Industries	Misushima	30		
TAIWAN	USI Far East Corp.	Kaohsiung	32		
KOREA	Dow Chem and Chungja Fertilizer	Ulsan	-	50	1971
INDIA	Avvind Petrochem	Koyali	40		
	Union Carbide of India	Trombay	10		
	Gujarat Olefines Project		40		
	The Alkali & Chemical Corp. of India	Rishra	10		
	Koyali Complex	Gujarat	-	40	1970-71
AUSTRALIA	ICIANZ	Botany	25		
	Union Carbide Australia	Altona	20		

	Companies	Location	Present Capacity (end-1970)	Planned Capacity	Remarks
TURKEY	Petkim Petrokimya AS	Ismit	14	15	1972
		Aliaga	-	45	1978
PAKISTAN	Barica Chemical	W. Pakistan	10		
	Valika Chemical Industries	Karachi	50		
ISRAEL	Israel Petrochem Industries	Haifa	17		
IRAQ	State Authority		22		
U A R	Egyptian General Petroleum	Alexandria	20		
SOUTH AFRICA	African Explosives & Chemical Industries	Midland	45		
	Karbochem	Sasolburg	-	50	-
ALGERIA	Sonatrach		-	68	1972

Annex Q-3.

PRODUCERS OF HDPE

(Unit : 1000 t/y)

	Companies	Location	Present Capacity (end-1970)	Planned Capacity	Remarks
U S A	Allied Chem	Baton Rouge, La.	137		
		Buffalo	11		
		Orange, Tex.	11		
		Tonawanda, N.Y.	11		
	Celanese Corp	Clear Lake	-	90	1972
		Houston, Tex.	116		
	Chemplex	Clinton, La.	137		
	Dow Chemical	Bay City, Mich.	11		
		Freeport, Tex.	27		
		Plaquamine, La.	38		
	Du Pont	Orange, Tex.	68		
	Gulf Oil	Port Arthur, Tex.	45		
		Orange, Tex.	45		
	Hercules Inc.	Parlin, N.Y.	45	10	1971
	Monsanto	Texas City, Tex.	118		
	National Distillers	Houston, Tex.	-	23	1971
	National Petro Chem	La Porte, Tex.	77		
		Deer Park	-	32	1971
	Phillips Petroleum	Pasadena, Tex.	95		
	Phillips Puerto Rico Core	Guayama, P.R.	40		
	Sinclair-Koppers	Port Arthur, Tex.	45		
	UCC	Seadrift, Tex.	113		
	Amoco Chemicals	Chocolate Bayou	45		
	Sinclair-Koppers Co.	Port Arthur,Tex.	-	34	1972
CANADA	Dow Chem of Canada	Sarnia,Ont.	12		
	Du Pont of Canada	" "	7		
	US Industrial Chem		34		
	Union Carbide Canada	Montreal	10		

	Companies	Location	Present Capacity (end-1970)	Planned Capacity	Remarks
FRANCE	Manolène	Gonfreville	15		
	Naphthachimie	Lavera	55		
	SNPA	Balan	-	50	1972
	Sté Industrielle de Polyolefines	Le Havre	60		
	Sté Normande de Matieres Plastiques	Lillebonne	6		
	Aquitaine-Organico	Balan	-	50	1975
	Veba Chemie	Gonfreville	-	60	1971-72
WEST GERMANY	Hoechst	Hoechst	230		
		Knapsak	50		
	Pheinische Olefin-werke GmbH	Wesseling	80	80	1972
			-	90	1974
	Rührchemie AG	Oberhausen-Holton	50		
	Vestlen GmbH	Gelsenkirchen	32	28	-
		Marl	54		
	BASF AG	Wesseling	-	55	1971
	Wacker-Chemie	Burghausen	-	24	
ITALY	Montedison	Brindisi	30	20	1972
		Cagliari	-	20	1973
	Solvay Italiana	Rosignano	50		
	Starlene SpA	Assemini	24		
	Rumianca SpA	Cagliari	10		
	ANIC	Gela	40		
	Societa Italiana Resina (SIR)	Solbiate Olona	25		
	Sarda Polimeri SpA	Sardinia	-	25	1971
NETHER-LANDS	DSM	Beek	30	30	1971
	Dow Chemical International NV	Beek	-	60	1971
BELGIUM	Polyolefins SA	Antwerp	60		

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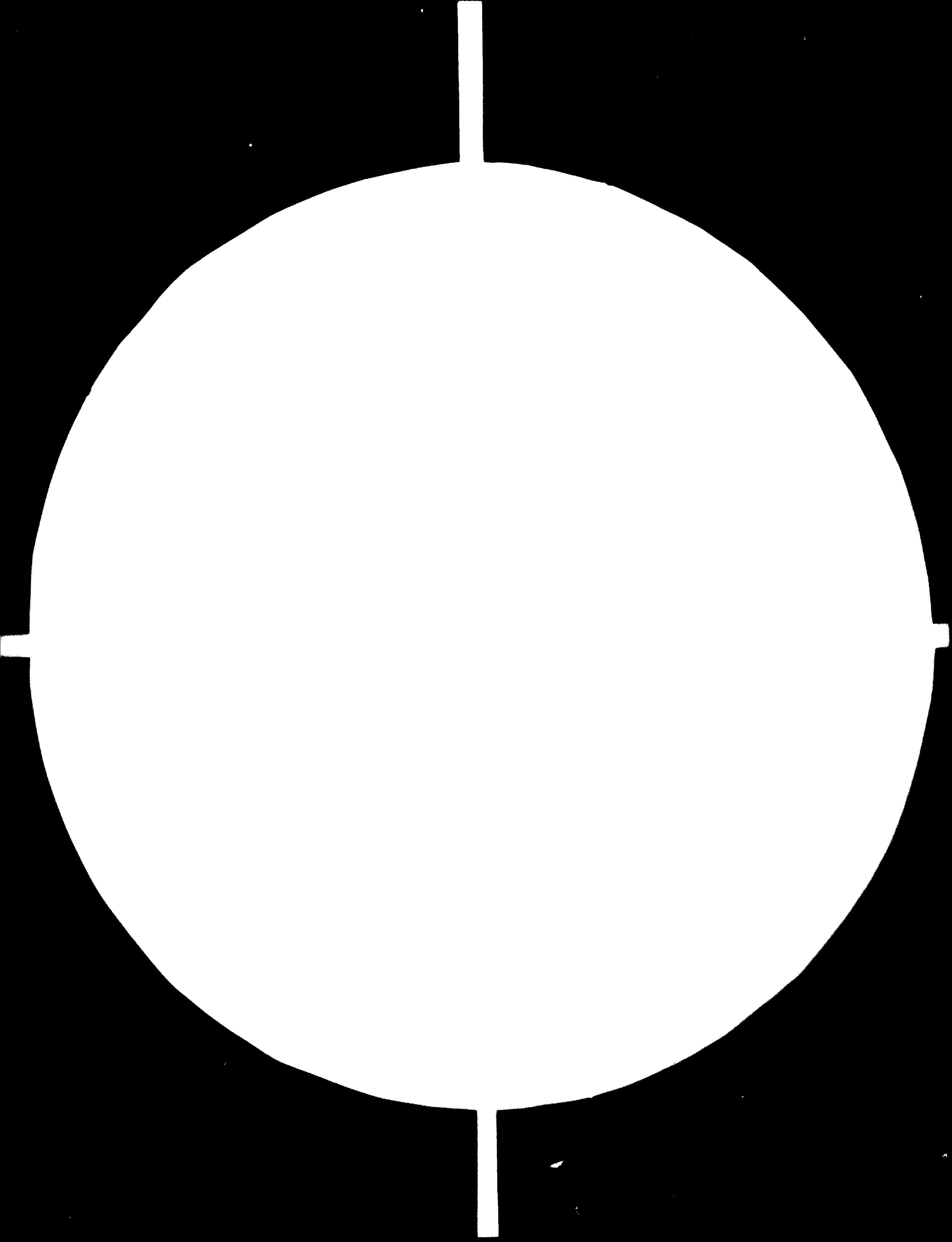


	Companies	Location	Present Capacity (end-1970)	Planned Capacity	Remarks
U K	BP Chemical (UK)	Grangemouth	44	26	1971
	Shell International Chemicals	Carrington	25	20	1972
AUSTRIA	Hoechst/ÖMV	Schwechat	-	50	
SWEDEN	Unifos Kemi AB	Stenungsund	-	30	1971
SPAIN	Calatrava SA	Puertollano	18		
	Dow Unguinesa	Tarragona	-	25	1972
			-	40	
ARGENTINA	Dow Quimica Argentina	Bahia Blanca	-	22	1972
	Imperial Chemical Industries	Ensenada	11	11	1972
	Ipako	Ensenada	-	9	1972
BRAZIL	Electroteno Ind. Plasticas	Sao Paulo	32		
JAPAN	Kasei Mizushima	Mizushima	50	80	1971
	Nippon Unicar	Kasumigaura	35		
	Asahi Chemical Ind.	Mizushima	23		
	Chisso Corp. (Chisso)	Goi	30		
		Chiba	30	60	1973
	Furukawa Chemical Ind.	Kawasaki	78		
		Mizushima	30		
	Japan Olefin Chem.	Kawasaki	70		
		Ohita	38		
	Mitsui Petrochemical Ind.	Iwakuni	50	60	1973
		Ichihara	123		
	Nissan Chemical Ind.	Goi	30	60	-
	Mitsubishi Chem Ind.	Mizushima	20		
	Mitsubishi Petrochem	Yokkaichi	-	20	-

	Companies	Location	Present Capacity (end-1970)	Planned Capacity	Remarks
JAPAN	Sumitomo Chem	Chiba	-	30	1971
		Ohe	7		
	Idemitsu Petrochem Ind	Chiba	-	30	1971
	Kanegafuchi Chem	Kashima	-	20	1972
	Tokuyama Soda	Tokuyama	-	30	1972
	Dainippon Ink & Chemicals and Toyo Soda	Yokkaichi	-	30	1972
KOREA	Korea Pacific Chem	Ulsan	-	50	1972
INDIA	Polyolefins Ind(PIL)	Thana,Maharashtra	20		
TURKEY	Petkin-Petrokimya	Aliaga	-	30	1974
S. AFRICA	Hoechst	Johannesburg	-	50	1972

Annex Q-4.

PRODUCERS OF PVC

(Unit: 1,000 tons)

	Companies	Location	Present Capacity (end-1970)	Planned Capacity	Remarks
U S A	Air Reduction Airco Chemicals & Plastics Div	Calvert City, Ky.	55		
	Allied Chem Plastics Div	Painesville, O,	90		
	American Chem	Long Beach, Calif.	-	34	1971
	Atlantic Tubing & Rubber	Cranston, R.I.	45		
	Borden Inc. Thermoplastics Products	Bainbridge, N.Y.	n.a.		
		Compton, Calif.	n.a.		
		Dempoplis, Ala.	n.a.		
		Illipolis, Ill. Leominster, Mass.)	114		
	Continental Oil	Aberdeen, Miss.	70	30	1972
	Thompson Apex	Aberdeen, Miss.	n.a.		
		Assonet, Mass.	n.a.		
	Diamond Shamrock Plastics Div	Deer Park, Tex. Delaware City, Del.)	110		
	Dow Chem	Midland, Mich.	36		
		Plaquamine, La.	n.a.		
	Escambia Chem	Pensacola, Fla.	23		
	Ethyl Corp.	Baton Rouge, La.	68		
	Firestone Tire & Rubber, Firestone Plastics Co., Div	Perryville, Md.	52		
		Pottstown, Penn.	57		

	Companies	Location	Present Capacity (end-1970)	Planned Capacity	Remarks
U S A	General Fabricators,	Van Nays, Calif.	n.a.		
	General Tire & Rubber Co., Chem/ Plastics Div	Ashtabula, O.	34		
	B. F. Goodrich	Avon Lake, O. Henry, Ill. Long Beach, Calif. Louisville, Ky. Niagara Falls, N.Y. Pedricktown, N.J.	290		
		Salem, N.J.	n.a.		
	Goodyear Tire & Rubber	Niagara Falls, N.Y.	36		
		Plaquemine, La.	36		
	Great American Plastics, Hooker Chem Corp., Ruco Div	Fitchburg, Mass.	18	54	
		Burlington Township, N.J.	55		
		Hicksville, N.Y.	4.5		
	Keysor Chem	Delaware City, Del.	n.a.		
		Saugus, Calif.	27		
	Lasco Industries	Montebello, Calif.	n.a.		
	Micron Chem Products	Brooklyn, N.Y.	n.a.		
	Millmaster Onyx, Onyx Chem Co. Div	Jersey City, N.J.	n.a.		
	Monsanto Hydrocarbons & Polymers Div	Springfield, Mass.	68		
	Neville Chem	Neville Island, Penn.	34		
	Pantasote, Eleanore Chem Div	Passaic, N.J. Point Pleasant, W.Va.	55		
	Reichhold Chem, Blane Chem Div	Mansfield, Mass.	n.a.		
	Richardson, Polymers Div	W. Haven, Conn.	n.a.		

	Companies	Location	Present Capacity (end-1970)	Planned Capacity	Remarks
U S A	Stauffer Chem, Plastics Div	Delaware City, Del.	68		
	Tenneco Chem, Tenneco Plastics Div	Burlington, N.J.	64		
		E. Brunswick, N.J.	86		
		Flemington, N.J.	34		
	UCC, Chem & Plastics Operation Div	S. Chaleston, W.Va.) Texas City, Tex.)	145		
	Uniroyal, Uniroyal Chem Div	Painesville, O.	61		
	American Chemical	Long Beach	-	34	1971
	Conoco Plastics	Oklahoma City	-	22.5	1971
	Olin	Assonet, Mass.	57		
CANADA	B F Goodrich Canada	Kitchener	13.6		
	Monsanto Canada	La Salle, Que.	11.3		
	Shawinigan Chem	Montreal	27.1		
	Imperial Oil	Sarnia, Ont.	20.4		
FRANCE	Aquitaine-Organico (SNPA)	Balan	35	30	1971
	Pechiney-St. Gobain	St. Auban) St. Fons) Montlucon)	240	200	1973
	Rhone-Poulene	Roussillon	40	40	1971
	Solvic	Tavaux	140	40	1971
	Ugine-Kuhlmann	Brignoud	70	70	1971

	Companies	Location	Present Capacity (end-1970)	Planned Capacity	Remarks
W. GERMANY	BASF AG	Ludwigshafen	100	275	1975
	Deutsche Solvay Werke AG	Rheinberg	70	50	1971
	Dynamit Nobel AG	Troisdort	70	30	1971
	Farbwerke Hoechst	Gendort	90		
		Hoechst	12	45	1971
		Knapsack	70	60	1971
	Chemische Werke Huls AG	Marl	270	130	1973
	Lonza Werke AG	Weil	12		
	Wacker-Chemie GmbH	Brughausen	175	75	1973
		Knapsack	-	30	1971
ITALY	Societa Chimica Ravenna	Ravenna	40	60	1971
	Montecatini-Edison SpA	Porto Marghera	240	120	1973
		Brindisi	60		
		Cagliari, Sardinia	-	70	1971
	Polisarda SpA	Porto Torres Sardinia	70		
	Polymer SpA	Terni	75		
	Pozzi Ferrandina	Ferrandina	40		
	Quirina Spa	Assemini Sardinia	30		
	Solvic	Ferrara	50	50	1972
	Societa Italiana Resine	Solbieta Olona	70	70	1975
	ANIC	Ravenna	50	60	1971
	Rumianca	Cagliari, Sardinia	50	30	1975

	Companies	Location	Present Capacity (end-1970)	Planned Capacity	Remarks
NETHERLANDS	Shell Nederland Chemie NV	Pernis	50	110	1972
	Dutch State Mines	Beek	-	50	1972
BELGIUM	Badiphil NV	Antwerp	50	50	1973
	Solvic SA	Jemeppe-sur-Sambre	90	25	1971
U K	B P Chemicals (UK)	Baglan Bay	140	90	1972
	ICI, Plastic Div	Hillhouse	180	170	1975
		Fleetwood, Lancs			
	BXL Plastics Materials Group	Aycliffe	15		
		Baglan Bay	-	45	1971
SWEDEN	Stockholms Superfosfatfabriks AB	Stockviksverken	50	80	
NORWAY	Norsk Hydro Elektrisk	Herya	50		
FINLAND	Pekema Oy.	Neartaly	-	80	1972
	Muovi Oy.	Porvoo	-	15	1971
	Neste	Porvoo	-	30	1971
SWITZERLAND	Lonza Ag	Zins	18		
PORTUGAL	CIRES (Companhia Industrial de Resinds Sinteticas)	Estarreja	12		
AUSTRIA	Halvic Kunststoffwerke GmbH	Hallein	18		

	Companies	Location	Present Capacity (end-1970)	Planned Capacity	Remarks
SPAIN	Compania Aragonesa de Industrias Quimicas	Sabinanigo	2	8	1972
	Etino Quimica SA	Manzon del Cina	15		
	Hispavic Ind SA	Torrelavega	50	50	1971
	Resinas Poliesters	Miranda de Ebro	30		
		Hernani	20		
	Oxycros	Pietollano	-	80	1971
			-	200	1972
	Monsanto	Mongon	30	60	1972
GREECE	Chemical Industries of Greece AE	Thessaloniki	12		
	Esso Pappos Chemical	Thessaloniki	18		
CHILE	Petroquimica/ Dow/Enap	Concepcion	15		
ARGENTINA	Dow Quimica Argentina	Bahia Blanca	-	55	1972
BRAZIL	Consorcio Paulista de Monomero		35	15	1971
	Ind. Quim Electro Cloro SA	Elclor	-	10	1971
	Braz Resinas Vinilicas	Elclor	-	18	1971
	Union Carbide do Brazil	Cubatao	-	75	
COLOMBIA	Carburos de Colombia SA	Medellin	6		

	Companies	Location	Present Capacity (end-1970)	Planned Capacity	Remarks
VENEZUELA	Instituto Kengolano de Petroquimica	Zulia	-	25	1971
MEXICO	Monsanto Mexicana	Lecheria			
	Geon de Mexico SA	Mexico City DF			
	Promociones Ind Mexicanas, SA	Puebla, Pue.			
JAPAN	Osaka Petrochem	Osaka	30		
	Senpoku Petrochem	Osaka	30		
	The Japanese Zeon	Mizushima	30	60	1973
		Takaoka	100		
	Kawasaki Organic Chemicals	Kawasaki	30	30	1971
	Sun Arrow Chemical	Tokuyama	30		
	Toa Gosei Chemical Ind.	Tokushima	55		
	Kanegafuchi Chemical Ind.	Takasago) Osaka	115		
		Kashima	50		
	Sumitomo Chemical	Kikumoto	50		
		Sodegaura	17		
	Mitsubishi Monsanto Chem	Yokkaichi	108		
	Tekkosha	Yokkaichi	36		
		Sakata	30		
	Chisso Corp	Mizushima	24		
		Goi	24		
	Kureha Chemical Ind	Nishiki	120		

	Companies	Location	Present Capacity (end-1970)	Planned Capacity	Remarks
JAPAN	Shinetsu Chem Ind	Kashima	60	60	1971
		Naoetsu	73		
		Tokuyama	30		
	Nissan Chemical Ind	Goi	50		
	Nippon Carbide Industries	Uozu	17		
		Hayatsuki	50		
	Nikka Chem Ind.	Mizushima	84		
	Mitsui Toatsu Chem	Nagoya	72		
		Osaka	30	30	1971
	Gunma Chem Ind.	Shibukawa	48		
	The Electro Chem Ind.	Qume	51		
		Chiba	36		
	Tokuyama Sekisui Ind.	Tokuyama	36		
INDIA	Shriram Vinyls	Kota	20		
	Plastic Resin Chem	Sahupuram	16		
	Ahmedabad Mfg & Calico Printing	Bombay, Maharastra	20		
	Assam Ind Development Corp.	Moran-Lakwa	6		
	Chemical & Plastics India	Mettur Dam	22		
	Gujarat Olefines Project		20		
	National Organic Chem	Thana, Bombay	20		

	Companies	Location	Present Capacity (end-1970)	Planned Capacity	Remarks
TURKEY	Petkim Petrokimya AS	Aliaga	-	91	1974
		Yarimca	43		
		Izmit	26		
SOUTH AFRICA	African Explosives & Industries		26		
ALGERIA	Sonatrach	Shikda	-	100	1972
KOREA	Daehan Plastics	Tejon	8		
	Kong Yong Chemical	Ulsan	8		
	Korea Chemical	Kimhe	19		
	Wupoong Chemical	Kung San	19		
	Tong Yang Chemical	Inchon	8		
TAIWAN	Formosa Plastics Co.	Kaoshing	73		
	China Gulf Plastics Co.	Tovfen	30		
	Cathay Plastics	Chvnan	21		
	Yi-Fang Plastics		15		
PHILIPPINES	Mabuhay Vinyl Corp.	Manila	9		

Annex Q-5.

PRODUCERS OF POLYSTYRENE

(Unit : 1000 t/y)

	Companies	Location	Present Capacity (end-1970)	Planned Capacity	Remarks
U S A	Cosden Oil & Chem	Calmet City	95		
		Ill	84		
	Dart Ind Inc	Joliet, Ill			
		Holyoke, Mass			
		Ludlow, Mass	64		
		Santa Ana, Calif			
	Solar Chemicals	Leominster, Mass	27	17.8	1971
		Houston, Tex			
	USS Chemicals	Haverhill, Ohio	90		
	US Steel Corp	Haverhill, Ohio	-	90	1971
	Alabama Binder & Chemicals	Tuscaloosa, Ala	n.a.		
	American Petrofina	Chicago, Ill	-	45	1972
	Amoco Chemicals	Joliet, Ill	77		
	Badische Products	S. Kearney NJ			
		Jamesburg NJ	36		
	Borden	Bainbridge NY	n.a.		
		Compton (Los Angeles)			
		Demopolis, Ala			
		Illiopolis, Ill			
		Leominster, Mass			
	Brand Plastics	Medina, O	5		
		Torrance, Calif	5		
		Willow Springs, Ill	16		
	Cities Service	Hicksville NY	5		
	Dow Chemicals	Torrance, Calif	417	55	1972
		Allyns Point, Conn			
		Hanging Rock, O			
		Midland, Mich			
		Riverside, Mo			

	Companies	Location	Present Capacity (end-1970)	Planned Capacity	Remarks
U S A	Diamond Plastics	Calif	23		
	Foster Grant	Leominster, Mass	95		
	Gordon Chemicals	Oxford, Mass			
		Worcester, Mass	11		
	S.C. Johnson & Son	Racine, Wisc			
	Onyx Chemicals	Jersey City, NJ			
	Monsanto	Addyston, O	n.a.		
		Long Beach Calif	170		
		Springfield, Mass	n.a.		
	Morton Chemicals	Ringwood, Ill	n.a.		
	O. Brien	S. Bend, Ind	n.a.		
	Pennsylvania Ind	Clairton, Penn	n.a.		
	Polymer Ind	Springdale, Conn	n.a.		
	Purex	Bristol, Penn	n.a.		
		Chicago, Ill	n.a.		
		Harbor City, Calif.	n.a.		
	Reichhold Chemicals	Elizabeth, NJ	n.a.		
	Richardson	W. Haven, Conn	14		
	Scholler Bros	Elwood, NJ	n.a.		
	Shell Chemicals	Marietta, O	36		
	Southern Petrochem	Houston, Tex	18		
		Tulsa, Okla	18		
	Polymeric Resins	Wilmington, Mass	n.a.		
	Sinclair-Koppers	Kobuta, Penn	136		
	UBS Chemicals	Cambridge, Mass; Lemont, Ill; Marlboro, Mass	n.a.		
	Ticonderoga Chemicals	Leominster, Mass	45.4		
	Union Carbide	Bound Brook, NJ; Marietta, O	84		
CANADA	Mobil Oil Canada	Lasalle	9		
	Monsanto Canada	Lasalle, Que	9		
	BASF	Greater Montreal	8		

	Companies	Location	Present Capacity (end-1970)	Planned Capacity	Remarks
FRANCE	Union Chim Elf Aquitaine	Gonfreville	90		
	Dispersions Plastiques	Villiers St. Paul	5	20	1971
	Plastichimie	Ribecourt	65		
	Monsanto	Wingles	28	37	1971
	Aquitaine-Organico	Gonfreville	-	90	1971
		Mont	65		
	SCC, Ugine Kuhlmann	Dieuge	20	80	1975
	Huiles Goundronset Derives	Vindin le Vieil	6		
	Plastugil	Lyon Vaise	13		
WEST GERMANY	Hüls	Marl	30	170	1973
	BASF	Lundwigshafen	175		
	Dow Chemicals	Greffern	60		
	Bayer	Leverkusen	10		
	Row	Ludwigshafen	n.a.		
ITALY	Montedison	Mantua	100	12	
		Ferrara	57		
	Dow Chimica Italiana	Livorno	16		
	Magguchelli	Castiglione	15		
	Montesud Petrochimica	Ferrara	100		
	S I R	Macherio	20		
	ETB (SIR Group)	Porto Torres	15		
BELGIUM	BASF Antwerpen NV	Antwerp	n.a.	n.a.	165 total capacity in 1971
	Belgochim SA	Feluy	45		
NETHERLANDS	Polumer Fabrieken Breda	Breda	110		
	Marbon Chem		15		
	Terneugen		30		

	Companies	Location	Present Capacity (end-1970)	Planned Capacity	Remarks
U K	BP Plastics	Stroud, England	18	23	1971
	Shell Chem	Carrington	35	10	1971
			-	70	1972
	Distrene (Dow)	Barry, S W	70		
	Sterling Moulding Plastics	Stalybridge	40	22	1971
	BXL	Manningtree	14		
	Monsanto Chems	Newport	32		
	Kaylis Chem	Bolton	6		
SPAIN	BASF Espanola	Tarragona	5	5	1972
	Monsanto	Monzon	33		
	Plasten	Valencia	-	5	1971
	Dow-Uniquinesa, SA	Bilbao	25		
	Arrahona	Sababell	25		
BRAZIL	CIA Brasileira de Plasticos "Koppers"	Sao Bernardo	12		
	Idrongal (BASF)	Guaratingueta SP	1		
	Bakol	Sao Caetano SP	5		
COLUMBIA	Dow Colombians	Cartagena	4		
ARGENTINA	BASF Argentina	Rosario	30		
	Monsanto Argentina SAIC	Zarate	5		
MEXICO	BASF Mexicana, SA	Santa Clara	n.a.		
	Monsanto Mexicana	Lecheria	n.a.		
	Union Carbide Mexicana S.A.		n.a.		
	National de Resina S.A.		n.a.		
JAPAN	Japan Polystyrene Ind	Kawasaki	50		
	Kanegafuchi Chem Ind	Takasago	25		
	Asahi Dow	Mizushima	150	50	1972
		Kawasaki	41	23	1972
	Dainippon Ink & Chem	Chiba	40		

	Companies	Location	Present Capacity (end-1970)	Planned Capacity	Remarks
JAPAN	Nippon Polystyrene	Kawasaki	46		
	Nippon Steel Chem	Kimitsu	14		
		Tobata	32		
	Toyo Polystyrene Ind	Osaka	34		
		Kawasaki	51		
	Denka Petrochem Ind	Chiba	47		
	Mitsubishi Monsanto Chem	Yokkaichi	56		
	Idemitsu Petrochem	Tokuyama	16		
	Teijin Limited	Sakai	-	25	1972
INDIA	Indoplast	Thana	24		
	Gujarat Olefines Project	Gujarat	14		
	Polychem	Goregaon, Bombay	10		
		Koyali, Gujarat	14		
TURKEY	Petkim Petrokimya AS	Yarimca	15		
		Aliaga	-	32	1974
		Izmit	-	15	1972
AUSTRALIA	Badocol Chem	Altona	5		
TAIWAN	Tai Ta Chem	Kaohsiung	3		
KOREA	Miwon	Seoul	8	4	1971

Annex Q-6.

PRODUCERS OF ACRYLONITRILE

(Unit : 1000 t/y)

	Companies	Location	Present Capacity (end-1970)	Planned Capacity	Remarks
U S A	American Cyanamid	Fortier, La	82	10	end-1971
	Du Pont	Memphis, Tenn	80		
		Beaumont, Tex	100		
	Monsanto	Texas City, Tex	55		
		Alvin, Tex	185		
	Union Carbide	Institute, W.Va	-	90	Planning
	Vistron (Soshio Chemical)	Lima, Ohio	136	136	end-1972
	Goodrich Chemical	Calvert City,Ky	18		
CANADA	Imperial Oil	Sarnia	14		
FRANCE	Ugilor	Saint Avold	50	25	end-1971
		Yvours	40	35	end-1971
WEST GERMANY	Erdölchemie	Köln-Worringen	100	100	1971
	Hoechst	Knapsack	20		
		Münchsmünster	-	90	mid-1972
		Plattenhofen	-	130	end-1972
ITALY	Montedison	Porto Marghera	30	30	
	Sincat	Priolo	60		
	Acrilsarda	Cagliari	25		
	ANIC	Gela	32		
NETHER-LANDS	DSM	Geleen	45	45	end-1971
U K	Border Chemicals	Grangemouth	50		
	Monsanto Textile	Seal Sands	68	22	end-1970
FINLAND	Sateri Oy		-	20	end-1971

	Companies	Location	Present Capacity (end-1970)	Planned Capacity	Remarks
SPAIN	Paular	Puertollano	-	40	end-1971
BRAZIL	Fisiba		15		
MEXICO	Pemex	Minatitlan	-	26	end-1971
JAPAN	Asahi Chemical Industry Co.,Ltd.	Mizushima	83		
		Kawasaki	52		
	Mitsubishi Chemical Industries, Ltd.	Mizushima	98		
	Sumitomo Chemical Co., Ltd.	Niihama	60		
	Sumitomo Chiba Chemical Co.,Ltd.	Chiba	80		
	Mitsui Toatsu Chemicals Inc.	Senpoku	43		
	Mitsui Petrochemical Industries Ltd.	Otake	16		
	Nitto Chemical Industry Co., Ltd.	Yokohama	72		
		Otake	42		
	Showa Denko K.K.	Kawasaki	79		
	Ube Kosan Co.,Ltd.	Ube	-	30	1971
INDIA	Government	Koyali	-	16	Beginning'71
	Manjustiree Industries	Barui	-	5	" '71
KOREA	Tong Suh Petrochemical	Ulsan	-	27	end-1971
TURKY	Petkim Petrokimya	Ismit	-	15	1973

Annex Q-7.

PRODUCERS OF ACRYLIC FIBER

	Companies	Location	Present Capacity (end-1970)	Planned Capacity	Remarks
USA	Du Pont	Camden, S.C.) Waynesboro, Va)	113	20 (1971)	S
	Monsanto	Decatur, Ala	102		S
	Union Carbide	South Charleston, W. Va	15		S
	American Cyanamid	Pensacola, Fla	54		S
	Tennessee Eastman	Kingsport, Tenn	20		S
	Dow Badische	Williamsburg, Va	43		S
	Courtaulds North America	Columbia, S.C	-	22 (1971)	
CANADA	Du Pont of Canada	Maitlant	15		S
FRANCE	CTA	Colmar	21		YS
	Courtaulds	Coquelles	16	11 (1972)	S
W.GERMANY	Bayer	Dormagen	122		YS
	Phrix Werke	Hamburg-Neumunster) Krefeld)	11		S
	Suddeutsche Chemiefaser	Kelheim	43		
	Monsanto	Lingen	-	16 (1972)	S
ITALY	Chatillon	Porto Marghera	45		YS
	Snia Viscosa	Cesano Maderno	20	15 (1972)	S
		Villacidro	4		S
	Anic	Pisticci	12		S
	Italiana Resine	Porto Torres	1		S
NETHERLANDS	Du Pont(Nederland)	Dordrecht	n.a.		n.a.
BELGIUM	Fabelta	Tubize	15		S
	SEFI	Hautrage	-	10 (1971)	S
UK	Courtaulds	Coventry) Grimsby)	95	86 (1971)	S
		Coventry	2		S
	Monsanto Textiles	Coleraine	39		S
	Du Pont (UK)	Maydown	23		S

	Companies	Location	Present Capacity (end-1970)	Planned Capacity	Remarks
SPAIN	Cyanenka	Prat de Llobregat	11	18 (1971)	S
	Quimicas Altamira	Miranda de Ebro	7		S
	Petrofibra	Zaragoza	-	14 (1972)	S
COLOMBIA	Fibras Acrilicas	Manizales	-	n.a.	S
BRAZIL	Rhodosa Industrias	Sao Jose dos Campos	n.a.		S
	Fisiba	Camacari	8		S
	Noracryl	Joao Pessoa	-	4	S
ARGENTINA	Hisisa Argentina	Baradero	4		S
MEXICO	Celulosa y Derivados	Atequiza	7		S
	Fibras Acrilicas	Cotaxtla	2		S
	Celanese Mexicana	Zacapu	-	7 (1973)	S
PERU	Bayer Industrial	Lima	-	6 (1971)	S
JAPAN	Asahi Chemical Industry Co.,Ltd.	Nobeoka, Fuji	45	4	S
	Mitsubishi Rayon Co., Ltd.	Hiroshima	50		S
	Japan Exran Industry Co.,Ltd.	Saidaiji	48		S
	Toray Industry Inc.	Ehime	30		S
	Touhou Vesron Co., Ltd.	Mishima	33		S
	Kanegafuchi Spinning Co.,Ltd.	Takasago	13		S
TAIWAN	Nan Ya Plastics	Kaohsiung	9		S
	Tong Hwa Synthetic	Hsinshu	-	n.a.	S
KOREA	Oriental Synthetic Fiber	Ulsan	7	3 (1972)	S
	Hanil Synthetic Fiber	Masan	4	4 (1972)	S
	Hankook Synthetic Fiber		-	6 (1971)	S
INDIA	J.K. Synthetics	Kota	4	12 (n.a.)	S
	New Swadeshi Mills	Baroda	-	4 (n.a.)	S
	Tata Textiles	Koyali	-	n.a.	S
ISRAEL	Israeli Chemical Fiber	Ashdod	2		S

Remarks: Y : Filament

S : Staple

M : Monofilament

Annex Q-8.

PRODUCERS OF POLYPROPYLENE

(Unit : 1000 t/y)

	Companies	Location	Present Capacity (end-1970)	Planned Capacity	Remarks
U S A	Hercules	Lake Charles	165	80	1971
		Parlin	36		
	Alamo Polymer	Pasadena	8		
	Amoco Chem	Alvin	68		
	Dart Ind	Odessa	23	13	1971
	D. Shamrock	Houston, Tex	9		
	Shell Chemical	Woodburg, NJ	113	68	1971
	El Paso Products	Odessa, Tex	-	23	1971
	Rexene Polymers	Odessa, Tex	-	60	1971
	Phillips Petroleum	Pasadena, Tex	36		
	Alamo Industry	Houston, Tex	32	32	1971
	Avisun	New Castle	113		
		Brazoria County	68		
	Diamond Shamrock	Deer Park	41		
	Eastman Kodak	Longview	40		
	Enjay	Baytown Baton Rouge)	10		
		Cedar Bayou	136		
	Novamont	Neal	36	37	
CANADA	Imperial Oil	Sarnia, Ont.	34		
FRANCE	Naphtachimie SA	Lavéra	15		
	Soc. Normande Matieres	Lillebonne	12	5	1971
			-	40	1972
	Soc. Industrielle des Polyolefines	Gonfreville	20		
WEST GERMANY	BASF	Ludwigshafen	3		
	Hoechst AG	Kelsterback	35	85	1971
	Vestolon GmbH	Gelsenkrichen	14	12	1972
		Marl	6	6	
	Rheinische Olefinwerke	Wesseling	24	46	1973

	Companies	Location	Present Capacity (end-1970)	Planned Capacity	Remarks
WEST GERMANY	Farbwerke Hoechst	Frankfurt-Höchst	60		
	VEBA Chemie/Hüls	Scholven	6		
ITALY	Montedison	Brindisi	-	30	1971
		Ferrara	60		
		Cagliari, Sardinia	-	60	1973
	Polymer SpA	Terni	52		
	Liquigas SpA	Sibari	-	60	1971
	ANIC	Gela	40		
NETHER-LANDS	Rotterdamse Polyolefinen	Pernis	30	45	1972
	Shell Nederland Chemie NV	Rotterdam	30	45	1972
BELGIUM	Amoco Chem Belgium	Geel	-	100	
U K	I C I	Wilton	60	60	1971
		Tees-side	30		
	Shell Chemical	Carrington	45	45	1972
AUSTRIA	Danubia Petrochemie	Schwechat	20	7	1971
			-	13	1972
SWEDEN	Esso Chemical AB	Stenungsund	-	13	
SPAIN	Paulas SA	Puertollano	14	16	1972
BRAZIL	Agro Brazil-Empreendimentas Rurais SA		15		
	Supercarbon Petroquimica SA	Aratu	-	15	
CHILE	Petroquimica Chilena SA	Conception	-	20	1971
JAPAN	Idemitsu Petrochem	Chiba	-	30	1971
	Japan Olefin Chem	Ohita	60		
	Mitsubishi Petrochem	Kashima	60		
		Yokkaichi	90		

	Companies	Location	Present Capacity (end-1970)	Planned Capacity	Remarks
JAPAN	Mitsui Senpaku Petro-Chem	Osaka	33		
	Showa Denko	Ohita	30		
	Ube Industry	Sakai	30	30	1971
		Chiba	-	20	1971
	Tonen Petrochemical	Kawasaki	-	30	1971
	Mitsui Toatsu Chem	Ohtake	80		
		Sakai	30	30	1972
	Tokuyama Soda	Tokuyama	30		
	Toyo Rayon	Chiba	-	30	1972
	Sumitomo Chiba Chem	Chiba	90		
	Sumitomo Chem	Ohe	50		
		Niihama	30		
	Mitsubishi Chem Ind	Mizushima	-	30	1971
	Mitsui Petrochemical Ind	Anegasaki	55		
	Chisso Petrochemical	Goi	110	35	1973
	Asahi Chem Ind		-		
	Chuubu Chemical	Yokkaichi	-	30	1972
INDIA	Alembic Chem Works	Koyali	11		
KOREA	Kuktae	Ulsan	-	20	1972
TURKEY	Petkim Petrokimya AS	Aliaga	-	35	1974

Annex Q-9.

PRODUCERS OF SBR

(Unit : 1000 t/y)

	Companies	Location	Present Capacity (end-1970)	Planned Capacity	Remarks
U S A	American Synthetic Rubber Corp.		125		
	Ameripol Inc.		192		
	Ashland Chemical Co.		60		
	Copolymer Rubber & Chemical Corp.		125		
	The Dow Chemical Co.		20		
	The Firestone Tire & Rubber Co.		358		
	CAF Corp.		20		
	The General Tire & Rubber Co.		90		
	BF. Goodrich Industrial Pralusts Co.		15		
	The Goodyear Tire & Rubber Co.		335		
	W.R. Grace & Co.		15		
	Hooker Chemical Corp.		5		
	Phillips Petroleum Co.		66.5		
	Shell Chemical Co.		97		
	Sinclair-Koppers Co.		20		
	Southwest Latex Corp.		5		
	Standard Brands Chemical Industries Inc.		31		
	Texas-US Chemical Industries Inc.		148		
	Uniroyal Inc.		26		
	Wica Chemicals Inc.		11.5		
CANADA	Dow Chemical of Canada Ltd.		10		
	Polymer Corp. Ltd.		140		

	Companies	Location	Present Capacity (end-1970)	Planned Capacity	Remarks
FRANCE	Compagnie Francaise des Produits Chemiques Shell		95		
	Firestone-France SA		8		
	Goodyear Chemical Products		4		
	Michelin & Cie, Clermont-Ferrand		10		
	Polymer Corp.(SAF)		140		
WEST GERMANY	Bunawerke Huls GmbH		180		
	Chemische Werke Huls AG		10		
	Dow Chemical GmbH		45		
	Synthomer Chemie GmbH		14		
ITALY	ANIC SpA		135	50	1971
	Grace Italiana SpA		1		
NETHER-LANDS	Dow Chemical (Nederland) NV		11		
	Marbon NV		10		
	Shell Nederland Chemie NV		135		
BELGIUM	Petrochim NV		45		
U K	Doverstrand Ltd.		10	10	1971
	Dow Chemical Co. (UK) Ltd.		6		
	Dunlop Chemical Products Div.		10.5		
	The International Synthetic Rubber Co. Ltd.		170		
	Mardon Chemical		30		
	Uniroyal Ltd.		15		
SPAIN	Dow (Spain)		20		

	Companies	Location	Present Capacity (end-1970)	Planned Capacity	Remarks
ARGENTINA	PASA Petroquimica		43		
	Dow Quimica Argentina		2		
			-	6	1974
BRAZIL	FABOR		60		
	Petrobras Quimica SA		20		
MEXICO	Adhesivas Resistol SA		7		
	Hules Mexicanos SA		44		
	Negromex SA		20		
JAPAN	Asahi Chemical Industry Co., Ltd.		26		
	Japan Synthetic Rubber Co., Ltd.		281		
	The Japanese Geon Co., Ltd.		150		
	Lacster Corp.		4		
	Sumitomo-Naugatuck Co., Ltd.		7		
	Takeda Chemical Industries		12		
KOREA	Korea Synthetic Rubber Corp.		-	15	1972
AUSTRALIA	Australian Synthetic Rubber Co., Ltd.		30		
	Dow Chemical (Australia) Pty.Ltd.		2		
INDIA	Synthetics & Chemicals Ltd.		30	20	1970/1971
TURKY	Petkim Petrokimya AS		-	26	1973

	Companies	Location	Present Capacity (end-1970)	Planned Capacity	Remarks
SOUTH AFRICA	Synthetic Latex Co. (Pty) Ltd.		2		
	The Synthetic Rubber Co.(Pty) Ltd.		35		
ARGERIA	Ste des Monomer de Synthese	Skikuda	-	50	1975

Annex Q-10.

PRODUCERS OF MALEIC ANHYDRIDE

(Unit : 1000 t/y)

	Companies	Location	Present Capacity (end-1970)	Planned Capacity	Remarks
U S A	Allied Chem	Moundsville W. Va	9	11	1971
	Koppers	Bridgeville Pa	15.4		
	Monsanto	St Louis Mo	47		
	Petro-Tex Chem	Houston Tex	23		
	Reichhold Chems	Elizabeth N J	13.6		
		Moris Ill	-	27	1971
	Tenneco	Fords N J	10		
	USS Chems	Neville Island Pa	18.1		
CANADA	Monsanto Canada	La Salle	3		
FRANCE	CFMC	Villiers-St-Paul	5		
	Société Chimique des Charbounages	Drocourt	3	8	2nd half 1971
	Pechiney-Saint Gobain	Chauny	2.4		
	Reichhold Beckacite	Niort	5		
	Ugnine Kuhlmann	Villers-Saint-Paul	13		
WEST GERMANY	BASF	Ludwigshafen	4	8	1971
	DIA Chemi Anlagen	Schkapau	2.5		
	Palycarbona Chemie	Meebeck-Meere	12		
	Ruhrol Chemiewerk	Battrop	20	1	July 1971
ITALY	Bombrini Parodi Deilfino	Colleferro	7.5		
	Montedison	Porto Marghera	5		
		Rho	4		
	SAVA-Ftalital	Scanzorosciate	15	15	1971
		Bergamo	10		

	Companies	Location	Present Capacity (end-1970)	Planned Capacity	Remarks
BELGIUM	Chimique de Selzaete	Zelzaete	5		
	UCB	Havre-Ville	2		
		Wondelgem	5.5		
U K	Bp Chems	Salt End	-	70	1971
	ICI	Ardeer Ayshire	-		
	Monsanto Chem	Newport	9	18	early 1972
	Burts and Harvey	Belvedere	1.5		
AUSTRIA	OSW	Linz	-	8	1971
SPAIN	Industrias Quimicas de Luchana	Luchana	1.5		
	Resinas Poliesteres	Miranda de Ebro			
BRAZIL	Industrias Quimicas Resana, SA		1		
JAPAN	Mitsui Toatsu Chemicals Inc.	Omuta	3.6		
		Senpoku	3.3	11.7	early 1971
		Nagoya		12	1972
	Mitsubishi Chemical Industries, Ltd.	Mizushima	18		
		Kurosaki	5.4		
	Japan Catalytic Chemical Industry Co., Ltd.	Fukita	22		
	Takeda Chemical	Hikari	6.	12	early 1972
	Nippon Oils & Fats Co., Ltd.	Oita	6	6	late 1971
	Dainippon Ink Co., Ltd.	Yokkaichi		6	(----)
	Dainippon Ink Co./ Kyowa Yuka Co./ Hitache Chemical	Yokkaichi		10.4	1973

Annex Q-11.

PRODUCERS OF ALKYLBENZENE

(Unit : t/y)

	Companies	Location	Present Capacity (end 1970)	Planned Capacity	Remarks
U S A	Atlantic Refining	Atreco, Tex	22,700		
			23,000		
	Continental Oil	Baltimore, Md.	68,000		
			100,000		
	Monsanto	St Louis, Mo.	68,000		
			68,000		
	Union Carbide	Institute, W Va.	68,000		
			68,000		
	Witfield	Watson, Cal	13,600		
			20,000		
	American International Refining	North Claymont, Del.	36,300	45,000	
FRANCE	Produits Chimiques	Grand Couronne	30,000		
	Shell	Berre	50,000		
	Petrosynthese	Gonfreville	40,000		
	Esso Standard	Port Jerome	30,000		
WEST GERMANY	Chemishe Huls	Marl	50,000		
	Rheinpreussen	Humburg	18,000		
	Wibarco		27,000		
ITALY	Sicedison	Mantua	24,000		
	SIR	Borgaro Torinesse	15,000		
		Mailand	30,000		
		Porto Torres	60,000		
BERGIUM	Petrochim SA	Antwerp	12,000	10,000	
	Compagne des Chimique Produits Shell Belle	Belle	70,000		

	Companies	Location	Present Capacity (end 1970)	Planned Capacity	Remarks
BERGIUM	Esso Chimie SA	Port Jerome	40,000	40,000	
	Petrosynthese SA	Gonfreville	25,000	25,000	
NETHER-LANDS	Shell Netherland Chimie NV	Pernis	n.a.		
U K	Grnge Chemical	Grangemouth	15,000		
	Monsanto	New Port	16,000		
	Shell Chemical	Shell Haven	35,000		
SPAIN	Petroqyimica Espanola	Cadix	50,000		
ARGENTINA	YPF	La Plata	-	15,000	Planning
BRAZIL	Empressa Carioca de Productos Quimicas SA	Sao Paulo	20,000		
MEXICO	Pemex	Azcapotzalco	25,300		
		Cudad Madero	25,300		
COLOMBIA	Empresa Colombiana de Petroleos	Barrancabermeja	-	15,000	1971
JAPAN	Nissan Conoco	Chiba	30,000		
	Nippon Atlantic	Kikumoto	20,000		
	Nippon Synthetic Detergent	Kawasaki	38,000		
	Mitsubishi Petro-chemical	Yokkaichi	47,000		
KOREA	Esso Chemical	Ulsan	-	18,000	1972
TAIWAN	Chinese Petroleum Corp.	Kaohsiung	-	25,000	1974

	Companies	Location	Present Capacity (end 1970)	Planned Capacity	Remarks
AUSTRALIA	Shell Chemical		8,000		
TURKY	Petrokimya	Izmit	10,000	10,000	

Annex Q-12.

PRODUCERS OF CAPROLACTAM

(Unit: 1,000 tons)

	Companies	Location	Present capacity (end-1969)	Planned capacity	Remarks
U.S.A.	Allied Chemical		135		
	Dow Badlsche		100		
	Columbia/Nipro		22	50	1972
	Union Carbide		22		
W. GERMANY	Bayer		123		
	BASF		140	20	1970
ITALY	Montecatini Edison		75		
	Rhodiatoce		9		
	Snia Viscosa		68		
	SIR		12		
	ANIC		20		
	Italiana Chemica Dow		-	80	1972
NETHERLANDS	DSM		110	10	1970
BELGIUM	Bayer		70		
	BASF		60	120	1971
U K	Nypro		20	50	1972
SWITZERLAND	Emserwerke		16	5	1971
SPAIN	Productos Quimicos		20	20	1971
	Esso		20		
	Rio Tinto/BASF		20		
	Productos del Aquitram		-	35	1971
MEXICO	Cicloamidas SA, Salamanco		15	50	1971
COLOMBIA	Monomeros Columbo-venezolanos S.A., Barranquilla		-	16.5	1970

	Companies	Present Capacity (end-1969)	Planned Capacity	Remarks
India	Gujarat State Fertilizers	-	20	1970
Korea	Toyo Caprolactam	10		
	Dong Yang Caprolactam	7.2		
	Allied Chemical/ Chungju	-	25	1972
Japan	Mitsubishi	96		
	Ube Kosan	105		
	Toyo Rayon	98.5		
	Nippon Lactam	40		
	Fuji Steel Co.	25		
	Honshu Kogaku	14.4		
Turkey	Petkim	-	25	

Annex 6-13.

PRODUCERS OF POLYAMID FIBERS

(Unit : 1,000 t/y)

	Companies	Location	Present Capacity (end-1970)	Planned Capacity	Remarks	
U S A	Du Pont	Seaford, Del.	45)		NY 66	YMS
		Martinsville, Va.	45)		NY 66	Y
		Chattanooga, Tenn.	45)		NY 66	Y
			27)		NY 66, N-44	Y
			5)	45 (1974)	NY 472	Y
		Richmond, Va.	64)		NY 66	Y
			32)		N-44	Y
			5)		NY 66	YS
		Camden, S.C.	18)		NY 66	
		Parkersburg, W.Va.	1)		NY6,66,610	YM
	Monsanto	Pensacola, Fla.	95		NY 66	YM
		Greenwood, S.C.	43		NY 66	YM
	Allied Chemical	Columbia, S.C.	95		NY 6	YM
		Hopewell, Va.	9		NY 6	YM
					NY 6	YS
	American Enkaeer	Enka, N.C.	36		NY 6	YMS
		Lowland, Tenn.	41		NY 6	YM
		Central, S.C.	-	18 (1971)	NY 6	
	Firestone Synthetic Fibers	Hopewell, Va.	20		NY 5	YM
	Beaunit Fibers	Elizabethton, Tenn.	5		NY 66	YS
		Itowah, Tenn.	45		NY 66	YS
	Fiber Industries	Greenville, S.C.	36		NY 66	YS
	Courtaulds North America	Le Moyne, Ala.	20		NY 5	YM
	Fibers International	Guayama, Puerto Rico	36		NY 66	Y
	Rohm and Haas	Fayetteville, N.C.	11		NY 6	YM
	North Carolina Textiles	Fuquay Varina, N.C.	1		NY 6	Y

	Companies	Location	Present Capacity (end-1970)	Planned Capacity	Remarks	
U S A	General Polymer	Wilkes Barre, Pa.	n.a.		NY 66	M
	Hanover Mills	Yanceyville, N.C.	1		NY 6	YM
	Nylon Engineering	Lowell, Mass.	n.a.		NY 6	YS
	Dow Badische	Anderson, S.C.	25		NY 6	YM
	Industrial Wire & Plastics	Spirit Lake, Iowa	n.a.		NY	M
	Chadbourn	Gainesville, Ga.	n.a.		NY	YM
	Newton Filaments	Homer, N.Y.	n.a.		NY 6,66,610	M
	Wellman	Johnsonville, S.C.	n.a.		NY 66	S
	Nypel	West Conshohocken, Pa.	n.a.		NY 6, 66	M
	Sauquoit Fibers	Scranton, Pa.	2		NY 6, 66	YM
	Soo Valley	Columbia, S.C.	n.a.		NY 6, 66	M
	Uniroyal Fiber & Textiles	Shelbyville, Tenn.	n.a.		NY 6	M
	Enjay Fibers & Laminates	Odenton, Mi.	n.a.		NY 6, 66	M
	Deering Milliken	Laurens, S.C.	n.a.		NY 6	M
	Monofilaments	Grottoes, Va.	n.a.		NY 6	M
CANADA	Du Pont of Canada	Kingston	31		NY 66	Y
	Courtaulds Canada	Cornwall	6		NY 6	Y
	Millhaven Fibres	Millhaven	5		NY 66	Y
	Union Carbide Canada	Aroprior	3		NY 6	YS
	Firestone Textiles	Woodstock	2		NY 6	YM

	Companies	Location	Present Capacity (end-1970)	Planned Capacity	Remarks	
FRANCE	Rhodiaceta	Besancon)	82		NY 6, 66	YS
		Lyon - Vaise)				
	CTA	Valence	6		NY 11	Y
		Vaulx - en Velin	9		NY 66	Y
	Norsyntex	Saint-Laurent-Blangy	8		NY 66	YS
	Courtaulds	Coquelles	n.a.		NY 6	Y
	Polyfibres	Saint - Nabord	7		NY 6	Y
	Chomarat	Marriac	n.a.		NY 6	Y
	ETS, Nysam	St. Quentin	n.a.		NY 6	Y
W.GERMANY	Glanzstoff	Oberbruch)			NY 66	Y
		Obernburg)	85			
		Kelsterbach)		)	NY 6	YS
	Hoechst	Bobingen	10		NY 6	YM
	Bayer	Domagen	29		NY 6	YS
	Rhodiaceta	Freiburg, Rottweil	14		NY 66	YS
	Zehlendorf	Barlin-Zehlendorf	5		NY 6	Y
	Phrix Werke	Hamburg-Neumunster	5		NY 6	YS
	J.P. Bemberg	Wuppertal-Oberbarmen	5		NY 6	Y
	ICI (Europe) Fibres	Ostringen	20	97 (1973)	NY 66	YS
		Offenbach	-	40 (1971)	NY 66	YS
	Du Pont(Deutschland)	Uentrop	14		NY 66	Y
ITALY	Rhodiatoce	Casoria)	50		NY 66	YS
		Pallanza)				
	Snia Viscosa	Cesano Maderno)				
		Varedo)	50		NY 6	YS
		Castellaccio)				
		Villacidro	5		NY 6	Y
	Orsi Mangelli	Forli	n.a.		NY 6	Y

	Companies	Location	Present Capacity (end-1970)	Planned Capacity		Remarks	
ITALY	Bemberg	Gozzano	5			NY 6	Y
	Ambrosiana	Pietra Santa	n.a.			NY 6	Y
	Omnia	Delebio	n.a.			NY 6	Y
	Radici Fil	Casnigo	n.a.			NY 6	Y
	Chatillon	Ivrea) Vercelli)	24			NY 6	Y
	Anic	Pisticci	10			NY 6	YS
	Fratelli Franchi	Canapale	n.a.			NY 6	Y
	Aquatex		n.a.			NY 6	
	Torcitura Di Borgomanero	Milano	n.a.			NY 6	Y
NETHERLANDS	Enka	Breda)	50 *			NY 6	Y
		Emmen)				NY 6	Y
		Arnkem	n.a.			NY 6	Y
BELGIUM	Fabelta	Zwijnaarde	15			NY 66	Y
	Bayer	Antwerpen	n.a.			NY 6	S
LUXEMBOURG	Monsanto	Echternach	14			NY 66	Y
U K	ICI Fibres	Pontypool)				NY 66	YS
		Doncaster)	113	23	(1971)	NY 66	YS
		Gloucester)				NY 66	YS
	Courtaulds	Spondon)	45			NY 6	Y
		Aintree)				NY 6	Y
	Monsanto Textiles	Dundonald	14	5	(1971)	NY 66	Y
	Plasticisers	Drighlington	3 *			NY 6	YMS
SWEDEN	Svenska Rayon	Alvenas	n.a.			NY 6	Y
FINLAND	Kone Oy	Kemi	n.a.				Y

	Companies	Location	Present Capacity (end-1970)	Planned Capacity	Remarks	
SWITZERLAND	Viscose Suisse	Emmenbruecke)	41 *		NY 66	Y
		Widnau)			NY 6	Y
	Ems Industries	Ems	n.a.		NY 6	YS
	Feldmuhle	Rorschach	5		NY 6	Y
SPAIN	SAFA	Blanes	11		NY 66	YS
	Seda de Barcelona	Alcala de Henares)	10		NY 6	YS
		Madrid)			NY 6	YS
	Inquitex	Andoain	2		NY 6	YS
	Solace	Torrelavega	5		NY 6	YS
	Fibras Esso	Zaragoza	6		NY 6	Y
PORTUGAL	CIFA	Sobrado	7 *		NY 6	Y
GREECE	Vomvix	Athens	3		NY 6, 66	Y
TURKEY	SIFAS	Bursa	13		NY 6	Y
	Islon Sentetik	Istanbul	2		NY 6	Y
MEXICO	Celanese Mexicana	Ocotlan, Toluca	5		NY 6	YS
	Nylon de Mexico	La Leona	1		NY 6	YS
	Fibras Quimicas	Monterrey	1		NY 6	YM
	Fibras Sinteticas	Mexico	2		NY 6	Y
	Fibrasomni	Ixtapalapa	n.a.		NY 6	M
	Kimex	Tlalnepantla	-	Planning	NY 6	Y
	Plastica Moderna	Tlalpan	n.a.		NY 6	M
	Productos Plasticos	Puebla	n.a.		NY 6	M

	Companies	Location	Present Capacity (end-1970)	Planned Capacity	Remarks	
BRAZIL	Rhodia Industrias	Santo Andre	34		NY 66	YS
	Textilquimica	Agua Branca, Sao Tose Dos Campos	n.a.		NY 6	Y
	Celfibras	Sao Bemardo do Campo	6		NY 66	Y
	Nailonsix	Sao Paulo	n.a.		NY 6	Y
	Brasileira de Sinteticos	Osasco	n.a.		NY 6	Y
	Soutex de Roupas	Rio de Janeiro	n.a.		NY 6	Y
	Fibra	Americana	n.a.		NY 6	Y
	Rhodia Nordeste	Cabo	n.a.		NY 66	S
ARGENTINA	Ducilo	Berazategui	4		NY 6, 66	Y
		Mercedes	3		NY 66	Y
	Nuevas Industrias	Hernandez-La Plata	1		NY 6	Y
	Prenyl	Ravson	0.4		NY 6	Y
	Hirlon	San Justo	n.a.		NY 6	Y
	Fibras Industriales	Quilmes	n.a.		NY 6	Y
	Valenciana Argentina	Buenos Aires	n.a.		NY 6	Y
	Petroquimica Sudamericana	Olmos-La Plata	n.a.		NY 6	YS
	Cordonsed Argentina	Arroyo Seco	n.a.		NY 6	Y
CHILE	Sumar	San Joaquin	5		NY 6	Y
	Nylinsa	Maipu	n.a.		NY 6	Y
COLOMBIA	Hilazas Vnylon	Barranquilla	5 *		NY 6	YM
	Enka de Colombia	Girardota	2		NY 6	Y
	Nylon de Colombia	Itagui	1		NY 6	Y
PERU	Manufacture Nylon	Vitarte	4		NY 6	Y
	Manufacturas del Sur	Arequipa	n.a.		NY 6, 66	Y
	Retex Peruana	Ventanilla	n.a.		NY 6	Y

	Companies	Location	Present Capacity (end-1970)	Planned Capacity	Remarks	
VENEZUELA	Inversiones Aragua	Maracay	3 *		NY 6	Y
	Fibras Quimicas	Valencia	1		NY 6	Y
	Hilados Flexilon	Caracas	n.a.		NY 6	Y
URUGUAY	Hisisa	Estacion Manga	0.5		NY 66	Y
	Sloawak	Montevideo	1		NY 6	YM
ELSALVADOR	Filpersa	San Salvador	n.a.		NY 6	M
JAPAN	Toray Industry Inc.	Aichi)			NY	F
		Shiga)	85	5	NY	F
		Okazaki)			NY	F
		Nagoya)	11		NY	S
		Shiga)			NY	S
	Unitika Co., Ltd.		53	5	NY	F
			3		NY	S
	Teijin Ltd.	Mihara	32		NY	F
	Kanegafuchi Spinning Co., Ltd.	Bofu	34		NY	F
	Asahi Chemical Industry Co., Ltd.	Nobeoka	29	3	NY 6, 66	F
	Toyobo Co., Ltd.	Tsuruga	29		NY	F
	Ube Kosan Co., Ltd.	Ube	-	1 (1971)	NY 66	F
INDIA	Nirlon Synthetic F & C	Goregaon	4		NY 6	YM
	Bombay Nylon	Thana	1		NY 6	YS
	Century Enka	Pimpri	2		NY 6	Y
	J.K. Synthetics	Kota	3		NY 6	YMS
	Gujarat Polyamides	Udhna	2		NY 6	Y
	Garware Nylons	Pimpri	1		NY 6	YM
	Delhi Cloth & General	Madras	-	Planning	NY 6	Y

	Companies	Location	Present Capacity (end-1970)	Planned Capacity	Remarks	
INDIA	Modipon	Modinagar	3	3	NY 6	Y
	Shree Synthetics	Bhopal	-	1 (1971)	NY 6	Y
	Ahmedabad Mfg	Ranoli	-	Planning	NY 6	Y
	Stretch Fibres India	Nagour	0.5		NY 6	Y
	Guptalon	Ludhiana	n.a.		NY 6	Y
ISRAEL	Rogosin Industries	Ashdod	4		NY 6, 66	Y
KOREA	Korea Nylon	Taegu	10		NY 6	Y
	Hanil Nylon	Anyang	5		NY 6	Y
	Tong Yang Nylon	Ulsan	5		NY 6	Y
PAKISTAN	Bengal Fibers	Karachi	n.a.		NY 6	Y
	Dawood Cotton Mills	Landhi	n.a.		NY 6	Y
	Fazal Nylon Mills	Lyallpur	1		NY 6	YM
	Pylon Industries	Chittagong	1		NY 6	Y
TAIWAN	United Nylon	Toufen	8		NY 6	Y
	Lien Yu Industrial	Liutu	5		NY 6	Y
	Kuo Hwa Chemical	Panchiao	5		NY 6	Y
	Jang Dah Nylon	Hsin Tien	1		NY 6	Y
	Hsieh Chin Fishing Net	Kaohsiung	n.a.		NY 6	M
	Ta Ming	Tainan	0.5		NY 6	Y
IRAN	Sherkat Sahani	Teheran	2		NY 6	Y
PHILIPPINES	Texfiber	Taytay	2		NY 6	Y
THAILAND	Toray Nylon Thai	Bangkok	1		NY 6	Y

	Companies	Location	Present Capacity (end-1970)	Planned Capacity	Remarks	
AUSTRALIA	Fibremakers	Bayswater	18		NY 66	YM
	Fibremakers Penrith	Penrith	3		NY 6	YM
	United Carpet Mills	Thanastown	n.a.		NY 6	Y
NEW ZEALAND	Fibremakers	Wiri	2		NY 66	YS
	Holeproof Mills	Shannon	0.6		NY 6	YS
SOUTH AFRICA	South African Nylon	Bellville	15 *		NY 66	YS
	Plastex	Isando	n.a.		NY 6	M
U A R	Misr Pour la Rayonne	Kafr-el-Dawar	1		NY 6	Y
					NY 6	S

***** ***** ***** ***** ***** ***** *****

Remarks :

*	:	Estimate
NY	:	Nylon
Y	:	Filament
S	:	Staple
M	:	Monofilament

Annex Q-14.

PRODUCERS OF POLYESTER FIBERS

	Companies	Location	Present Capacity (end-1970)	Planned Capacity	Remarks
USA	Du Pont	Kinston, N.C) Old Hickory, Tenn) Wilmington, N.C)	304	146 (1972)	YS YS S
	Beaunit Fibers	Elizabethton, Tenn	44		YS
	Tennessee Eastman	Kingsport, Tenn	91		YS
	Carolina Eastman	Columbia, S.C	50	31 (1971)	S
	Fiber Industries	Shelby, N.C) Salisbury, N.C)	265		YS YS
	Monsanto	Decatur, Ala	57		YS
	American Enka	Lowland, Tenn	28	6 (1971)	YS
	Allied Chemical	Moncure, N.C) Hopewell, Va)	23	36 (1971)	YS
	FMC	Front Royal, Va) Lewistown, Pa)	40	50 (1972)	YS
	Phillips Fibers	Rocky Mount, N.C	18		Y
	Hystron Fibers	Spartanburg, S.C	45		YS
	Goodyear Tire & Rubber	Point Pleasant, W.Va	15		Y
	Wellman	Johnsonville, S.C	2		S
	Soo Valley	Columbia, S.C	n.a.		M
	IRC Fibers	Painesville, Ohio	11		Y
	Newton Filaments	Homer, N.Y	n.a.		M
	Firestone Synthetic Fibers	Hopewell, Va	2		Y
	Dow Badische	Anderson, S.C	14	16 (1972)	YS
CANADA	Millhaven Fibers	Millhaven	23		YS
	Du Pont of Canada	Morrisburg	14		Y
FRANCE	Rhodiaceta	Besancon	57		YS
	CTA	Valence	9		S

	Companies	Location	Present Capacity (end-1970)	Planned Capacity	Remarks
W.GERMANY	Glanzstoff	Oberbruch) Obernburg	60		YS
	Hoechst	Bobingen	100		YS
		Bad Hersfeld	16		M
	Spinnfaser	Kassel-Bettenhausen	5		S
	Du Pont (Deutschland)	Uentrop	23	59 (1971)	YS
	ICI (Europa)	Ostringen	16	9 (1973)	YS
	Fibres	Offenbach	—	18 (1971)	YS
	Zehlendorf	Berlin-Zehlendorf	12		S
	Faserwerke Huels	Marl	24	15 (1974)	YS
	Rhodiaceta	Freiburg	—	6 (1972)	Y
	Phrix-Werke	Kreis Deggendorf	—	12 (1972)	Y
ITALY	Rhodiatoce	Casoria) Pallanza	26	16 (1973)	YS
	Generale Resine	Vibo Valentia	6		YS
	Chatillon	Vercelli) Ivrea	13		YS
	Anic	Pisticci	12		S
	Snia Viscosa	Cesano Maderno) Varedo	23	33 (1971)	YS
	Italiana Resino	Porto Torres	20		YS
NETHERLANDS	Enka	Breda) Emmen	41		Y
UK	Hoechst	Limavady	5	3 (1971)	Y
	ICI Fibers	Wilton) Kilroot	77	23 (1971)	YS
	British Enkalon	Antrim	11		Y
	Courtaulds	Carrickfergus	-	9 (1971)	Y
SWITZERLAND	Ems-Gelsenberg	Domat	10	5 (1972)	S
	Viscose Suisse	Widnau	-	n.a.(1971)	Y
AUSTRIA	Austria Faserwerke	Lenzing	25		S
PORTUGAL	Finicia-Fibras	Portalegre	5		S
SPAIN	SAFA	Blanes	14		YS
	Seda de Barcelona	Prat de Llobregat	1		YS

	Companies	Location	Present Capacity (end-1970)	Planned Capacity	Remarks
GREECE	Polyetma	Athens	-	1 (1971)	Y
VENEZUELA	Fibras Quimicas	Valencia	1		YS
	Hilados Flexilon	Caracas	n.a.		
	Sudantex	Maracay	n.a.		
	Fibras Sinteticas	Maracay	1		S
COLOMBIA	Polimeros Colombianos	Medellin	1		YS
	Celanese Colombiana	Yumbo	n.a.		S
	Enka de Colombia	Girardota	1		YS
BRAZIL	Rhodia Industria Quimicas	Santo Andre	3		YS
	Rhodia Nordeste	Cabo	n.a.		YS
	Cotonificio Gavea	Rio de Janeiro	1		S
	Textilquimica	Sao Jose dos Campos	3		S
	Polynor	Joao Pessoa	-	n.a.	YS
	Soutex de Roupas	Rio de Janeiro	n.a.		Y
	Safron	Salvador	n.a.		YS
ARGENTINA	Copet	Peccar	4		YS
	Petroquimica Sudamericana	Olmos - La Plata	3		YS
	Sudamtex	Azul	3		S
	Nahamias	Buenos Aires	n.a.		Y
	Rhodiaseta Argentina	Quilmes	n.a.		Y
MEXICO	Policron de Mexico	La Leona	n.a.		S
	Celanese Mexicana	Cootlan	1		Y
		Toluca	1		S
	Fibras Quimicas	Monterrey	n.a.		YS
	Kimex	Tlalnepantla	n.a.		Y
	Nylon de Mexico	La Leona	-	3 (1971)	Y
CHILE	Quimica Industrial	Maipu	1		S
	Fibro-Quimica	Santiago	3		S
	Sumar	San Joaquin	1		YS
PERU	Celanese Peruana	Lima	3		YS
URGUAY	Slowak	Montevideo	n.a.		YS

	Companies	Location	Present Capacity (end-1970)	Planned Capacity	Remarks
JAPAN	Toray Industry Inc.	Mishima	30	3	Y
		Mishima) Ehime	37	3	S
	Teijin Ltd.	Tokuyama) Matsuyama	39	3	Y
		Matsuyama) Ehime	30	3	S
	Kurare	Saijo) Tamashima	9	5	Y
		Tamashima	24	3	S
	Toyobo Co., Ltd.	Tsuruga) Iwakuni	15	1	Y
		Iwakuni	16	3	S
	Japan Ester Co., Ltd.	Okazaki	9		Y
		Okazaki	21	5	S
	Asahi Chemical Industry Co.,Ltd.	Nobeoka	3	6	Y
	Shinko Ester Co., Ltd.	Toyohashi	6	3	Y
	Kanegafuchi Spinning Co.,Ltd.	Boufu	6	3	Y
	Toyobo Pet Code	Tsuruga	7		Y
TAIWAN	Hualon-Teijin	Toufen	4		YS
	Kuo Hwa Chemical	Panchiao	2		Y
	Asia Cement	Hsinpu	-	n.a.	S
	Hung Chou Chemical	Kuishan	-	n.a.	Y
	Lien Yu Industrial	Liutu	-	n.a.	Y
	Nan Ya Plastics	Taishan	-	n.a.	S
	Shinkong Synthetic Fibers	Chungli	-	n.a.	Y
	Yu Ho Fiber	Tao-yuan	-	n.a.	Y
KOREA	Daehan Synthetic Fiber	Pusan	7		YS
	Sam Yang	Chonju	5		YS
	Sun Kyong-Teijin	Suwon	3	8	Y
	Tai Han Industrial	Taegu	1		S
	Korea Polyester	Taegu	n.a.		Y
PHILLIPPINES	Filipinas Synthetic	Manila	n.a.		YS

	Companies	Location	Present Capacity (end-1970)	Planned Capacity	Remarks
THAILAND	Teijin Tetoron	Rangsit	n.a.		S
	Toray Nylon Thai	Bangkaen	n.a.		Y
INDIA	Chemicals & Fibres	Thana	6		S
	Ahmedabab Mfg	Ranoli	-	n.a.	S
	Indian Organic Chemicals	Manali	-	n.a.	S
	J.K. Synthetics	Kota	-	n.a.	Y
	Swadeshi Polytex	Kovinagar	-	n.a.	S
	Nirlon Synthetic	Goregaon	-	n.a.	Y
TURKEY	Polylen Sentetik	Bursa	8		YS
	Sancak Tul	Istanbul	n.a.		Y
	Sasa Suni	Adana	5		S
AUSTRALIA	Fibremakers	Baywater	7		YS
NEW ZEALAND	Holeproof Mills	Shannon	n.a.		YS
SOUTH AFRICA	Hoechst Fibres & Chemicals	Milnerton	1		S
	South African Nylon	Bellville	1.5		Y

Remarks: Y : Filament
S : Staple
M : Monofilament

Annex R-1 -(a)

CUSTOM DUTY OF PETROCHEMICALS

(Unit : %)

Countries	Assessable Price	LDPE 1968	LDPE 1970	LDPE 1972	HDPE 1968	HDPE 1970	HDPE 1972	VCM 1968	VCM 1970	VCM 1972
EEC Countries	CIF	20	16	10	20	16	10	19	13.3	9.5
UK	CIF	Free	Free	Free	Free	Free	Free	Free	Free	Free
Sweden	CIF		10			10			11	
Norway	CIF		10			10			Free	
Spain	CIF		22			22			12.5	
Portugal	CIF		2.4 Es/kg			2.4 Es/kg			12	
USA	Remarks 1	2.8 ¢/lb + 18% av	1.9 ¢/lb + 14% av	1.4 ¢/lb + 9% av	2.8 ¢/lb + 18% av	1.9 ¢/lb + 14% av	1.4 ¢/lb + 9% av	2.7 ¢/lb + 13% av	2.1 ¢/lb + 10% av	1.5 ¢/lb +7.5% av
Canada	Remarks 2		7.5			7.5			10	
Mexico	Remarks 3		0.05 P/kg + 6% av			0.05 P/kg + 6% av			0.01 P/kg + 3% av	
Brazil	Remarks 4		45			45			30	
Argentina	Remarks 5		100			100			60	
Venezuela	FOB		2.00 B/kg			2.00 B/kg			2.00 B/kg	
Colombia	CIF		40			40			40	
Peru	FOB Price x 1.2		2.5 So/kg + 30% av			2.5 So/kg + 30% av			2.0 So/kg + 30% av	
Japan	CIF	48.6 ¥/kg	41.8 ¥/kg	35 ¥/kg	48.6 ¥/kg	41.8 ¥/kg	35 ¥/kg	18	14	10

Annex R-1 -(b)

CUSTOM DUTY OF PETROCHEMICALS

(Unit : %)

Countries	Assessable Price	PVC			Styrene			Polystyrene		
		1968	1970	1972	1968	1970	1972	1968	1970	1972
EEC Countries	CIF	16	14	10	8	5.6	4	20	16	10
UK	CIF	Free	Free	Free	Free	Free	Free	Free	Free	Free
Sweden	CIF		10			Free			10	
Norway	CIF		26			Free			26	
Spain	CIF		28			Free			23.5	
Portugal	CIF		3.375 Es/kg			12			Free	
USA	Remarks 1	2.2 ¢/lb + 11% av	1.7 ¢/lb +8.5% av	1.25 ¢/lb + 6% av	2.5 ¢/lb + 16% av	1.9 ¢/lb +12.5% av	1.4 ¢/lb + 9% av	2.8 ¢/lb + 18% av	1.9 ¢/lb + 14% av	1.4 ¢/lb + 9% av
Canada	Remarks 2		12.5			10			7.5	
Mexico	Remarks 3		0.10 P/kg + 10% av			0.01 P/kg + 4% av			0.3 P/kg + 40% av	
Brazil	Remarks 4		55			20			55	
Argentina	Remarks 5		100			60			100	
Venezuela	FOB		2.00 B/kg			2.00 B/kg			2.00 B/kg	
Colombia	CIF		40			25			40	
Peru	FOB Price x 1.2		2.5 So/kg + 30% av			1.20 So/kg + 30% av			2.5 So/kg + 30% av	
Japan	CIF	18	14	10	18	14	10	18	14	10

Annex R-1 -(c)

CUSTOM DUTY OF PETROCHEMICALS

(Unit : %)

Countries	Assessable Price	PG			Acrylonitrile			Acrylic Fiber		
		1968	1970	1972	1968	1970	1972	1968	1970	1972
EEC Countries	CIF	19	15.1	12.5	14	9.8	7	14	10.7	8.5
UK	CIF	Free	Free	Free	Free	Free	Free	Free	Free	Free
Sweden	CIF		11			Free			10	
Norway	CIF		24			24			24	
Spain	CIF		13			Free			9	
Portugal	CIF		Free			12			0.8 Es/kg	
USA	Remarks 1	2.7 ¢/lb + 13% av	2.1 ¢/lb + 10% av	1.5 ¢/lb +7.5% av	2.5 ¢/lb +12.5% av	1.7 ¢/lb +8.5% av	1.25 ¢/lb + 6% av	3 ¢/lb	1.8 ¢/lb	1 ¢/lb
Canada	Remarks 2		10			10			5	
Mexico	Remarks 3		0.5 P/kg + 15% av			0.5 P/kg + 15% av			0.1 P/kg + 15% av	
Brazil	Remarks 4		15			15			30	
Argentina	Remarks 5		20			20			70	
Venezuela	FOB		2.00 B/kg			2.00 B/kg			2.00 B/kg	
Colombia	CIF		40			15			30	
Peru	FOB Price x 1.2		1.5 So/kg + 30% av			3.0 So/kg + 30% av			2.0 So/kg + 30% av	
Japan	CIF	19	17	15	18	14	10	22.5	17.5	12.5

Annex R-1 -(d)

CUSTOM DUTY OF PETROCHEMICALS

(Unit : %)

Countries	Assessable Price	PP			SBR			Maleic Anhydride		
		1968	1970	1972	1968	1970	1972	1968	1970	1972
EEC Countries	CIF	23	16.1	11.5	10	6.4	4	15	10.5	7.5
UK	CIF	Free	Free	Free	Free	Free	Free	Free	Free	Free
Sweden	CIF		10			Free			Free	
Norway	CIF		26			Free			Free	
Spain	CIF		Free			Free			17.3	
Portugal	CIF		Free			Free			Free	
USA	Remarks 1	2.8 ¢/lb + 18% av	1.96 ¢/lb +12.6% av	1.4 ¢/lb + 9% av	Free	Free	Free	3.5 ¢/lb + 20% av	2.42 ¢/lb + 16% av	1.7 ¢/lb + 10% av
Canada	Remarks 2		7.5			Free			10	
Mexico	Remarks 3		0.1 P/kg + 6% av			0.3 P/kg + 25% av			0.01 P/kg + 6% av	
Brazil	Remarks 4		55			20			37	
Argentina	Remarks 5		60			100			20	
Venezuela	FOB		2.00 B/kg			2.00 B/kg			2.00 B/kg	
Colombia	CIF		40			10			30	
Peru	FOB Price x 1.2		2.5 So/kg + 30% av			6.0 So/kg + 30% av			5.0 So/kg + 30% av	
Japan	CIF	53.6 ¥/kg	46.8 ¥/kg	40.0 ¥/kg	Free	Free	Free	16	14	12

Annex R-1 -(e)

CUSTOM DUTY OF PETROCHEMICALS

(Unit : %)

Countries	Assessable Price	Alkylbenzene			Caprolactam			Nylon 6		
		1968	1970	1972	1968	1970	1972	1968	1970	1972
EEC Countries	CIF	16	10.3	6.5	16	9.1	6.5	14	10.7	8.5
UK	CIF	Free	Free	Free	Free	Free	Free	Free	Free	Free
Sweden	CIF		Free			10			10	
Norway	CIF		Free			24			24	
Spain	CIF		17.3			45			9	
Portugal	CIF		Free			12			0.8 Es/kg	
USA	Remarks 1	3.5 ¢/lb + 20% av	2.42 ¢/lb + 16% av	1.7 ¢/lb + 10% av	2.7 ¢/lb + 18% av	2 ¢/lb + 14% av	1.5 ¢/lb + 10% av	3 ¢/lb	1.8 ¢/lb	1 ¢/lb
Canada	Remarks 2		10			5			5	
Mexico	Remarks 3		n.a.			n.a.			0.1 P/kg + 15% av	
Brazil	Remarks 4		37			15			30	
Argentina	Remarks 5		n.a.			20			70	
Venezuela	FOB		2.00 B/kg			2.00 B/kg			2.00 B/kg	
Colombia	CIF		10			25			30	
Peru	FOB Price x 1.2		n.a.			7.0 So/kg + 30% av			2.0 So/kg + 30% av	
Japan	CIF	13.5	10.5	7.5	18	14	10	22.5	17.5	12.5

Annex R-1 -(f)

CUSTOM DUTY OF PETROCHEMICALS

(Unit : %)

Countries	Assessable Price	TDI			DMT			Polyester Fiber		
		1968	1970	1972	1968	1970	1972	1968	1970	1972
EEC Countries	CIF	16	11.2	8	18	9.8	7	14	10.7	8.5
UK	CIF	Free	Free	Free	Free	Free	Free	Free	Free	Free
Sweden	CIF		12			Free			10	
Norway	CIF		24			Free			24	
Spain	CIF		Free			1			9	
Portugal	CIF		12			12			0.8 Es/kg	
USA	Remarks 1	3.5 ¢/lb + 20% av	2.42 ¢/lb + 16% av	1.7 ¢/lb + 10% av	11	8.5	6	3 ¢/lb	1.8 ¢/lb	1 ¢/lb
Canada	Remarks 2		10			10			5	
Mexico	Remarks 3		0.5 P/kg + 50% av			0.5 P/kg + 65% av			0.1 P/kg + 15% av	
Brazil	Remarks 4		15			15			30	
Argentina	Remarks 5		20			20			70	
Venezuela	FOB		2.00 B/kg			2.00 B/kg			2.00 B/kg	
Colombia	CIF		25			30			30	
Peru	FOB Price x 1.2		1.0 So/kg + 30% av			5.0 So/kg + 30% av			2.0 So/kg + 30% av	
Japan	CIF	18	14	10	20	16	10	22.5	17.5	12.5

Remarks of Annex R-1

1. American Selling Price

2. Market Prices in the export countries

3. Higher price whether invoice price or official price decided by Ministry of Commerce and Industry of Mexico

4. Appropriate price in import price

5. Higher price whether CIF or official fixed price by government

As the concession rate of the listed countries without EEC, UK, USA and Japan are not written in the List of Custom Tariff of each country, the tariff in 1968 and 1972 are excluded.

Abbreviations :	¢/lb ... Cents/pound	E/kg ... Escudo/kilogram
	P/kg ... Pesos/kilogram	So/kg... Sols/kilogram
	B/kg ... Bolivar/kilogram	av ..... ad valorem

Source : List of Custom Tariff of Each Country

Chemical Product Data (published by ECN Chemical Data Services)

Annex R-2

OTHER IMPORT TAXES

BELGIUM	TRANSMISSION TAX: 7% of the duty paid value (this tax is payable, in effect, at the same rates on goods produced in Belgium).
FRANCE	VALUE ADDED TAX: 23.45% of the duty paid value (this tax is also payable at the same rate, on goods produced in France).
WEST GERMANY	IMPORT TURNOVER TAX (Einfurhumsatzsteuer): 11% assessed on the duty paid value including transport charges up to first place of destination in Federal territory. (less rebate of 4%)
ITALY	ADMINISTRATION FEE: 1% levied on c.i.f. value. GENERAL TURNOVER TAX (I.G.A.): 4% of the gross landed value. Also levied on the invoice value of the goods, in each subsequent transaction. COMPENSATORY TAX: 2.4% of the gross landed value. This tax is levied only on importation.
NETHERLANDS	VALUE ADDED TAX: 12% of the importers' selling price.
U K	NONE
SWEDEN	SALES TAX of 10% levied on both imported and locally produced goods. Certain raw materials are exempt.

NORWAY	SALES TAX: 13.64% on imported and locally produced goods on the final calculation of cost. Some raw materials and products for agricultural use are exempt.
SPAIN	HOME COMPENSATION TAX: 10% levied on the duty paid value
PORTUGAL	None
U S A	None
CANADA	SALES TAX: 12% of the duty paid value (not collected at time of importation on materials used in manufacture or goods imported by licenced wholesalers.)
MEXICO	SURTAX: 3% of the total duty payable. Certain Imports are also liable to an IMPORT SURCHARGE of 10% ad. val. f.o.b.
BRAZIL	MANUFACTURED GOODS TAX: 4% of duty paid value. Imports are also liable to Port Charges, Warehousing Charges, Despatcher's Commission and Merchant Marine Fund Contribution.
ARGENTINA	SALES TAX: 10% of the landed value (levied on imported and locally produced goods). Imports are also liable to FREIGHT TAX and STATISTICAL FEES.
VENEZUELA	Imports liable to Consular charges based on the value of the consignment.

COLOMBIA	SALES TAX: 3% of the selling price of all goods whether imported or locally produced CONSULAR FEE: 1% of the f.o.b. value.
PERU	SURCHARGE: 10% of the c.i.f. value. FREIGHT TAX: 4% of the freight charges. STATISTICAL TAX: 1.5% of the c.i.f. value. PORT HANDLING CHARGE: 13/27 soles per ton. SALES TAX: 5% of the selling price.
JAPAN	None

Annex S. Maximum Pruchase Price of Raw Material

Since at the present time, firm committments on prices from the possible suppliers of raw materials could not be obtained, (the price utilized in the report are actually shadow prices based on world market or export prices), the estimation of a maximum purchase price of certain raw material was required by T&T especially in the case that the supply of raw material could be expected only from the existing Petrochemical Plant (TEXACO) and no Complex based upon the prospective raw materials could not be materialized, A maximum purchase price of raw matêrial was derived by following assumptions.

1) The selling price is T&T FOB price

2) Rate of return on investment is 10.3% uniformly with every product. (Net income is 10% of Capital Investment)

The results are shown as follows:

(1) Maleic Anhydride ⟶ Benzene

For selling maleic anhydride of 23,400 t/y at 197.2 $/t (T&T FOB Price), 30,000 t/y of Benzene must be required at 69.72 $/t.

(2) TDI ⟶ Toluene

For selling TDI of 30,000 t/y at 596.4 $/t, 20,400 t/y of toluene must be required at 223.53 $/t.

(3) Linear Alkylbenzene ⟶ Benzene, ⟶ n-Paraffine

For selling L-Alkylbenzene of 71,600 t/y at 148.7 $/t, 73,000 t/y of n-Paraffine and 27,200 t/y of benzene must be required respectively a) at 102.82 $/t and 55.6 $/t or b) at 90.57 $/t and 88.5$/t.

(4) Nylon-6-F ⟶ Caprolactam ⟶ Cyclohexane

For selling Nylon-6-F of 18,000 t/y at 1,177.7 $/t, 17,700 t/y of Caprolactam at 424.23 $/t or 19,500 t/y of Cyclohexane at 157.37 $/t must be required.

(5) DMT ⟶ Terephthalic Acid ⟶ P-Xylene ⟶ Xylene

For selling DMT of 52,700 t/y at 304.4 $/t, 45,300 t/y of terephthalic acid at 237.72 $/t, or 34,000 t/y of P-xylene at 109.09 $/t, or 40,000 t/y of Xylene at 55.67 $/t must be required.

Annex T. Preliminary Calculations for Assessment of Stepwise Implementation.

(1) Group 1

Group 1 consists of maleic anhydride, nylon-6-F and linear alkyl benzene. The following calculation was based on the assumption that:

for maleic anhydride; 32,000 t/y of benzene will be supplied at the price of 55.6 $/t by Texaco,

for nylon-6-F; 19,600 t/y of cyclohexane will be supplied at the price of 61.75 $/t by Texaco,

for linear alkylbenzene; 19,000 t/y of benzene will be supplied at the price of 55.6 $/t and 51,000 t/y of n-paraffine will be supplied at the price of 90.57 $/t by Texaco.

The net manufacturing costs are shown in Table T-(1)-1-3 (there are shown the manufacturing costs based on the different plant capacities for understanding the scale effects - depending on the available quantity from Texaco). The rates of return on investment are calculated and shown in Table T-(1)-4-5 and Figure T-2.
(The scale effects on rates of return on investment are shown in Figure T-3 for reference)

(2) Group 2

Group 2 consists of HDPE, PVC, BR, acrylonitrile or PP, and maleic anhydride. The following calculation was based on the assumption that:

410,000 t/y of condensate will be supplied at the price of 16.65 $/t by AMOCO and the API gravity of condensate be 49° (rather heavier cut), and the composition of condensate was roughly estimated from this API gravity to anticipate the quantities of ethylene, propylene, B-B fraction and cracked gasoline etc. derived by thermal cracking thereof. (Condensate Cracking Section is same as in said Case 2)

Condensate cracking gives 128,000 t/y of ethylene, 75,500 t/y of propylene and 24,000 t/y of butadiene.

As to ethylene derivatives, two end products, 70,000 t/y of HDPE and 106,700 t/y of PVC, are anticipated and the capacities of both of them are of international scale.

As to propylene derivatives, there is a possibility to choose acrylonitrile or PP. The simultaneous production of both of them are considered not appropriate because the given quantity of propylene is not large enough to give two products at the same time.

The rate of return on investment of acrylonitrile (36.3%) is larger than that of PP (23.0%), but the transportation of acrylonitrile (poisonous) needs the special tanker or special caution. Furthermore one can utilize the sales network of HDPE and PVC for PP, so PP is prefered to acrylonitrile as a whole consideration.

Condensate cracking gives also 21,600 t/y of benzene, 15,800 t/y of toluene and 10,000 t/y of xylene, and it is assumed in this case, differ from Case 2, that the latter two (toluene, xylene) will be exported at the prices of 36.6 $/t and 42.4 $/t respectively. As to benzene derivatives, 16,900 t/y of maleic anhydride will be produced.

The net manufacturing costs and the rates of return on investment are shown in Table - (2)-1-5, Table -(2)-6-7 and Figure T-2.

For assessment of the overall rate of return on investment with the complex, PP (not acrylonitril)was entered in the complex.

(3) Group 3

Group 3 consists of combination of Group 1 and 2.
It is assumed in this case that 21,600 t/y and 10,400 t/y of benzenes will be supplied respectively by condensate cracker and Texaco to produce 25,000 t/y of maleic anhydride. The matter connetcted with the combination of Group 1 and 2 concerns only the quantity of benzene.

Regarding the products derived from other than benzene, the combination of Group 1 and 2 means only the arithmetic addition and no mutual connection. With respect to the net manufacturing costs and the rates of return on investment, one can easily figure them from the data of Group 1 and 2.

T-(1)-1-3 **Manufacturing Costs of Group 1 Commodities**

T-(1)-1 MALEIC ANHYDRIDE

			Case A	Case B	Case C
Capacity (t/y)			16,900	25,000	35,000
Capital Investment (1,000 $)		Process Section	4,190	5,300	6,490
		Utilities & General Service Facilities	838	1,060	1,292
		Total Capital Investment (1,000 $)	5,028	1,360	7,782

Item	Unit Cost Case A, B, C	Basis (1/t)	Total Cost ($/t) Case A	Case B	Case C
Materials					
Benzene	55.6 $/t	1.28 t	71.17	71.17	71.17
Catalyst & Chemicals		4.21 $/t	4.21	4.21	4.21
Utilities					
Powers	0.0065 $/kwh	1,730 kwh	11.25	11.25	11.25
Steam	0.48 $/t	- 6.6 t	- 3.17	- 3.17	- 3.17
Cooling Water	0.0013 $/t	180 t	0.24	0.24	0.24
Fuel	0.446 $/$10^6$ kcal	— 10^6 kcal			
Process Water	0.040 $/t	— t			
		Men / Shift Case A / Case B / Case C			
Labour					
Operator	1.40 $/m.h.	8 / 10 / 10	5.25	4.44	3.17
Superviser	2.15 $/m.h.	2 / 2 / 2	2.02	1.36	0.97
Payroll Burden	5% of Labour		0.36	0.29	0.24
Maintenance	3% of Total Capital Investment		8.93	7.63	6.67
Depreciation	10% "		29.75	25.44	22.23
Interest	7% "		20.83	17.81	15.56
Tax & Insurance	2% "		5.95	5.09	4.45
Overheads	2% "		5.95	5.09	4.45
Net Manufacturing Cost			162.74	150.85	137.25

T-(1)-1-3 Manufacturing Costs of Group 1 Commodities

T-(1)-2 Caprolactam - Nylon 6 Chip - Nylon 6-F

Capacity (t/y)			Case A	Case B	Case C
			10,000	18,000	30,000*
Capital Investment (1,000 $)	Process Section		21,700	30,860	41,900**
	Utilities & General Service Facilities		4,340	6,170	8,380**
	Total Capital Investment (1,000 $)		26,040	37,030	50,280**

Item	Unit Cost	Basis (1/t)	Total Cost ($/t) Case A	Case B	Case C
Materials					
Cyclohexane	61.75 $/t	1.09 t	67.31	67.31	67.31
Waste Nylon 6	300 $/t	0.04 t	12.00	12.00	12.00
Oleum & Sulfaric Acid	20.00 $/t	1.79 t	35.80	35.80	35.80
By-Product					
Ammonium Sulfate	30.67 $/t	- 2.56 t	- 78.52	- 78.52	- 78.52
Catalyst & Chemicals		38.40 $	38.40	38.40	- 38.40
Utilities					
Power	0.0065 $/kwh	1,366.3 kwh	8.88	8.88	8.88
Steam	0.48 $/t	14.6 t	7.01	7.01	7.01
Cooling Water	0.0013 $/t	241.8 t	0.31	0.31	0.31
Fuel	0.446 $/$10^6$ kcal	3.36 10^6 kcal	1.50	1.50	1.50
Process Water	0.040 $/t	— t			

Item	Unit Cost	Men / Shift Case A	Case B	Case C	Case A	Case B	Case C
Labour							
Operator	1.40 $/m.h.	185	317	520***	205.13	195.27	192.19
Superviser	2.15 $/m.h.	20	33	53****	34.06	31.22	30.08
Payroll Burden	5% of Labour				10.31	11.32	11.11
Maintenance	3% of Capital Investment				78.12	61.72	50.28
Depreciation	10% "				260.40	205.72	167.60
Interest	7% "				182.28	144.01	117.32
Tax & Insurance	2% "				52.08	41.14	33.52
Overheads	2% "				52.08	41.14	33.52
Net Production Cost					967.14	864.43	727.82

* Annual Production Amount of Nylon 6 Yarn-F

** The sum of C.I's of Nylon 6-F, Nylon 6 CHIP and Caprolactam Plants

*** Operators are allocated to Caprolactam, Nylon 6 Chip, and Nylon-6 Fiber plants

	Caprolactam	Nylon 6 Chip	Nylon-6-F
Case A	8	7	170
Case B	8	9	300
Case C	8	12	500

**** Supervisers are allocated to Caprolactam, Nylon 6 Chip, and Nylon 6-Fiber plants

	Caprolactam	Nylon 6 Chip	Nylon-6-F
Case A	2	1	17
Case B	2	1	30
Case C	2	1	50

T-(1)-1-3 Manufacturing Costs of Group 1 Commodities

T-(1)-3 LINEAR ALKYLBENZENE

		Case A	Case B	Case C
Capacity (t/y)		30,000	50,000	70,000
Capital Investment (1,000 $)	Process Section	4,400	6,000	7,320
	Utilities & General Service Facilities	880	1,200	1,464
	Total Capital Investment (1,000 $)	5,280	7,200	8,784

Item	Unit Cost Case A, B, C	Basis (1/t)	Total Cost ($/t) Case A	Case B	Case C
Materials					
N-Paraffins	90.57 $/t	1.02 t	92.38	92.38	92.38
Benzene	55.6 $/t	0.38 t	21.13	21.13	21.13
By-Product					
Heavy N-Paraffin	110 $/t	- 0.24 t	- 26.40	- 26.40	- 26.40
Utilities					
Powers	0.0065 $/kwh	344 kwh	2.24	2.24	2.24
Steam	0.48 $/t	0.67 t	0.32	0.34	0.34
Cooling Water	0.0013 $/t	504 t	0.66	0.66	0.66
Fuel	0.446 $/$10^6$ kcal	5.4 x 10^6 kcal	2.40	2.40	2.40
Process Water	0.040 $/t	___ t			
		Men / Shift: Case A / Case B / Case C			
Labour					
Operator	1.40 $/m.h.	4 / 4 / 7	1.48	1.11	1.11
Superviser	2.15 $/m.h.	1 / 1 / 1	0.57	0.34	0.24
Payroll Burden	5% of Labour		0.10	0.07	0.07
Maintenance	3% of Total Capital Investment		5.28	4.32	3.76
Depreciation	10% "		17.60	14.40	12.55
Interest	7% "		12.32	10.08	8.78
Tax & Insurance	2% "		3.52	2.88	2.51
Overheads	2% "		3.52	2.88	2.51
Net Manufacturing Cost			137.12	128.83	124.28

T-(1)-4 Rates of Return on Investment of Group 1 Commodities

	TOTAL CAPITAL INVESTMENT (1,000 $)	TOTAL SALES AMOUNT (t/y)	T & T FOB PRICE ($/t)	TOTAL SALES VALUE (1,000 $/y)	NET MANUFACTURING COST PER UNIT ($/t)	TOTAL MANUFACTURING COST (1,000 $/y)	TOTAL NET PROFIT (1,000 $/y)	RATE OF RETURN ON INVESTMENT (%)
1. MALEIC ANHYDRIDE	6,360	25,000	197.2	4,930	150.85	3,771	1,159	17.9
2. CAPROLACTAM-NYLON 6-F	37,030	18,000	1,177.7	21,204	864.43	15,554	5,650	15.1
3. LINEAR ALKYL BENZENE	7,200	50,000	148.7	7,435	128.83	6,442	993	13.8

T-(1)-5 Calculation of Rates of Return on Investment of Group 1 Commodities
(Discounted Cash Flow Calculation Result Sheet of Computer)

CAPROLACTAM - NYLON 6-F   Capacity 18,000 t/y

DISCOUNTED CASH FLOW CALCULATION RESULTS

	END OF YEAR	INVESTMENT	TOTAL SALES VALUE	TOTAL PRODUCT COST	INCOME BEFORE TAX	CORPORATE TAX	INCOME AFTER TAX	DEPRECIATION	CASH FLOW BACK	DISCOUNT RATE R = 15.1%	PRESENT VALUE	PRESENT VALUE AT PROJ. START-UP
ENG. + CONST	-1	37030. *1	0.	0.	0.	0.	0.	0.	0.	0.0	0.	0.
OPERATION	1	0. *2	21204.	15554.	5650.	0.	5650.	3703.	9353.	0.86909	8128.	42608.
START-UP	2	0.	21204.	15554.	5650.	0.	5650.	3703.	9353.	0.75532	7064.	
	3	0.	21204.	15554.	5650.	0.	5650.	3703.	9353.	0.65644	6140.	
	4	0.	21204.	15554.	5650.	0.	5650.	3703.	9353.	0.57050	5336.	
	5	0.	21204.	15554.	5650.	0.	5650.	3703.	9353.	0.49582	4637.	
	6	0.	21204.	15554.	5650.	2542.	3107.	3703.	6810.	0.43091	2935.	
	7	0.	21204.	15554.	5650.	2542.	3107.	3703.	6810.	0.37450	2550.	
	8	0.	21204.	15554.	5650.	2542.	3107.	3703.	6810.	0.32547	2217.	
	9	0.	21204.	15554.	5650.	2542.	3107.	3703.	6810.	0.28287	1926.	
	10	0. *3	21204.	15554.	5650.	2542.	3107.	3703.	6810.	0.24584	1674.	
											42608.	

*1) TOTAL INVESTMENT COSTS
*2) WORKING CAPITAL
*3) SALVAGE VALUE

RATE OF RETURN ON INVESTMENT 15.1 %

MALEIC ANHYDRIDE Capacity 25,000 t/y

DISCOUNTED CASH FLOW CHALCULATION RESULTS

END OF YEAR		INVESTMENT	TOTAL SALES VALUE	TOTAL PRODUCT COST	INCOME BEFORE TAX	CORPORATE TAX	INCOME AFTER TAX	DEPRECIATION	CASH FLOW BACK	DISCOUNT RATE	PRESENT VALUE	PRESENT VALUE AT PROJ. START-UP
										R = 17.9%		
ENG. + CONST	-1	6340. *1	0.	0.	0.	0.	0.	0.	0.	0.0	0.	0.
OPERATION	1	0. *2	4930.	3739.	1191.	0.	1191.	636.	1827.	0.84808	1549.	7499.
START-UP	2	0.	4930.	3739.	1191.	0.	1191.	636.	1827.	0.71925	1314.	
	3	0.	4930.	3739.	1191.	0.	1191.	636.	1827.	0.60998	1114.	
	4	0.	4930.	3739.	1191.	0.	1191.	636.	1827.	0.51732	945.	
	5	0.	4930.	3739.	1191.	0.	1191.	636.	1827.	0.43873	802.	
	6	0.	4930.	3739.	1191.	536.	655.	636.	1291.	0.37208	480.	
	7	0.	4930.	3739.	1191.	536.	655.	636.	1291.	0.31555	407.	
	8	0.	4930.	3739.	1191.	536.	655.	636.	1291.	0.26762	345.	
	9	0.	4930.	3739.	1191.	536.	655.	636.	1291.	0.22696	293.	
	10	0. *3	4930.	3739.	1191.	536.	655.	636.	1291.	0.19248	248.	
											7499.	

*1) TOTAL INVESTMENT COSTS
*2) WORKING CAPITAL
*3) SALVAGE VALUE

RATE OF RETURN ON INVESTMENT 17.9 %

LINEAR ALKYL BENZENE Capacity 50,000 t/y

DISCOUNTED CASH FLOW CALCULATION RESULTS

END OF YEAR		INVESTMENT	TOTAL SALES VALUE	TOTAL PRODUCT COST	INCOME BEFORE TAX	CORPORATE TAX	INCOME AFTER TAX	DEPRECIATION	CASH FLOW BACK	DISCOUNT RATE	PRESENT VALUE	PRESENT VALUE AT PROJ. START-UP
										R = 13.8%		
ENG. + CONST	-1	7200. *1	0.	0.	0.	0.	0.	0.	0.	0.0	0.	0.
OPERATION	1	0. *2	7435.	6441.	994.	0.	994.	720.	1714.	0.87855	1506.	8195.
START-UP	2	0.	7435.	6441.	994.	0.	994.	720.	1714.	0.77185	1323.	
	3	0.	7435.	6441.	994.	0.	994.	720.	1714.	0.67811	1162.	
	4	0.	7435.	6441.	994.	0.	994.	720.	1714.	0.59576	1021.	
	5	0.	7435.	6441.	994.	447.	547.	720.	1267.	0.52340	897.	
	6	0.	7435.	6441.	994.	447.	547.	720.	1267.	0.45983	582.	
	7	0.	7435.	6441.	994.	447.	547.	720.	1267.	0.40399	512.	
	8	0.	7435.	6441.	994.	447.	547.	720.	1267.	0.35492	450.	
	9	0.	7435.	6441.	994.	447.	547.	720.	1267.	0.31182	395.	
	10	0. *3	7435.	6441.	994.	447.	547.	720.	1267.	0.27395	347.	
											8195.	

*1) TOTAL INVESTMENT COSTS
*2) WORKING CAPITAL
*3) SALVAGE VALUE

RATE OF RETURN ON INVESTMENT 13.8 %

T-(2)-1-5 **Manufacturing Cost of Group 2 Commodities**

* **For maleic anhydride, refer to T-(1)-1**

T-(2)-1 H D P E

Capacity (t/y)			70,000
Capital Investment (1,000 $)	Process Section		22,620
	Utilities & General Service Facilities		4,520
	Total Capital Investment (1,000 $)		27,140
Item	**Unit Cost**	**Basis (1/t)**	**Total Cost ($/t)**
Materials			
Ethylene	56.64 $/t	1.06 t	60.04
Catalyst & Chemicals		30 $/t	30.00
Utilities			
Powers	0.0065 $/kwh	900 kwh	5.85
Steam	0.48 $/t	7 t	3.36
Cooling Water	0.0013 $/t	700 t	0.91
Fuel	0.446 $/$10^6$ kcal	— 10^6 kcal	
Process Water	0.040 $/t	— t	
Labour			
Operator	1.40 $/m.h.	50 men/shift	7.92
Superviser	2.15 $/m.h.	5 men/shift	1.22
Payroll Burden	5% of Labour		0.46
Maintenance	3% of Total Capital Investment		11.63
Depreciation	10% "		38.77
Interest	7% "		27.14
Tax & Insurance	2% "		7.75
Overheads	2% "		7.75
Net Manufacturing Cost			202.80

T-(2)-1-5 **Manufacturing Cost of Group 2 Commodities**

T-(2)-2 VCM - PVC

Capacity (t/y)				106,700 *
Capital Investment (1,000 $)	Process Section			14,240 **
	Utilities & General Service Facilities			2,848 **
	Total Capital Investment (1,000 $)			17,088 **
Item	**Unit Cost**		**Basis (l/t)**	**Total Cost ($/t)**
Materials				
Ethylene	56.64	$/t	0.50 t	28.32
Chlorine	55.11	$/t	0.65 t	35.85
Catalyst & Chemicals			9.86 $/t	9.86
Utilities				
Power	0.0065	$/kwh	494 kwh	3.21
Steam	0.48	$/t	4.625 t	2.22
Cooling Water	0.0013	$/t	710 t	0.92
Fuel	0.446	$/$10^6$ kcal	1.26 x 10^6 kcal	0.56
Process Water	0.040	$/t	— t	
Labour				
Operator	1.40	$/m.h.	44 men/shift ***	4.57
Superviser	2.15	$/m.h.	7 men/shift ****	1.12
Payroll Burden	5% of Labour			0.28
Maintenance	3% of Capital Investment			4.80
Depreciation	10% "			16.01
Interest	7% "			11.21
Tax & Insurance	2% "			3.20
Overheads	2% "			3.20
Net Production Cost				125.30

* Annual Production Amount of PVC

** The Sum of C.I's of VCM and PVC Plants

*** 20 persons are allocated to VCM Plant

**** 3 persons are allocated to VCM Plant

T-(2)-1-5 **Manufacturing Costs of Group 2 Commodities**

T-(2)-3 ACRYLONITRILE

Capacity (t/y)			65,700
Capital Investment (1,000 $)	Process Section		12,000
	Utilities & General Service Facilities		2,400
	Total Capital Investment (1,000 $)		14,400

Item	Unit Cost	Basis (1/t)	Total Cost ($/t)
Materials			
Propylene	50 $/t	1.15 t	57.50
Ammonia	40 $/t	0.37 t	14.80
Catalyst & Chemicals		13.90 $/t	13.90
Utilities			
Powers	0.0065 $/kwh	600 kwh	3.90
Steam	0.48 $/t	8 t	3.84
Cooling Water	0.0013 $/t	500 t	0.54
Fuel	0.446 $/$10^6$ kcal	— 10^6 kcal	
Process Water	0.040 $/t	— t	
Labour			
Operator	1.40 $/m.h.	12 men/shift	2.03
Superviser	2.15 $/m.h.	1 men/shift	0.26
Payroll Burden	5% of Labour		0.11
Maintenance	3% of Total Capital Investment		6.58
Depreciation	10% "		21.92
Interest	7% "		15.34
Tax & Insurance	2% "		4.38
Overheads	2% "		4.38
Net Manufacturing Cost			149.48

T-(2)-1-5 Manufacturing Costs of Group 2 Commodities

T-(2)-4 p p

Capacity (t/y)		60,400
Capital Investment (1,000 $)	Process Section	19,220
	Utilities & General Service Facilities	3,844
	Total Capital Investment (1,000 $)	23,064

Item	Unit Cost	Basis (1/t)	Total Cost ($/t)
Materials			
Propylene	50 $/t	1.25 t	62.50
Catalyst & Chemicals		30.2 $/t	30.20
Utilities			
Powers	0.0065 $/kwh	1,100 kwh	7.15
Steam	0.48 $/t	8.3 t	3.98
Cooling Water	0.0013 $/t	800 t	1.04
Fuel	0.446 $/$10^6$ kcal	— 10^6 kcal	
Process Water	0.040 $/t		
Labour			
Operator	1.40 $/m.h.	17 men/shift	3.12
Superviser	2.15 $/m.h.	2 men/shift	0.56
Payroll Burden	5% of Labour		0.18
Maintenance	3% of Total Capital Investment		11.46
Depreciation	10% "		38.19
Interest	7% "		26.73
Tax & Insurance	2% "		7.64
Overheads	2% "		7.64
Net Manufacturing Cost			200.39

T-(2)-1-5 Manufacturing Cost of Group 2 Commodities

T-(2)-5 BR

Capacity (t/y)					23,000
Capital Investment (1,000 $)	Process Section				10,100
	Utilities & General Service Facilities				2,020
	Total Capital Investment (1,000 $)				12,120
Item	Unit Cost		Basis (1/t)		Total Cost ($/t)
Materials					
Butadiene	116.63	$/t	1.05	t	122.46
Catalyst & Chemicals			28	$/t	28
Utilities					
Power	0.0065	$/kwh	1,000	kwh	6.5
Steam	0.48	$/t	7	t	3.36
Pro^ess Water	0.040	$/t	500	t	20
Labour					
Opearator	1.40	$/m.h.	18	men/shift	8.68
Superviser	2.15	$/m.h.	2	men/shift	1.48
Payroll Burden	5% of Labour				0.51
Maintenance	3% of Total Capital Investment				15.81
Depreciation	10%	"			52.70
Interest	7%	"			36.89
Tax & Insurance	2%	"			10.54
Overheads	2%	"			10.54
Net Manufacturing Cost					317.47

T-(2)-6 **Rates of Return on Investment of Group 2 Commodities**

	TOTAL CAPITAL INVESTMENT (1,000 $)	TOTAL SALES AMOUNT (t/y)	T & T FOB PRICE ($/t)	TOTAL SALES VALUE (1,000 $/y)	NET MANUFACTURING COST PER UNIT ($/t)	TOTAL MANUFACTURING COST (1,000 $/y)	TOTAL NET PROFIT (1,000 $/y)	RATE OF RETURN ON INVESTMENT (%)
1. MALEIC ANHYDRIDE	5,028	16,900	197.2	3,333	162.74	2,750	583	11.9
2. HDPE	27,140	70,000	266.2	18,634	202.80	14,196	4,438	16.0
3. VCM - PVC	17,088	106,700	187.4	19,996	125.30	13,370	6,626	32.2
(4. ACRYLONITRILE)	(14,400)	(65,700)	(249.1)	(16,366)	(149.48)	(9,821)	(6,545)	(36.3)
5. PP	23,064	60,400	297.5	17,969	200.39	12,104	5,865	23.0
6. BR	12,120	23,000	365.0	8,395	317.47	7,302	1,093	9.5
7. CONDENSATE CRACKING	21,000	128,000	56.64	7,250	40.49	5,183	2,067	10.3
8. BUTADIENE EXTRACTION	2,340	24,000	116.63	2,799	106.88	2,565	234	10.3
9. AROMATICS RECOVERY	3,670	48,000	47.70	2,290	40.05	1,922	368	10.3
10. HYDROGEN PRODUCTION	912	23,760,000 Nm^3	0.0187	444	0.0149	354	90	10.3
COMPLEX	112,362	——	——	81,110	——	59,746	21,364	19.2

T-(2)-7 Calculation of Rates of Return on Investment of Group 2 Commodities
(Discounted Cash Flow Calculation Result Sheet of Computer)

COMPLEX OF GROUP 2

DISCOUNTED CASH FLOW CHALCULATION RESULTS

	END OF YEAR	INVESTMENT	TOTAL SALES VALUE	TOTAL PRODUCT COST	INCOME BEFORE TAX	CORPORATE TAX	INCOME AFTER TAX	DEPRECIATION	CASH FLOW BLACK	DISCOUNT RATE R = 19.2%	PRESENT VALUE	PRESENT VALUE AT PROJ. START-UP
ENG. + CONST	-1	112362. *1	0.	0.	0.	0.	0.	0.	0.	0.0	0.	0.
OPERATION	1	0. *2	81110.	59746.	21364.	0.	21364.	11236.	32600.	0.83907	27354.	128395.
START-UP	2	0.	81110.	59746.	21364.	0.	21364.	11236.	32600.	0.70404	22952.	
	3	0.	81110.	59746.	21364.	0.	21364.	11236.	32600.	0.59074	19258.	
	4	0.	81110.	59746.	21364.	0.	21364.	11236.	32600.	0.49568	16159.	
	5	0.	81110.	59746.	21364.	0.	21364.	11236.	32600.	0.41591	13559.	
	6	0.	81110.	59746.	21364.	9614.	11750	11236.	22986.	0.34898	8022.	
	7	0.	81110.	59746.	21364.	9614.	11750.	11236.	22986.	0.29282	6731.	
	8	0.	81110.	59746.	21364.	9614.	11750.	11236.	22986.	0.24569	5648.	
	9	0.	81110.	59746.	21364.	9614.	11750.	11236.	22986.	0.20616	4739.	
	10	0. *3	81110.	59746.	21364.	9614.	11750.	11236.	22986.	0.17298	3974.	
											128395.	

*1) TOTAL INVESTMENT COSTS
*2) WORKING CAPITAL
*3) SALVAGE VALUE

RATE OF RETURN ON INVESTMENT 19.2 %

MALEIC ANHYDRIDE **Capacity 16,900 t/y**

DISCOUNTED CASH FLOW CHALCULATION RESULTS

END OF YEAR		INVESTMENT	TOTAL SALES VALUE	TOTAL PRODUCT COST	INCOME BEFORE TAX	CORPORATE TAX	INCOME AFTER TAX	DEPRECIATION	CASH FLOW BACK	DISCOUNT RATE	PRESENT VALUE	PRESENT VALUE AT PROJ. START-UP
										R = 11.9%		
ENG. + CONST	-1	5028. *1	0.	0.	0.	0.	0.	0.	0.	0.0	0.	0.
OPERATION	1	0. *2	3333.	2750.	583.	0.	583.	503.	1086.	0.89386	971.	5625.
START-UP	2	0.	3333.	2750.	583.	0.	583.	503.	1086.	0.79898	867.	
	3	0.	3333.	2750.	583.	0.	583.	503.	1086.	0.71418	775.	
	4	0.	3333.	2750.	583.	0.	583.	503.	1086.	0.63837	693.	
	5	0.	3333.	2750.	583.	0.	583.	503.	1086.	0.57061	620.	
	6	0.	3333.	2750.	583.	262.	321.	503.	823.	0.51005	420.	
	7	0.	3333.	2750.	583.	262.	321.	503.	823.	0.45591	375.	
	8	0.	3333.	2750.	583.	262.	321.	503.	823.	0.40752	336.	
	9	0.	3333.	2750.	583.	262.	321.	503.	823.	0.36426	300.	
	10	0. *3	3333.	2750.	583.	262.	321.	503.	823.	0.32560	268.	
											5625.	

*1) TOTAL INVESTMENT COSTS
*2) WORKING CAPITAL
*3) SALVAGE VALUE

RATE OF RETURN ON INVESTMENT 11.9 %

HDPE **Capacity 70,000 t/y**

DISCOUNTED CASH FLOW CALCULATION RESULTS

END OF YEAR		INVESTMENT	TOTAL SALES VALUE	TOTAL PRODUCT COST	INCOME BEFORE TAX	CORPORATE TAX	INCOME AFTER TAX	DEPRECIATION	CASH FLOW BACK	DISCOUNT RATE	PRESENT VALUE	PRESENT VALUE AT PROJ. START-UP
										R = 16.0%		
ENG. + CONST	-1	27140. *1	0.	0.	0.	0.	0.	0.	0.	0.0	0.	0.
OPERATION	1	0. *2	18634.	14196.	4438.	0.	4438.	2714.	7152.	0.86222	6167.	31477.
START-UP	2	0.	18634.	14196.	4438.	0.	4438.	2714.	7152.	0.74342	5317.	
	3	0.	18634.	14196.	4438.	0.	4438.	2714.	7152.	0.64100	4585.	
	4	0.	18634.	14196.	4438.	0.	4438.	2714.	7152.	0.55268	3953.	
	5	0.	18634.	14196.	4438.	0.	4438.	2714.	7152.	0.47653	3408.	
	6	0.	18634.	14196.	4438.	1997.	2441.	2714.	5155.	0.41088	2118.	
	7	0.	18634.	14196.	4438.	1997.	2441.	2714.	5155.	0.35427	1826.	
	8	0.	18634.	14196.	4438.	1997.	2441.	2714.	5155.	0.30546	1575.	
	9	0.	18634.	14196.	4438.	1997.	2441.	2714.	5155.	0.26337	1358.	
	10	0. *3	18634.	14196.	4438.	1997.	2441.	2714.	5155.	0.22708	1171.	
											31477.	

*1) TOTAL INVESTMENT COSTS
*2) WORKING CAPITAL
*3) SALVAGE VALUE

RATE OF RETURN ON INVESTMENT 16.0 %

VCM - PVC Capacity 106,700 t/y

DISCOUNTED CASH FLOW CALCULATION RESULTS

END OF YEAR		INVESTMENT	TOTAL SALES VALUE	TOTAL PRODUCT COST	INCOME BEFORE TAX	CORPORATE TAX	INCOME AFTER TAX	DEPRECIATION	CASH FLOW BACK	DISCOUNT RATE	PRESENT VALUE	PRESENT VALUE AT PROJ. START-UP
										R = 32.2%		
ENG. + CONST	-1	170[illegible]. *1	0.	0.	0.	0.	0.	0.	0.	0.0	0.	0.
OPERATION START-UP	1	0. *2	19996.	13372.	6623.	0.	6623.	1709.	8332.	0.75664	6304.	22584.
	2	0.	19996.	13372.	6623.	0.	6623.	1709.	8332.	0.57251	4770.	
	3	0.	19996.	13372.	6623.	0.	6623.	1709.	8332.	0.43318	3609.	
	4	0.	19996.	13372.	6623.	0.	6623.	1709.	8332.	0.32776	2731.	
	5	0.	19996.	13372.	6623.	0.	6623.	1709.	8332.	0.24800	2066.	
	6	0.	19996.	13372.	6623.	2980.	3643.	1709.	5352.	0.18765	1004.	
	7	0.	19996.	13372.	6623.	2980.	3643.	1709.	5352.	0.14198	760.	
	8	0.	19996.	13372.	6623.	2980.	3643.	1709.	5352.	0.10743	575.	
	9	0.	19996.	13372.	6623.	2980.	3643.	1709.	5352.	0.08128	435.	
	10	0. *3	19996.	13372.	6623.	2980.	3643.	1709.	5352.	0.06150	329.	
											22584.	

*1) TOTAL INVESTMENT COSTS
*2) WORKING CAPITAL
*3) SALVAGE VALUE

RATE OF RETURN ON INVESTMENT 32.2 %

ACRYLONITRILE Capacity 65,700 t/y

DISCOUNTED CASH FLOW CALCULATION RESULTS

END OF YEAR		INVESTMENT	TOTAL SALES VALUE	TOTAL PRODUCT COST	INCOME BEFORE TAX	CORPORATE TAX	INCOME AFTER TAX	DEPRECIATION	CASH FLOW BACK	DISCOUNT RATE	PRESENT VALUE	PRESENT VALUE AT PROJ. START-UP
										R = 36.3%		
ENG. + CONST	-1	14400. *1	0.	0.	0.	0.	0.	0.	0.	0.0	0.	0.
OPERATION START-UP	1	0. *2	16366.	9828.	6538.	0.	6538.	1440.	7978.	0.73367	5853.	19627.
	2	0.	16366.	9828.	6538.	0.	6538.	1440.	7978.	0.53827	4294.	
	3	0.	16366.	9828.	6538.	0.	6538.	1440.	7978.	0.39491	3151.	
	4	0.	16366.	9828.	6538.	0.	6538.	1440.	7978.	0.28973	2311.	
	5	0.	16366.	9828.	6538.	0.	6538.	1440.	7978.	0.21257	1696.	
	6	0.	16366.	9828.	6538.	2942.	3596.	1440.	5036.	0.15595	785.	
	7	0.	16366.	9828.	6538.	2942.	3596.	1440.	5036.	0.11442	576.	
	8	0.	16366.	9828.	6538.	2942.	3596.	1440.	5036.	0.08395	423.	
	9	0.	16366.	9828.	6538.	2942.	3596.	1440.	5036.	0.06159	310.	
	10	0. *3	16366.	9828.	6538.	2942.	3596.	1440.	5036.	0.04519	228.	
											19627.	

*1) TOTAL INVESTMENT COSTS
*2) WORKING CAPITAL
*3) SALVAGE VALUE

RATE OF RETURN ON INVESTMENT 36.3 %

PP   **Capacity 60,400 t/y**

DISCOUNTED CASH FLOW CHALCULATION RESULTS

	END OF YEAR	INVESTMENT	TOTAL SALES VALUE	TOTAL PRODUCT COST	INCOME BEFORE TAX	CORPORATE TAX	INCOME AFTER TAX	DEPRECIATION	CASH FLOW BACK	DISCOUNT RATE	PRESENT VALUE	PRESENT VALUE AT PROJ. START-UP
										R = 23.0%		
ENG. + CONST	-1	23064. *1	0.	0.	0.	0.	0.	0.	0.	0.0	0.	0.
OPERATION START-UP	1	0. *2	17969.	12104.	5865.	0.	5865.	2306.	8171.	0.81270	6641.	28379.
	2	0.	17969.	12104.	5865.	0.	5865.	2306.	8171.	0.66049	5397.	
	3	0.	17969.	12104.	5865.	0.	5865.	2306.	8171.	0.53678	4386.	
	4	0.	17969.	12104.	5865.	0.	5865.	2306.	8171.	0.43625	3565.	
	5	0.	17969.	12104.	5865.	0.	5865.	2306.	8171.	0.35454	2897.	
	6	0.	17969.	12104.	5865.	2639.	3226.	2306.	5532.	0.28814	1594.	
	7	0.	17969.	12104.	5865.	2639.	3226.	2306.	5532.	0.23417	1295.	
	8	0.	17969.	12104.	5865.	2639.	3226.	2306.	5532.	0.19031	1053.	
	9	0.	17969.	12104.	5865.	2639.	3226.	2306.	5532.	0.15467	856.	
	10	0. *3	17969.	12104.	5865.	2639.	3226.	2306.	5532.	0.12570	695.	
											28379.	

*1) TOTAL INVESTMENT COSTS
*2) WORKING CAPITAL
*3) SALVAGE VALUE

RATE OF RETURN ON INVESTMENT 23.0 %

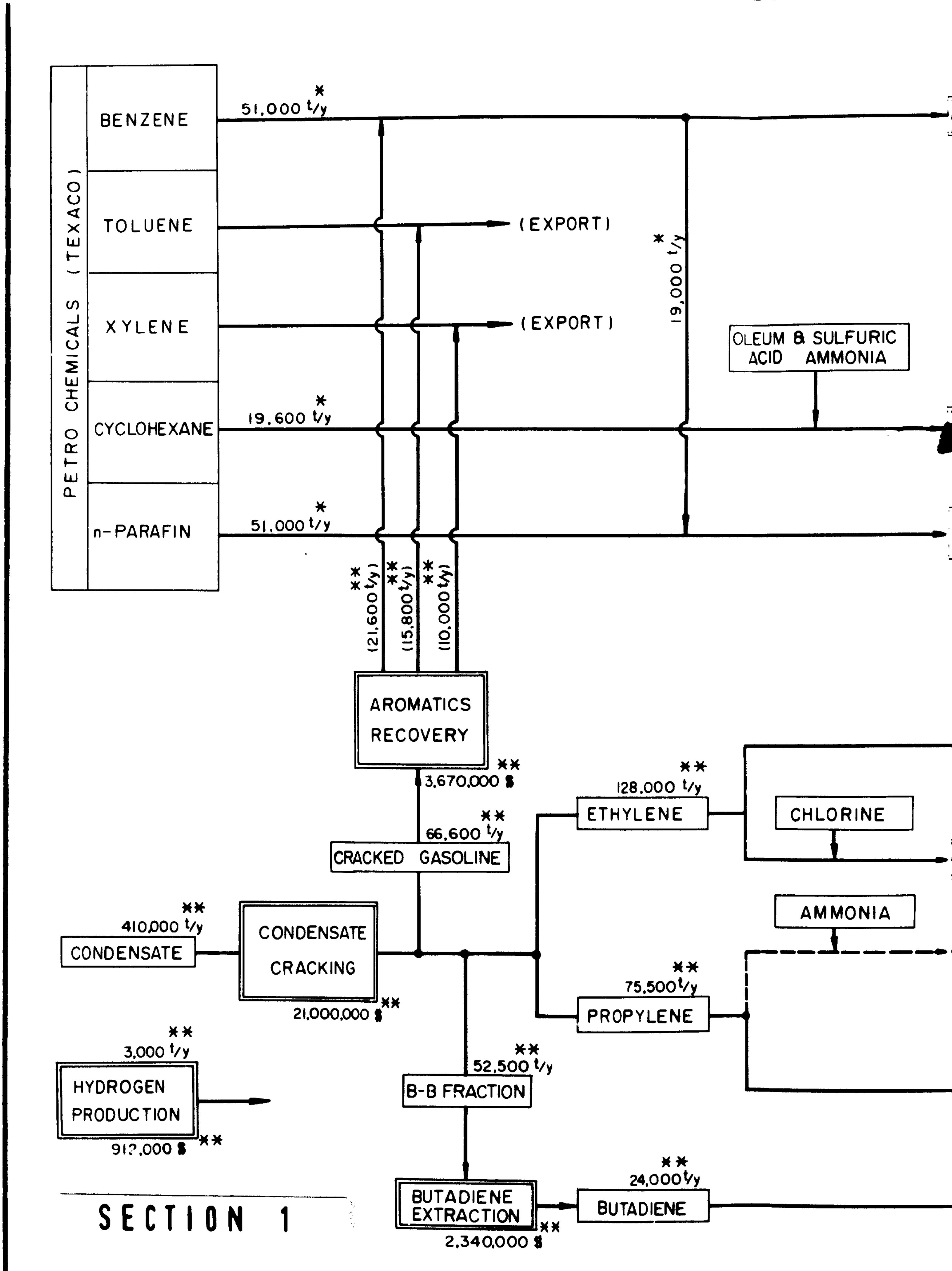
BR   **Capacity 23,000 t/y**

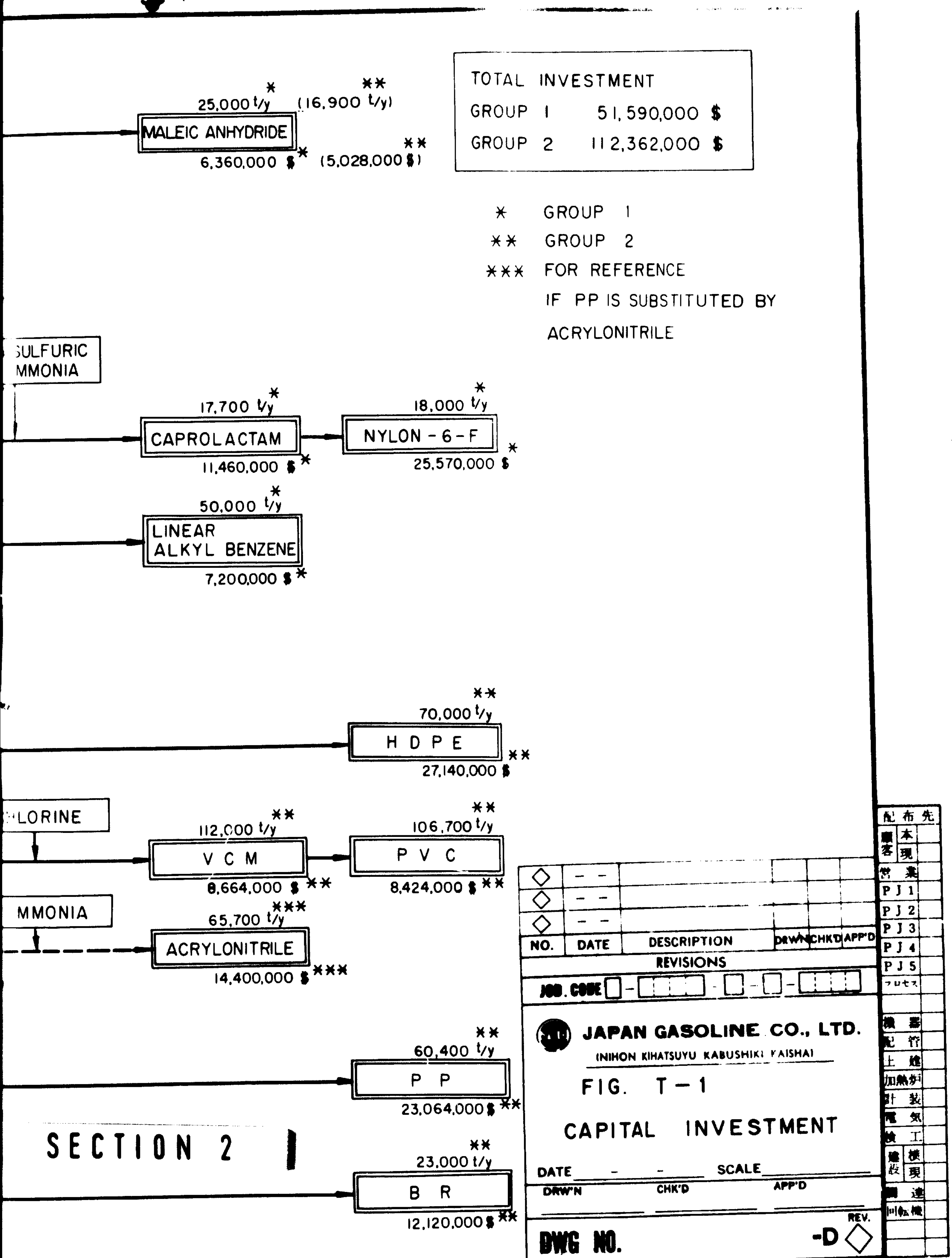
DISCOUNTED CASH FLOW CHALCULATION RESULTS

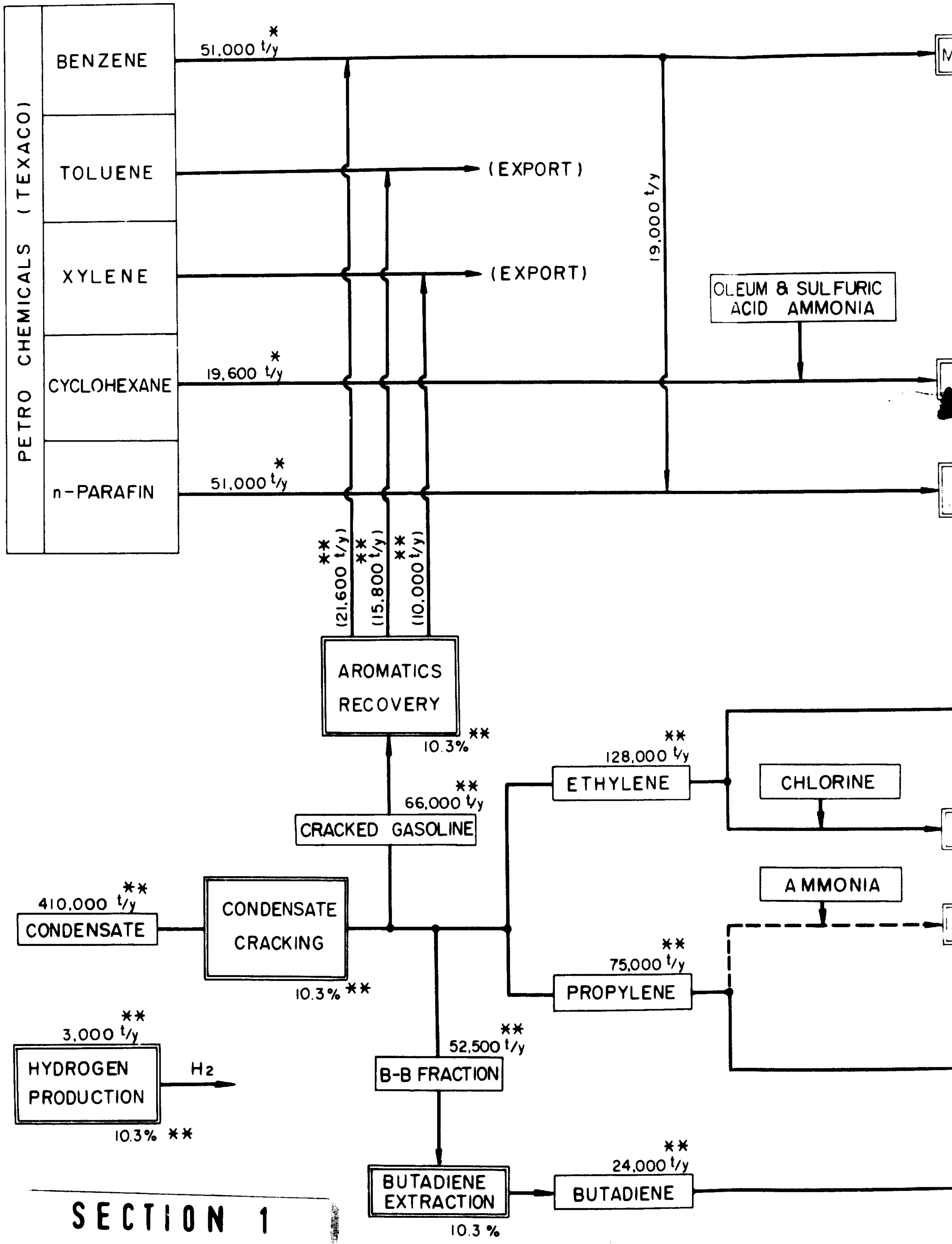
	END OF YEAR	INVESTMENT	TOTAL SALES VALUE	TOTAL PRODUCT COST	INCOME BEFORE TAX	CORPORATE TAX	INCOME AFTER TAX	DEPRECIATION	CASH FLOW BACK	DISCOUNT RATE	PRESENT VALUE	PRESENT VALUE AT PROJ. START-UP
										R = 9.5%		
ENG. + CONST	-1	12120. *1	0.	0.	0.	0.	0.	0.	0.	0.0	0.	0.
OPERATION START-UP	1	0. *2	8395.	7301.	1094.	0.	1094.	1212.	2306.	0.91317	2106.	13272.
	2	0.	8395.	7301.	1094.	0.	1094.	1212.	2306.	0.83389	1923.	
	3	0.	8395.	7301.	1094.	0.	1094.	1212.	2306.	0.76149	1756.	
	4	0.	8395.	7301.	1094.	0.	1094.	1212.	2306.	0.69537	1603.	
	5	0.	8395.	7301.	1094.	0.	1094.	1212.	2306.	0.63500	1464.	
	6	0.	8395.	7301.	1094.	492.	602.	1212.	1814.	0.57986	1052.	
	7	0.	8395.	7301.	1094.	492.	602.	1212.	1814.	0.52952	960.	
	8	0.	8395.	7301.	1094.	492.	602.	1212.	1814.	0.48354	877.	
	9	0.	8395.	7301.	1094.	492.	602.	1212.	1814.	0.44156	801.	
	10	0. *3	8395.	7301.	1094.	492.	602.	1212.	1814.	0.40322	731.	
											13272.	

*1) TOTAL INVESTMENT COSTS
*2) WORKING CAPITAL
*3) SALVAGE VALUE

RATE OF RETURN ON INVESTMENT 9.5 %


PETRO CHEMICALS (TEXACO)
BENZENE
TOLUENE
XYLENE
CYCLOHEXANE
n-PARAFIN
51,000 t/y *
19,600 t/y *
51,000 t/y *
(EXPORT)
(EXPORT)
19,000 t/y *
OLEUM & SULFURIC ACID AMMONIA
(21,600 t/y) **
(15,800 t/y) **
(10,000 t/y) **
AROMATICS RECOVERY
3,670,000 $ **
66,600 t/y **
CRACKED GASOLINE
128,000 t/y **
ETHYLENE
CHLORINE
AMMONIA
410,000 t/y **
CONDENSATE
CONDENSATE CRACKING
21,000,000 $ **
75,500 t/y **
PROPYLENE
3,000 t/y **
HYDROGEN PRODUCTION
912,000 $ **
52,500 t/y **
B-B FRACTION
BUTADIENE EXTRACTION
2,340,000 $ **
24,000 t/y **
BUTADIENE
SECTION 1


TOTAL INVESTMENT
GROUP 1 51,590,000 $
GROUP 2 112,362,000 $
* GROUP 1
** GROUP 2
*** FOR REFERENCE
IF PP IS SUBSTITUTED BY ACRYLONITRILE
25,000 t/y * (16,900 t/y) **
MALEIC ANHYDRIDE
6,360,000 $ * (5,028,000 $) **
SULFURIC
MMONIA
17,700 t/y *
CAPROLACTAM
11,460,000 $ *
18,000 t/y *
NYLON-6-F
25,570,000 $ *
50,000 t/y *
LINEAR ALKYL BENZENE
7,200,000 $ *
70,000 t/y **
H D P E
27,140,000 $ **
LORINE
112,000 t/y **
V C M
8,664,000 $ **
106,700 t/y **
P V C
8,424,000 $ **
MMONIA
65,700 t/y ***
ACRYLONITRILE
14,400,000 $ ***
60,400 t/y **
P P
23,064,000 $ **
23,000 t/y **
B R
12,120,000 $ **
SECTION 2
NO.
DATE
DESCRIPTION
DRW'N
CHK'D
APP'D
REVISIONS
JOB. CODE
JAPAN GASOLINE CO., LTD.
(NIHON KIHATSUYU KABUSHIKI KAISHA)
FIG. T-1
CAPITAL INVESTMENT
DATE - -
SCALE
DRW'N
CHK'D
APP'D
DWG NO.
REV.
-D
配布先
顧客
本現
営業
P J 1
P J 2
P J 3
P J 4
P J 5
プロセス
機器
配管
土建
加熱炉
計装
電気
検工
建設
横現
調達
回転機


PETRO CHEMICALS (TEXACO)
BENZENE
TOLUENE
XYLENE
CYCLOHEXANE
n-PARAFIN
51,000 t/y *
19,600 t/y *
51,000 t/y *
(EXPORT)
(EXPORT)
19,000 t/y
OLEUM & SULFURIC ACID AMMONIA
(21,600 t/y) **
(15,800 t/y) **
(10,000 t/y) **
AROMATICS RECOVERY
10.3% **
66,000 t/y **
CRACKED GASOLINE
410,000 t/y **
CONDENSATE
CONDENSATE CRACKING
10.3% **
128,000 t/y **
ETHYLENE
CHLORINE
AMMONIA
75,000 t/y **
PROPYLENE
3,000 t/y **
HYDROGEN PRODUCTION
H2
10.3% **
52,500 t/y **
B-B FRACTION
BUTADIENE EXTRACTION
10.3 %
24,000 t/y **
BUTADIENE

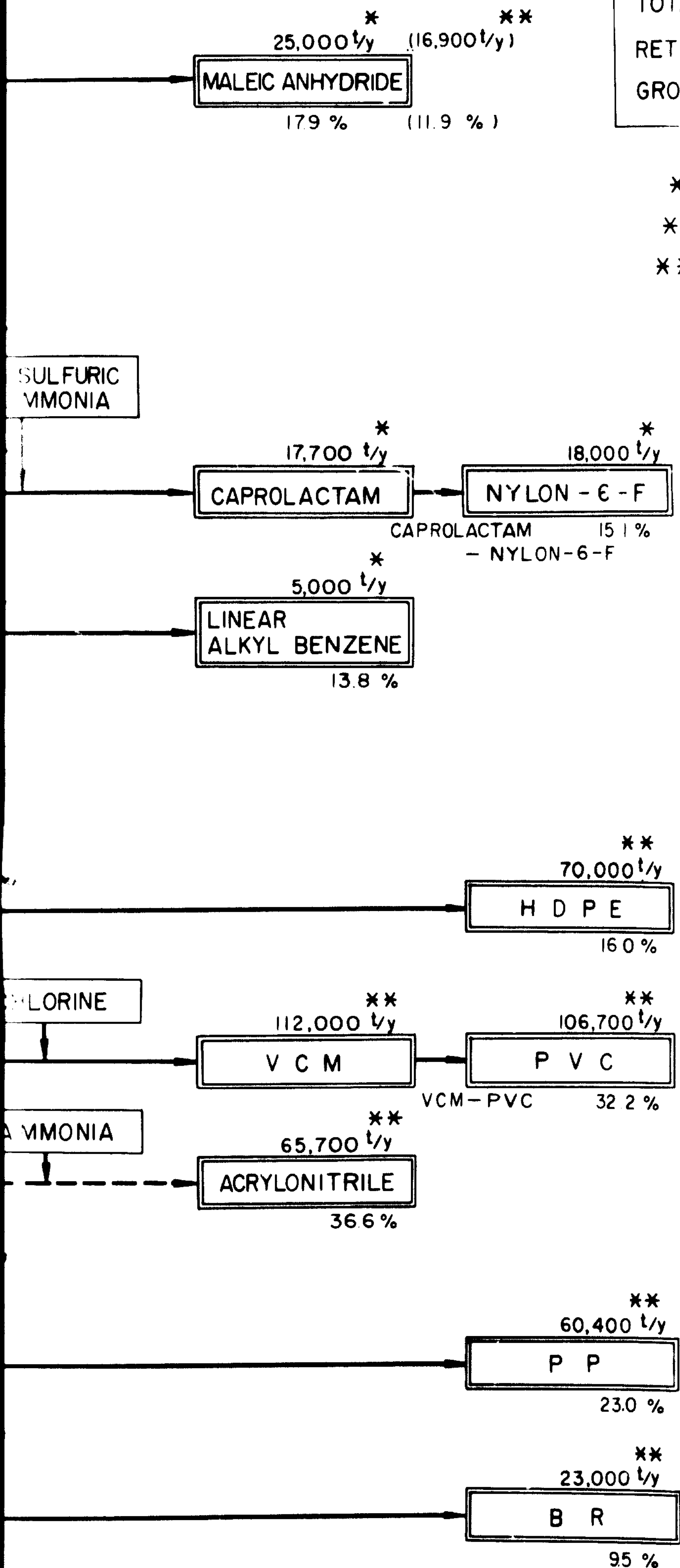
SECTION 1

TOTAL RATE OF RETURN ON INVESTMENT GROUP 2 : 19.2 %

* GROUP 1

** GROUP 2

*** FOR REFERENCE IF PP IS SUBSTITUTED BY ACRYLONITRILE



SECTION 2

NO.	DATE	DESCRIPTION	DRW'N	CHK'D	APP'D
◇	- -				
◇	- -				
◇	- -				

REVISIONS

JOB. CODE

JAPAN GASOLINE CO., LTD.
(NIHON KIHATSUYU KABUSHIKI KAISHA)

FIG. T-2

RATE OF RETURN ON INVESTMENT

DATE - - SCALE

DRW'N CHK'D APP'D

DWG NO. -D REV.

配布先	
顧客	本
	現
営業	
PJ 1	
PJ 2	
PJ 3	
PJ 4	
PJ 5	
プロセス	
機器	
配管	
土建	
加熱炉	
計装	
電気	
検工	
建設	横
	現
調達	
回転機	

FIG. T-3

THE SCALE EFFECTS ON RATES OF RETURN ON INVESTMENT WITH GROUPE 1 COMMODITIES

FIG. T-3-(1) RATE OF RETURN ON INVESTMENT
MALEIC ANHYDRIDE

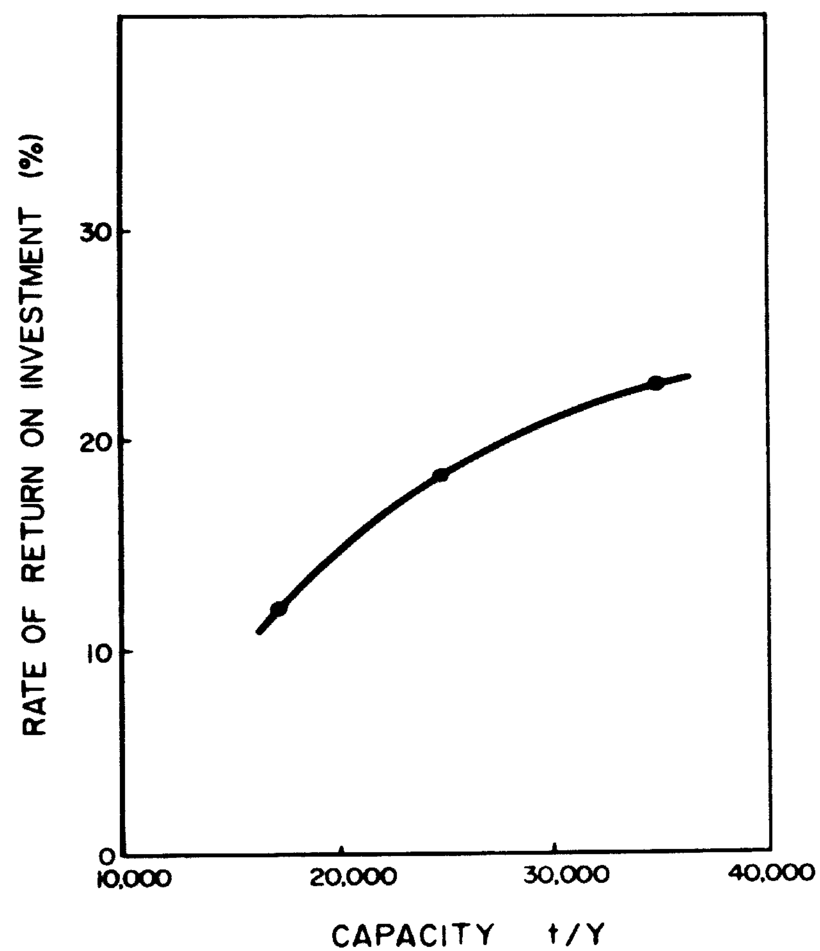


FIG. T-3-(2) RATE OF RETURN ON INVESTMENT
LINEAR ALKYLBENZENE

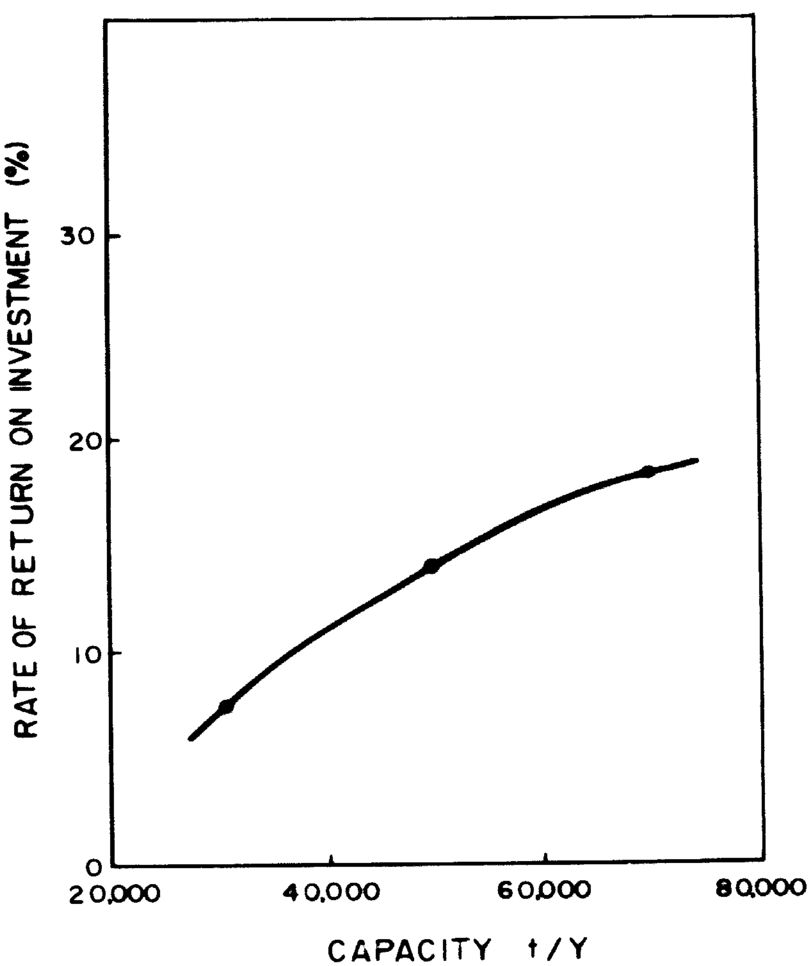
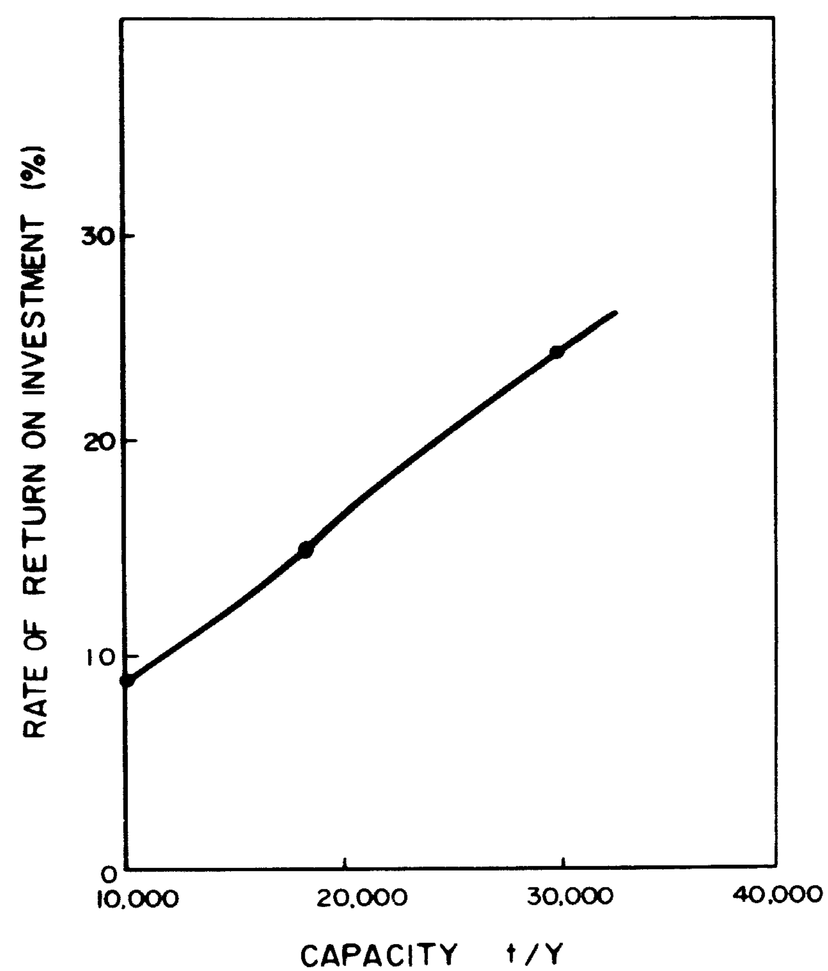


FIG. T-3-(3) RATE OF RETURN ON INVESTMENT
CAPROLACTAM-NYLON 6-F



ANNEX U.- 1

CALCULATION BASIS FOR DELIVERED PRICE AND DOMESTIC PRICE

(unit: $/ton)

		U K		Other European Countries								
				France		W. Germany		Italy		Average		
Products	Selling Price	Delivered Price[1]	Domestic Price[2]	Delivered Price	Domestic Price	Delivered Price	Domestic Price	Delivered Price	Domestic Price	Delivered Price	Domestic Price	Share[3]
LDPE	168.47	211	353	292	257	265	352	256	266	270	292	64.0
HDPE	229.80	280	474	387	408	353	553	342	503	360	488	89.8
VCM	93.27	130	n.a.	178	168	161	194	156	179	165	180	81.6
PVC	139.41	178	294	245	276	222	359	215	317	227	318	79.4
Styrene	112.05	151	198	193	179	175	203	170	243	180	208	80.9
Polystyrene	191.13	236	298	330	298	300	397	290	302	307	332	63.1
PG	203.26	254	310	350	304	318	298	308	302	325	301	67.3
Acrylonitrile	177.69	225	311	298	342	270	538	262	434	277	438	89.6
Acrylic Fiber	1,105.83	1,265	1,760	1,687	n.a.	1,528	n.a.	1,483	n.a.	1,566	n.a.	86.5
PP	206.02	253	534	352	450	319	798	309	503	326	584	77.6
SBR	238.64	290	325	373	342	338	298	327	344	346	328	74.4
Maleic Anhydride	154.72	200	400	265	406	240	410	232	602	245	473	88.6
Alkylbenzene	143.93	188	n.a.	247	304	224	n.a.	218	n.a.	230	n.a.	65.5
Caprolactam	319.05	385	n.a.	506	n.a.	458	n.a.	445	n.a.	470	n.a.	68.9
Polyamide Fiber	1,073.03	1,226	1,390	1,639	2,019	1,483	2,255	1,439	1,543	1,520	1,936	71.0
TDI	469.47	555	817	742	853	672	922	651	756	688	843	90.0
DMT	287.23	348	n.a.	463	n.a.	420	n.a.	407	n.a.	430	n.a.	69.5
Polyester Fiber	1,022.44	1,170	1,440	1,562	n.a.	1,286	n.a.	1,415	n.a.	1,420	n.a.	79.6

Remarks:
1) Delivered price is the average price which petrochemicals of Trinidad and Tobago are sold to the users in each country.
2) Domestic price is the average local delivered prices in each country.
3) Production share of France, W. Germany and Italy in West Europe except UK.

ANNEX U - 2

CALCULATION BASIS FOR DELIVERED PRICE AND DOMESTIC PRICE

(Unit : $/ton)

Products	Selling Price	North America: Delivered Price	North America – USA: Domestic Price	North America – USA: Share 4)	Southeast Asia: Delivered Price	Southeast Asia – Japan: Domestic Price	Southeast Asia – Japan: Share 5)	CIF Price from T&T	Latin America – CIF Price at Latin America: Mexico	Peru	Brazil	Colombia	Chile	Average	Share 6)
LDPE	168.47	286	287	95.0	342	287	83.7	195	215	230	240	230	220	226	70.0
HDPE	229.80	363	397	95.2	411	386	94.2	258	355	380	400	380	360	375	75.0
VMC	93.27	191	110	95.0	172	147	86.9	123	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
PVC	139.41	236	309	96.6	219	218	88.5	166	285	355	290	300	290	305	70.0
Styrene	112.05	213	176	96.0	196	186	91.2	140	180	245	175	195	215	200	72.0
Polystyrene	191.13	315	326	98.0	283	258	93.7	218	300	350	305	n.a.	335	323	73.0
PG	203.26	326	287	98.0	319	206	95.0	236	280	-	260	-	295	278	80.0
Acrylonitrile	177.69	283	320	97.9	279	291	100.0	206	350	-	330	-	-	340	65.0
Acrylic Fiber	1,105.83	1,310	1,963	95.9	1,485	1,110	90.1	1,154	1,310	1,510	1,420	1,410	1,560	1,440	72.0
PP	206.02	331	463	96.5	398	367	98.6	234	390	430	500	-	400	430	75.0
SBR	238.64	295	391	92.2	306	349	88.6	267	340	-	350	-	-	345	77.0
Maleic Anhydride	154.72	234	353	98.0	250	300	100.0	184	380	-	320	-	-	350	n.a.
Alkylbenzene	143.93	270	232	98.0	230	221	98.0	173	210	210	200	230	176	205	82.0
Caprolactam	319.05	480	540	98.0	458	410	95.7	352	440	-	450	440	425	440	70.0
Polyamide Fiber	1,073.03	1,273	1,984	94.8	1,444	1,096	76.9	1,120	n.a.	1,610	2,500	-	1,780	1,960	70.0
TDI	469.47	690	815	97.1	650	380	100.0	507	780	-	680	-	-	780	65.0
DMT	287.23	378	330	97.0	426	503	98.0	319	385	-	n.a.	-	-	385	n.a.
Polyester Fiber	1,022.44	1,216	1,525	96.4	1,376	1,278	86.9	1,068	1,470	1,940	1,165	-	-	1,520	82.0

Remarks:
4) Production share of USA in North America.
5) Production share of Japan in Southeast Asia.
6) Demand share of Mexico, Peru, Brazil, Colombia, Chile in Latin America.

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