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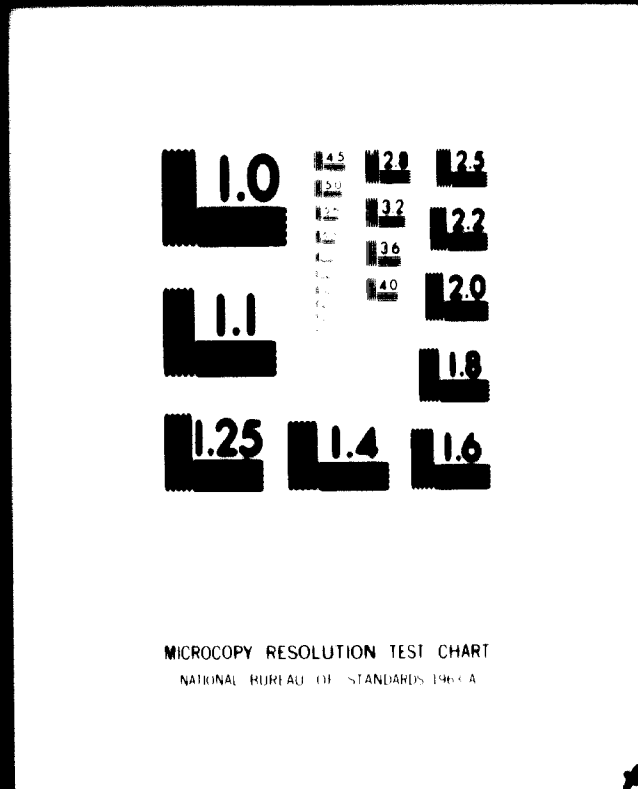
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**REPORT FOR THE PETROCHEMICAL  
AND FERTILIZER MEETING  
OF THE INDUSTRIAL CENTRE  
FOR ARAB STATES - KUWAIT**

October 1970

Ref. 90 204

**Bureau d'  
Etudes  
Industrielles et de  
Coopération de l'  
Institut français du  
Pétrole**

October 1970

Contract N° 70 / 40

**REPORT**

**FOR THE PETROCHEMICAL AND FERTILIZER MEETINGS  
OF THE INDUSTRIAL CENTRE FOR ARAB STATES,**

**EMIRAT /**

**OCTOBER 1970 .**

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## I - INTRODUCTION

In response to a request from the Industrial Development Center for Arab States (I.D.C.A.S.), the United Nations Industrial Development Organization has entrusted to the Bureau d'Etudes Industrielles et de Cooperation de l'Institut Français du Pétrole (B.E.I.C.I.P.) the preparation of a report for the petrochemical and fertilizer meeting that will be held in Kuwait on behalf of IDCAS.

The aim of the report is to present -on the basis of future internal consumption and possibilities for exports in the periods 1971-1975 and 1976-1980-recommendations on the targets of production to be undertaken in the Arab world, on the type, size and location of the projects that could be installed and on the structure of the industry to be established.

The plan of treatment that has been adopted is the following :

In chapter II, a summary of conclusions and recommendations is given ;

In chapter III the targets of production are indicated for intermediate and finished petrochemical products as well as for fertilizers.

In chapter IV are discussed several aspects to be taken into account at the stage of planning, such as necessity of integrated complexes, price of raw materials, opportunity to obtain or not the participation of foreign partners for financial technical or commercial reasons etc...

In chapter V, are presented the different parameters that must be considered to justify and promote harmonization and co-operation between projects.

In chapter VI, are studied the complexes that appear to be feasible in 1975 and 1980 ; all data regarding process routes, material balances, investments, operating costs and profitability of the projects are given. Whenever possible, precise recommendation on location, type and size of complexes, date of start-up have been given. When precise conclusion was not possible, all the technical and economical bases that are necessary for final decision that can be taken for political or conjunctural reasons- have been forwarded.

This report is based on the data, investigations and findings of the Survey Mission carried out by a team of six Arab experts at the beginning of 1970 in the Arab countries.

Other market information obtained in the course of previous studies performed by BEICIP in this part of the world or supplied by UNIDO have also been taken into account ; the data regarding process routes, investments, operating costs, etc... result from BEICIP's experience, they have been collected through many studies, contacts with process licensors and manufacturing companies and through participation to industrial projects.



It must be pointed out that the following additional information related to local conditions in the Arab countries, that IDCAS was supposed to provide to BEICIP were not received.

- . price of naphta, petrochemical intermediate and end products
- . cost for transport of raw materials
- . erected plant costs
- . tariffs applicable to petrochemical products and equipment
- . utilities cost
- . cost of man power

Estimates or data already available in BEICIP have had to be used, the authors feel that they are reliable but it can be assumed that they will have to be brought up to date when reaching the stage of final decision for the different complexes that are recommended.

The above described approach to the problem had been discussed and decided in a meeting on July 1st at UNIDO's headquarters in presence of representatives of UNIDO, IDCAS and BEICIP.

A draft of the report has been presented and discussed in September 16th in an other meeting at UNIDO. Very helpful comments and remarks have been made and they have been taken into account in the preparation of the final report.

It is hoped that the present report -although it has not been possible to give final answers to several of the questions that arise due to the lack of some information, to the very short period of time assigned to the work and principally to the fact that political aspects have not been considered- will form a satisfactory working document that contains most of the technical and economical facts and figures necessary for the discussions to be held in the IDCAS meeting.

Thanks must be addressed to UNIDO and IDCAS for their assistance and cooperation to the work conducted by BEICIP.

## II - SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

### 1<sup>o</sup>) - SETTING GOALS FOR PETROCHEMICALS AND FERTILIZERS

The targets of production to be undertaken have been estimated in the following way.:

The total quantities that can be produced are equal to the local demand plus the possibilities for exports. The production capacities to be installed should be equal to the difference between quantities to be produced and existing capacities. However, attention must be paid to the existing units if they are not already obsolete; if the consumption increases at a continuous pace, additional capacity has to be gradually installed; new plants not yet in production are now at the stage of engineering studies or even under construction.

#### a) - Petrochemical products

The future demand in 1975 and 1980 in the Arab countries has been established for the end products and the corresponding amounts of intermediates that will be necessary have been calculated.

The estimates have been made country by country whenever possible -see chapter III- then they have been assembled according to the usual group of Arab countries into: North Africa (N.A.), North East Africa (N.E.A.) and Middle East Arab countries (M.E.A.C.). The results for the main end products are given in Table A.

For plastics, the general tendency is that the demand for Polyethylene which is now appreciably below that for PVC will be approximately equal in 1980 (115,000 to 120,000 M.T./Y). At that time, the total polyethylene plus PVC will still represent more than 50 % of the total demand for plastics.

The major consumers for plastics are now U.A.R. and Algeria. Their position will not change in 1980 (28,000 M.T. of PE and 28,000 M.T. of PVC in UAR; 16,600 M.T. of PE and 15,400 M.T. of PVC in Algeria).

Morocco, Syria and Irak are also potential consumers for important quantities. Possibilities for exports may arise in Greece (P.E.) Yugoslavia (PVC) East Africa (P.E. and PVC) and India (P.E.).

For synthetic fibers, polyamides will remain the major product; nylon 6 being much more important than nylon 66. The total demand for the Arab countries will be 26,000 M.T. of polyamids in 1975 and 41,400 M.T. in 1980. The demand will grow at a very high pace in Algeria, Morocco, and U.A.R.. Algeria will consume 6,700 MT of polyamide, 5,000 T. of polyesters and 2,000 T. of polyacrylics in 1980, Morocco will consume 6,100 T. of polyamides, 4,500 T. of polyesters and 1850 T. of polyacrylics, U.A.R. will consume 7,600 T. of polyamides, and 3,700 of polyesters.

**Table A : WORLD DEMAND FOR ETHYLENE GLYCOL AND PROPYLENE GLYCOL  
IN THE ARAB COUNTRIES (MT/Y)**

	1975				1980			
	North Africa	North East Africa	Middle East Arab Countries	Total	North Africa	North East Africa	Middle East Arab Countries	Total
<b><u>PLASTICS</u></b>								
Polyethylene	18,900	18,800	27,000	64,700	33,500	33,800	47,800	115,100
P. V. C.	22,500	23,400	29,500	75,400	33,300	34,600	52,500	120,400
Polystyrene	4,100	4,000	5,200	13,300	5,750	6,050	7,700	19,500
Polypropylene	1,500	na	na	5,000	na	na	na	15,000
<b><u>TEXTILE FIBRES</u></b>								
Polyamide	10,900	7,000	8,000	25,900	14,900	11,900	15,000	41,400
Polyester	6,000	3,000	5,000	14,000	11,000	5,500	10,000	26,500
Polyacrylates	1,500	1,900	2,000	5,750	4,500	4,900	4,000	13,000
<b><u>NONTEXTILE FIBRES</u></b>								
S.B.R.	11,000	8,300	8,900	29,000	16,400	14,700	11,900	43,000
Polybutadiene	3,400	2,400	2,500	8,300	6,800	6,100	5,000	17,900
<b><u>OTHERS</u></b>								
(D.B.L.)	14,900	7,100	15,000	36,600	20,500	11,000	22,000	53,900

North Africa { Morocco  
Algeria  
Tunisia

North East Africa { Libya  
S.A.R.  
Sudan

Middle East Arab Countries

{ Lebanon  
Jordan  
Syria  
Saudi Arabia  
Kuwait  
Emirate

In spite of very strong competition from existing suppliers there could be possibility for exports in India (Nylons and polyesters) East Africa (nylon and polyesters) and Iran (polyesters).

For synthetic rubbers, SBR will remain the major product ; polybutadiene coming in second rank. The total demand in the arab world will be 29,000 T. of SBR in 1975 and 43,000 T. in 1980. U.A.R. (17,000 T. of synthetics in 1980), Algeria (12,600 T.) and Morocco (12,600 T) will be the major consumers ; but the total amount per country will remain small and create problems to establish economical plants.

The possibilities for exports are not given in the report.

For synthetic detergents, dodecyl benzene sulphonate will remain the major product. The total consumption of DDB should reach 36,600 in 1975 and 53,500 T. in 1980 for the total Arab world (Algeria (10,000 T. of D.D.B. in 1980), U.A.R. (8,000 T.) and Morocco (7,000) will have the largest demand. There will be possibilities for exports in East Africa.

The intermediates (ethylene, propylene, butadiene, benzene and paraxylene) that will be necessary to manufacture the petrochemical end products, have also been studied ; the results are given in table.

Table B - Future demand for petrochemical intermediates in the Arab countries (M.T/Y)

	1975				1980			
	N.A.	W.P.T.A.	M.E.A.C.	Total	N.A.	N.E.A.	M.E.A.C.	Total
Ethylene	35,200	35,300	48,000	118,500	57,900	59,000	84,300	201,200
Propylene	20,000	12,000	22,400	54,400	36,000	23,000	36,200	95,200
Butadiene	11,100	7,900	8,400	27,400	17,900	16,000	13,000	46,900
Benzene	25,700	17,100	22,900	70,700	35,500	27,300	37,400	100,200
Paraxylene	5,000	2,500	4,100	11,800	9,100	4,500	8,300	21,950

b) - Fertilizers

The Arab countries are already producers of nitrogen and phosphate fertilizers ; several large units are presently under construction and raw materials (natural gas and phosphate ore) are available in large quantities. It was then advisable to concentrate the survey on these productions.

The results regarding future demand are presented in table C for nitrogen and phosphate fertilizers.

Table C - Future demand for Nitrogen and Phosphate fertilizers

	1975				1980			
	N.A.	N.E.A.	M.E.A.C.	Total	N.A.	N.E.A.	M.E.A.C.	Total
Nitrogen (N)	135.000	501.000	126.100	762.000	210.000	670.000	230.000	1.110.000
Phosphate (P <sub>2</sub> O <sub>5</sub> )	148.000	170.000	70.000	388.000	220.000	292.000	150.000	662.000

Still very limited, the consumption in the Arab countries will grow at a high rate, especially in North Africa and U.A.R. The ratio N/P<sub>2</sub>O<sub>5</sub> will be approximately 1 in North Africa, it will remain approximately 2 in the whole Arab world. Urea and superphosphate which have a higher content in nutrients will be more commonly used in the future. There will be possibilities for export of Nitrogen fertilizers in India, Pakistan, China and Africa; for phosphate, present importers such as Western Europe, Asia and even U.S.S.R. will offer large opportunities.

c) - Production capacities

In the case of petrochemicals, there is no plant under production; several units are being built in Morocco, Algeria, U.A.R.; projects have been announced in most of the other Arab countries; in the report, the plants now being built or firmly decided have been taken into account when presenting the recommendation.

In the case of fertilizers, there are presently several units of large capacity producing Nitrogen and phosphate fertilizers; the results are summarized in table D.

Table D - Present and future production capacities for Nitrogen and Phosphate fertilizers

(1,000 MT/Y)

	1970				1975				1980			
	NA	NEA	MEAC	total	NA	NEA	MEAC	total	NA	NEA	MEAC	total
(N)	0	220	321	841	385	70	1366	2491	n.a.	N.a.	n.a.	n.a.
P <sub>2</sub> O <sub>5</sub>	335	60	35	430	435	200	260	895	830	330	260	1.420

It must be pointed out that several new phosphate deposits (Iraq, Jordan) have been already discovered and will probably be exploited before 1980.

Comparison of tables C and D shows that there will be a large overcapacity and that the production of new plants will be mainly for export. Exceptional conditions such as availability of raw materials at low price and plants of large capacities should enable to reach these goals, provided that all necessary steps are taken to guarantee adequate structure of the industry and harmonization between projects.

The conclusions of the market survey are the following :

For petrochemical end products it is recommended that no special provision for export outside the Arab countries should be made when setting the design basis of the units ; Export capacity will automatically exist because newly erected units built to supply the local demand will not produce at full capacity at the beginning.

For petrochemical intermediates, the above is also true but it is necessary to pay attention to a probable gap between production and demand for aromatics in Europe in 1975. Attention must be paid also to the possibilities of producing olefins, at very low price in specific conditions (association of L.N.C. plant with a steam-cracker).

For fertilizers, it has been indicated that most of the new plants to be erected will have to export their production.

## 2°) - STRUCTURE OF THE INDUSTRY TO BE ADOPTED

Some fundamental concepts are discussed in this study ; the necessity of having a phased development is emphasized as well as the interest of integrated complexes that will guarantee the best utilization of by products.

The question of raw material prices especially natural gas and naphta is also analysed and the consequences of fixing high prices are outlined.

Capital availability is also an important problem ; should the Arab countries try to finance the foreign exchange part of the projects through loans or through participation of foreign share holders ? Both possibilities are studied from the financial stand point (payment of interest or repatriation of profits) but attention is paid also to the advantages offered by association with foreign partners where looking at the commercialization of the products.

In conclusion it appears that the production of intermediate or of end products whose the productions technics are well known and can be obtained by purchasing of licenses can be undertaken without foreign partners ; on the contrary for complexe products where complete know-how and permanent research work are necessary, it is advisable to obtain the assistance of a foreign partner who is already in the business in his own country and who has or can create a commercial network with customers assistance and technical sale services.

### 3°) - HARMONIZATION AND COOPERATION BETWEEN PROJECTS

The recommendations presented in this report are based in the assumption that complete coordination for the development of the industry will be established between the Arab countries. Harmonization must include legal, financial, commercial and technical provisions.

Customs duties and taxes : the policy regarding customs duties for petrochemical products must be decided, exchanges between the Arab countries on the one hand and trade with non-Arab countries on the other hand must be considered ; quotas must be fixed in specific cases and existing bi-lateral agreements have to be taken into account.

The problem of imports duties on machinery, equipment, spare parts, catalysts etc... must also be investigated in order to decrease the erected cost and operating cost of the plants.

Incentives to encourage foreign investments, when they look advisable have to be decided. They can cover : simple procedure to obtain the authorization to build projects ; duty and taxes exemption during the first years of production, guarantees for the repatriation of profits. Of course, they have to be balanced by obligations to have local partners, to employ indigenous man power, to perform the training of local specialists, to guarantee the take-off of certain products, etc...

As regards the commercial aspects, it is advisable for the Arab producers not to act individually when they try to compete with existing suppliers on the export markets.

Interarabic commercial associations should be organized -as they already exist in Europe for example- and be in position to decide on credit facilities to be granted to the customers (especially in Asia), on eventual participation into down-stream investments in the buyers country (for example in plants that could be erected to manufacture finished fertilizers from imported ammonia coming from the Arab countries) and to ensure complete coordination and exchange of information on bilateral agreements between Arab and non-Arab countries (Kuwait, Turkey for instance)

Many technical factors can make the object of regional cooperation.

The infrastructure (port facilities, land and sea transportation, production and distribution of electricity, etc...) must be established on a region wide scale.

Interregional companies for equipment manufacturing, civil engineering and plant erection, inspection and maintenance of plants can be created.

At the stage of planning and design of the complexes, it would be advisable to have an international body entrusted to coordinate the decisions, to look for potential partners and to make sure that the projects are performed according to the best engineering standards. Such entities would also be entrusted to watch over the installation of application laboratories and technical assistance to the customers (plastics, fertilizers etc...), to arrange financing facilities for the Arab customers (fertilizers), to coordinate the installation of the processing equipment that will be necessary to transform the production of the petrochemical units into finished articles (plastic processing, textile fibers spinning and weaving equipment, etc...).

Finally the training at all levels which is now carried out by engineering and construction companies, by manufacturing companies or by special training organizations that have been installed by individual countries (Iraq, Kuwait, U.A.R., Algeria etc...) should be organized on a regional scale, taking advantage of the existing facilities and experience that are available in the Arab world or in the rest of the world.

.../...



#### 4°) - RECOMMENDED DEVELOPMENT ROUTES AND PRESENTATION OF FEASIBLE PETROCHEMICAL PROJECTS

Considering the results of the market forecasts reported hereabove either for local consumption of the different Arab Countries or for possible exports, this chapter presents the feasibility study of the different projects which might be envisaged to provide a suitable basis to develop a viable petrochemical program in Arab Countries.

The study of these feasible projects which might be set up in order to meet market requirements and export possibilities has been carried out with the following aims :

- 4.1.) to utilize the raw materials which are available in the different areas and which constitute the best suitable feed-stocks regarding :
  - . their delivery prices
  - . quantities available on long term period
  - . their characteristics and specifications
- 4.2.) to group in the same location productions planned by the different countries in petrochemical complexes integrated with already existing complementary plants or with units supplying necessary feed-stocks
- 4.3.) to select products having sufficient demand in order to implement petrochemical and fertilizer plants with minimum economic size in order to develop a viable program for industrial development
- 4.4.) to point out the influence of the different technical and economic factors on the profitability of the alternate projects in order to establish priorities in the realization of the program

#### 5°) - PRESENTATION OF ALTERNATE FEASIBLE PROJECTS

##### 1. Complex based on olefins production and their derivatives

Complex A - Plastic and detergent based complex producing :

- . 15,000 MT/year of polyethylene
- . 15,000 MT/year of polyvinylchloride
- . 10,000 MT/year of dodecylbenzene

.../...

- a. raw material : propane
- b. possible locations : Algeria  
UAR  
Syria  
Irak
- c. to supply corresponding 1975 sub-region markets and partly neighbouring countries
- d. end-products will be respectively manufactured in the various countries of the sub-regions

Complex A<sub>1</sub> - Plastic and detergent based complex producing

- . 30,000 MT/year of polyethylene
- . 30,000 MT/year of polyvinylchloride
- . 20,000 MT/year of dodecylbenzene

- a. raw material : propane
- b. possible locations : Algeria or UAR  
Syria or Irak  
  
to supply 1975 North Africa and North East Africa markets and 1975 Middle East Arab Countries markets
- c. possible locations : Algeria  
UAR  
Syria  
Irak  
  
to supply corresponding 1980 sub-region markets and partly neighbouring countries
- d. end-products will be respectively manufactured in the various countries of the sub-regions

Complex B - Plastic and detergent based complex producing

1. Basic products : 80,000 MT/year of ethylene and propylene
2. Monomers and polymers as follows :

Complex B<sub>1</sub> - producing :

- . 30,000 MT/year of polyethylene
  - . 30,000 MT/year of polyvinylchloride
  - . 20,000 MT/year of dodecylbenzene
- a. raw material : naphtha and mixed ethane propane cuts
  - b. possible locations and markets supplied : see Complex A<sub>1</sub>

Note : excess ethylene will be exported to Arab Countries or to possible buyers.

Complex B<sub>2</sub> - producing :

- . 30,000 MT/year of polyethylene
  - . 30,000 MT/year of polyvinylchloride
  - . 20,000 MT/year of dodecylbenzene
- a. raw material : naphtha and mixed ethane propane cuts
  - b. possible locations : Algeria or UAR  
Iraq or Syria
  - c. to supply 1980 North Africa and North East Africa markets and 1980 Middle East Arab Countries markets
3. End-products will be respectively manufactured in the various countries of the sub-regions.

.../...

1. propylene production will depend upon feed-stocks used in the steam-cracking

Complex C - 150,000 MT/year and 300,000 MT/yearEthylene production by Ethane steam-cracking

1. to supply ethylene for its derivatives as : polyethylene and PVC to be produced for the local market and for exports to consuming countries
2. possible locations : integrated with large capacity LNG plant under construction or under planning stage in Libya, Algeria and Middle East Arab Countries.

Note : The evaluation of such a project is compared to the production of ethylene by naphtha steam-cracking in units already existing or planned in big ethylene consuming areas.

2. Complex based on aromatic production and their derivativesComplex D - Aromatic based complex producing :

- . 45,000 MT/year of benzene
- . 12,500 MT/year of P-xylene
- . 18,000 MT/year of O-xylene

- a. raw material : gasoline cuts supplied by refineries processing Algerian or Libyan crude oils
- b. possible locations : Algeria or Libya
- c. to supply major part of the aromatic demand in Arab Countries for 1975

Complex D<sub>1</sub> - Aromatic based complex producing :

- . 80,000 MT/year of benzene
- . 20,000 MT/year of P-xylene
- . 30,000 MT/year of O-xylene

integrated with a coking unit producing :

- . 90,000 MT/year of electrodes coke

- a. raw material : gasoline cuts and low sulfur residuum supplied by refineries processing Algerian or Libyan crudes
- b. possible locations : Algeria or Libya
- c. to supply the aromatic demand in Arab Countries for 1975 and to export the remaining products and electrodes coke to European Countries where deficits will persist for the next years. In 1980, such a complex might supply the whole aromatic demand in Arab Countries

Complex D<sub>2</sub> - Aromatic derivatives based complex producing respectively 15,000 and 30,000 MT/year of caprolactame (for nylon 6 manufacture)

- a. raw material : benzene produced in complex D or D<sub>1</sub>
- b. possible location : taking into account the availability of other raw materials as : ammonia and sulfuric acid which have to be supplied and disposal of by-produced ammonium sulfate, Algeria might be considered as the best location for these productions
- c. to supply respectively all the North Africa demand and partly other Arab Countries for 1975 and the major part of the total demand for 1980

Complex D<sub>3</sub> - Aromatic derivatives based complex producing respectively 15,000 and 30,000 MT/year of dimethylterephthalate (for polyesters manufacture)

- a. raw material : p-xylene produced in Complex D or D<sub>1</sub>
- b. possible location : Algeria or UAR (based on p-xylene produced in Algeria)
- c. to supply the total demand of Arab Countries respectively for 1975 and 1980

.../...

Complex D<sub>4</sub> - Manufacture of 6,000 MT/year nylons 6 fibers

- a. raw material : caprolactame produced in Complex D<sub>2</sub>
- b. possible location : Morocco, Algeria, UAR, Syria and Irak
- c. to supply their local market for 1975 and to export excess products to other Arab Countries, additional units of same size might be provided for 1980

Complex D<sub>5</sub> - Manufacture of 3,000 and 6,000 MT/year polyesters fibers

- a. raw material : DMT produced in Complex D<sub>3</sub>
- b. possible locations and supply :
  - one 6,000 MT/year unit for every sub-region located in : Algeria, Irak or Syria and supplying the local market for 1975
  - one 3,000 MT/year unit for the following countries : Algeria, Morocco, UAR, Irak and Syria and supplying the local market for 1975
  - additional units of capacities included in the same range might be provided for supplying 1980 local markets of the different sub-regions

3. Projects based on export possibilities

The large availability of natural gas in Arab Countries coupled with the growing demand of LNG for peak shaving operation and load gas supply allow natural gas at very attractive prices for ammonia and methanol production.

Large size projects based on these low cost raw material and oriented towards export markets might compete favourably with European or US similar projects.

.../...

Complex E - 1,000 MT/year ammonia based complex

Possible location and supply :

- . Middle East Arab Countries for Far East and East Africa markets
- . Algeria and Libya for European countries and West Africa and Mediteranean countries

Complex F - 1,000 MT/year methanol based complex

Possible location and supply :

Algeria or Libya for European markets

6°) - ANALYSIS OF THE ALTERNATE FEASIBLE PROJECTS AND PROFITABILITY CALCULATIONS :  
BASIS FOR THE SELECTION OF RECOMMENDED PROJECTS

For the different complexes presented hereabove, the following technical and economic data have been supplied :

- . material balance for the different units and the overall complex
- . capital cost for the overall complex
- . total product sales
- . operating cost of the overall complex
- . profitability calculations

The influence of the different technical and economic factors on the profitability of the possible projects will be pointed out in order to allow the participants of the meeting organized by IDCAS to discuss the different alternate feasible projects and to appraise the program of realization for recommended projects.

### III - TARGETS OF PRODUCTION TO BE UNDERTAKEN

The first part of this study aims to assess the targets of production to be undertaken in the Arab World and the types of products to be manufactured. This is based on :

The future prospects for the consumption in two periods, namely 1971-1975 and 1975-1980.

The possibilities and potentialities for **export** in the same two periods

The existing production capacities have to be taken into consideration as well as the projects now being implemented or firmly decided.

When reaching the conclusion of this first part, attention shall be given to the projects that have been announced but have not yet started, in order to check if they can be included in the scope of recommended projects.

#### III. GENERALITE.

##### III.1. The products to be studied

They can be divided into :

##### - Finished petrochemical products

Polyethylene	)	Plastics
Polypropylene	)	
Polystyrene	)	
Polyvinyl chloride	)	
Polybutadiene	)	Rubbers
Styrene-Butadiene	)	
Polyester	)	Synthetic fibers
Nylon	)	
Acrylic	)	
Synthetic detergents		

##### - Intermediates

Ethylene  
 Propylene  
 Butadiene  
 B.T.X.  
 Styrene  
 Caprolactam  
 D.M.T. or TPA  
 Acrylonitrile  
 Dodecyl Benzene



- Fertilizers

Nitrogen Fertilizers  
Phosphate Fertilizers  
Compound Fertilizers

- Sulfur (as a recoverable product)

**III .1.2. The market to be studied**

- Arab countries

Morocco	)	
Algeria	)	North Africa
Tunisia	)	
Libya	)	
UAR	)	North East Africa
Sudan	)	
Jordan	)	
Syria	)	
Irak	)	
Kuweit	)	Middle East Arab Countries
Lebanon	)	
Saudi Arabia	)	
Emirates	)	

- Countries offering possibilities for exports

. Countries along the Mediterranean

France  
Italy  
Spain  
Yougoslavia  
Greece  
Turkey

. East Africa

. Central Africa

. Asia, namely : India  
Pakistan  
Iran

### III.1.3. Methodology

The Market information that appear in this report, have been collected from the most recent studies made by O.N.U.D.I., B.E.T.C.I.P. or specialized organisations; available published data have also been utilised and the report prepared by the arab experts on behalf of I.D.C.A.S. has been of great help.

The main criteria in the selection of basic information has been their homogeneity :

- homogeneity in the sources of information,
- homogeneity in the results and in their presentation.

The forecast for consumption have been based on :

- a comprehensive appraisal of the past and present situation (chronological series)
- a realistic estimate of the marketing possibilities.

Information on the past and present situation have been collected from reliable sources such as :

- national statistics (production, consumption, external trade)
- international statistics
- published information
- previous studies available to BEICIP
- contacts with producers or consumer recently taken by BEICIP in the course of other studies.

The estimate of the market possibilities has been made by using different methods which permit cross-checking of the results :

- extrapolation of chronological series
- using of correlations such as consumption Vs Gross National income
- determining of the rates of growth for the consumption of main products
- breaking down of the consumption into the different types of finish products.

No figure or estimate has been taken into account without being the result of applying several of the above mentioned methods.

The results are presented in the following chapters :

- in chapter III.2 the consumption forecast for the main petrochemical products are presented by country or by group of countries ;

- in chapter III.3, based on the future demand for the end products, the forecasts for main intermediates are presented by country or by group of countries ;
- in chapter III.4 fertilizers are studied ;
- chapter III.5 deals with sulphur.

In each of these chapters, the information are presented, when available, in the following systematic form :

- 
- Table A shows the variation of the demand in the Arab countries ;
- Table B shows the production capacities in the Arab countries ;
- Table C shows the variations of the demand in selected countries where there could be possibilities for export ;
- Table D shows the production capacities in these countries.

Since, these report is going to be discussed during the seminary to be held in Kuwait, only very brief comments are given and all efforts have been concentrated on presenting sufficient and reliable figures.

### III - 2/ FINISHED PETROCHEMICAL PRODUCTS

#### III - 2/ I - Plastics

##### General characteristics of the market

The rate of growth for consumption of plastic materials is approximately 8 to 10 % in industrialized countries; it is much higher, usually between 10 and 20 % in other countries :

The production of plastic materials (polymers) requires high investments and large capacities ; there is a continuous growth of the "minimum economic sizes" and the oil producing and refining companies are now joining the chemical companies in the production of plastics intermediates and polymers . On the contrary the processing of plastics into finished products remains usually in the hands of small scale industries.

The present study is concentrated on thermoplastic resins which represent now 60 to 65 % of the demand in Western Europe and approximately 70 to 75 % in the industrializing countries. This is due to the fact that they are cheaper, easy to process and can fulfil most of the requirements of these countries ; on the contrary thermosetting resins such as epoxies, reinforced polyesters which cannot be processed by injection molding have very specific application and are not yet consumed in notable quantities.

The main application of thermoplastics are :

- packaging (fibers, films, blown articles)
- Agriculture (bags, pipes, green houses)
- building (insulating materials, sheets, flooring, pipes, profiles, etc...)

In Western Europe, where thermoplastics represent 60 to 65 % of the demand, polyethylene, P.V.C. and polysterene represent approximately 50 % of the same ; that means that the share of polypropylene for example, remains very low, approximately 2 % in France and 4 % in Italy in 1969.

For that reason, the market estimates which are given in the following table, if they have been estimated with good accuracy for polyethylene, P.V.C. and polysterene have been roughly evaluated for polypropylene ; no precise figures are available and it can be assumed that the consumption will remain moderate.

In the following paragraphs, the situation for polyethylene, P.V.C., polysterene and polypropylene is presented and illustrated in a series of tables :

- In Table I A, I B, I C, I D, are presented the figures for polyethylene ;  
 " 2 A to 2 D, are presented the figures for P.V.C. ;  
 " 3 A to 3 D, are presented the figures for polysterene ;  
 " 4 A to 4 D, are presented the figures for polypropylene.

III- 2 - I' I- Polyethylene

Still inferior to the consumption of P.V.C., the demand for polyethylene is growing at a high rate. This is due to price conditions, multiplicity of uses, and to the development of specific applications such as fertilizers bags.

The general tendency in the Arab countries is that the demand for polyethylene will be in 1980 approximately equal to that for P.V.C. ; that means that the rate of growth will be higher for polyethylene than for P.V.C. (particularly in North Africa).

The share of Polyethylene in the total consumption of thermoplastics is given for some representative countries in the table below :

Polyethylene consumption (in % of total thermoplastics)

	<u>Morocco</u>	<u>Algeria</u>	<u>Tunisia</u>	<u>U.A.R.</u>
1965	22	8,5	37	33
1970	27,5	30	38	33
1975	34	41	40	37
1980	38	43	42	41

All the results regarding demand are presented in table I A to I D.

conclusions : the consumption of Polyethylene in arab countries will be approximately 65,000 T. in 1975 and 115,000 T. in 1980.

The annual rate of growth for consumption will decrease; now between 15 and 28 % according to the regions in 1965-70 it will go down to 15-17,5 % in 1970-75 and to 12 - 12,5 % in 1975-1980.

In foreign countries the production capacities will grow according to the demand, however there can be possibilities for exports in Grece, India and Africa.

## A.R.G. annual rate of growth

## I a - DEMAND FOR POLYETHYLENE ( M.T./Y.)

	<u>1965</u>	<u>1970</u>	<u>1975</u>	<u>1980</u>
Morocco	1.300	3.100	6.600	12.400
Algeria	585	4.000	9.800	16.600
Tunisia	550	1.300	2.500	4.500
<b>Total North Africa</b>	2.435	8.400	18.900	33.500
	a.r.g. 28 %	a.r.g. 17,5 %	a.r.g. 12 %	
Libya	300	900	2.000	4.100
U.A.R.	4.000	7.700	15.800	28.000
Sudan	200	500	1.000	1.700
<b>Total N.E. Africa</b>	4.500	9.100	18.800	33.800
	a.r.g. 15 %	a.r.g. 15,5 %	a.r.g. 12,5 %	
Jordan	200	600(1969)	700	
Syria	2.100	1.900( " )	5.500	
Irak	1.000	3.300( " )	3.700	
Kuweit	-	200( " )	200	
Lebanon	700	2.000( " )	2.400	
Saudi Arabia	300	m.a.( " )	400	
<b>Total Middle East arab countries.</b>	4.000	12.900	27.000	47.800
	a.r.g. (26 %)	a.r.g. 16 %	a.r.g. 12 %	
<b>Total Arab countries</b>	10.935	30.400	64.700	115.100

## I b - PRODUCTION CAPACITIES (M.T./Y)

Algeria	40.000	(SKIKDA)
U.A.R.	45.000	
Syria	20.000	(BASRAH)
Irak	25.000	

Ic - FOREIGN COUNTRIES ; CONSUMPTION OF POLYETHYLENE (M.T./Y)

<u>Consumption</u>	<u>1965</u>	<u>1970</u>	<u>1975</u>	<u>1980</u>
East Africa	3,600	10,700	21,600	45,900
Central Africa	1,100	5,300	7,600	16,000
<b>Sub Total</b>	4,700	14,000	29,200	61,900
India	18,000	45,000	15,000	210,000
Pakistan	3,500	6,500(1968)		26,000
Iran	5,000	10,000( " )		85,000
<b>Sub Total</b>	26,500	85,000	190,000	321,000
France	128,000	300,000	485,000	
Italy	100,000	200,000	360,000	
Spain	51,000	90,000	130,000	
Greece	6,500	15,000	25,000	
Yugoslavia	14,000	30,000	55,000	
Turkey	5,000	12,000	20,000	
<b>Sub Total</b>	304,500	647,000	1,075,000	1,500,000

Id - PRODUCTION CAPACITIES IN FOREIGN COUNTRIES

India	8,500	46,000(1969)	64,000	140,000
Pakistan	5,000	5,000	40,000	
Iran		20,000 (abadan)		
	13,500	89,000		
France	142,000	460,000		
Italy	196,000	430,000		
Spain	33,000	120,000	360,000	
Greece				
Yugoslavia	5,000	20,000	120,000	
Turkey		12,000	100,000	
<b>Sub Total</b>	376,000	859,000		

III- 2/ 1 . 2 - POLYVINYL CHLORIDE

Presently, P.V.C. is still the most commonly used plastic product ; its share will decrease in the future until P.V.C. and Polyethylene consumption are approximately equal in 1980. However, the consumption will continue to grow due to the development of building and packaging industries and also to a large amount of irrigation projects (rigid pipes). As regards agriculture and production of fertilizer bags, there will be a trend to manufacture polyethylene heavy duty bags which are adapted to climatic conditions rather than P.V.C. bags.

The share of P.V.C. in the total consumption of thermoplastics is given below for some selected countries :

P.V.C. consumption (in % of total thermoplastics)

	<u>Morocco</u>	<u>Algeria</u>	<u>Tunisia</u>	<u>U.A.R.</u>
1965	59	78	50	49
1970	55,5	52	45,5	50
1975	44	39	43	45
1980	41,5	39	39	41

The results regarding demand of production of P.V.C. are presented in tables 2 A to 2 D.

Conclusion : The consumption of P.V.C. in the arab countries will be approximately 75 000 T. in 1975 and 120.000 T. in 1980.

The annual rate of growth which is between 9 and 17 % according to the regions will decrease to 8,5 - 14 % in 1970-1975 and to 8 - 12 % in 1975-1980.

In foreign countries the production capacities will grow according to the demand, with a sensible over capacity in France and Italy, however, there can be small possibilities for exports in Yugoslavia and Africa.



a.r.g. - ANNUAL RATE OF GROWTH

## 2 A - DEMAND FOR P.V.C. ( M.T./Y)

	<u>1965</u>	<u>1970</u>	<u>1975</u>	<u>1980</u>
Morocco	3.500	6.000	9.200	13.800
Algeria	5.400	7.500	10.300	15.400
Tunisia	750	1.550	3.000	4.100
<b>Total North Africa</b>	9.650	15.050	22.500	33.300
	a.r.g. 9 %	a.r.g. 8,5 %	a.r.g. 8 %	
Libya	500	1.500	3.000	4.600
U.A.R.	6.000	11.500	19.000	28.000
Soudan	600	950	1.400	2.000
<b>Total Nord East Africa</b>	7.100	13.950	23.400	34.600
	a.r.g. 14,5%	a.r.g. 11 %	a.r.g. 8 %	
Jordan	300	900 (1969)	1.000	
Syria	640	1.800 "	2.000	
Irak	2.000	4.000 "	4.400	
Kuwait	n.a.	300 "	300	
Lebanon	3.500	6.000 "	6.800	
Saudi Arabia	400	700 "	800	
<b>Total Middle East Arab Countries</b>	6.840	15.300	29.500	52.500
	a.r.g. 17 %	a.r.g. 14 %	a.r.g. 14 %	
<b>Total Arab Countries</b>	23.590	44.300	75.400	120.400

## 2 B - PRODUCTION CAPACITIES (MT/Y)

Morocco				
Algérie				
U.A.R.		10.000 (Kenitra)	35.000 (SKIKDA)	
			40.000	
Libya				5.000
Irak				
Saudi Arabia				60.000

**2 C - FOREIGN COUNTRIES CONSUMPTION OF P.V.C. ( M.T./Y )**

<u>Consumption</u>	<u>1965</u>	<u>1970</u>	<u>1975</u>	<u>1980</u>
East Africa	6,100	13,200	25,500	48,300
Central Africa	<u>2,600</u>	<u>6,400</u>	<u>12,700</u>	<u>24,400</u>
Sub Total	8,700	19,600	38,200	72,700
India	15,500	1,800 (1967)		200,000
Pakistan	4,200	5,800 (1967)	13,500	25,000
Iran	<u>6,500</u>	<u>10,000 (1967)</u>		<u>85,000</u>
Sub Total	26,200	70,000	160,000	310,000
France	182,000	340,000	520,000	
Italy	150,000	320,000	500,000	
Spain	54,000	80,000	130,000	
Greece	13,500	25,000	35,000	
Yugoslavia	22,000	40,000	60,000	
Turkey	<u>9,000</u>	<u>16,000</u>	<u>28,000</u>	
Sub Total	430,500	821,000	1,273,000	1,700,000

**2 D - PRODUCTION CAPACITIES IN FOREIGN COUNTRIES (M.T./Y.)**

India	31,000	19,000 (1969)	56,000	115,000
Pakistan	-	5,000	30,000	30,000
Iran	4,000	24,000 ( ARMAZ, ABADAN)		
France	240,000	420,000		
Italy	299,000	520,000		
Spain	40,000	100,000	250,000	
Greece	-	12,000	18,000	
Yugoslavia	8,000	25,000	125,000	
Turkey	-	<u>32,000</u>	<u>225,000</u>	
Sub Total	587,000	1,109,000		

### III. 2 - I- 3. POLYSTYRENE

Presently, polysterene is essentially consumed in molded articles ; for these applications, polysterene is going to be in competition with other thermoplastics (polypropylene, A.B.S.,etc...) but a new outlet will appear in the packaging industry.

The share of polysterene in the total consumption of thermoplastics which is now usually 8,5 to 12 % will decrease until 6,5 to 8 %.

This is illustrated in the table below :

#### Polystyrene consumption (in % of table thermoplastics)

	<u>Morocco</u>	<u>Algeria</u>	<u>Tunisia</u>	<u>U.A.R.</u>
1965	12	8,5	5	10
1970	10,5	8	6	9,5
1975	10	7,5	6	7,5
1980	8	6,5	6,5	7,5

The results regarding demand and production of polystyrene are shown in tables J A to 3 D.

**Conclusion :** The consumption of polysterene in the Arab countries, will be approximately 13.500 T in 1975 and 20.000 T in 1980.

The annual rate of growth for consuption will decrease from approximately 13 % in 1965-70 to 9 - 10,5 % in 1970-75 and to 6,5 - 8 % in 1975-80. It must be noted that the only project for polysterene production is in Algeria and the size and location of this project have not been firmly decided. The future consumption could be higher if any other project was undertaken.

a.r.g. annual rate of growth

3 a - DEMAND FOR POLYSTYRENE ( M.T./Y)

	<u>1965</u>		<u>1970</u>		<u>1975</u>		<u>1980</u>
Morocco	700		1.200		1.900		2.600
Algeria	600		1.100		1.800		2.500
Tunisia	<u>80</u>		<u>200</u>		<u>400</u>		<u>650</u>
<b>Total North Africa</b>	1.380	a.r.g. 12,8 %	2.500	a.r.g. 10,5 %	4.100	a.r.g. 6,5 %	5.750
Libya	100		250		500		800
U.A.R.	1.200		2.150		3.200		4.800
Sudan	<u>100</u>	a.r.g. 13,2 %	<u>200</u>	a.r.g. 9 %	<u>300</u>	a.r.g. 8,5 %	<u>450</u>
<b>Total North East Africa</b>	1.400		2.600		4.000		6.050
Jordan	n.a						
Spain	300						
Irak	400						
Kuweit	300						
Lebanon	750						
Saudi Arabia	<u>n.a</u>						
<b>Total middle East Arab Countries.</b>	1.750	a.r.g. 13 %	3.200	a.r.g. 10 %	5.200	a.r.g. 8 %	7.700
<b>Total Arab countries</b>	4.530		8.300		13.300		19.500

3 B - PRODUCTION CAPACITIES

Algeria

?

3 C - FOREIGN COUNTRIES - CONSUMPTION OF POLYSTYRENE (M.T./Y)

<u>Consumption</u>	<u>1965</u>	<u>1970</u>	<u>1975</u>	<u>1980</u>
East Africa	1,120	2,650	4,660	8,600
Central Africa	430	1,080	2,000	3,700
Sub-Total	1,550	3,730	6,660	12,300
India	10,000	7,500 (1967)		70,000
Pakistan	1,600	3,200 (1967)		14,000
Iran	1,800	2,600 (1967)		21,000
Sub total	13,400	31,000	60,000	105,000
France	65,000	95,000	135,000	
Italy	78,000	95,000	130,000	
Spain	19,000	30,000	45,000	
Greece	2,500	6,000	9,000	
Yugoslavia	6,000	12,000	20,000	
Turkey	2,000	4,000	9,000	
Sub Total	172,500	242,000	348,000	520,000

3 D - PRODUCTION CAPACITIES IN FOREIGN COUNTRIES

India	15,000 (1969)	21,000	60,000
Italy	170,000		
Spain	46,000		
Greece	6,000		
Yugoslavia	6,500		10,000
Turkey			45,000

**III- 2/ I - 4. POLYPROPYLENE**

Information regarding the market of polypropylene is very scarce : the present consumption is practically zero in the Arab countries. Since the importance of polypropylene varies to a large extent in industrialized countries (small in France, high in Italy) it is difficult to make precise evaluations.

It can be assumed that polypropylene will find its main application in molded articles (building industry, house wares) and in packaging.

It has been estimated that the total demand in arab countries will be approximately 5.000 T. in 1975 and 15.000 T. in 1980.

Possibilities for exports could exist in many countries since the only producing plants in the area that is presently studied are in France, in Italy and in Spain and that projects are being announced in Spain; India, Pakistan, Algeria and U.A.R.

In tables 4 A to 4 D has been collected the small amount of available information.

**4 A - DEMAND FOR POLYPROPYLENE ( M.T./Y)**

	<u>1965</u>	<u>1970</u>	<u>1975</u>	<u>1980</u>
North Africa	n.a.		1.500	
North East Africa	n.a.			
Middle East Arab countries	n.a.			
			<del>4</del> 5.000	<del>4</del> 15.000

**4 B - PRODUCTION CAPACITIES (M.T./Y)**

Algeria	?	(ORAN)
U.A.R.	30.000	

4 C - FOREIGN COUNTRIES - CONSUMPTION OF POLYPROPYLENE ( M.T./Y )

	<u>1965</u>	<u>1970</u>	<u>1975</u>	<u>1980</u>
India				25.000
Pakistan	1.800 (1968) 1.900		3.500	
France	5.500	31.000		
Italy	25.000	50.000		

4 D - PRODUCTION CAPACITIES IN FOREIGN COUNTRIES (M.T./Y.)

India			15.000
Pakistan			5.000
France	10.000	20.000	
Italy	44.000	70.000	174.000
Spain		12.000	
Turkey		26.000	15.000



### III. 2 - 2. SYNTHETIC FIBERS

To look at the market of synthetic fibers, it is necessary to see what is and will be their position in the entire picture of textile fibers.

The world consumption of textile fibers is growing at a rate of 3,7 % a year ; the demand for wool is practically constant and the demand for cotton increases at slow rate (approximately 1 % per year) ; it seems that the consumption of artificial fibers will not grow very much in the future excepting in the non industrialized countries where new plants recently erected are reaching their full capacity. That means that all important changes are going to be supported by synthetics. The following table indicates the breakdown of the demand in 1967 and 1980.

World consumption of textile fibers (in %)

		<u>1967</u>	<u>1980</u>
natural fibers	cotton	60	48
	wool	8	6
chemical fibers	artificial	17	14
	synthetic	<u>15</u>	<u>32</u>
		100	100
		19.10 <sup>6</sup> T.	30.10 <sup>6</sup> T.

This corresponds to an annual growth of 12 % for synthetic fibers.

The manufacturing industry of synthetic fibers (polymerisation and spinning) is characterised by the high value of the product (5 times more expensive than plastic products), small economic capacities (1.000 to 5.000 T. per year). The investments are approximately proportionnal to the size of the units (no economy of scales). However, the major groups are now going to complete integration from the production of intermediate to polymerization and spinning.

The main fields of application of synthetic fibers are :

- . clothing (woven and knitted materials)
- . industrial uses (tyre cords, conveying belts, etc...)
- . hosiery.

There is a competition between the three major types (nylons, polyesters and acrylics) which represent 90 % of the total synthetic fibers.

- . nylon (either 6 or 66) is used in clothing and tyre cords ; it is not very well adapted to tropical conditions.
- . polyesters, generally under the form of discontinuous filaments mainly used for clothing in mixture with wool and cotton.
- . acrylics are substitute for wool.

The situation in the Arab countries has the following characteristics :

- The demand is growing at a particularly high rate in Algeria, Morocco and U.A.R. where artificial fibers were already consumed in large quantities and are now being replaced by synthetics.
- The importance of the textile industry in several countries (Morocco, Algeria, U.A.R., Tunisia, Lebanon) and the existing or projected production of cotton (North Africa, U.A.R., Soudan) will encourage the consumption of synthetic fibers for the production of mixtures.

In the following paragraphs, the situation for nylons, polyesters and polyacrylics is presented and illustrated in a series of Tables :

- In table 5 A to 5 D are given the figures for nylons ;
- " 6 A to 6 D are given the figures for polyesters ;
- " 7 A to 7 D are given the figures for acrylics .

### III- 2/ 2.1. POLYAMIDES (OR NYLONS)

The properties of nylon 6 or 6.6. are approximately similar and their position on a given market depends on the situation of the producer and on the patents and royalties. The trend in the future is a strong advantage to nylon 6 (produced from caprolactam).

The position of nylon in the arab countries remains good due to their adaptability to various uses and prices inferior to polyesters. But the competition is very strong with polyesters which are better adapted to hot climate conditions (for clothings).

The results regarding polyamide fibers demand and production are given in table 5 A to 5 D.

. conclusion : The consumption for polyamide fibers in the arab countries will be approximately 26.000 T. in 1975 and 41.000 T. in 1980.

The rate of growth will be higher in Middle East Arab countries than in African arab countries.

There is a possibility for exports in Asia and Africa but strong competition will be exercised by present suppliers (Japan, China etc...) and, since the minimum economic size are small, most of the industrializing countries will have the possibility to build their own plants.

A - DEMAND FOR POLYESTER FIBERS ( M.T. Y / )

	<u>1965</u>	<u>1970</u>	<u>1975</u>	<u>1980</u>
Domestic	1,000	1,200	4,600	6,100
Exports	1,000	1,000	4,600	6,700
Imports	1,200	1,350	1,700	2,100
<b>Total North Africa</b>	<b>6,000</b>	<b>7,550</b>	<b>10,900</b>	<b>14,900</b>
Latin America	500	700	1,150	2,100
Europe	800	850	1,200	1,900
<b>I.A.S.</b>	<b>1,300</b>	<b>2,350</b>	<b>4,700</b>	<b>7,600</b>
<b>Total North East Africa</b>	<b>1,000</b>	<b>6,250</b>	<b>7,050</b>	<b>11,500</b>

100 (M)

India	200	300	8,000	15,000
China		550		
Japan		300		
U.S.S.R.				
Other				
<b>Total Middle East Arab countries</b>	<b>1,500</b>	<b>1,650</b>	<b>8,000</b>	<b>15,000</b>
<b>Total Arab countries</b>	<b>6,200</b>	<b>15,000</b>	<b>25,950</b>	<b>41,400</b>

B - PRODUCTION CAPACITIES (M.T. Y.)

<b>I.A.S.</b>	1,000	1,000	4,000	Caprolactam
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**5 C - FOREIGN COUNTRIES - CONSUMPTION FOR POLYAMIDES**

	<u>1965</u>	<u>1970</u>	<u>1975</u>	<u>1980</u>
Consumed Abroad	600	800	1,000	1,100
Export Allowance	<u>2,300</u>	<u>2,900</u>	<u>3,500</u>	<u>4,200</u>
Sub Total	2,900	3,700	4,500	5,300
Production				
India		3,200 (1967)		70,000
Japan		4,500 ( " )		70,000
		<u>8,000 ( " )</u>		<u>51,000</u>
Sub Total		15,600		191,000

**5 D - PRODUCTION CAPACITIES IN FOREIGN COUNTRIES**

France	50,000	70,000		
Italy	77,000	15,000		145,000
Spain	11,000	19,000		
Greece		1,500		2,500
Argentina		3,000		
Yugoslavia	<u>1,000</u>	<u>6,000</u>		<u>10,000</u>
Sub Total	137,500	199,000		
Production				
India	1,500	2,000		1,000
Japan	1,500	12,000		26,000
	<u>0</u>	<u>2,000</u>		<u>1,000</u>
Sub Total	2,800	16,500		33,000

### III.2.2. POLYESTERS

The available information and forecasts are given in Tables 6 A to 6D.

The consumption of polyester fibers in the Arab countries will be approximately 14,000 T. in 1975 and 26,500 T. in 1980.

The rate of growth will be particularly high in Libya, UAR and in the Arab countries in Asia.

There could be possibilities of exports in Africa and in Iran, but here again, the competition with present suppliers will be very difficult (Europe, Japan).

### III.2.2.3. ACRYLICS

The available information and forecast are given in Tables 7A to 7D.

The consumption of acrylic fibers in the Arab countries will be approximately 6,000 T. in 1975 and 13,000 T. in 1980.

The consumption is now very low, the rate of growth will be approximately equivalent in Morocco, Algeria and UAR. Since there are two projects to produce acrylonitrile in UAR and Syria, their implementation could be an incentive to the consumption.

Possibilities for export are not known.

6 A - DEMAND FOR POLYESTER FIBERS (M.T/Y)

	<u>1965</u>	<u>1970</u>	<u>1975</u>	<u>1980</u>
Morocco	250	800	2,700	4,500
Algeria	250	800	2,400	5,000
Tunisia	150	350	950	1,500
<b>Sub Total North Africa</b>	650	<b>1,950</b>	6,050	11,000
Libya	100	150	500	1,000
U.A.R.	100	650	2,000	3,700
Saudi Arabia	100	200	500	800
<b>Sub Total North East Africa</b>	300	1,000	3,000	5,500

Jordan	500	70 (68)	2,200	
Syria		20 (69)	50	
Iran				
Kuwait				
Lebanon				
<b>Sub Total Middle East Arab countries</b>	1,000	3,000	5,000	10,000

<b>Total Arab countries</b>	1,950	5,950	14,050	26,500
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6 B - PRODUCTION CAPACITIES (M.T/Y)

U.A.R.	25,000 (DMT ?)
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**6 C - FOREIGN COUNTRIES - CONSUMPTION OF POLYESTER FIBERS (M.T./Y)**

	<u>1965</u>	<u>1970</u>	<u>1975</u>	<u>1980</u>
Central Africa	400	750	1,450	2,900
East Africa	1,400	2,400	5,000	11,000
Pakistan		1,500 (1967)		4,000
India		3,500 (1967)		76,000
Iran		1,000 (1967)		6,400
				<u>86,400</u>

**6 D - PRODUCTION CAPACITIES IN FOREIGN COUNTRIES (M.T./Y)**

France	30,000	36,000	20,000
Italy	14,000	<del>20,000</del>	10,000
Spain	8,000	15,000	8,500
Turkey	-	5,000	
Yugoslavia	-		
Pakistan	0	3,000	30,000
India	2,000	7,000	
		24,000 (D.M.T.)	

7 A - DEMAND FOR POLYACRYLIC FIBERS (M.T./Y)

	<u>1965</u>	<u>1970</u>	<u>1975</u>	<u>1980</u>
Morocco	150	400	750	1.850
Algeria	150	400	750	2.000
Tunisia	100	200	300	650
<b>Sub Total North Africa</b>	400	1.000	1.800	4.500
Libya	50	150	350	800
U.A.R.	50	650	1.300	3.000
Soudan	100	200	300	700
<b>Sub total North East Africa</b>	200	1.000	1.950	4.500

70 (68)

Jordan				
Syria				
Irak		100		
Kuwait				
Lebanon				
Saudi Arabia				
<b>Sub Total Middle East Arab Countries</b>	300	1.000	2.000	4.000
<b>Total Arab countries</b>	900	3.000	5.750	13.000

7 B - PRODUCTION CAPACITIES (M.T./Y)

U.A.R.	500	5.000 (Acrylonitrile)	10.000 (Acrylonitrile)
Syrie			



7 C - FOREIGN COUNTRIES - CONSUMPTION OF POLYACRYLIC FIBERS (M.T./Y)

	<u>1965</u>	<u>1970</u>	<u>1975</u>	<u>1980</u>
Pakistan				4.000
India	300 (1967)			18.000
Iran	300 (1967)			6.400
	1.000 (1967)			

7 D - PRODUCTION CAPACITIES IN FOREIGN COUNTRIES (M.T./Y)

A) Fibers

France	12.500	20.000	115.000
Italy	24.000	70.000	15.000
Spain	0	3.000	35.000
Yugoslavia	4.500	4.500	
Spain		20.000	
India	0	13.000	15.000
Pakistan	0	5.000	

B) Acrylonitrile

France	10.000	60.000	
Italy	15.000	125.000	
Spain	0	3.000	
Yugoslavia			
Egypt		6.000	10.000
Syria			
India		16.000	

### III-2.3. SYNTHETIC RUBBERS

The market of synthetic rubber must be investigated taking into account the complete rubber situation (natural synthetic) and the characteristics of all the synthetics.

The rubber market is characterised by a rate of growth of approximately 6,5 % per year which should not vary much before 1980. The annual rate for synthetics will remain above 9 %.

The competition between natural and synthetic will depend on the price of the products, but, if the production cost for synthetic is easily calculated, the production cost for natural rubber which varies from one country to another is difficult to evaluate. The price of natural rubber which has decreased from 34 C/lb. in 1956 to 18 C/lb. in 1968 is now stable at this level and many other facts than production costs must be taken into account. Synthetic rubber will represent 75 % of the total world consumption in 1975 (82 % in the U.S.A., 65 % in other countries).

The production of synthetic rubbers which requires high investments and large capacities, is in the hands of international groups.

The processing of rubber is similar to plastic processing industry and is usually in the hands of small scale industry, excepting the manufacturing of tyres which is again undertaken by international groups.

The most important synthetic rubbers are : S.B.R., stereospecifics (polyisoprene and polybutadiene), ethylene propylene rubber, butyl, neoprene, nitrile, etc...

The most important are S.B.R. and polybutadiene for general use, butyl for air tubes.

The predominance of S.B.R. (60 % of total synthetics) is now due to large over capacities in the U.S.A. and Canada. Since no new S.B.R. units are being built in these countries, the share of stereospecifics will grow more rapidly. On the contrary, there are still many S.B.R. plants being erected outside the U.S.A.

In table 8A are shown the estimates for synthetic rubbers total demand in the Arab countries :

To estimate the demand in S.B.R. one must consider that :

- . The local processing industry will not produce all the articles to be used in the region, and that finished products will have to be imported.

The estimated demand of synthetic rubber for the local industry is indicated below :  
(table 8 B)

**8 - DEMAND FOR SYNTHETIC RUBBERS ( M.T./Y )**

	<u>1965</u>	<u>1970</u>	<u>1975</u>	<u>1980</u>
<b>Sub Total North Africa</b>	10.600	14.800	22.200	32.000
Morocco	4.200	5.500	8.700	12.300
Algeria	5.000	7.100	10.100	14.800
Tunisia	1.400	2.200	3.400	4.900
<b>Libya</b>	700	1.500	2.700	5.000
<b>U.A.R.</b>	3.000	5.500	11.800	20.000
<b>Saudi Arabia</b>	800	1.600	2.400	3.700
<b>Sub Total North East Africa</b>	4.500	8.600	16.900	28.700
Jordan	1.200	1.800	2.100	3.000
Syria	2.000	2.500	3.500	5.000
Iraq	2.500	3.600	4.800	6.000
Kuwait	600	1.500	2.000	2.600
Lebanon	2.000	2.500	3.200	4.200
Saudi Arabia	3.500	4.500	5.500	7.500
<b>Sub Total Middle East Arab countries</b>	11.800	16.400	21.100	28.300
<b>Total Arab countries</b>	26.900	39.800	60.200	89.000
India	20.000	50.000	110.000	205.000
Pakistan	3.000			102.000
Iran	1.000	10.000		

**8B. Estimated demand OF SYNTHETIC RUBBERS (M.T/Y) FOR THE LOCAL INDUSTRY**

	<u>1975</u>		<u>1980</u>	
	<u>Total demand of the country</u>	<u>demand of the local industry</u>	<u>Total demand of the country</u>	<u>demand of the local industry</u>
Morocco	8.700	6.600 (75 %)	12.300	10.500 (85 %)
Algeria	10.100	7.600 (75 %)	14.800	12.600 (85 %)
Tunisia	3.400	2.700 (80 %)	4.900	4.200 (85 %)
<b>Total North Africa</b>	<b>22.200</b>	<b>16.900</b>	<b>32.000</b>	<b>27.300</b>
Libya	2.700	1.600 (60 %)	5.000	3.500 (70 %)
U.A.R.	11.800	8.900 (75 %)	20.000	17.000 (85 %)
Soudan	2.400	1.400 (60 %)	5.700	4.000 (70 %)
<b>Total N.E. Africa</b>	<b>16.900</b>	<b>11.900</b>	<b>30.700</b>	<b>24.500</b>
<b>Middle East Arab countries</b>	<b>21.100</b>	<b>12.700 (60 %)</b>	<b>28.300</b>	<b>19.800 (70 %)</b>
<b>Total Arab Countries</b>	<b>60.200</b>	<b>41.500</b>	<b>91.000</b>	<b>71.600</b>

A tentative breakdown between S.B.R., polybutadiene and other synthetics is given below (table 9) :

**Table 9 - Estimated future demand for SBR, Polybutadiene and other synthetics**

	<u>1975</u>			<u>1980</u>		
	<u>S.B.R.</u>	<u>P.B.</u>	<u>Others</u>	<u>S.B.R.</u>	<u>P.P.</u>	<u>Others</u>
North Africa	11.800	3.400	2.700	16.400	6.800	4.200
North East Africa	8.300	2.400	2.200	14.000	6.100	3.700
Arab countries in Asia	8.900	2.500	1.300	11.900	5.000	2.900
<b>Total Arab countries</b>	<b>29.000</b>	<b>8.300</b>	<b>4.200</b>	<b>43.000</b>	<b>17.900</b>	<b>10.800</b>

Three projects have been announced in U.A.R. : 12.000 T./Y of polybutadiene in 1975  
in Algeria : production of S.B.R. and polybutadiene in Oran around 1975.  
(capacities not indicated).

## III- 2/ 4. SYNTHETIC DETERGENTS

### . General characteristic

The industry of detergents must be investigated simultaneously with the soap industry. The synthetic detergents represent a growing part of the total detergent + soap, 87 % in the U.S.A., 75 % in Europe, approximately 50 % in industrialising countries.

The most important detergents are the anionics : alkyl benzene sulphonates, linear alkyl sulphonates or alphaolefin sulphonates ; the anionics represent 75 % of synthetic detergents in U.S.A. and much more in industrialising countries. Since pollution problem (biodegradability) are not yet important in most of non industrialized countries, the alky benzene sulphonates (A.B.S.) are consumed in very large quantities.

The production is broken down into :

- Domestic detergents (powders or liquids) with a content of 15 to 20 % of active material,
- Industrial detergents, which are consumed in textile, paper, mining industry, metallurgy, etc... The average content of active product is 40 %.

The industry of synthetic detergents is in the hands of very large industrial international groups and there is a general tendency towards integration, however, the last stage of production (compounding and packaging) can be undertaken by small scale industries.

### . Future market

The results are presented in table IO A to IO B.

It appears that the average rate of growth in the arab countries will remain superior to 10 % until 1980 (lower in North Africa, due to a large production capacity of soap).

The consumption of dodecyl benzene which is the most important raw material for the production of synthetic detergents should reach approximately 36.500 T. in 1975 and 53.500 T. in 1980.

There will be possibilities of export in Africa but the local consumption could justify by itself the productions of D.D.B.

	<u>1965</u>	<u>1970</u>	<u>1975</u>	<u>1980</u>
<b>Sub Total North Africa</b>				
Algeria	2,500	3,500	5,500	7,000
Tunisia	3,000	4,500	7,000	10,000
	<u>1,000</u>	<u>1,300</u>		
	6,500	9,300	14,500	20,500
<b>Libya</b>	500	900	1,300	2,000
<b>E.A.U.</b>	1,100	2,000	5,000	8,000
<b>Sudan</b>	<u>200</u>	<u>300</u>	<u>800</u>	<u>1,000</u>
	1,800	3,200	7,100	11,000
<b>Sub Total North East Africa</b>				
<b>Syria</b>	600	600		
<b>Lebanon</b>	3,000	6,000		
<b>Israel</b>	800	500		
<b>E.U.A.S.</b>	<u>800</u>	<u>1,000</u>		
	5,000	10,000	15,000	22,000
<b>Sub Total Middle East Arab countries</b>				
<b>Total Arab countries</b>	<u>13,300</u>	<u>22,500</u>	<u>36,000</u>	<u>53,500</u>

**10 B1 - PRODUCTION CAPACITIES (finished products in M.T/Y)**

<b>Algeria</b>	13 & 15,000	2 unite
<b>Tunisia</b>	22,000	2 unite
<b>Libya</b>	5 & 6,000	3 & 4 unite
<b>E.A.U.</b>	4,600	6,400
<b>Syria</b>	7,500	
<b>Lebanon</b>	4,000	
	25,000	
	?	

**10 B2 - PRODUCTION CAPACITIES (M.T./Y OF D.D.B.)**

<b>E.A.U.</b>	6,000
<b>Lebanon</b>	10,000
<b>Syria</b>	10,000

**8-C - FOREIGN COUNTRIES CONSUMPTION OF SYNTHETIC DETERGENTS (M.T.Y. OF D.D.B.)**

	<u>1965</u>	<u>1970</u>	<u>1975</u>	<u>1980</u>
East Africa	2,000	3,000	7,600	14,900
Central Africa	300	900	1,400	2,100
Latin Poland Iran		4,000 500		30,000 10,000 8,000

France  
Italy  
Spain  
Greece  
Yugoslavia  
Turkey

**10 B - PRODUCTION CAPACITIES (M.T.Y. OF ALKYL BENZENE)**

France	100,000		
Italy	70,000		
Spain		90,000	25,000
Turkey		50,000	
India		20,000	
Poland		4,000	5,000
Iran		10,000	10,000

## 11-3. INTERMEDIATES

The quantities of intermediates to be produced have been calculated starting from the end-products to be manufactured. The yields are those of the most commonly used manufacturing processes.

### 1 - Vinyl chloride (M.V.C.)

Vinyl chloride will be used for the manufacture of P.V.C. The results are indicated in table 11 below :

Table 11 - Estimated demand for vinyl chloride (M.V.C.)

Demand	North Africa		North East Africa		Middle East Arab Countries		All Arab countries	
	1975	1980	1975	1980	1975	1980	1975	1980
P.V.C.	22,500	31,000	23,600	31,600	29,500	32,500	52,500	70,400
VINYL CHLORIDE	22,500	31,000	23,200	31,200	29,000	32,000	52,000	70,000

### 1.1.2 - Styrene

Styrene will have to be produced for the manufacture of polystyrene and S.B.R.

The future consumption is indicated in table 10 A for polystyrene and table 9 for S.B.R.

In table 12 below, are shown the necessary quantities of styrene :

Table 12 - ESTIMATED DEMAND FOR STYRENE

Demand	North Africa		North East Africa		Middle East Arab countries		All Arab countries	
	1975	1980	1975	1980	1975	1980	1975	1980
Polystyrene	4,000	5,750	4,000	5,750	5,000	7,750	5,000	7,500
S.B.R.	1,000	16,000	1,000	17,000	1,000	11,000	20,000	41,000
Styrene for Polystyrene	4,000	5,750	4,000	5,750	5,000	7,750	13,000	20,500
Styrene for S.B.R.	2,000	15,250	2,000	21,250	1,750	12,250	5,700	18,500
Total in Styrene	6,000	21,000	6,000	27,000	6,750	20,000	18,700	39,000



**III. POLYESTER**

Caprolactam will be used for the manufacture of polyamide fibers. The results are indicated in table 11 below. It has been assumed that all local production will be used to meet demand.

Table 11 Estimated Demand for Caprolactam (M)

Demand	North Africa		North East Africa		Middle East Arab countries		All Arab countries	
	1977	1980	1977	1980	1977	1980	1977	1980
polyamide fibers	10,000	14,000	11,000	15,000	12,000	16,000	13,000	17,000
Caprolactam	12,000	17,000	13,000	18,000	14,000	19,000	15,000	20,000

**IV. DIURETIC POLYESTER**

D.M. will be used for the manufacture of polyester fibers. The results are indicated in table 12 below.

Table 12 Estimated Demand for D.M. (M)

Demand	North Africa		North East Africa		Middle East Arab countries		All Arab countries	
	1977	1980	1977	1980	1977	1980	1977	1980
polyester fibers	8,000	11,000	9,000	12,000	10,000	13,000	11,000	14,000
D.M.	10,000	14,000	11,000	15,000	12,000	16,000	13,000	17,000

**V. ACRYLAMIDE**

Acrylamide will be used for the manufacture of acrylic fibers. The results are shown in table 13 below.

Table 13 Estimated Demand for Acrylamide (M)

Demand	North Africa		North East Africa		Middle East Arab countries		All Arab countries	
	1977	1980	1977	1980	1977	1980	1977	1980
Acrylic fibers	1,000	1,500	1,100	1,600	1,200	1,700	1,300	1,800
Acrylamide	1,500	2,200	1,600	2,300	1,700	2,400	1,800	2,500

2 - Synthetic Isoprene (D.D.)

D.P. will be used for the production of synthetic isoprene. The results have already been indicated in table 10 A. They are summarized in table 10 below.

Table 10 - Estimated Demand for Synthetic Isoprene (D.D.)

Demand	North Africa		North East Africa		Middle East Countries		All Arab Countries	
	1952	1953	1952	1953	1952	1953	1952	1953
D.D.	10,000	20,000	10,000	20,000	10,000	22,000	30,000	40,000

Isoprene will be used for the manufacture of polyisoprene, polybutadiene, polyisobutylene (I.B.) and S.B. The results are shown in table 11 below.

Table 11 - Estimated Demand for Polyisoprene

Demand	North Africa		North East Africa		Middle East Countries		All Arab Countries	
	1952	1953	1952	1953	1952	1953	1952	1953
Polyisoprene	10,000	20,000	10,000	20,000	10,000	22,000	30,000	40,000
Polybutadiene	20,000	40,000	20,000	40,000	20,000	45,000	60,000	80,000
Polyisobutylene	10,000	20,000	10,000	20,000	10,000	22,000	30,000	40,000
S.B.	10,000	20,000	10,000	20,000	10,000	22,000	30,000	40,000
Total Demand	50,000	100,000	50,000	100,000	50,000	110,000	150,000	200,000

The quantities necessary for producing styrene, I.B., as intermediate into the production of polyisoprene have all been taken into account.

**8 - Propylene**

Propylene will be used in the manufacture of polypropylene acrylic fibers (acrylonitrile) and Rubbery nitrone (D.D.N.). The results are shown in table 18 below :

**Table 18 Estimated demand for PROPYLENE (M.T.C)**

Demand	North Africa		North East Africa		Middle East Arab countries		All Arab countries	
	1977	1980	1977	1980	1977	1980	1977	1980
Polypropylene	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	1,000	1,500
Acrylonitrile	1,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000
Propylene for Polypropylene	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	1,500	2,500
Propylene for Acrylonitrile	1,000	2,000	2,000	11,000	1,000	2,000	2,000	2,000
Propylene for Rubbery nitrone	1,000	2,000	1,200	1,000	1,200	1,000	1,000	21,000
<b>Total Polypropylene</b>	<b>20,000</b>	<b>25,000</b>	<b>20,000</b>	<b>22,000</b>	<b>22,000</b>	<b>24,000</b>	<b>25,000</b>	<b>27,200</b>

**9 - Butadiene**

Butadiene will be used in the manufacture of synthetic rubbers (S.B.R. and polystyrene). The results are shown in table 19 below :

**Table 19 Estimated demand for BUTADIENE (M.T.C)**

Demand	North Africa		North East Africa		Middle East Arab countries		All Arab countries	
	1977	1980	1977	1980	1977	1980	1977	1980
Butadiene	11,000	14,000	8,000	14,000	8,000	11,000	20,000	23,000
Polystyrene	2,000	4,000	2,000	2,000	2,000	2,000	8,000	12,000
Butadiene for S.B.R.	7,000	10,000	7,000	9,000	7,000	7,000	18,000	27,000
Butadiene for Polystyrene	1,000	2,000	2,000	4,000	2,000	2,000	8,000	15,000
<b>Total Butadiene</b>	<b>11,000</b>	<b>22,000</b>	<b>7,000</b>	<b>19,000</b>	<b>8,000</b>	<b>15,000</b>	<b>27,000</b>	<b>56,000</b>

### 11. 1. 10 - Benzene

Benzene will be used in the manufacture of polystyrene (styrene) S.B.R. (styrene) polyamide fibers (caprolactam) and detergents (D.D.B.). The results are presented in table 20 below :

Table 20 - Estimated demand for BENZENE (M.T/Y)

Demand	North Africa		North East Africa		Middle East Arab countries		All Arab countries	
	1975	1980	1975	1980	1975	1980	1975	1980
Styrene	600	9,200	850	9,350	7,150	10,400	19,600	28,800
Caprolactam	12,000	16,400	7,800	12,050	8,800	16,500	33,000	45,500
D.D.B.	14,500	20,300	7,100	11,000	12,000	22,000	56,600	67,500
Benzene for Styrene	6,100	8,000	5,400	8,500	6,600	9,600	18,100	26,600
Benzene for Caprolactam	13,200	18,000	8,600	14,000	9,700	18,200	36,500	50,200
Benzene for DDB	6,400	9,000	3,100	4,500	6,600	9,600	11,700	23,400
	25,700	35,500	17,100	27,300	22,900	37,400	70,700	100,200

### 11. 1. 11 - Paraxylene

Paraxylene will be used in the production of polyester fibers (D.B.). The results are shown in table 21, below :

Table 21 - Estimated demand for PARAXYLENE (M.T./Y)

Demand	North Africa		North East Africa		Middle East Arab countries		All Arab countries	
	1975	1980	1975	1980	1975	1980	1975	1980
D.B.	6,650	12,100	1,400	6,050	5,500	11,100	15,450	29,250
Paraxylene	5,000	9,100	2,500	5,500	4,100	8,300	11,600	21,900

### III - 4. FERTILIZERS

#### GENERAL CHARACTERISTICS OF THE MARKET

The fertilizer industry is the most important (in tonnage produced) of the world chemical industry.

The continuous growth of fertilizer consumption and production has not changed since 1950 and the annual rate is approximately 8 %.

- The world population increases by approximately 2 % per year involving a corresponding development of the demand ; since approximately half of the world population still suffers from malnutrition, the needs for agricultural products and fertilizers increase at a higher pace in developing countries.
- The areas of cultivatable lands are now limited and the use of fertilizers is absolutely necessary to increase production and prevent their impoverishment in nutrients.
- The upper limit of nutrients that can be profitably utilized by unit of land is far from being reached even in industrialized countries (excepting Japan, Belgium and Holland).

It is estimated that the local demand for nutrients will be approximately 100 million tons in 1975.

The modern industry is now manufacturing products with a high concentration of nutrients such as :

- Ammonium nitrate (33,5 %) and Urea (46 %)
- Triple superphosphate (45 %) and diammonium phosphate (46 % of  $P_2O_5$ )
- Potassium sulphate or chloride (up to 50 or 60 %).

These high analysis products result in large savings in transportation and storage costs.

The newly installed units have large capacities and low production costs.

In developing countries, others factors must be taken into account :

- Although the developing countries represent now 2/3 of the world population (and 3/4 in 1980) the consumption of fertilizers is only 18 to 20 % of the world consumption.
- The fertilizer consumption in developing countries is increasing at approximately 12 % TVA save 16 % per year (10 % in Africa).

In the Arab countries, the consumption of fertilizers is still very limited ; the North African countries and U.A.R. are the largest consumers and their demand will probably continue to grow at a higher rate than the rest of the Arab world.

Agonomists recommend that the ratio N :  $P_2O_5$  in the industrialized countries should be between 1 and 2 (depending on the types of crops)

In North Africa, the proportion of nitrogen fertilizers is approximately 70 % of phosphate fertilizers giving a ratio of 0,7. This ratio will rise and the amount of nitrogen and phosphate fertilizers in 1980 will be approximately equal, giving a ratio of 1.

In other countries, particularly Egypt and Sudan, the ratio N/P<sub>2</sub>O<sub>5</sub> is very high (4,3 in 1970 in North East Africa). It will go down to 1,7 in 1980.

In the following chapters, special attention will be given to the following products :

- Nitrogen fertilizers where the nutrient is N
- Phosphate fertilizers where the nutrient is P<sub>2</sub>O<sub>5</sub>
- Potassic fertilizers where the nutrient is K<sub>2</sub>O
- Complex fertilizers which are obtained by the chemical combination of nutrients (N/P<sub>2</sub>O<sub>5</sub>, K<sub>2</sub>O).

#### III 4. I - Nitrogen fertilizers

In the industry of nitrogen fertilizers, the feedstock (coal, gas and liquid hydrocarbon) is at the same time the raw material and the source of energy.

Ammonia is the fundamental component for nitrogen fertilizers. Ammonia is now produced in plants with a capacity of 500 to 2.000 T da<sup>-1</sup>, with low pressure synthesis and centrifugal compressors. This permits large savings in investment, production cost and utility consumption.

The most commonly used raw materials are coal, natural gas and liquid hydrocarbons ; but the importance of coal is decreasing and natural gas is now the most utilized feed-stock, especially in areas where it is available in large quantities (Venezuela, Algeria, Middle-East etc...).

In non-industrialized countries, the growth of nitrogen fertilizer production is much more important than the production of phosphate or potash fertilizers. This is particularly true in the Middle East.

The average annual rate of growth for nitrogen fertilizer consumption is now approximately 12 % a year in the world.

Among the various nitrogen fertilizers (ammonium sulphate, ammonium nitrate, urea) urea is now becoming the most important especially in recently erected plants ; for example in Japan, one of the largest world producers, it represents approximately 40 % of the production.

It must be noted also, that calcium nitrate is highly consumed in U.A.R.

The historical and projected supply and demand for nitrogen are summarized in table 12. Also given are supply and demand data for other countries as an indication of possibilities for export from the Arab countries.

s.f.g. annual rate of growth

**22 A - DEMAND FOR NITROGEN FERTILIZERS (M.T/Y of Nitrogen)**

	<u>1965</u>	<u>1972</u>	<u>1975</u>	<u>1980</u>
<b>Western</b>				
Algeria	15,000	28,000	50,000	80,000
Tunisia	18,000	35,000	65,000	100,000
	<u>8,000</u>	<u>13,000</u>	<u>20,000</u>	<u>30,000</u>
<b>Total North Africa</b>	41,000	76,000	135,000	210,000
		17 %	10 %	
<b>Libya</b>			8,000	20,000
<b>U.A.R.</b>	1,500	3,000	8,000	20,000
<b>Sudan</b>	250,000	310,000	420,000	550,000
	<u>35,000</u>	<u>50,000</u>	<u>73,000</u>	<u>100,000</u>
<b>Total North East Africa</b>	28,000	373,000	501,000	670,000
<b>Jordan</b>	1,800	3,600	7,400	23,000
<b>Syria</b>	12,800	26,000	52,000	89,000
<b>Yemen</b>	2,500	5,000	9,700	25,000
<b>Kuwait</b>	-	-	-	-
<b>Lebanon</b>	10,000	20,000	39,000	68,000
<b>Saudi Arabia</b>	5,000	10,000	18,000	25,000
	<u>32,100</u>	<u>64,600</u>	<u>126,100</u>	<u>230,000</u>
<b>Total Middle East Arab countries</b>	359,600	513,600	762,100	1,110,000

**22 B - PRODUCTION CAPACITIES IN THE ARAB COUNTRIES**

<b>Algeria</b>	270,000 (Alger)	350,000 (Arzew)
<b>Tunisia</b>	30,000	35,000
<b>Libya</b>	11,000 (imported NH3)	18,000
<b>Syria</b>		16,000
<b>A.R.</b>	50,000 (Basrah)	
<b>Sudan</b>	110,000	500,000
<b>Saudi Arabia</b>	150,000 (Dammam)	390,000
<b>Yemen</b>		240,000
<b>Libya</b>		300,000
<b>U.A.R.</b>	220,000	440,000
	<u>841,000</u>	<u>2,491,000</u>

22 C - FOREIGN COUNTRIES CONSUMPTION OF NITROGEN FERTILIZERS (M.T./Y)

	<u>1965</u>	<u>1970</u>	<u>1975</u>	<u>1980</u>
East Africa	20,000	33,000		
India	570,000	1,450,000	3,000,000	
Pakistan	162,000	333,000		
Tanzania	30,000	60,000		
Turkey	802,000			
Yugoslavia	404,000			
Zambia	72,000			

22 B - PRODUCTION CAPACITIES IN FOREIGN COUNTRIES (M.T./Y)

India	260,000	1,100,000	2,500,000	5,000,000
Pakistan	84,000	260,000	700,000	1,200,000
Tanzania	25,000	100,000	450,000	
Turkey	1,070,000			
Yugoslavia	860,000	1,700,000	2,500,000	
Zambia		1,000,000	1,500,000	
Zimbabwe		200,000	500,000	
Zambia		300,000	450,000	
Zimbabwe		120,000	300,000	



The consumption of nitrogenous fertilizers in the arab countries will be 760,000 T. in 1975 and 1,110,000 T. in 1980. The U.A.R. will remain the main consumer with 400,000 T. in 1975 and 550,000 T. in 1980.

The rate of growth will probably decrease after 1975 in North Africa and U.A.R. it will remain very high in other countries.

There are no possibilities of exports in the Mediterranean countries. The deficit will remain in Asia (particularly in India, Pakistan and China) and Africa, but there will be a very strong competition with the present suppliers (Western Europe, U.S.A., Japan).

## 2 - Phosphate fertilizers

They are presently consumed in large quantities in U.A.R., Algeria and Morocco ; Since the units now in operation are producing simple superphosphate (excepting Morocco and Tunisia where triple superphosphate and diammonium phosphate are produced), this product is the most commonly used (90% of the total phosphate fertilizers in U.A.R., 85% in Morocco 70% in Algeria).

In 1980, with the establishment of modern units, the share of simple superphosphate on the one hand and of triple superphosphate plus diammonium phosphate on the other hand will be about equal in the arab countries.

The results of the market study are shown in table 20 A to 20 C.

The consumption of phosphate fertilizers in the arab countries should be approximately 1,000,000 (P<sub>2</sub>O<sub>5</sub>) in 1975 and 1,700,000 (P<sub>2</sub>O<sub>5</sub>) in 1980. U.A.R., Algeria and Morocco will remain the most important consumers.

The production capacity which is now approximately 400,000 T. should grow to 900,000 T. in 1975 and to at least 1,400,000 T. in 1980. Several large projects have been announced and new phosphate deposits have not been developed (Syria, Iraq, etc.).

There will be large excesses available for export in 1980 (1,000,000 T. in Morocco, 1,000,000 T. in Tunisia, 800,000 T. in U.A.R., 600,000 T. in Algeria), but there will be good possibilities for exports to the countries which are already importers (Western Europe, Asia) and eventually to the U.S.A. which is now the second largest consumer in the world.

## 3 - Potash and complex fertilizers

Potash fertilizers are consumed in very small quantities by developing countries. Europe, North America and U.S.A. represent 85% of the world consumption. This is due to the fact that very few potash units are installed in non industrialized countries and to the specific end uses of potash fertilizers.

Potassium chloride is the most commonly consumed and there is a tendency towards using highly concentrated products.

23 A - DEMAND FOR PHOSPHATE FERTILIZERS (M.T. OF P<sub>2</sub>O<sub>5</sub>)

	1961	1970	1982
Algeria	23,000	60,000	90,000
Libya	1,000	65,000	90,000
Tunisia	13,000	20,000	40,000
<b>Total North Africa</b>	<b>37,000</b>	<b>145,000</b>	<b>220,000</b>
U.S.S.R.	1,000	2,000	12,000
P.A.F.	30,000	80,000	250,000
Others	500	5,000	10,000
<b>Total North East Africa</b>	<b>31,500</b>	<b>170,000</b>	<b>292,000</b>
India	3,000		
Spain	8,000		
Iran	3,000		
Indonesia	14,000		
South America	500		
<b>Total Arab countries in Asia</b>	<b>28,500</b>	<b>70,000</b>	<b>150,000</b>
<b>Total Arab countries</b>	<b>221,000</b>	<b>300,000</b>	<b>662,000</b>

23 B - PRODUCTION CAPACITIES IN THE ARAB COUNTRIES (M.T. OF P<sub>2</sub>O<sub>5</sub>)

	1961	1970	1982
Algeria	41,000	150,000	270,000
Libya	1,000	2,000	25,000
Tunisia	140,000	160,000	230,000
<b>U.A.R.</b>	<b>35,000</b>	<b>60,000</b>	<b>330,000</b>
Spain		270,000	270,000
<b>Total</b>	<b>317,000</b>	<b>542,000</b>	<b>1,125,000</b>

TABLE I  
**20 C - PRODUCTION CAPACITIES IN PUBLIC UTILITIES (M.T.Y. OF PG&S)**

	1972	1973
Capacity	320,000	280,000
Reserve	520,000	180,000
Transmission	200,000	
Substation	150,000	
Transformer	15,000	
Total	890,000	95,000
Reserve	1,720,000	1,000,000
Total	2,610,000	1,095,000

There is no production of potash fertilizers in the Arab countries; studies are being made to develop a deposit significance of potash already discovered in Jordan.

The available information regarding the market in the Arab countries are given in table 2. It appears that Algeria, Morocco and T. A. R. will consume moderate quantities of potash fertilizers in 1975 and 1980.

The question of complex fertilizers is very difficult to study in the industrializing countries where the market is not yet developed through sophisticated products.

The most commonly used complex fertilizers are products with 2 nutrients such as:

- Potassium nitrate
- Ammonium phosphates and nitrophosphate
- Potassium phosphate

The complex fertilizers are presently manufactured in industrialized countries and the markets are Europe and North America, but also South America, India and South Korea, because they are receiving international assistance.

In the Arab countries, complex fertilizers are consumed in Algeria (30% of phosphate fertilizers) and Jordan (15% to 20%); also in Tunisia (10% to 20%) but this is not representative since the total amount consumed in the country is very low (2,500 T P<sub>2</sub>O<sub>5</sub>).

It can be assumed that the installation of modern units producing ammonium phosphate in Morocco, Tunisia and probably Algeria will be an incentive to the consumption of complex fertilizers.

2. - NUMBER AND GRADE FERTILIZING ELEMENTS IN 177 OF EGGS

Grade	Element	Number	Grade	Element	Number
100	N	100	100	P	100
		100			100
90	N	90	90	P	90
		90			90
80	N	80	80	P	80
		80			80
70	N	70	70	P	70
		70			70
60	N	60	60	P	60
		60			60
50	N	50	50	P	50
		50			50
40	N	40	40	P	40
		40			40
30	N	30	30	P	30
		30			30
20	N	20	20	P	20
		20			20
10	N	10	10	P	10
		10			10

100 - 1970

Output of elementary sulphur is consumed mainly in agriculture and in the industry of artificial fibres. The main other key output is sulphuric acid (H<sub>2</sub>SO<sub>4</sub>) which is used in textile industry, metallurgy, chemical industry (pesticides, detergents, dyes, explosives) but mainly in the fertilizers industry.

It is difficult to estimate the future consumption of sulphur starting from the consumption of sulphuric acid since other use estimates than pure sulphur are available (pesticides, explosives) but it is interesting to see what will be the consumption of sulphuric acid. The available information is given in table 23.

Table 23 Estimated demand of sulphuric acid (1000 t of H<sub>2</sub>SO<sub>4</sub>)

	1970	1975	1980	1985
France	15,000	22,000	28,000	35,000
Algeria	10,000	12,000	15,000	18,000
Tunisia	12,000	15,000	18,000	22,000
Libya	n.a.	n.a.	n.a.	n.a.
E.A.S.	10,000	12,000	15,000	18,000
Other	10,000	12,000	15,000	18,000
China	10,000	12,000	15,000	18,000
1970			150,000	210,000
	100,000	150,000	200,000	250,000

Table 24 Production capacities of sulphuric acid (1000 t of H<sub>2</sub>SO<sub>4</sub>)

	1970	1975	1980	1985
France	15,000	22,000	28,000	35,000
Algeria	10,000	12,000	15,000	18,000
Tunisia	12,000	15,000	18,000	22,000
E.A.S.	10,000	12,000	15,000	18,000
Libya		10,000	12,000	15,000
Other	10,000	12,000	15,000	18,000
China		10,000	12,000	15,000
	100,000	150,000	200,000	250,000

0 This is based on the assumption that the production of sulphuric acid will be the utilization of the

0 0 10% of the sulphur is produced from sulphur

The situation for a-123456 and 789 is compared to the situation for 101112 in the same area. The production capabilities are indicated in table 1 below.

Table 1. Production capabilities for a-123456, 789, and 101112.

	a-123456	789	101112
1000	1000	1000	1000
2000	2000	2000	2000
3000	3000	3000	3000
4000	4000	4000	4000
5000	5000	5000	5000
6000	6000	6000	6000
7000	7000	7000	7000
8000	8000	8000	8000
9000	9000	9000	9000
10000	10000	10000	10000

It is not possible to use a-123456 and 789 in the same way as 101112. It appears that the utilization of a-123456 and 789 will be restricted to 1000 and 2000 units respectively in the same way as 101112. It will be necessary to use a-123456 and 789 in the same way as 101112 in the other projects.





In view of the foregoing and with the exception of recitations and of such specific cases that are outlined in the following chapters, no special provision for export trade within the area mentioned has been made when setting the basic basis of the various governmental acts

In the country, national supply has been considered as a fundamental objective and all the companies that are recommended will have to fulfill the requirements of one or two of the main areas of activity that have been considered (North Africa, West Africa, the Caribbean, etc.)

RESEARCH ON THE PROBLEM OF THE

17 - 1 Research of planning chemical and integrated complexes

1 Chemical complexes are needed

Recent petrochemical industry in the USSR countries is small even though the predicted per capita consumption of petrochemicals is high, the estimated total consumption in future years is relatively high because of the extent of the USSR countries

to economical petrochemical plants should be as big as possible and be equipped at as high order capacity as possible. It is therefore very important to provide the maximum utilization of the intermediate and finished products which will suddenly become available when the plants start-up and to avoid the artificial interferences between the plants of complexes

17 - 1 2 Integrated complexes are needed

Since the main operations in petrochemical production are as follows: hydrocracking, dehydrogenation, etc. are not so selective they produce several products at a time in order to achieve maximum economy in operation, one will have to do what is being done elsewhere that is to use all the products produced as possible at the same time

The result is that petrochemicals need to be produced in a complex of plants capable of absorbing all the by products

rather than the integrated complexes is the necessity of avoiding the producing of waste gases. The gas and process a gas has when the whole complex is operated in the complex. These however the complex is split in many several complexes and there are several stages in a petrochemical production each stage will absorb it to absorb the waste by utilizing the intermediate product at a high rate as possible. In addition, maximum higher value of value of each intermediate product the question remains in petrochemical complexes that intermediate product

In other parts of the world the petrochemical complex is done in a fully integrated complex which will absorb all the byproducts. The advantage is operation of operation at each of the intermediate stages and other petrochemicals of various intermediate stages which result and in fact will all of the important stages

17 - 1 3 Size of the complex

research and the results of the petrochemical complex in other petrochemical industry will be able to give a clear idea of what size will become available in the future of petrochemical complexes

In the case of natural gas some factors have to be taken into account

Production cost, price at the well head

Utilization factor (existing reserves, existing or planned collection units, facilities already installed)

Transportation costs to the coast line (including compression, etc.) and inland terminal etc.

Market facilities

Some examples of natural gas prices at the coast line are 100-150 to 20

Area	Price	Notes
Algeria	100-150	
Libya	100-150	
Iran	100-150	
U.S.A.	100-150	

In the case of liquids, the problem is more complicated since the distribution costs, among products, is a factor to be taken into account. The price can be used directly or after some processing. The value is around 1 dollar per ton. This is the high end of the spectrum and it is not possible to consider petrochemical production for a liquid that could have been sold as gasoline.

Based on the present price of liquids in the world market and on the fact that petrochemicals is a non-tradable commodity it is possible to estimate that the price of liquids for petrochemicals use is around 1 dollar per ton.

General market - III

Some examples of natural gas prices at the coast line of a petrochemical industry

Some gas is required

- 1. for the production of ethylene
- 2. for the production of propylene
- 3. for the production of butadiene

Therefore, depending on the existing capacity, the price of gas for the production of ethylene, propylene and butadiene is higher than for the production of other products. The price of gas for the production of ethylene is around 1.5 dollars per ton.

A foreign share holder in a corporation usually brings in his proportionate share of the equity capital - usually all in the form of foreign currency. This reduces the total foreign exchange requirements of the projects, and often means that the foreigner's equity payment covers all the foreign exchange requirements up to and even after start-up of the plant.

There are some distinct financial advantages, for instance:

- a) The loan negotiations which are usually conducted with a foreign bank will be simplified by the intervention of the foreigner, and because of the commercial guarantee that his presence affords.
- b) The equity capital brought in means that it is not necessary to find immediately the foreign exchange component corresponding to that part of the project.

There are some less attractive aspects as well:

- a) Whether the foreign exchange to directly support the plant, or supplied by a foreign shareholder as his equity, is nevertheless restricted or unregulated of the country.

In the first case the annual principal and interest payments must be met.

In the second case, if a plant called as they usually must be made, the foreign shareholder may negotiate his capital if he is in a foreign country.

There are some financial advantages if an action of this type is supported in that it means the total foreign exchange available, but that a percentage of the output of which is used is found.

- a) Any profits of this operating project will be distributed proportionately among the shareholders, and foreigners being able to repatriate their share.

The question of foreign participation must be investigated with reference to political aspects, as well as to the technical and commercial aspects of the project.

### Other projects

Investment in government or in part of the operation to produce and sell to world.

There are some cases where the total output of a given plant can be sold to one of two large companies, and also the existing plant to be developed in some case through contracts. These types of projects involve the transfer of the output to world in some form, but not in a large volume of small amounts, and thus require a complete and total study, taking into account the various parts of a complete system.

A number of commercial networks exist in the Arab countries, but these are essentially in the private sector: normally they do not consist of highly trained people in the petrochemical sense. It is usually the foreign companies, experienced in the field abroad, who are capable of creating their own highly trained commercial networks, or strengthening existing ones in Arab countries if they choose.

The public sector does not as yet have such commercial networks, though there are some signs in other fields that they are beginning to create them.

If the public sector wishes to become involved in the production of the more developed petrochemicals, it will be necessary for it to decide whether, in order to sell the products, it prefers to undertake the considerable effort necessary to develop an adequate commercial network, or to take advantage of facilities provided by the Arab countries private sector, or foreign firms, or both.

### 3. Technical Specifications

There are certain essential limitations (the technical considerations, as well as freedom of choice as to whether the national sector alone should undertake certain operations).

Generally speaking, petrochemicals can be divided into two great classes. There is of course some overlap.

In the first class, which we call "Class A", are all those products whose chemical and physical properties are well defined, and whose finished product specifications are clearly established internationally by committees of experts.

In the second class, "Class B", are all those more complex products whose chemical properties are well defined, but whose physical properties and finished product specifications are generally set by the specific use to which they are intended.

A common necessary characteristic to them is that they are well defined.

There is full technical freedom of choice in developing the standard systems of production and testing under "Class A": these standards are established by the same committees, whether such locally or imported.

In contrast, products from "Class B" plants have extremely specific requirements. In case of petrochemicals that is suitable for fuel, the same requirements to make a particular type, the specific use to which a particular plant, the demand that the immediate user, etc.

These requirements have been established in large "agreements international" and it is often possible at any time to enter in agreement with a manufacturer to produce the particular "Class B": it is very difficult to do it properly unless one's own laboratory.

- Formulation Laboratory and
- Customer Service Network

The other countries are not at present equipped to supply either of these two essential items. This is particularly true in the case of the public sector. Theoretically there is no reason that they could not eventually be built, but it is not believed that such an operation would be feasible until there is a very solid basic petrochemical industry equipped with all its own laboratories.

Two plants in "Class 2" they seem to be two essential requirements:

- 1) A foreign participant, who is already in the business in his own country, who will supply and maintain or supply the specialized services and technical-commercial "know-how", which continues to evolve over time.
- 2) A partner already having an R&D and able to create a commercial network which will provide the customer maintenance and technical sales services.

It is therefore recommended for these public technical centers that in the early stages of the development of the industry at least:

The other countries outside class 2 should not try to realize these plants without foreign participation. It is desirable that they rather in these class 2, to concentrate their efforts on these 2 plants.

The additional decision of the need of these 2 plants should be made by foreigners, or what participation each country should have in these 2 plants can be a principle used as capital contribution, taking into account each project in the country involved.

TABLE 2

CLASSIFICATION OF ...

CLASSIFICATION	DESCRIPTION
1. ...	...
2. ...	...
3. ...	...
4. ...	...
5. ...	...
6. ...	...
7. ...	...
8. ...	...
9. ...	...
10. ...	...
11. ...	...
12. ...	...
13. ...	...
14. ...	...
15. ...	...
16. ...	...
17. ...	...

The Commission desires to express its appreciation for the cooperation that complete records will be developed for the development of the Fund will be established under the 1945 Convention. The Commission's recommendations will include legal, financial, commercial and technical provisions.

Under Article 10 of the Convention, the public records of the Fund for international products will be divided among the member states. The 1945 Convention of the Fund and the Fund will be developed with the 1945 Convention of the Fund and will be considered under the 1945 Convention. The Commission desires to express its appreciation for the cooperation that complete records will be developed for the development of the Fund will be established under the 1945 Convention.

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International cooperation for equipment, as well as, civil and military and plant construction, inspection and maintenance of plants, etc. is needed

At the stage of planning and design of the complex, it would be advisable to have an international sub-organization to coordinate the activities to look for potential partners and to make sure that the processes are performed according to the best available standards. Such activities would also be extended to watch over the installation of application, maintenance and technical assistance to the customers, plastics, fertilizers, etc. It is also necessary to arrange financing facilities for the new customers, fertilizers, etc. to coordinate the installation of the personnel, equipment that will be necessary to the start of the production of the particular product. It is also necessary to look for articles (plastics, personnel, fertilizers, etc.) and working equipment, etc.

Finally, the training of all levels which is required for construction and manufacturing cooperation, as well as, technical training organizations that have been established in different countries, should be given the advantage of the existing facilities and equipment which are available to the world as a whole.

II. ECONOMIC POLICY AND DEVELOPMENT

1.1.1. ECONOMIC POLICY AND DEVELOPMENT

Considering the results of the market research reported elsewhere along the lines of consumption of the different food commodities or the possible expansion, this chapter presents the feasibility study of the different projects which might be envisaged to provide a suitable basis to develop a stable agricultural program in the country.

The study of these feasible projects which might be set up in order to meet market requirements and export possibilities has been carried out with the following aims:

- 1. to define the economic situation as a whole in the different areas and then determine the most suitable investments regarding:
  - their different prices
  - their relations with long term price
  - their characteristics and quality etc.
- 2. to go on to the same level as production planned in the different countries in agricultural commodities reported in the different countries and plants or with other crops for the same products.
- 3. to select products which might be used in order to improve the economic situation and determine places of their expansion. This study involves a stable program for the country in the long term.
- 4. to go on to the definition of the different crops and their possible features in the possibilities of the different countries in order to determine possibilities in the production of the same.

1.1.2. ECONOMIC POLICY AND DEVELOPMENT

In the light of the conditions mentioned in the previous chapter, the study is based on the following premises and is carried out with the following aims:

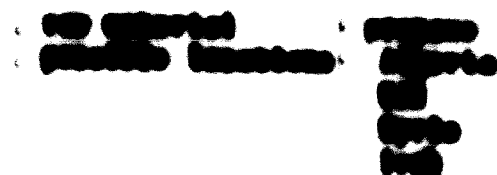
**11.2.1. Material, Labor, and Machine Requirements for the Production**

**11.2.1.1. Material and Machine Requirements for the Production**

- 10,000 sq/yard of polyethylene
- 10,000 sq/yard of polypropylene
- 10,000 sq/yard of polyethylene

**11.2.1.2. Material Requirements**

The general operation of the plant is illustrated in Figure 1 together with the material balance of the different units.



to supply corresponding 100% sub-region curves and their corresponding curves.

All products will be respectively manufactured in the various countries of the sub-region.

**11.2.1.3. Material and Machine Requirements**

Required inputs, material balances are shown with the following tables 1, 2, 3 and 4.

**11.2.1.4. Material**

Required material costs for the process units and the other facilities have been noted in separate columns in the table.

These costs have been noted from detailed cost estimates by similar units and should be considered as preliminary. Definitive cost estimates will result completion of detailed engineering design specifications.

**11.2.1.5. Material Requirements**

Required inputs, outputs and demands, like resources are set forth in the tables 1, 2 and 3.

1. **RESEARCH, ANALYSIS, AND DEVELOPMENT**

Research, analysis, and development work is conducted on a wide range of subjects, including the design and development of new products, the improvement of existing products, and the development of new processes and procedures. This work is carried out by a team of scientists and engineers, and is supported by a variety of facilities, including laboratories, test equipment, and computer resources. The results of this work are used to develop new products and processes, and to improve existing products and processes.

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- 3. SECRET

**TABLE 1. SUMMARY OF STUDY DATA**

**TABLE 1**  
**Summary of Study Data**

Study	Year	Location	Sample Size (n)	Mean (SD)	Range
1	1978	USA	100	1.2 (0.5)	0.0 - 3.0
2	1979	USA	150	1.5 (0.6)	0.0 - 4.0
3	1980	USA	200	1.8 (0.7)	0.0 - 5.0
4	1981	USA	250	2.0 (0.8)	0.0 - 6.0
5	1982	USA	300	2.2 (0.9)	0.0 - 7.0
6	1983	USA	350	2.5 (1.0)	0.0 - 8.0
7	1984	USA	400	2.8 (1.1)	0.0 - 9.0
8	1985	USA	450	3.0 (1.2)	0.0 - 10.0
9	1986	USA	500	3.2 (1.3)	0.0 - 11.0
10	1987	USA	550	3.5 (1.4)	0.0 - 12.0
11	1988	USA	600	3.8 (1.5)	0.0 - 13.0
12	1989	USA	650	4.0 (1.6)	0.0 - 14.0
13	1990	USA	700	4.2 (1.7)	0.0 - 15.0
14	1991	USA	750	4.5 (1.8)	0.0 - 16.0
15	1992	USA	800	4.8 (1.9)	0.0 - 17.0
16	1993	USA	850	5.0 (2.0)	0.0 - 18.0
17	1994	USA	900	5.2 (2.1)	0.0 - 19.0
18	1995	USA	950	5.5 (2.2)	0.0 - 20.0
19	1996	USA	1000	5.8 (2.3)	0.0 - 21.0
20	1997	USA	1050	6.0 (2.4)	0.0 - 22.0
21	1998	USA	1100	6.2 (2.5)	0.0 - 23.0
22	1999	USA	1150	6.5 (2.6)	0.0 - 24.0
23	2000	USA	1200	6.8 (2.7)	0.0 - 25.0
24	2001	USA	1250	7.0 (2.8)	0.0 - 26.0
25	2002	USA	1300	7.2 (2.9)	0.0 - 27.0
26	2003	USA	1350	7.5 (3.0)	0.0 - 28.0
27	2004	USA	1400	7.8 (3.1)	0.0 - 29.0
28	2005	USA	1450	8.0 (3.2)	0.0 - 30.0
29	2006	USA	1500	8.2 (3.3)	0.0 - 31.0
30	2007	USA	1550	8.5 (3.4)	0.0 - 32.0
31	2008	USA	1600	8.8 (3.5)	0.0 - 33.0
32	2009	USA	1650	9.0 (3.6)	0.0 - 34.0
33	2010	USA	1700	9.2 (3.7)	0.0 - 35.0
34	2011	USA	1750	9.5 (3.8)	0.0 - 36.0
35	2012	USA	1800	9.8 (3.9)	0.0 - 37.0
36	2013	USA	1850	10.0 (4.0)	0.0 - 38.0
37	2014	USA	1900	10.2 (4.1)	0.0 - 39.0
38	2015	USA	1950	10.5 (4.2)	0.0 - 40.0
39	2016	USA	2000	10.8 (4.3)	0.0 - 41.0
40	2017	USA	2050	11.0 (4.4)	0.0 - 42.0
41	2018	USA	2100	11.2 (4.5)	0.0 - 43.0
42	2019	USA	2150	11.5 (4.6)	0.0 - 44.0
43	2020	USA	2200	11.8 (4.7)	0.0 - 45.0
44	2021	USA	2250	12.0 (4.8)	0.0 - 46.0
45	2022	USA	2300	12.2 (4.9)	0.0 - 47.0
46	2023	USA	2350	12.5 (5.0)	0.0 - 48.0
47	2024	USA	2400	12.8 (5.1)	0.0 - 49.0
48	2025	USA	2450	13.0 (5.2)	0.0 - 50.0

TABLE 1. SUMMARY OF STUDY DATA. n = NUMBER OF STUDIES; MEAN (SD) = MEAN AND STANDARD DEVIATION; RANGE = RANGE OF VALUES.

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Table 1

OPERATIONAL INFORMATION

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<p>SECRET</p> <p>OPERATIONAL INFORMATION</p> <p>SECRET</p>	<p>SECRET</p>	<p>SECRET</p>	<p>SECRET</p>
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<p>SECRET</p> <p>OPERATIONAL INFORMATION</p> <p>SECRET</p>	<p>SECRET</p>	<p>SECRET</p>
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**TABLE 1 - STATE OF TEXAS - 1950**

**TABLE 1  
STATE OF TEXAS - 1950**

	1949	1950
Population	10,000,000	10,500,000
Area (sq. miles)	695,621	695,621
Population per sq. mile	14.4	15.1
Population per 100 sq. miles	1.44	1.51
Population per 1,000 sq. miles	0.144	0.151
Total	10,000,000	10,500,000

**TABLE 2  
STATE OF TEXAS - 1950**

	1949	1950
Population	10,000,000	10,500,000
Area (sq. miles)	695,621	695,621
Population per sq. mile	14.4	15.1
Population per 100 sq. miles	1.44	1.51
Population per 1,000 sq. miles	0.144	0.151
Total	10,000,000	10,500,000

**STATE OF TEXAS**

1981

**GENERAL INVESTMENT FUND**

	1981
<p><b>Revenue 1981:</b></p> <ul style="list-style-type: none"> <li>From State Lottery</li> <li>From State</li> <li>From State</li> <li>From State</li> <li>From State</li> <li>From State</li> </ul>	<p align="right">1,000,000</p> <p align="right">1,000,000</p> <p align="right">1,000,000</p> <p align="right">1,000,000</p> <p align="right">1,000,000</p> <p align="right">1,000,000</p> <hr/>
<p align="right"><b>Total Revenue 1981</b> (including operating charges)</p>	<p align="right"><b>10,000,000</b></p>
<p><b>Expenses</b></p>	<p align="right"><b>7,000,000</b></p>
<p><b>Total Investment Fund</b></p>	<p align="right"><b>25,000,000</b></p>

TABLE 1. Summary of the experimental design and results

TABLE 1

Summary of the experimental design and results

Response	Condition 1		Condition 2		Condition 3	
	Mean	SD	Mean	SD	Mean	SD
Reaction time	1.2	0.1	1.1	0.1	1.0	0.1
Accuracy	0.9	0.05	0.9	0.05	0.9	0.05
Number of errors	0.1	0.05	0.1	0.05	0.1	0.05

TABLE 2. Summary of the experimental design and results

Condition	Mean	SD
Condition 1	1.2	0.1
Condition 2	1.1	0.1
Condition 3	1.0	0.1

TABLE 3. Summary of the experimental design and results



**TABLE 1. SUMMARY OF STUDY DATA**

**TABLE 1**  
**Summary of Study Data**  
**Number of Subjects and Mean Age**

	Group 1	Group 2
Number of Subjects	10	10
Mean Age (years)	25.5	25.5
Standard Deviation (years)	2.5	2.5
Range (years)	20 - 30	20 - 30
Minimum (years)	20	20
Maximum (years)	30	30



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TABLE 1

MEMBER LIST

NAME	ADDRESS	PHONE	STATUS
Mr. J. Edgar Hoover	Washington, D.C.	20535	President
Mr. Tolson	Washington, D.C.	20535	President
Mr. Boardman	Washington, D.C.	20535	Vice President
Mr. Nichols	Washington, D.C.	20535	Vice President
Mr. Belmont	Washington, D.C.	20535	Member
Mr. Mohr	Washington, D.C.	20535	Member
Mr. DeLoach	Washington, D.C.	20535	Member
Mr. Casper	Washington, D.C.	20535	Member
Mr. Callahan	Washington, D.C.	20535	Member
Mr. Conrad	Washington, D.C.	20535	Member
Mr. Felt	Washington, D.C.	20535	Member
Mr. Gale	Washington, D.C.	20535	Member
Mr. Rosen	Washington, D.C.	20535	Member
Mr. Sullivan	Washington, D.C.	20535	Member
Mr. Tavel	Washington, D.C.	20535	Member
Mr. Trotter	Washington, D.C.	20535	Member
Mr. Tele. Rm.	Washington, D.C.	20535	Member
Mr. Holmes	Washington, D.C.	20535	Member
Miss Gandy	Washington, D.C.	20535	Member

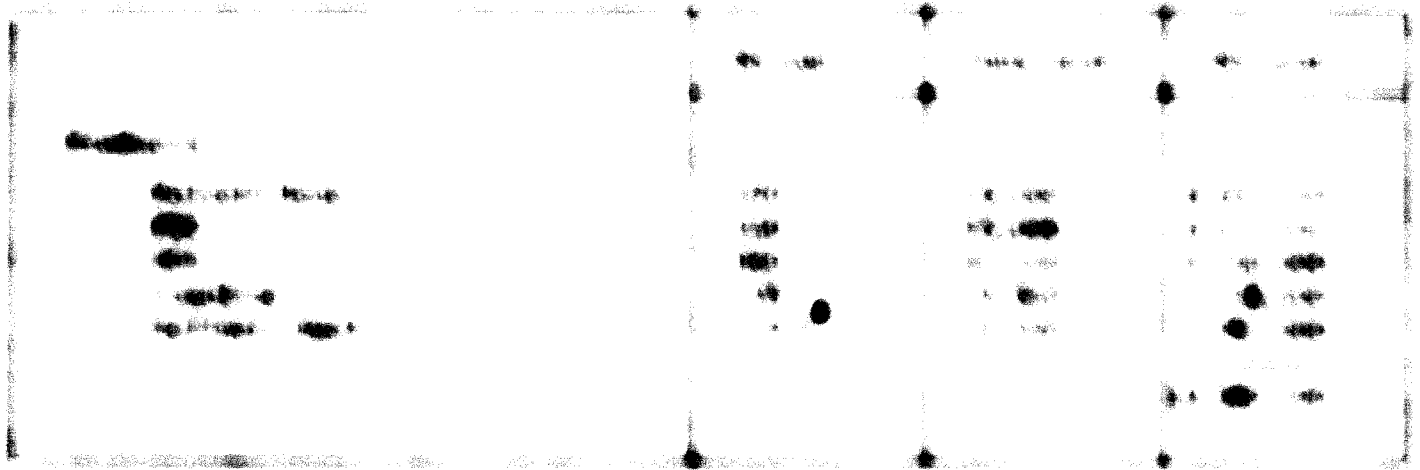




Figure 1. *Phylogenetic relationships among the studied species*

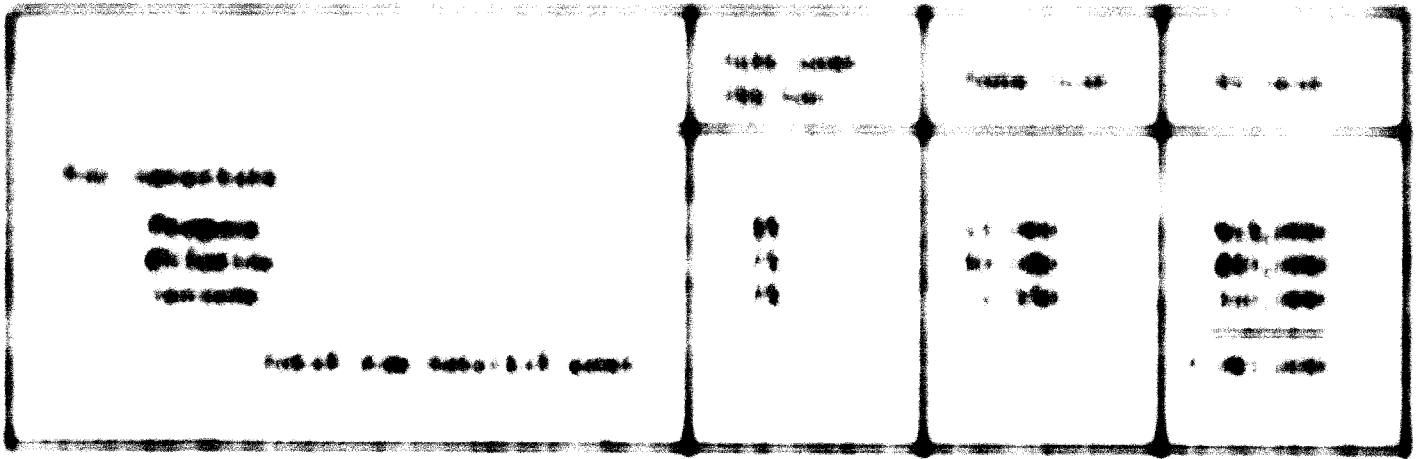
Scale bar

0.1 substitutions per site



Species names and their corresponding positions in the tree.

Figure 2. *Phylogenetic relationships among the studied species*

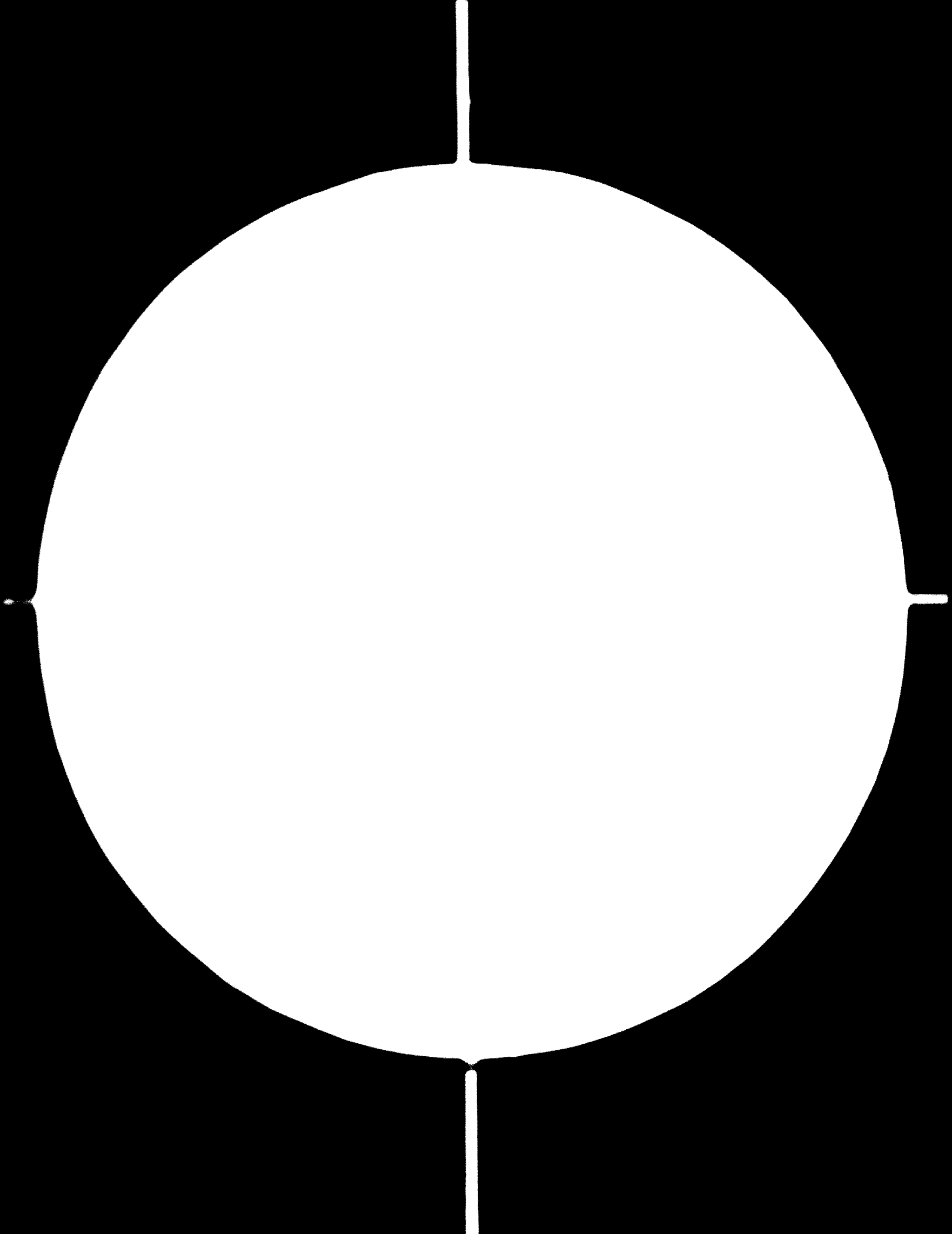


Species names and their corresponding positions in the tree.

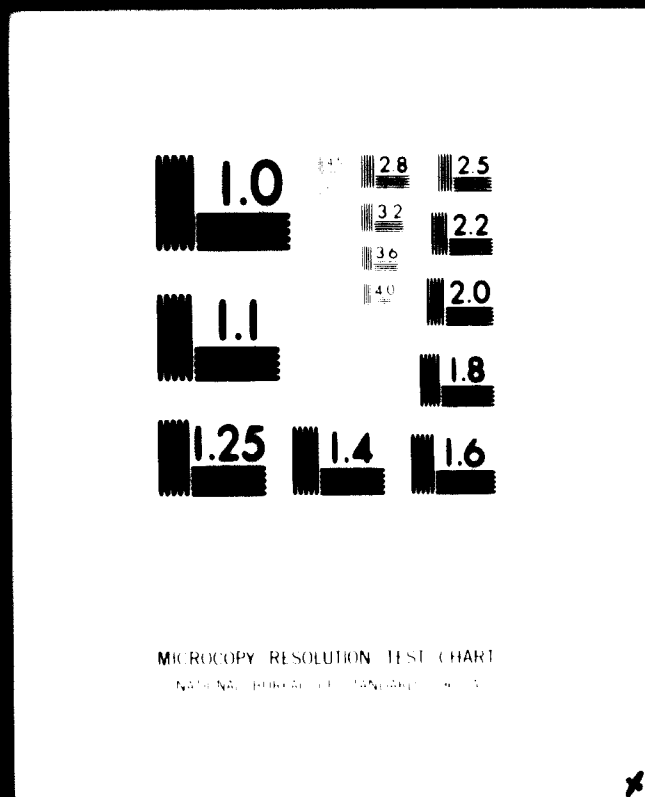
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COMPLEX A - PLASTIC AND DETERGENT BASED COMPLEX

Table 12  
Estimated operating cost  
(US\$/year)

<b>Variable charges</b>	
. Utilities	1,495,000
. Labor	1,200,000
. Catalysts and chemicals	533,000
. Miscellaneous	50,000
	<hr/>
<b>Total variable charges</b>	<b>3,278,000</b>
<b>Fixed charges</b>	
. Amortization at 10% of investment	3,637,000
. Interest at 4% of investment	1,450,000
. Maintenance at 4% of process units and offsites	1,060,000
. Interest on working capital at 8%	56,000
. General plant overhead, taxes and insurance at 1% of investment	363,000
	<hr/>
<b>Total fixed charges</b>	<b>6,566,000</b>
	-----
<b>Total operating cost</b>	<b>9,844,000</b>
<b>Estimated working capital</b>	<b>700,000</b>
<p>On the basis of : raw material consumption (benzene and chlorine) during 15 days: production of finished products as (PE, PVC, DDB) during 15 days: cost of variable charges during one month.</p>	

COMPLEX A - PLASTIC AND DETERGENT BASED COMPLEX

Table 13  
Estimated investment profitability

	US\$
<b>Credit</b>	
<b>Product sales (see table 11)</b>	12,580,400
<b>Debit</b>	
<b>Operating cost (see table 12)</b>	9,844,000
<b>Raw material cost (see table 11)</b>	2,095,000
	<hr/>
<b>Manufacturing cost</b>	11,939,000
<b>Profitability</b>	
<b>Benefits<sup>▲</sup> before taxes</b>	641,400
<b>Benefits after taxes at 50%</b>	320,700
<b>Amortization provides</b>	3,637,000
<b>Benefits after taxes plus amortization</b>	3,957,700
<b>Return on capital</b>	11 %
<b>Pay-out time on total investment</b>	9.2 years

▲. calculated as credit less manufacturing cost

**Complex A, Plastic and Detergent based complex producing**

- . 30,000 MT/year of PE
- . 30,000 MT/year of PVC
- . 20,000 MT/year of DDB

**a. Brief description**

The general operation of the plant is illustrated in Figure 2 hereafter with the material balance of the different units.

- . raw material : propane
- . possible locations : Algeria or UAR  
Syria or Irak

to supply 1975 North Africa and North East Africa markets and 1975 Middle East Arab Countries markets

- . possible locations : Algeria  
UAR  
Syria  
Irak

to supply corresponding 1980 sub-regions markets and partly neighbouring countries

- . end-products will be respectively manufactured in the various countries of the sub-regions

**b. Technical and economic data**

Detailed basic calculations required by the feasibility study are given in the following tables 1, 2, 3, 4 and 5.

**c. Investment**

Estimated investment costs for the overall complex are shown with the Table 6 hereafter.

**d. Operating cost and profitability**

Estimated operating cost and profitability calculations are presented in the tables 7, 8 and 9 hereafter.

**e. Effect of feed-stock price**

The effect of propane value on profitability of the project is illustrated in Figure 3 hereafter.

FIG. 2 CONVEX A1 Manufacturing Scheme & Material Balance (tons/year)

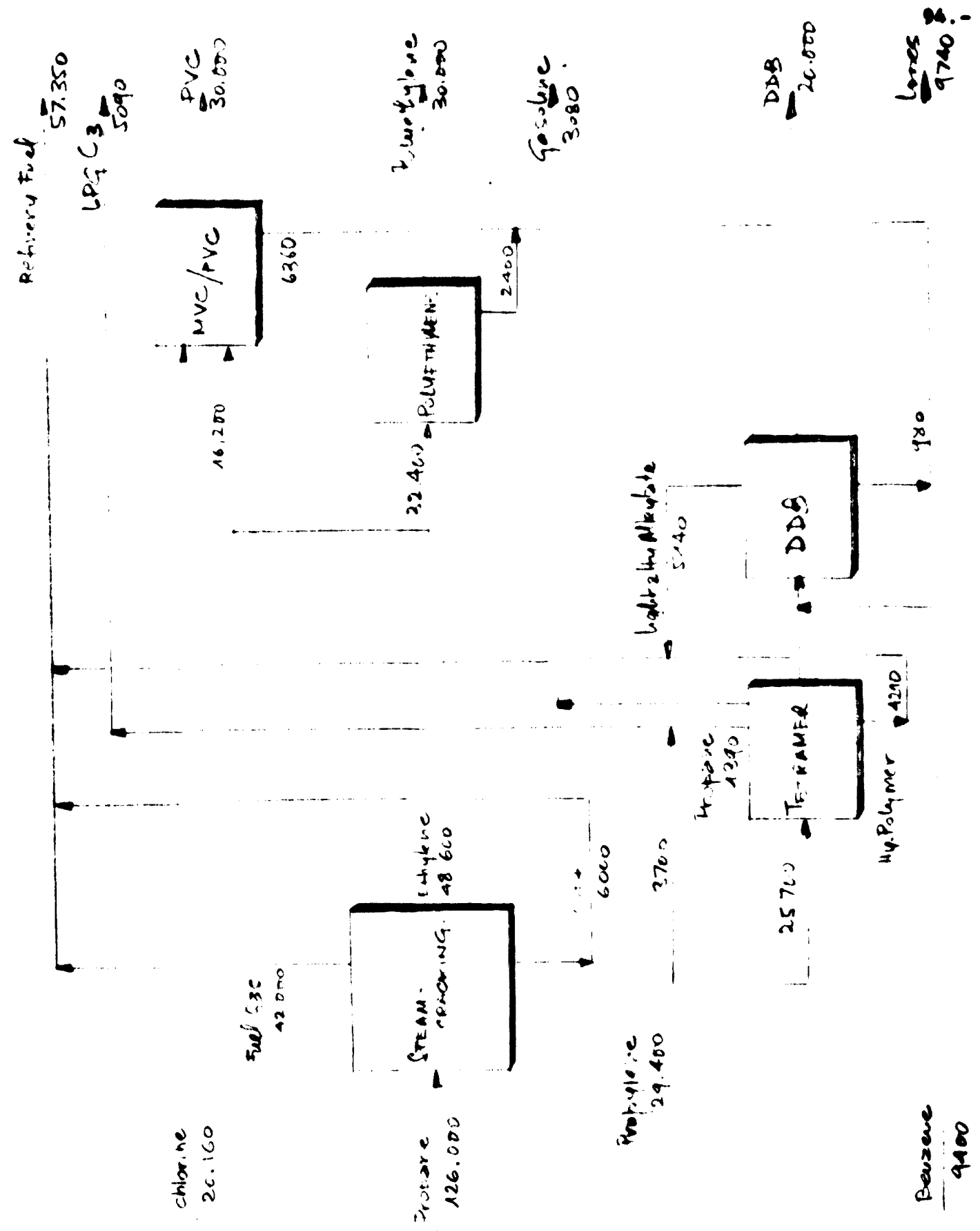




Fig. 3 COMPLEX Aa : Effect of feed stock price on profitability.

Pay.out Time (years)

8 .  
7 .  
6 .  
5 .

10

15

20

25

Propane value  
US \$/ton

COMPLEX A<sub>1</sub> - PLASTIC AND DETERGENT BASED COMPLEX

producing :

- . 30,000 MT/year of polyethylene
- . 30,000 MT/year of polyvinylchloride
- . 20,000 MT/year of dodecylbenzene

COMPLEX A<sub>1</sub> - PLASTIC AND DETERGENT BASED COMPLEX

Table 1  
Estimated investment cost

	US\$
<b>Process Units</b>	
Propane steam-cracking	7,900,000
Polyethylene	9,000,000
MVC unit	6,900,000
PVC unit	2,500,000
Tetramer	1,400,000
Dodecylbenzene	<u>1,200,000</u>
<b>Total Process Units</b> <b>(including engineering expenses)</b>	<b>28,900,000</b>
<b>Off-sites</b>	<b>12,100,000</b>
	<hr/>
<b>Total investment cost</b>	<b>41,000,000</b>

**COMPLEX A<sub>1</sub> - PLASTIC AND DETERGENT BASED COMPLEX**

**Table 2**

**Utility consumption and annual cost**

	Electricity kwh/hr	HP steam kg/hr	LP steam kg/hr	Water m <sup>3</sup> /hr	Fuel 10 <sup>6</sup> kcal/hr
Process Units	26,340	38,074	15,800	5,622	62.0
Off-sites	2,260	-	14,060	1,178	32.0
<b>Total consumption</b>	<b>28,600</b>	<b>38,074</b>	<b>29,860</b>	<b>6,800</b>	<b>114.0</b>

Annual cost of utilities :

US\$/year

Electricity

$$28,600 \times 7920 \text{ hr} \times 0.01 \text{ US\$/kwh}$$

2,280,000

Fuel

$$114.0 \times 10^6 \text{ kcal/hr} \times 7920 \text{ hr} \times 0.7 \text{ US\$/}10^6 \text{ kcal}$$

630,000

Demineralized water

$$41 \text{ m}^3/\text{hr} \times 7920 \text{ hr} \times 0.25 \text{ US\$/m}^3$$

80,000

**Total**

**2,990,000**

**COMPLEX A<sub>1</sub> - PLASTIC AND DETONANT BASED COMPLEX**

**Table 3**

Manpower requirements and annual cost

	Administ.	Engineers	Feremen	Chief Operator	Operator	Chemist & skilled pers.	Helpers	Total
Salaries US\$	12,000	10,000	8,000	6,000	5,000	4,000	2,000	
Man/day US\$	-	2	1	-	-	2	7	12
Man/shift		20,000	8,000			8,000	14,000	50,000
Process units Off-sites			3	5	25	-	-	
Total man/shift			-	-	8	5	5	49
Total man/year			3	5	31	5	5	221
US\$/year			13	22	140	23	23	
Total			104,000	132,000	700,000	92,000	46,000	1,074,000
	Man/year						233	
	US\$/year						1,124,000	
							276,000	
							<u>1,400,000</u>	

Technical assistance and cost of training estimated at

COMPLEX A<sub>1</sub> - PLASTIC AND DETERGENT BASED COMPLEX

Table 4  
Estimated initial charge and annual consumption

	Initial charge US\$	Yearly consumption US\$
<b>Process Units</b>		
Steam-cracking	100,000	40,000
Polyethylene		640,000
MVC		80,000
PVC		220,000
Tetramer	22,000	60,000
Dodecylbenzene		16,000
Chemical products		10,000
	<hr/>	<hr/>
<b>Total</b>	122,000	1,066,000

COMPLEX A<sub>1</sub> - PLASTIC AND DETERGENT BASED COMPLEXTable 3

Estimated royalty cost  
(including know-how fee)

	US\$
<b>Process Units</b>	
<b>Steam-cracking</b>	300,000
<b>Polyethylene</b>	3,000,000
<b>MVC and PVC</b>	1,000,000
<b>Tetramer and DDB</b>	450,000
	<hr/>
<b>Total</b>	4,750,000

COMPLEX A<sub>1</sub> - PLASTIC AND DETERGENT BASED COMPLEXTable 6Estimated total investment

	US\$
<b>Total investment cost (ref. table 1)</b>	<b>41,000,000</b>
<b>royalties (ref. table 3)</b>	<b>4,750,000</b>
<b>Start-up expenses</b>	<b>2,500,000</b>
<b>Contingencies</b>	<b>4,500,000</b>
	<hr/>
<b>Total investment (to be amortized)</b>	<b>52,750,000</b>
<b>Initial charge of catalysts and chemicals (ref. table 4)</b>	<b>122,000</b>
<b>Additional charge of catalyst and chemicals</b>	<b>122,000</b>
<b>Spare parts</b>	<b>600,000</b>
	<hr/>
<b>Estimated total investment</b>	<b>53,994,000</b>
<b>Estimated working capital (see table )</b>	<b>1,400,000</b>



COMPLEX A<sub>1</sub> - PLASTIC AND DETERGENT BASED COMPLEXTable 7  
Estimated product sales

	US\$/ton	Tons/year	US\$/year
<b>Products</b>			
Polyethylene	370	30,000	11,000,000
PVC	340	30,000	10,200,000
MS	160	20,000	3,200,000
Gasoline	25	3,000	76,000
Refinery fuel <sup>0</sup>	0.7	62,440	504,000
<b>Total product sales</b>			<u>25,160,000</u>

0. 0.7 US\$/10<sup>6</sup> kcalFuel refinery heat value estimated at 13.4.10<sup>6</sup> kcal/tonEstimated raw material cost

	Unit cost	Tons/year	US\$/year
<b>Raw materials</b>			
Propane	15	126,000	1,890,000
Chlorine	75	20,100	1,507,500
Isopropane	75	9,100	682,500
			<u>4,100,000</u>

**COMPLEX A<sub>1</sub> - PLASTIC AND DETERGENT BASED COMPLEX**

---

**Table 2**  
**Estimated operating cost**  
 (US\$/year)

<b>Variable charges</b>	
. Utilities	2,990,000
. Labor	1,400,000
. Catalyst and chemicals	1,066,000
. Miscellaneous	100,000
	<hr/>
<b>Total variable charges</b>	<b>5,556,000</b>
<b>Fixed charges</b>	
. Amortization at 10% of investment	3,275,000
. Interest at 4% of investment	2,110,000
. Maintenance at 4% of Process Units and Offsites	1,640,000
. Interest on working capital at 8%	112,000
. General plant overhead, taxes and insurance at 1% of investment	527,000
	<hr/>
<b>Total fixed charges</b>	<b>9,664,000</b>
	-----
<b>Total operating cost</b>	<b>15,220,000</b>
<b>Estimated working capital</b>	<b>1,400,000</b>

COMPLEX A<sub>1</sub> - PLASTIC AND DETERGENT BASED COMPLEXTable 9Estimated investment profitability

	US\$/year
<b>Credit</b>	
Product sales (see table 7)	25,160,800
<b>Debit</b>	
Operating cost (see table )	15,220,500
Raw material cost (see table )	4,190,000
Manufacturing cost	19,410,500
<b>Profitability</b>	
Benefits <sup>†</sup> before taxes	5,750,300
Benefits after taxes at 50%	2,875,150
Amortisation provides	5,275,000
Benefits after taxes plus amortisation	8,150,000
Return on capital	15.2 %
Pay-out time on total investment	6.6 years

†. calculated as credit less manufacturing cost

**Complex B Plastic and Detergent based complex producing :**

1. Basic products : 80,000 MT/year of ethylene and propylene
2. Monomers and polymers as follows :

**Complex B<sub>1</sub> producing :**

- . 30,000 MT/year of PE
- . 30,000 MT/year of PVC
- . 20,000 MT/year of DDB

1. From : Ethane propane cut as feed-stocka. Brief description

The general operation of the plant is illustrated in Figure 4 hereafter with the material balance of the different units:

- . raw material : ethane propane mixed cut
- . possible locations and markets supplied : see Complex A<sub>1</sub> with excess ethylene to be exported to Arab Countries or to possible buyers
- . end-products will be respectively manufactured in the different countries

b. Investment

Estimated investment cost for the overall complex is shown with the table 1 hereafter.

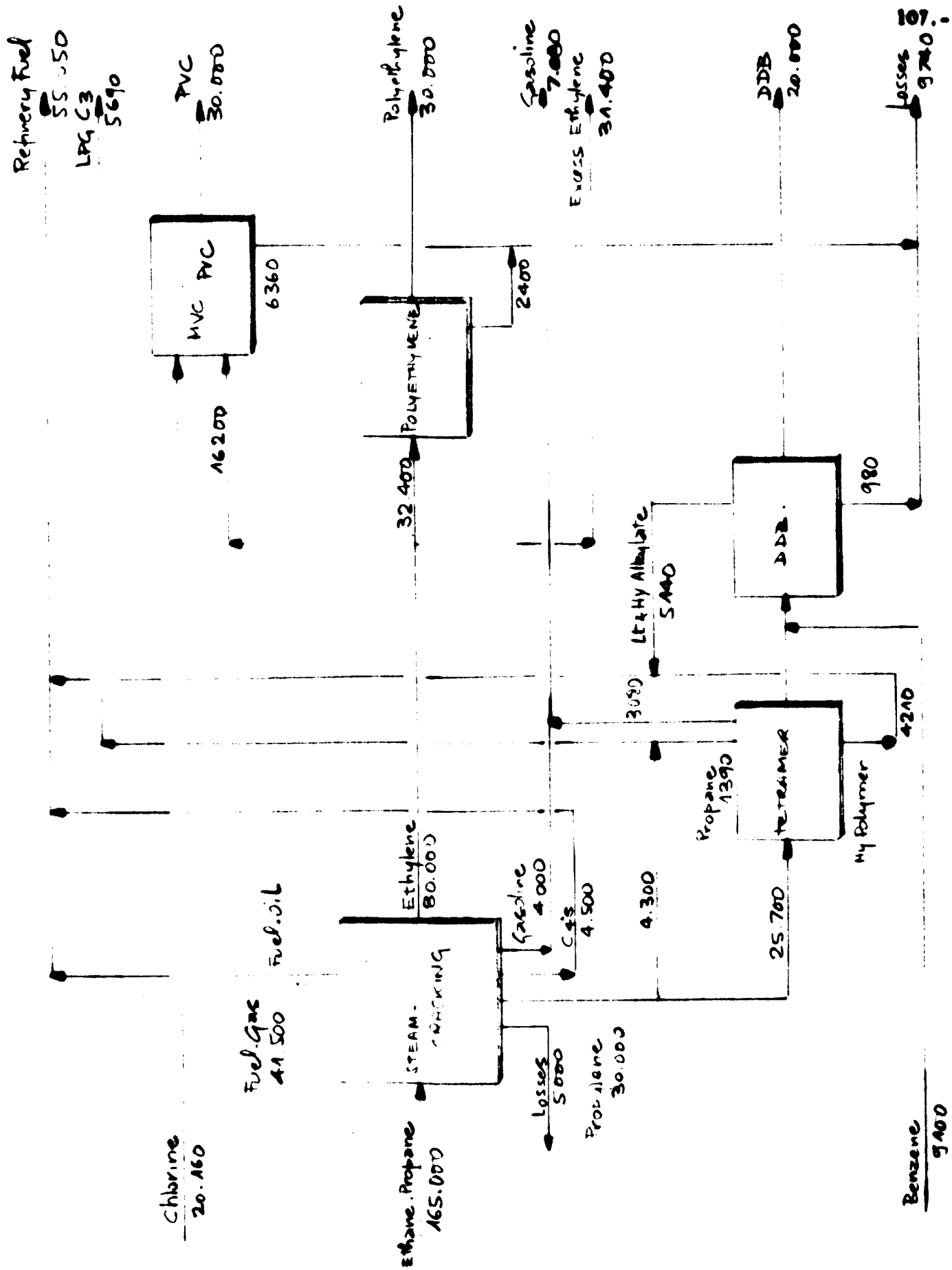
c. Operating cost and profitability

Estimated operating cost and profitability calculations are presented in the following tables 2, 3 and 4.

d. Effect of feed-stock and exported ethylene prices on profitability

The effect of ethane propane mixed charge value and exported ethylene price are respectively shown with the figures 5 and 6.

Fig. 4 Computer BA: Manufacturing Scheme & Material Balance (Ethane-Propane Steam-Cracking)



**COMPLEX B - PLASTIC AND DETERGENT BASED COMPLEX**

producing :

- . 30,000 MT/year of polyethylene
- . 30,000 MT/year of polyvinylchloride
- . 20,000 MT/year of dodecylbenzene

(feed-stock : ethane-propane cut)

**COMPLEX B<sub>1</sub> - PLASTIC AND DETERGENT BASED COMPLEX****(ethane-propane feed-stock)****Table 1****Estimated Investment Cost**

	US\$
<b>Process Units</b>	
Ethane - Propane steam-cracking	10,100,000
Polyethylene	9,000,000
MVC unit	6,900,000
PVC unit	2,500,000
Tetramer	1,400,000
Dodecylbenzene	<u>1,200,000</u>
<b>Total Process Units</b>	<b>31,100,000</b>
<b>Off-sites</b>	<b>13,500,000</b>
<b>Royalties</b>	<b>4,750,000</b>
<b>Start-up expenses</b>	<b>3,000,000</b>
<b>Contingencies</b>	<b><u>4,000,000</u></b>
<b>Total Investment</b>	<b>56,350,000</b>
<b>Estimated working capital</b>	<b>1,700,000</b>

COMPLEX B<sub>1</sub> - PLASTIC AND DETERGENT BASED COMPLEX

(ethane propane feed-stock)

Table 2Estimated Product Sales

	Unit Cost US\$/ton	Tons/year	US\$/year
<b>Products</b>			
Polyethylene	370	30,000	11,100,000
PVC	340	30,000	10,200,000
Dodecylbenzene	160	20,000	3,200,000
Ethylene	70	31,400	2,200,000
Gasoline	25	7,080	176,000
C <sub>3</sub> LPG	20	5,690	113,800
Refinery fuel <sup>a</sup>	0.7	55,350	520,000
<b>Total Product Sales</b>			<b>27,509,800</b>

<sup>a</sup>. 0.7 US\$/10<sup>6</sup> kcalEstimated Raw Material Cost

	Unit Cost US\$/ton	Tons/year	US\$/year
<b>Raw Materials</b>			
Ethane Propane	15	165,000	2,470,000
Chlorine	75	20,160	1,620,000
Benzene	75	9,100	680,000
			<b>4,770,000</b>



COMPLEX B<sub>1</sub> - PLASTIC AND DETERGENT BASED COMPLEX

(ethane propane feed-stock)

Table 3Estimated Operating Cost

	US\$/year
<b>Variable Charges</b>	
. Utilities	3,200,000
. Labor	1,500,000
. Catalyst and chemicals	1,100,000
. Miscellaneous	100,000
<b>Total Variable Charges</b>	<b>5,900,000</b>
<b>Fixed Charges</b>	
. Amortization at 10% of investment	5,635,000
. Interest at 4% of investment	2,250,000
. Maintenance at 4% of Process Units + Offsites	1,750,000
. Interest on working capital at 8%	136,000
. General plant overhead, taxes and insurance at 1% of investment	563,000
<b>Total Fixed Charges</b>	<b>10,334,000</b>
	-----
<b>Total Operating Cost</b>	<b>16,234,000</b>

**COMPLEX B<sub>1</sub> - PLASTIC AND DETERGENT BASED COMPLEX**

(ethane propane feed-stock)

**Table 4****Estimated Investment Profitability**

	US\$/year
<b>Credit</b>	
Product Sales (see table 2)	27,509,800
<b>Debit</b>	
Operating cost (see table 3)	16,234,000
Raw material cost (see table 2)	4,770,000
	<hr/> 21,004,000
<b>Profitability</b>	
Benefits before taxes	6,505,000
Benefits after taxes at 50%	3,252,000
Amortisation provides	5,635,000
Benefits after taxes plus amortisation	8,887,000
Pay-out time on total investment	6.3 years

Fig 5 COMPLEX BA : Effect of lead price on profitability

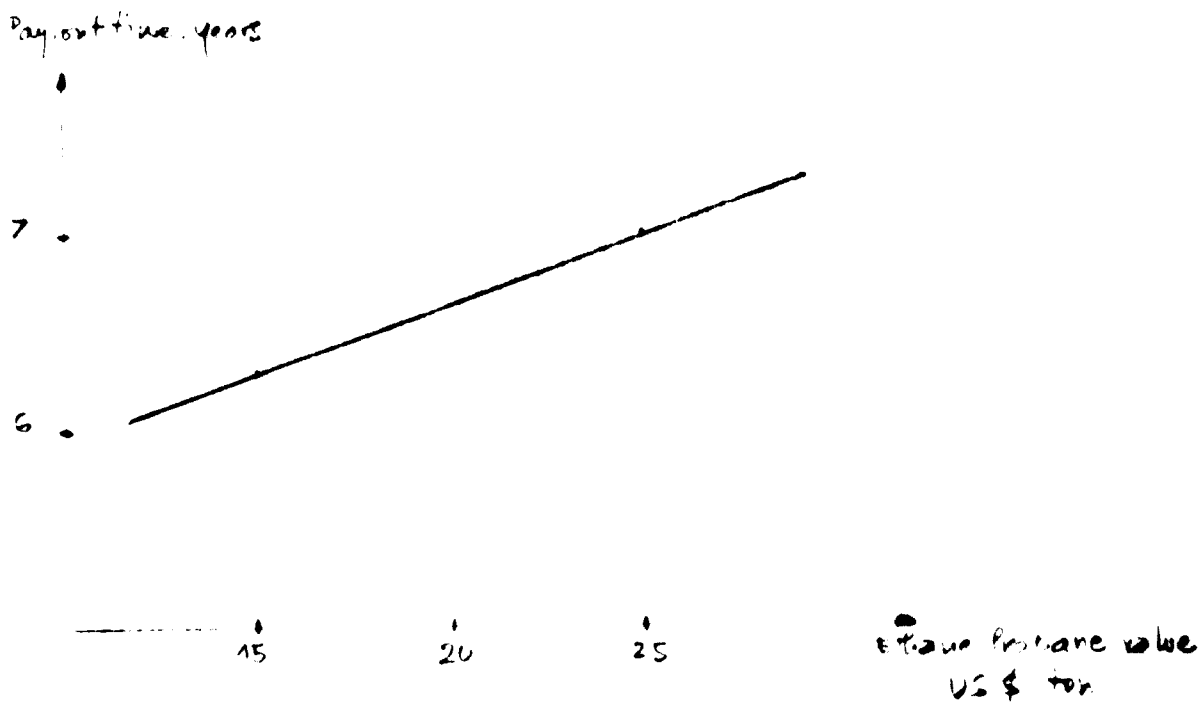
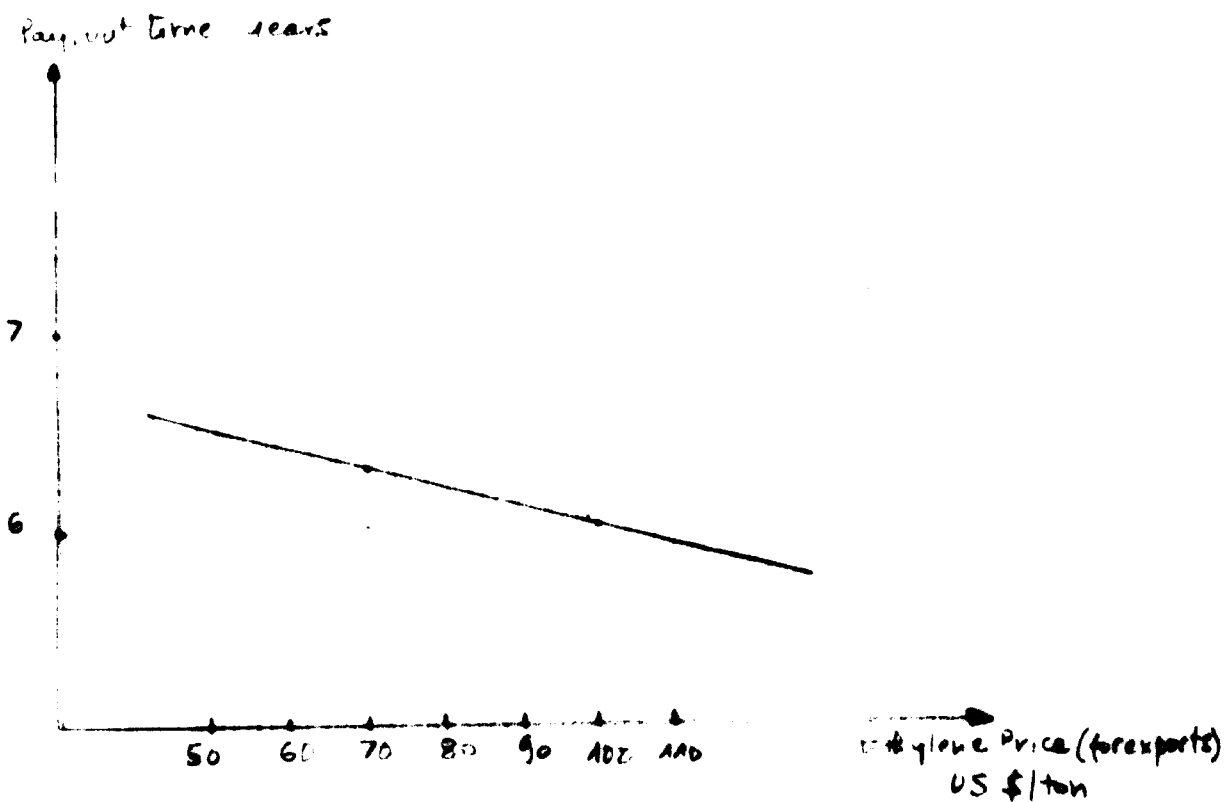


Fig. 6 COMPLEX BA Effect of estimated oil price on profitability



**2. from : Naphtha as feed-stock****c. Brief description**

The manufacturing scheme of plant is illustrated in figure 7 hereabove with the material balance of the different units :

- . raw material : naphtha
- . possible locations and markets supplied : see Complex B based on ethane propane charge
- . end-products will be respectively manufactured in the different countries of the sub-region

**b. Investment**

Estimated investment cost for the overall complex is shown in the table 1 hereafter.

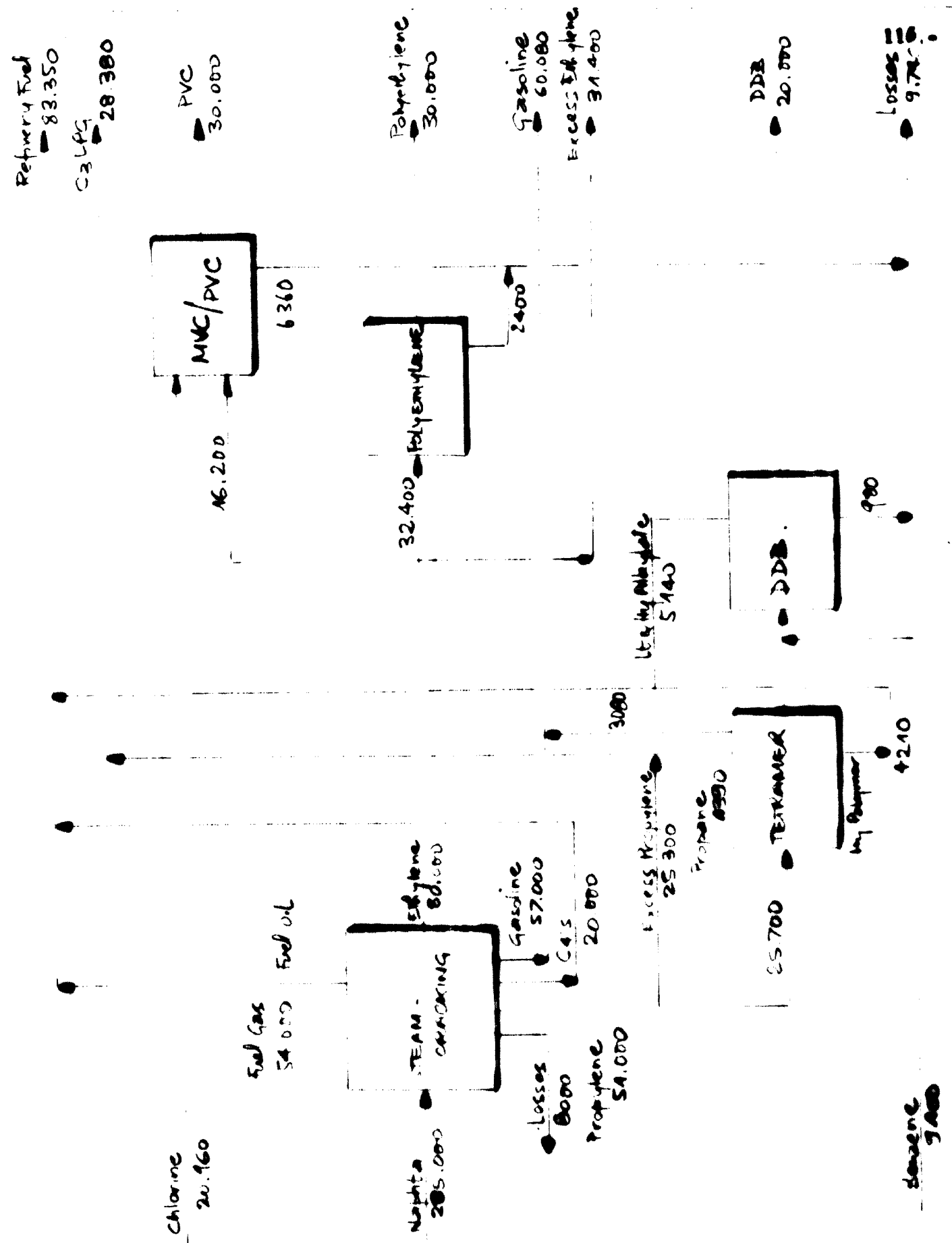
**c. Operating cost and profitability**

Estimated operating cost and profitability calculations are presented in the following tables 2, 3 and 4.

**d. Effect of the feed-stock and exported ethylene prices**

The effect of naphtha value and exported ethylene price are respectively shown with the figures 8 and 9.

Fig. 7 Material Balance (Nobita Steam Coking)



**COMPLEX 3 - PLASTIC AND SURFACANT BASED COMPLEX**

producing :

- . 30,000 MT/year of polyethylene
- . 30,000 MT/year of polyvinylchloride
- . 20,000 MT/year of dodecylbenzene  
(feed-stock : naphtha)

**EXHIBIT 1 - PLASTIC AND RETIREMENT MACHS COMPANY**

(Naphto Stock-Stock)

**Table 1**

**Estimated Investment Cost**

	USD
<b>Process Units</b>	
Naphto steam-cracking	11,000,000
Polyethylene	9,000,000
MSE unit	4,000,000
PSE unit	2,500,000
Tetraer	1,400,000
Inducthane	1,200,000
<b>Total Process Units</b>	<b>12,000,000</b>
Off-site	10,000,000
Reserves	4,750,000
Start-up expenses	1,000,000
Contingencies	4,250,000
<b>Total Investment</b>	<b>22,000,000</b>
<b>Estimated Working Capital</b>	<b>1,700,000</b>

COMPLEX B<sub>1</sub> - PLASTIC AND DETERGENT BASED COMPLEX

(naphtha feed-stock)

Table 2Estimated Product Sales

	Unit Cost US\$/ton	Tons/year	US\$/year
<b>Products</b>			
Polyethylene	370	30,000	11,100,000
PVC	340	30,000	10,200,000
DBB	160	20,000	3,200,000
Ethylene	70	31,400	2,200,000
Gasoline	25	60,000	1,520,000
C <sub>3</sub> LPG	30	28,300	870,000
Refinery fuel <sup>a</sup>	0.7	83,300	700,000
<b>Total Product Sales</b>			<u>29,570,000</u>

a. 0.7 US\$/10<sup>6</sup> kcal - Fuel refinery heat value estimated at 13.4.10<sup>6</sup> kcal/ton

Estimated Raw Material Cost

	Unit Cost US\$/year	Tons/year	US\$/year
<b>Raw Materials</b>			
Naphtha	10	285,000	2,850,000
Chlorine	75	20,100	1,520,000
Sonaxene	75	9,100	680,000
<b>Total Raw Material Cost</b>			<u>7,440,000</u>



**COMPLEX B<sub>1</sub> - PLASTIC AND DETERGENT BASED COMPLEX**

(naphtha feed-stock)

**Table 3****Estimated Operating Cost**

	US\$/year
<b>Variable Charges</b>	
. . Utilities	3,400,000
. Labor	1,500,000
. Catalysts and chemicals	1,100,000
. Miscellaneous	100,000
<b>Total Variable Charges</b>	<b>6,100,000</b>
<b>Fixed Charges</b>	
. Amortisation at 10% of investment	5,795,000
. Interest at 4%	2,310,000
. Maintenance at 4% of Process Units + Offsites	1,810,000
. Interest on working capital at 8%	136,000
. General plant overhead, taxes and insurance at 1%	579,000
<b>Total Fixed Charges</b>	<b>10,630,000</b>
	-----
<b>Total Operating Cost</b>	<b>16,730,000</b>

**COMPLEX B<sub>1</sub> - PLASTIC AND DETERGENT BASED COMPLEX**

(naphtha feed-stock)

**Table 4****Estimated Investment Profitability**

	US\$/year
<b>Credit</b>	
Product Sales (see table 2)	29,570,000
<b>Debit</b>	
Operating cost (see table 3)	16,730,000
Raw material cost (see table 2)	7,440,000
	<hr/>
<b>Total Debit</b>	<b>24,170,000</b>
<b>Profitability</b>	
Benefits before taxes	5,400,000
Benefits after taxes at 90%	2,700,000
Amortisation provides	5,795,000
Benefits after taxes plus amortisation	8,495,000
 Pay-out time on total investment	 7 years

Fig. 8 COMPLEX BA : Effect of feed stock price on time to pay out

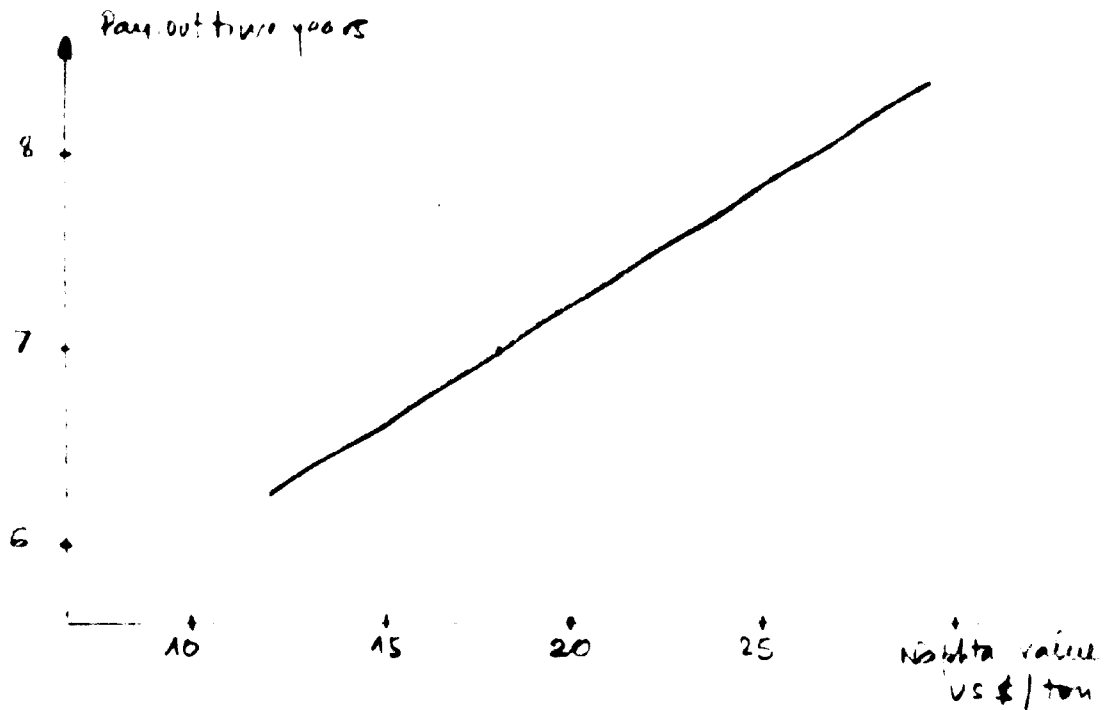
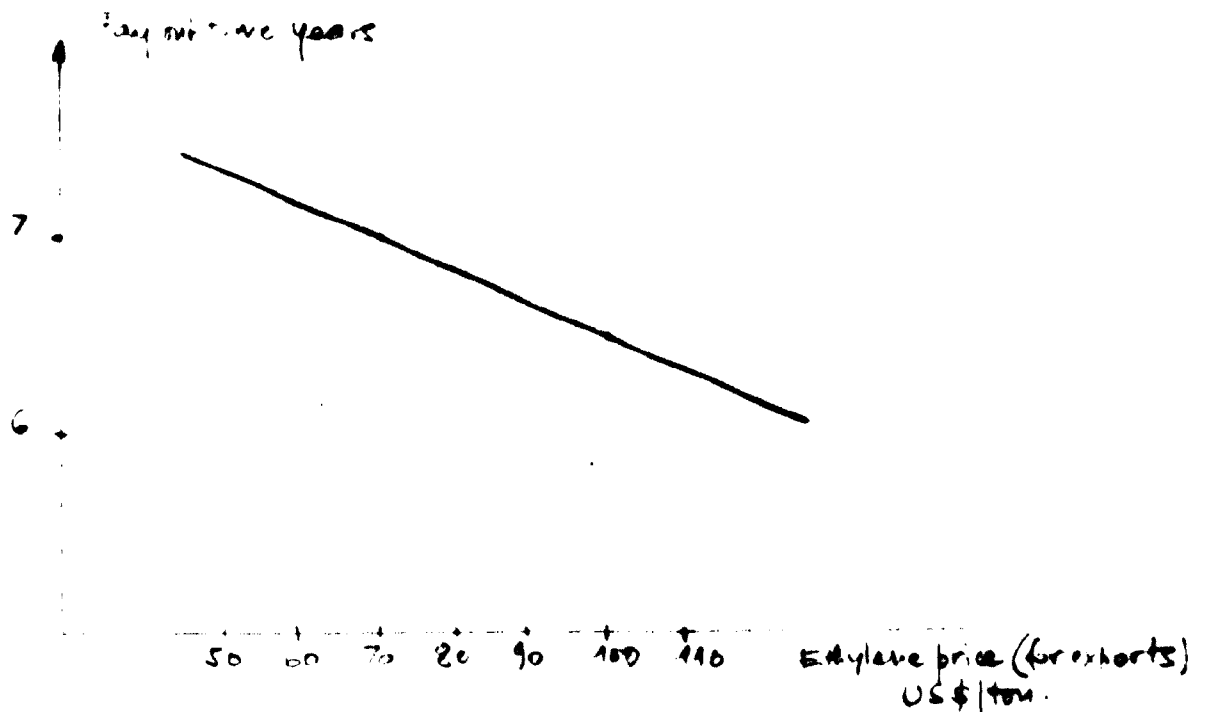


Fig. 9. COMPLEX BA Effect of ammonia fertilizer price on time to pay out



**Complex B<sub>2</sub> producing :**

- . 30,000 MT/year of PE
- . 30,000 MT/year of PVC
- . 20,000 MT/year of DDB

**a. Brief description**

The manufacturing scheme of the plant is illustrated in Figure 10 hereafter with the relevant material balance of the different units.

- . raw material : naphtha and mixed ethane propane cuts
- . possible locations : Algeria or UAR  
Iraq or Syria
- . to supply 1980 North Africa and North East Africa markets and 1980 Middle East Arab Countries markets.
- . end-products will be respectively manufactured in the different countries of the sub-regions.

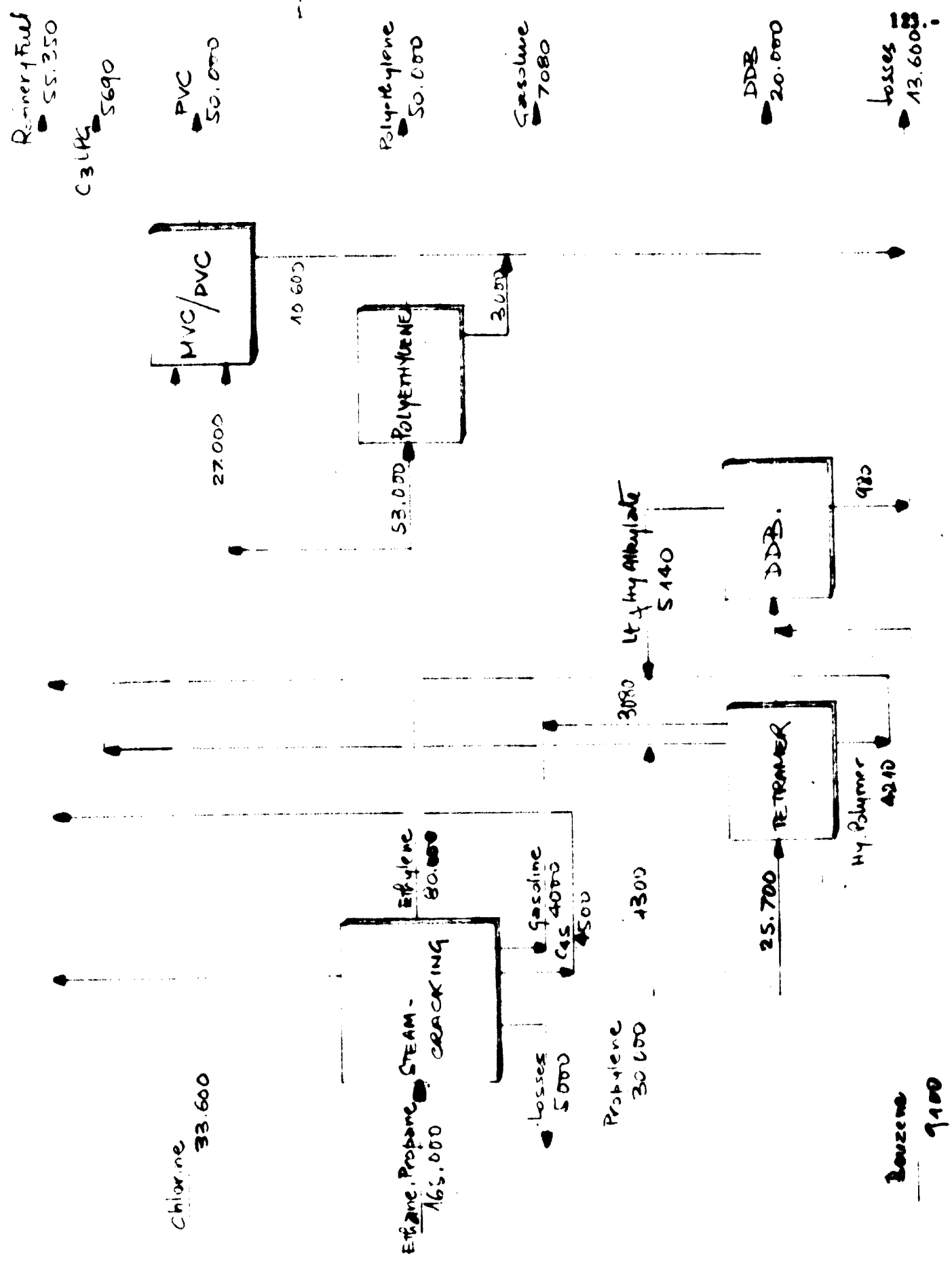
**b. Investment**

Estimated investment cost for the overall complex is shown in the table 1 hereafter.

**c. Operating cost and profitability**

Estimated operating cost and profitability calculations are presented in the following tables 2, 3 and 4.

Fig. A0 C.M.E.U. B2 Manufacturing Process & Material Balance (Ethane & Propane Steam Cracking)



**COMPLEX B<sub>2</sub> - PLASTIC AND DETERGENT BASED COMPLEX**

producing :

- . 50,000 MT/year of polyethylene
- . 50,000 MT/year of polyvinylchloride
- . 20,000 MT/year of dodecylbenzene

(feed-stock : ethane propane cut)

COMPLEX B<sub>2</sub> - PLASTIC AND DETERGENT BASED COMPLEX

Table 1  
Estimated Investment Cost

	US\$
<b>Process Units</b>	
Ethane Propane steam-cracking	10,100,000
Polyethylene unit	14,000,000
MVC unit	10,200,000
PVC unit	4,100,000
Tetramer	1,400,000
DDB	1,200,000
<b>Total Process Units</b>	<u>41,000,000</u>
<b>Offsites</b>	17,000,000
<b>Royalties</b>	6,000,000
<b>Start-up expenses</b>	4,000,000
<b>Contingencies</b>	5,000,000
<b>Total Investment</b>	<u>73,000,000</u>
<b>Working Capital</b>	2,800,000

COMPLEX B<sub>2</sub> - PLASTIC AND DETERGENT BASED COMPLEX

Table 2  
Estimated Product Sales

	US\$/ton	Tons/year	US\$/year
<b>Products</b>			
Polyethylene	370	90,000	18,500,000
PVC	340	50,000	17,000,000
Dodecylbenzene	160	20,000	3,200,000
Gasoline	25	7,000	176,000
C. LPG	20	5,690	113,000
Refinery fuel	0.7	55,330	520,000
<b>Total Product Sales</b>			<b>39,509,000</b>

Estimated Raw Material Cost

	US\$/ton	Tons/year	US\$/year
<b>Raw Materials</b>			
Ethane Propane	15	165,000	2,470,000
Chlorine	75	20,160	1,620,000
Benzene	75	9,100	680,000
			<b>4,770,000</b>



COMPLEX B<sub>2</sub> - PLASTIC AND DETERGENT BASED COMPLEX

Table 3  
Estimated Operating Cost

	US\$/year
<b>Variable Charges</b>	
. Utilities	4,500,000
. Labor	2,100,000
. Catalysts and chemicals	2,000,000
. Miscellaneous	200,000
	<hr/>
<b>Total Variable Charges</b>	<b>8,800,000</b>
<b>Fixed Charges</b>	
. Amortisation at 10% of investment	7,300,000
. Interest at 4% of investment	2,920,000
. Maintenance at 4% of Process Units + Offsites	2,320,000
. Interest on working capital at 8%	224,000
. General plant overhead, taxes and insurance at 1% of investment	730,000
	<hr/>
<b>Total Fixed Charges</b>	<b>13,494,000</b>
<b>Total Operating Cost</b>	<b>22,294,000</b>

COMPLEX B<sub>2</sub> - PLASTIC AND DETERGENT BASED COMPLEXTable 4Estimated Investment Profitability

	US\$/year
<b>Credit</b>	
Product Sales (see table 2)	39,509,000
<b>Debit</b>	
Operating Cost (see table 3)	22,294,000
Raw material cost (see table 2)	4,770,000
<b>Total Debit</b>	<hr/>
<b>Profitability</b>	
Benefits before taxes	12,445,000
Benefits after taxes at 50%	6,223,000
Amortization provided	7,300,000
Benefits after taxes plus amortization	13,523,000
 Pay-out time on total investment	 5.4 years

**Question 6 100,000 and 200,000 MT/year ethylene production  
by ethane steam-cracking**

**a. Brief description**

That production is intended to supply ethylene :

- . for its derivatives as : polyethylene and PVC to be produced for the local market
- . for exports to consuming countries

These ethane steam cracking plants should be located closely or integrated with large capacity LMS plant under construction or under planning stage from which ethane could be recovered at low cost and in sufficient quantities.

Possible locations are : Libya, Algeria and Middle East Arab Countries where LMS plants are foreseen.

**b. Economics**

Elements of operating cost, investment cost, estimated manufacturing cost and ethylene selling price are summarized in the tables 1 and 2.

The economics that large steam cracking has to offer is presented in the table 2.

The economics of such a project is compared to the production of ethylene by naphtha steam-cracking in units already existing or planned in big ethylene consuming areas.

CHAPTER C - STUDENT FOR SERVICE BOUND CHAPTER

BY THESE STUDENT-ORGANIZATIONS

TABLE 1. SUMMARY OF RESULTS FROM SAMPLES IN WHICH THE RESULTS ARE

TABLE 1  
SUMMARY OF RESULTS FROM SAMPLES IN WHICH THE RESULTS ARE

<p>1. The first column contains the sample number, the second column the date of collection, the third column the number of specimens examined, the fourth column the number of specimens found to be positive, and the fifth column the percentage of positive specimens.</p>	<p>2. The first column contains the sample number, the second column the date of collection, the third column the number of specimens examined, the fourth column the number of specimens found to be positive, and the fifth column the percentage of positive specimens.</p>	<p>3. The first column contains the sample number, the second column the date of collection, the third column the number of specimens examined, the fourth column the number of specimens found to be positive, and the fifth column the percentage of positive specimens.</p>	<p>4. The first column contains the sample number, the second column the date of collection, the third column the number of specimens examined, the fourth column the number of specimens found to be positive, and the fifth column the percentage of positive specimens.</p>
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1. The first column contains the sample number, the second column the date of collection, the third column the number of specimens examined, the fourth column the number of specimens found to be positive, and the fifth column the percentage of positive specimens.



## VI.2.2. Complex based on aromatic production and their derivatives

### Complex 1: Aromatic based complex production :

- . 45,000 MT/year of benzene
- . 12,500 MT/year of P-nylon
- . 17,000 MT/year of O-nylon

#### a. Brief description

The manufacturing scheme of the plant integrated in an existing or projected refinery is illustrated in Figure 11 hereafter with the material balance of the different units.

- . raw material : gasoline cuts or reformate supplied by refineries processing Algerian or Libyan crude oils
- . possible locations : Algeria or Libya
- . markets : to supply major part of the aromatic demand in Arab Countries for 1975

#### b. Yields and conversion

Estimated yields, material balances are shown with the following tables 1, 2 and 3.

#### c. Investment

Estimated investment cost including royalties and initial catalyst cost are given in the tables 4, 5, 6 and 7.

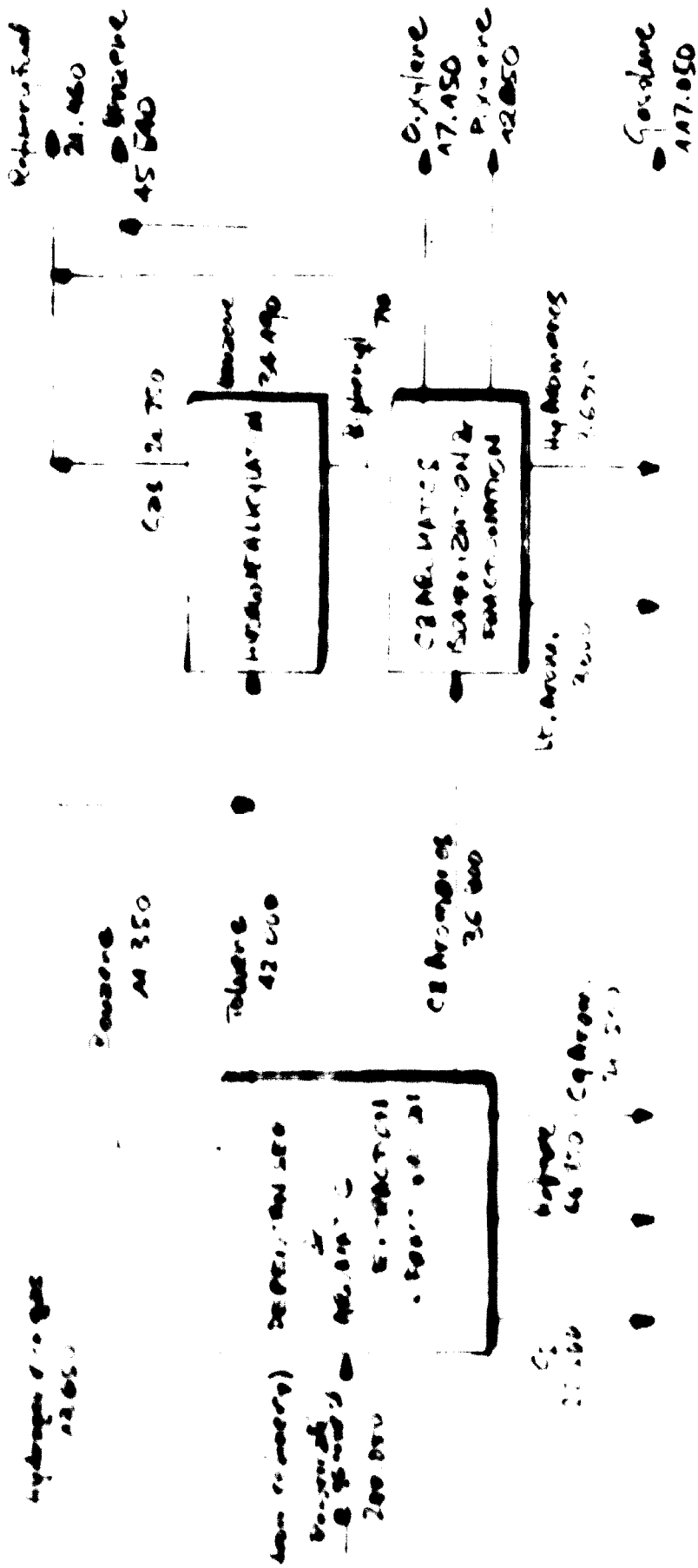
#### d. Operating requirements

Estimated utility, catalyst and chemicals, labor requirements are set forth in the tables 8, 9 and 10.

#### e. Operating cost and profitability

Estimated operating cost and profitability calculations are presented in the tables 10, 11 and 12.

Fig. 10 Process Flow Diagram of Ethanol Production





COMPLEX D - AROMATIC BASED COMPLEX

COMPLEX D - AROMATIC BASED COMPLEX

Table 1  
Aromatic extraction - Material balance

	% wt	Tons/year
<b>Feed-Stock</b>		
Reformate C <sub>9</sub> <sup>+</sup>	100.0	200,000
Benzene	5.7	11,400
Toluene	21.4	42,800
C <sub>8</sub> aromatics	20.9	41,800
C <sub>7</sub> aromatics	17.1	34,000
Total aromatics	65.1	130,200
<b>Products</b>		
Benzene		11,350
Toluene		42,000
C <sub>8</sub> aromatics		36,800
C <sub>7</sub> aromatics		20,500
Total aromatics		110,650
Refinate (included pentanes)		89,350
Total		200,000

## 0. % aromatic recovery

Benzene	99.5 %
Toluene	98 %
C <sub>8</sub> aromatics	88 %
C <sub>7</sub> aromatics	88 %

**COMPLEX D - AROMATIC BASED COMPLEX**

**Table 2**  
**Toluene Hydrodealkylation**  
**Material Balance**

	% wt	Tons/year
<b>Feed-Stock</b>		
Toluene from aromatic extraction	100	42,000
N <sub>2</sub> rich gas from catalytic reforming <sup>Ⓢ</sup>	32.5	13,690
Total	132.5	55,690
<b>Products</b>		
Pool-gas	49.4	20,790
Benzene	81.4	34,190
Biphenyl	1.7	710
Total	132.5	55,690

Ⓢ. Absorber-stripper has to be planned in the hydrodealkylation unit to increase the N<sub>2</sub> content in the gases coming from catalytic reforming

COMPLEX D - AROMATIC BASED COMPLEXTable 3Extraction and Isomerization of C<sub>8</sub> Aromatics  
Material Balance

	% wt	Tons/year
<b>Feed-Stock</b>		
C <sub>8</sub> aromatics from aromatic extraction	100.0	36,800
Ethylbenzene	20	7,360
Ortho-xylene	16	5,900
Meta-xylene	45	16,540
Para-xylene	19	7,000
<b>Products</b>		
Ortho-xylene	46.6	17,150
Para-xylene	33.8	12,450
Light aromatics	9.8	3,600
Heavy aromatics	9.8	3,600
	—	—
<b>Total</b>	<b>100.0</b>	<b>36,800</b>

COMPLEX A - AROMATIC BASED COMPLEX

Table 4  
Estimated Investment Cost

	US\$
<b>Process Units</b>	
Benzoniser	300,000
Aromatic extraction	1,800,000
Toluene hydrodealkylation	1,400,000
Absorber-stripper	100,000
Ortho-xylene fractionator	900,000
P-xylene crystallization	1,800,000
Isomerization of C <sub>8</sub> aromatics	1,100,000
<b>Total Process Units (engineering included)</b>	<b>7,400,000</b>
<b>Off-sites</b>	<b>3,000,000</b>
<b>Total investment cost</b>	<b>10,400,000</b>

COMPLEX D - AROMATIC BASED COMPLEX

Table 3  
Utility consumption and annual cost

Process Units	Electric Power kwh/hr	HP steam kg/hr	LP steam kg/hr	Cooling Water m <sup>3</sup> /hr	Fuel 10 <sup>6</sup> kcal/hr
Depentaniser	35			91	2.9
Aromatic extraction	155	19,450		377	
Hydrodealkylation	60	2,550		196	3.5
Absorber-stripper	30			26	0.6
O-nylon fractionator	300			41	13.0
P-nylon crystallinizer	600	200	600	150	
Isomerization of aromatics	115			44	3.8
<b>Total Process Units</b>	<b>1,445</b>	<b>16,200</b>	<b>600</b>	<b>925</b>	<b>28.8</b>
<b>Off-site</b>	<b>525</b>		<b>3,510</b>	<b>200</b>	<b>19.6</b>
<b>Total Consumption</b>	<b>1,970</b>	<b>16,200</b>	<b>4,110</b>	<b>1,125</b>	<b>48.4</b>

Annual cost of utilities	US\$/year
Electric power 1,970 kwh/hr $\times$ 7020 hr/year $\times$ 0.01 US\$/kwh	136,000
Fuel 48.4 10 <sup>6</sup> kcal/hr $\times$ 7020 hr/year $\times$ 0.7 US\$/10 <sup>6</sup> kcal	230,000
Demineralized water 12.2 m <sup>3</sup> /hr $\times$ 7020 hr/year $\times$ 0.25 US\$/m <sup>3</sup>	24,000
<b>Total</b>	<b>410,000</b>

**COMPASS D - ANAESTHETIC BOARD COMPASS**

**Table 5**

**MANPOWER REQUIREMENTS AND ANNUAL COSTS**

	Administrative	Engineers	Personnel	Chief Operator	Operator	Chemist & skilled para.	Support	Total
Salaries	12,000	10,000	8,000	6,000	5,000	6,000	2,000	
Benefits		2,000			2,000	6,000	4,000	14
Technical assistance and cost of training estimated at		20,000			10,000	24,000	8,000	62,000
Personnel costs			1	3	10	7	2	14
Grand total			1	3	5	7	2	14
Total man/shift			1	3	15	7	2	28
Total man/year			5	14	60	32	9	120
Grand total			60,000	24,000	340,000	120,000	18,000	600,000
							14.2	
							672,000	
							178,000	
							<u>850,000</u>	

CHAPTER 9 - AROMATIC BASED COMPLEXTable 1Catalysts and Chemicals  
Estimated Initial Charge and Annual Consumption

	Initial Charge USD	Yearly Consumption USD
Aromatic extraction	420,000	12,000
Toluene hydrodealkylation	22,000	10,000
C <sub>7</sub> isomerization	400,000	20,000
Chemical products	.	4,000
Total cost of catalysts and chemicals	842,000	46,000



COUPLER D - AROMATIC BASED COUPLERTable A

Estimated available cost  
(including know-how fee)

	US\$
Aromatic extraction	250,000
Toluene hydrodealkylation	250,000
O-xylene fractionation	50,000
Para-xylene crystallization	600,000
C <sub>8</sub> compression	40,000
Total	1,190,000

CHAPTER 10. FINANCIAL STATEMENTS

Table 1

Estimated Total Investment Cost

	(\$)
Total Investment Cost (see table 6)	10,000.00
Reserves (see table 6)	1,100.00
Start-up expenses	500.00
Contingencies	100.00
	<hr/>
Total Investment	12,700.00
Initial charge of concrete and steelwork (see table 7)	50.00
Additional charge of concrete and steelwork	100.00
Spare parts	100.00
	<hr/>
Grand Total Investment	13,400.00
Working Capital	100.00

**STATE OF CALIFORNIA**

**TABLE  
GENERAL STATE FINANCE**

	1965-66	1966-67	1967-68
Revenue	100.00	100.00	100.00
Expenses	100.00	100.00	100.00
<b>Total</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>

**TABLE  
GENERAL STATE FINANCE**

	1965-66	1966-67	1967-68
Revenue	100.00	100.00	100.00
Expenses	100.00	100.00	100.00
<b>Total</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>

**STATE OF NEW YORK**

**1913**

**ANNUAL REPORT**

		1913
<b>Receipts</b>		
From State		1,000,000
From Counties		500,000
From Cities		250,000
From Towns		250,000
From Other Sources		50,000
Total Receipts		2,050,000
<b>Expenditures</b>		
For State		1,000,000
For Counties		500,000
For Cities		250,000
For Towns		250,000
For Other Purposes		50,000
Total Expenditures		2,050,000
<b>Balance</b>		
Carried Over		1,000,000
Balance Forward		1,000,000

STATE OF MICHIGAN

TABLE

MANUFACTURING INDUSTRY

	1959
<b>Receipts</b>	
Receipts before taxes (1)	1,000,000
<b>Costs</b>	
Operating cost (2)	6,500,000
Tax reported and to-provide cost	1,100,000
Manufacturing cost	6,600,000
<b>Contributions</b>	
Receipts before taxes	400,000
Receipts after taxes (3)	275,000
Contributions provided	1,000,000
Receipts after taxes plus contributions	1,275,000
Receipts tax	0 0 zero

### **Section 2. Crude Oil Refining Schemes**

- 20,000 MT/year of benzene
- 20,000 MT/year of P-xylene
- 10,000 MT/year of O-xylene

integrated with a coking unit producing :

- 20,000 MT/year of electrode coke

#### **a. Plant Description**

The manufacturing scheme of the different projected plants integrated in an existing or projected refinery is illustrated in Figure 12 hereafter, with the material balance of the different units

- raw material : gasoline cuts and low sulfur residues supplied by refineries processing Algerian or Libyan crudes
- possible locations : Algeria or Libya
- to supply the aromatic demand in Arab Countries for 1975 and to export the remaining products and electrode coke to European Countries where deficits will persist for the next years. In 1980, such a complex might supply the whole aromatic demand in Arab Countries.

#### **b. Units and Connections**

Estimated yields, material balances are shown with the following tables 1, 2, 3, 4, 5 and 6.

c. Investment

Estimated investment cost including process units and utilities, royalties and initial charge of catalysts and chemicals are given in the tables 7, 10, 11 and 12.

d. Operating Requirements

Estimated utility, catalysts and chemicals, labor requirements are set forth in the tables 8, 9 and 10.

e. Operating cost and Profitability

Estimated operating cost and profitability calculations are presented in the tables 13, 14 and 15.

1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12. 13. 14. 15. 16. 17. 18. 19. 20. 21. 22. 23. 24. 25. 26. 27. 28. 29. 30. 31. 32. 33. 34. 35. 36. 37. 38. 39. 40. 41. 42. 43. 44. 45. 46. 47. 48. 49. 50. 51. 52. 53. 54. 55. 56. 57. 58. 59. 60. 61. 62. 63. 64. 65. 66. 67. 68. 69. 70. 71. 72. 73. 74. 75. 76. 77. 78. 79. 80. 81. 82. 83. 84. 85. 86. 87. 88. 89. 90. 91. 92. 93. 94. 95. 96. 97. 98. 99. 100. 101. 102. 103. 104. 105. 106. 107. 108. 109. 110. 111. 112. 113. 114. 115. 116. 117. 118. 119. 120. 121. 122. 123. 124. 125. 126. 127. 128. 129. 130. 131. 132. 133. 134. 135. 136. 137. 138. 139. 140. 141. 142. 143. 144. 145. 146. 147. 148. 149. 150. 151. 152. 153. 154. 155. 156. 157. 158. 159. 160. 161. 162. 163. 164. 165. 166. 167. 168. 169. 170. 171. 172. 173. 174. 175. 176. 177. 178. 179. 180. 181. 182. 183. 184. 185. 186. 187. 188. 189. 190. 191. 192. 193. 194. 195. 196. 197. 198. 199. 200. 201. 202. 203. 204. 205. 206. 207. 208. 209. 210. 211. 212. 213. 214. 215. 216. 217. 218. 219. 220. 221. 222. 223. 224. 225. 226. 227. 228. 229. 230. 231. 232. 233. 234. 235. 236. 237. 238. 239. 240. 241. 242. 243. 244. 245. 246. 247. 248. 249. 250. 251. 252. 253. 254. 255. 256. 257. 258. 259. 260. 261. 262. 263. 264. 265. 266. 267. 268. 269. 270. 271. 272. 273. 274. 275. 276. 277. 278. 279. 280. 281. 282. 283. 284. 285. 286. 287. 288. 289. 290. 291. 292. 293. 294. 295. 296. 297. 298. 299. 300. 301. 302. 303. 304. 305. 306. 307. 308. 309. 310. 311. 312. 313. 314. 315. 316. 317. 318. 319. 320. 321. 322. 323. 324. 325. 326. 327. 328. 329. 330. 331. 332. 333. 334. 335. 336. 337. 338. 339. 340. 341. 342. 343. 344. 345. 346. 347. 348. 349. 350. 351. 352. 353. 354. 355. 356. 357. 358. 359. 360. 361. 362. 363. 364. 365. 366. 367. 368. 369. 370. 371. 372. 373. 374. 375. 376. 377. 378. 379. 380. 381. 382. 383. 384. 385. 386. 387. 388. 389. 390. 391. 392. 393. 394. 395. 396. 397. 398. 399. 400. 401. 402. 403. 404. 405. 406. 407. 408. 409. 410. 411. 412. 413. 414. 415. 416. 417. 418. 419. 420. 421. 422. 423. 424. 425. 426. 427. 428. 429. 430. 431. 432. 433. 434. 435. 436. 437. 438. 439. 440. 441. 442. 443. 444. 445. 446. 447. 448. 449. 450. 451. 452. 453. 454. 455. 456. 457. 458. 459. 460. 461. 462. 463. 464. 465. 466. 467. 468. 469. 470. 471. 472. 473. 474. 475. 476. 477. 478. 479. 480. 481. 482. 483. 484. 485. 486. 487. 488. 489. 490. 491. 492. 493. 494. 495. 496. 497. 498. 499. 500. 501. 502. 503. 504. 505. 506. 507. 508. 509. 510. 511. 512. 513. 514. 515. 516. 517. 518. 519. 520. 521. 522. 523. 524. 525. 526. 527. 528. 529. 530. 531. 532. 533. 534. 535. 536. 537. 538. 539. 540. 541. 542. 543. 544. 545. 546. 547. 548. 549. 550. 551. 552. 553. 554. 555. 556. 557. 558. 559. 560. 561. 562. 563. 564. 565. 566. 567. 568. 569. 570. 571. 572. 573. 574. 575. 576. 577. 578. 579. 580. 581. 582. 583. 584. 585. 586. 587. 588. 589. 590. 591. 592. 593. 594. 595. 596. 597. 598. 599. 600. 601. 602. 603. 604. 605. 606. 607. 608. 609. 610. 611. 612. 613. 614. 615. 616. 617. 618. 619. 620. 621. 622. 623. 624. 625. 626. 627. 628. 629. 630. 631. 632. 633. 634. 635. 636. 637. 638. 639. 640. 641. 642. 643. 644. 645. 646. 647. 648. 649. 650. 651. 652. 653. 654. 655. 656. 657. 658. 659. 660. 661. 662. 663. 664. 665. 666. 667. 668. 669. 670. 671. 672. 673. 674. 675. 676. 677. 678. 679. 680. 681. 682. 683. 684. 685. 686. 687. 688. 689. 690. 691. 692. 693. 694. 695. 696. 697. 698. 699. 700. 701. 702. 703. 704. 705. 706. 707. 708. 709. 710. 711. 712. 713. 714. 715. 716. 717. 718. 719. 720. 721. 722. 723. 724. 725. 726. 727. 728. 729. 730. 731. 732. 733. 734. 735. 736. 737. 738. 739. 740. 741. 742. 743. 744. 745. 746. 747. 748. 749. 750. 751. 752. 753. 754. 755. 756. 757. 758. 759. 760. 761. 762. 763. 764. 765. 766. 767. 768. 769. 770. 771. 772. 773. 774. 775. 776. 777. 778. 779. 780. 781. 782. 783. 784. 785. 786. 787. 788. 789. 790. 791. 792. 793. 794. 795. 796. 797. 798. 799. 800. 801. 802. 803. 804. 805. 806. 807. 808. 809. 810. 811. 812. 813. 814. 815. 816. 817. 818. 819. 820. 821. 822. 823. 824. 825. 826. 827. 828. 829. 830. 831. 832. 833. 834. 835. 836. 837. 838. 839. 840. 841. 842. 843. 844. 845. 846. 847. 848. 849. 850. 851. 852. 853. 854. 855. 856. 857. 858. 859. 860. 861. 862. 863. 864. 865. 866. 867. 868. 869. 870. 871. 872. 873. 874. 875. 876. 877. 878. 879. 880. 881. 882. 883. 884. 885. 886. 887. 888. 889. 890. 891. 892. 893. 894. 895. 896. 897. 898. 899. 900. 901. 902. 903. 904. 905. 906. 907. 908. 909. 910. 911. 912. 913. 914. 915. 916. 917. 918. 919. 920. 921. 922. 923. 924. 925. 926. 927. 928. 929. 930. 931. 932. 933. 934. 935. 936. 937. 938. 939. 940. 941. 942. 943. 944. 945. 946. 947. 948. 949. 950. 951. 952. 953. 954. 955. 956. 957. 958. 959. 960. 961. 962. 963. 964. 965. 966. 967. 968. 969. 970. 971. 972. 973. 974. 975. 976. 977. 978. 979. 980. 981. 982. 983. 984. 985. 986. 987. 988. 989. 990. 991. 992. 993. 994. 995. 996. 997. 998. 999. 1000.

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→ 2000-01-01  
85,205

→ 2000-02-01  
85,205

→ 2000-03-01  
85,205

→ 2000-04-01  
85,205

→ 2000-05-01  
85,205

②

→ 2000-06-01  
85,205

→ 2000-07-01  
85,205

→ 2000-08-01  
85,205

→ 2000-09-01  
85,205



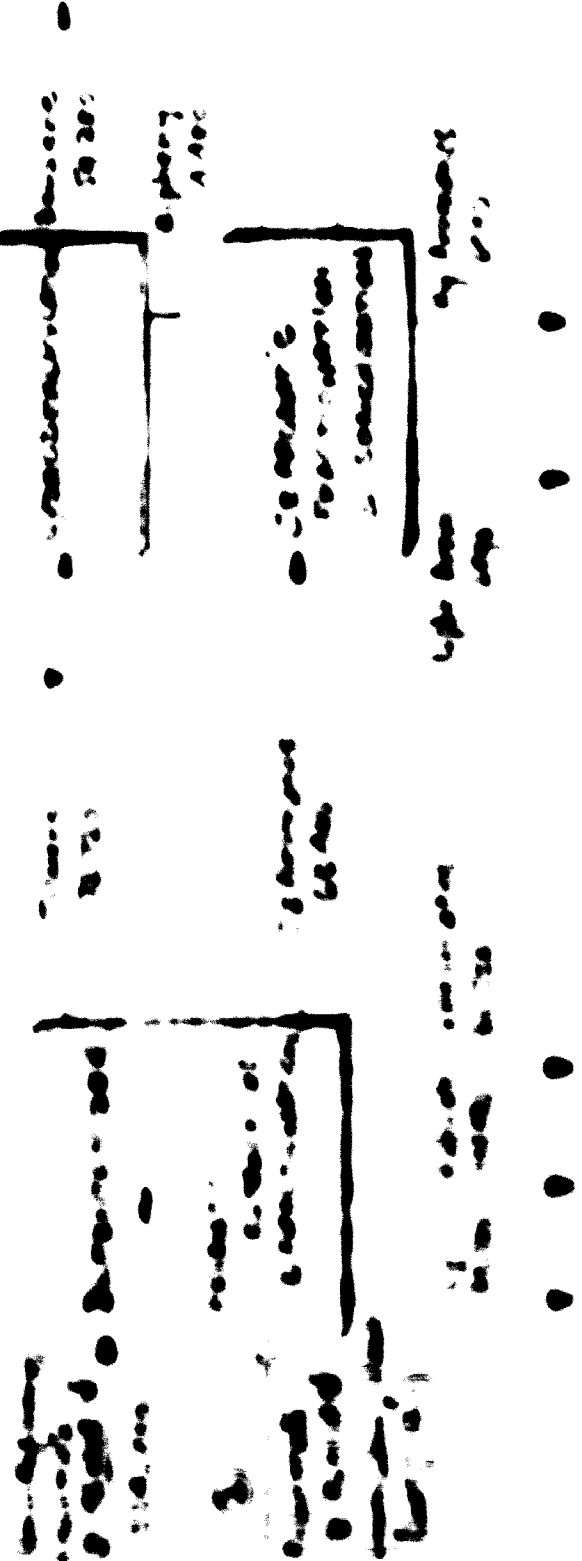


2. 2<sup>nd</sup> Capacity DA Manufacturing System - Process of Balance (continued)

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EXHIBIT 2 - ANNUAL BIODIGESTER

Table 1  
Estimated values of atmospheric emissions  
from the plant

|  | 1 yr   | Year/year |
|--|--------|-----------|
| <b>Feed-Stock</b>                                |        |           |
| Atmospheric emissions of North African crude oil | 100.0  | 400,000   |
| <b>Products</b>                                  |        |           |
| Fuel gas   | 10.00  | 40,000    |
| CH <sub>4</sub>                                  | 2.00   | 11,000    |
| C <sub>2</sub> H <sub>6</sub>                    | 4.00   | 10,000    |
| C <sub>3</sub> H <sub>8</sub>                    | 2.00   | 10,000    |
| C <sub>4</sub> H <sub>10</sub>                   | 1.00   | 4,000     |
| C <sub>5</sub> H <sub>12</sub>                   | 1.00   | 10,000    |
|  | <hr/>  | <hr/>     |
| Total 100  | 10.00  | 40,000    |
| CH <sub>4</sub> - 100% methane                   | 40.00  | 100,000   |
|  | 20.00  | 80,000    |
|  | <hr/>  | <hr/>     |
| Total  | 100.00 | 400,000   |

EXHIBIT 3 - ANNUAL BASED COSTS

Table 1

Infrastructure of water supply

Annual Returns

|                             | 1 yr         | Yrs/yr         |
|-----------------------------|--------------|----------------|
| <b>Feed-Stock</b>           |              |                |
| $C_2$ - 100% carbon content | 100.0        | 100,000        |
| Hydrogen at 100%            | 1.1          | 1,000          |
| Total                       | <u>101.1</u> | <u>101,000</u> |
| <b>Products</b>             |              |                |
| $H_2$                       | 0.1          | .              |
| $C_2H_2$                    | 0.2          | 100            |
| $C_2H_4$                    | 0.0          | 1,000          |
| $C_2H_6$                    | 1.0          | 1,000          |
| $C_2H_8$                    | 2.4          | 6,000          |
| Total gas                   | <u>4.0</u>   | <u>8,100</u>   |
| $C_2$                       | 0.0          | 0,000          |
| $C_2$ - 100% gasoline       | 97.1         | 100,000        |
| Total                       | <u>101.1</u> | <u>108,100</u> |

CUMPLE 2 - ANNUAL BOND CUMPLE

Table 1  
Statistical reference  
Financial balance

|   | Sp. Gravel | 1 wt          | Tons/year      |
|---|------------|---------------|----------------|
| Feed-stock<br>Coking gasifier <sup>0</sup>  | 0.750      | 100.0         | 100,000        |
| Producers                                   |            |               |                |
| Fuel  |            |               |                |
| Superior gas                                |            | 11.00         | 20,000         |
| Gas from stabilization column               |            | 1.75          | 2,075          |
| LPG   |            |               |                |
| C <sub>2</sub>                              |            | 0.75          | 0,075          |
| C <sub>3</sub>                              |            | 7.40          | 12,000         |
| reference C <sub>3</sub>                    | 0.750      | 75.10         | 120,000        |
|   |            | <u>100.00</u> | <u>100,000</u> |
| Characteristics of reference C <sub>3</sub> |            |               |                |
| 100 clear                                   | 00         |               |                |
| 100 to 100 at 0.000/1                       | 100        |               |                |

0. After subtracting

GROUP 1 - ANNUAL BUDGET GROUP

Table A  
ANNUAL BUDGET  
ANNUAL BUDGET

|                                     | 1st          | 2nd Year      |
|-------------------------------------|--------------|---------------|
| <b>Food-Feed</b>                    |              |               |
| Incentive \$                        | 10.00        | 10.00         |
| Incentive                           | 10.00        | 10.00         |
| Incentive                           | 10.00        | 10.00         |
| Incentive                           | 10.00        | 10.00         |
| Incentive                           | 10.00        | 10.00         |
| <b>Total incentive</b>              | <b>50.00</b> | <b>50.00</b>  |
| <b>Feed</b>                         |              |               |
| Incentive                           | 10.00        | 10.00         |
| Incentive                           | 10.00        | 10.00         |
| Incentive                           | 10.00        | 10.00         |
| Incentive                           | 10.00        | 10.00         |
| <b>Total incentive</b>              | <b>40.00</b> | <b>40.00</b>  |
| <b>Incentive (persons included)</b> |              | <b>10.00</b>  |
| <b>Total</b>                        |              | <b>100.00</b> |

**2. Incentive recovery**

Incentive  
Incentive  
Incentive  
Incentive

100.00

STATE OF NEW YORK

TABLE

REVENUE ACCOUNTS

1911-1912

|   | 1911              | 1912              |
|---|-------------------|-------------------|
| <b>Receipts</b><br>From accounts receivable<br>For the calendar year<br>Total | 100<br>100<br>200 | 100<br>100<br>200 |
| <b>Payments</b><br>For gas<br>For rent<br>For interest                        | 100<br>100<br>200 | 100<br>100<br>200 |

**STATE OF MISSISSIPPI**

**Table 1**

**DEPARTMENT OF REVENUE, STATE OF MISSISSIPPI**  
**General Fund**

|                         | 1968        | 1969        |
|-------------------------|-------------|-------------|
| <b>Expenses</b>         |             |             |
| * salaries and benefits | 10.0        | 12.0        |
| * salaries              | 5.0         | 6.0         |
| * salaries              | 5.0         | 6.0         |
| * salaries              | 0.0         | 0.0         |
| * salaries              | 0.0         | 0.0         |
| <b>Income</b>           |             |             |
| * salaries              | 5.0         | 6.0         |
| * salaries              | 5.0         | 6.0         |
| * salaries              | 0.0         | 0.0         |
| * salaries              | 0.0         | 0.0         |
| <b>Total</b>            | <b>10.0</b> | <b>12.0</b> |

STATE OF NEW YORK

IN SENATE  
January 12, 1910

|                       | 1909      |
|-----------------------|-----------|
| <b>Personal</b>       |           |
| Salary                | 10,000.00 |
| Expenses of office    | 1,000.00  |
| Expenses of traveling | 500.00    |
| Expenses of printing  | 200.00    |
| Expenses of postage   | 100.00    |
| Expenses of telegrams | 50.00     |
| Expenses of telephone | 50.00     |
| Expenses of interest  | 50.00     |
| Expenses of sundries  | 50.00     |
| Total Personal        | 13,450.00 |
| Expenses of printing  | 1,000.00  |
| Expenses of postage   | 500.00    |
| Expenses of telegrams | 250.00    |
| Expenses of telephone | 250.00    |
| Expenses of interest  | 250.00    |
| Expenses of sundries  | 250.00    |
| Total Personal        | 3,750.00  |
| Total Personal        | 17,200.00 |
| Expenses of printing  | 1,000.00  |
| Expenses of postage   | 500.00    |
| Expenses of telegrams | 250.00    |
| Expenses of telephone | 250.00    |
| Expenses of interest  | 250.00    |
| Expenses of sundries  | 250.00    |
| Total Personal        | 3,750.00  |
| Total Personal        | 20,950.00 |



**TABLE 1**  
**Summary of the results of the**  
**analysis of the data on the**  
**effect of the treatment on the**  
**growth of the plants**

|                         | T1   | T2   | T3   | T4   | T5   |
|-------------------------|------|------|------|------|------|
| Mean height (cm)        | 15.2 | 18.5 | 22.1 | 25.3 | 28.7 |
| Standard deviation (cm) | 2.1  | 2.5  | 3.0  | 3.5  | 4.0  |

The results of the analysis of variance are shown in Table 1. The mean height of the plants in the different treatments is significantly different (P < 0.05). The standard deviation of the height of the plants is also significantly different (P < 0.05).



STATE OF NEW YORK

1911

STATE OF NEW YORK

STATE OF NEW YORK

|                                   | Total<br>Expenses<br>1911 | Total to<br>Appropriation<br>1911 |
|-----------------------------------|---------------------------|-----------------------------------|
| <b>General Fund</b>               |                           |                                   |
| Appropriation                     | 100.00                    | 100.00                            |
| Other sources                     | 10.00                     | 10.00                             |
| Private enterprise                | 20.00                     | 20.00                             |
| State institutions                | 15.00                     | 15.00                             |
| Interest on U.S. bonds            | 15.00                     | 15.00                             |
| Interest on State bonds           | 15.00                     | 15.00                             |
| Total of all sources and receipts | 175.00                    | 175.00                            |

GROUP 1 - ANNUAL BOND INTEREST

Table 11

ANNUAL BOND INTEREST  
(including tax-free tax)

|                      | 1980          |
|----------------------|---------------|
| <b>Interest Rate</b> |               |
| 10%                  | 10.00         |
| 12% (with 10)        | 12.00         |
| 15% (with 10)        | 15.00         |
| 18% (with 10)        | 18.00         |
| 20% (with 10)        | 20.00         |
| 25% (with 10)        | 25.00         |
| 30% (with 10)        | 30.00         |
| 35% (with 10)        | 35.00         |
| 40% (with 10)        | 40.00         |
| 45% (with 10)        | 45.00         |
| 50% (with 10)        | 50.00         |
| 55% (with 10)        | 55.00         |
| 60% (with 10)        | 60.00         |
| 65% (with 10)        | 65.00         |
| 70% (with 10)        | 70.00         |
| 75% (with 10)        | 75.00         |
| 80% (with 10)        | 80.00         |
| 85% (with 10)        | 85.00         |
| 90% (with 10)        | 90.00         |
| 95% (with 10)        | 95.00         |
| 100% (with 10)       | 100.00        |
| <b>Total</b>         | <b>100.00</b> |

TABLE 1 - SUMMARY OF INVESTMENT

Table 1  
Estimated Total Investment, \$100

|  | \$        |
|--|-----------|
| Total investment (see table 1)                             | 10,000.00 |
| Equipment (see table 1)                                    | 1,000.00  |
| Start-up expenses  | 1,000.00  |
| Contingencies  | 1,000.00  |
|  | <hr/>     |
| Total investment   | 10,000.00 |
| <br>   |           |
| Initial charge of equipment and materials<br>(see table 1) | 2,000.00  |
| Additional charge of equipment and materials               | 1,000.00  |
| Other items  | 500.00    |
|  | <hr/>     |
| Total total investment                                     | 13,500.00 |
| <br>   |           |
| Working capital  | 500.00    |

**TABLE 1 - SUMMARY OF COSTS**

**TABLE 1  
SUMMARY OF COSTS**

|                           | Unit Price<br>(\$/ton) | Quantity | Total Cost  |
|---------------------------|------------------------|----------|-------------|
| Material                  | 15                     | 100      | 1500        |
| Labor                     | 20                     | 100      | 2000        |
| Overhead                  | 25                     | 100      | 2500        |
| Profit (10%)              |                        |          | 250         |
| <b>Total Project Cost</b> |                        |          | <b>6250</b> |

**TABLE 2 - SUMMARY OF COSTS**

|                           | Unit Price<br>(\$/ton) | Quantity | Total Cost  |
|---------------------------|------------------------|----------|-------------|
| Material                  | 15                     | 100      | 1500        |
| Labor                     | 20                     | 100      | 2000        |
| Overhead                  | 25                     | 100      | 2500        |
| Profit (10%)              |                        |          | 250         |
| <b>Total Project Cost</b> |                        |          | <b>6250</b> |

STATE OF NEW YORK

IN SENATE  
January 15, 1913

|  | 1912   |
|--|--|
| <b>Executive Branch</b><br>Salaries<br>Allowances<br>Commissions on Contracts<br>Total Executive Branch  | \$ 2,000,000<br>1,000,000<br>500,000<br><hr/> 3,500,000  |
| <b>Judicial Branch</b><br>Salaries of Justices of the Court<br>Salaries of Justices of the Appellate Division<br>Salaries of Justices of the County Courts<br>Salaries of Justices of the City Courts<br>Salaries of Justices of the District Courts<br>Total Judicial Branch<br><br>Total | \$ 1,000,000<br>1,000,000<br>500,000<br>500,000<br>500,000<br><hr/> 3,500,000<br><br>7,000,000 |

STATE OF NEW YORK

1913

ANNUAL REPORT OF THE COMMISSIONER OF EDUCATION

|  | 1913         |
|--|--------------|
| <b>EXPENDITURES</b><br>For the year ending June 30, 1913         | 1,000,000.00 |
| <b>Salaries</b><br>For the year ending June 30, 1913             | 400,000.00   |
| <b>Operating expenses</b><br>For the year ending June 30, 1913   | 200,000.00   |
| <b>Capital expenditures</b><br>For the year ending June 30, 1913 | 100,000.00   |
| <b>Total</b>   | 700,000.00   |



**SECTION 1. GENERAL REGULATIONS FOR THE SERVICE**  
**CHAPTER 1. GENERAL REGULATIONS FOR THE SERVICE**

**ARTICLE 1. GENERAL REGULATIONS**

The purpose of this regulation is to establish the general principles and rules governing the service of the organization. It is intended to provide a clear and concise framework for the conduct of all members and staff.

**ARTICLE 2. MEMBERSHIP**

Membership in the organization is open to all individuals who are interested in the work of the organization. The process of becoming a member is outlined in the following sections.

**ARTICLE 3. DUTY AND RESPONSIBILITIES**

Members are expected to perform their duties with integrity and efficiency. The specific responsibilities of each member are detailed in the following sections.

THE HISTORY OF THE UNITED STATES

CHAPTER I

THE DISCOVERY OF AMERICA

STATE OF TEXAS

COUNTY OF DALLAS

|                  | No.         |
|------------------|-------------|
| [Illegible text] | [Illegible] |
| [Illegible text] | [Illegible] |
| [Illegible text] | [Illegible] |
| [Illegible text] | [Illegible] |
| [Illegible text] | [Illegible] |
| [Illegible text] | [Illegible] |
| [Illegible text] | [Illegible] |
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| [Illegible text] | [Illegible] |
| [Illegible text] | [Illegible] |
| [Illegible text] | [Illegible] |

SECRET

SECRET

| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
|------------|------------|------------|------------|------------|
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |



THE UNITED STATES OF AMERICA

1944

1945

[REDACTED]

[REDACTED]

| [REDACTED] | [REDACTED] |
|------------|------------|
| [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] |





SECRET

SECRET

| No. | Name        | Rank        | Grade       |
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UNITED STATES DEPARTMENT OF AGRICULTURE

REPORT OF THE  
COMMISSIONER OF AGRICULTURE

| CATTLE                               |         |
|--------------------------------------|---------|
| 1. Number of head                    | 1,000   |
| 2. Value of animals                  | 100,000 |
| 3. Number of head slaughtered        | 500     |
| 4. Value of animals slaughtered      | 50,000  |
| 5. Number of head retained           | 500     |
| 6. Value of animals retained         | 50,000  |
| 7. Total value of cattle             | 100,000 |
| 8. Total quantity of beef            | 50,000  |
| 9. Total quantity of hides           | 50,000  |
| 10. Total quantity of tallow         | 50,000  |
| 11. Total quantity of other products | 50,000  |
| 12. Total value of products          | 100,000 |
| 13. Total value of waste             | 50,000  |
| 14. Total value of by-products       | 50,000  |
| 15. Total value of all products      | 100,000 |

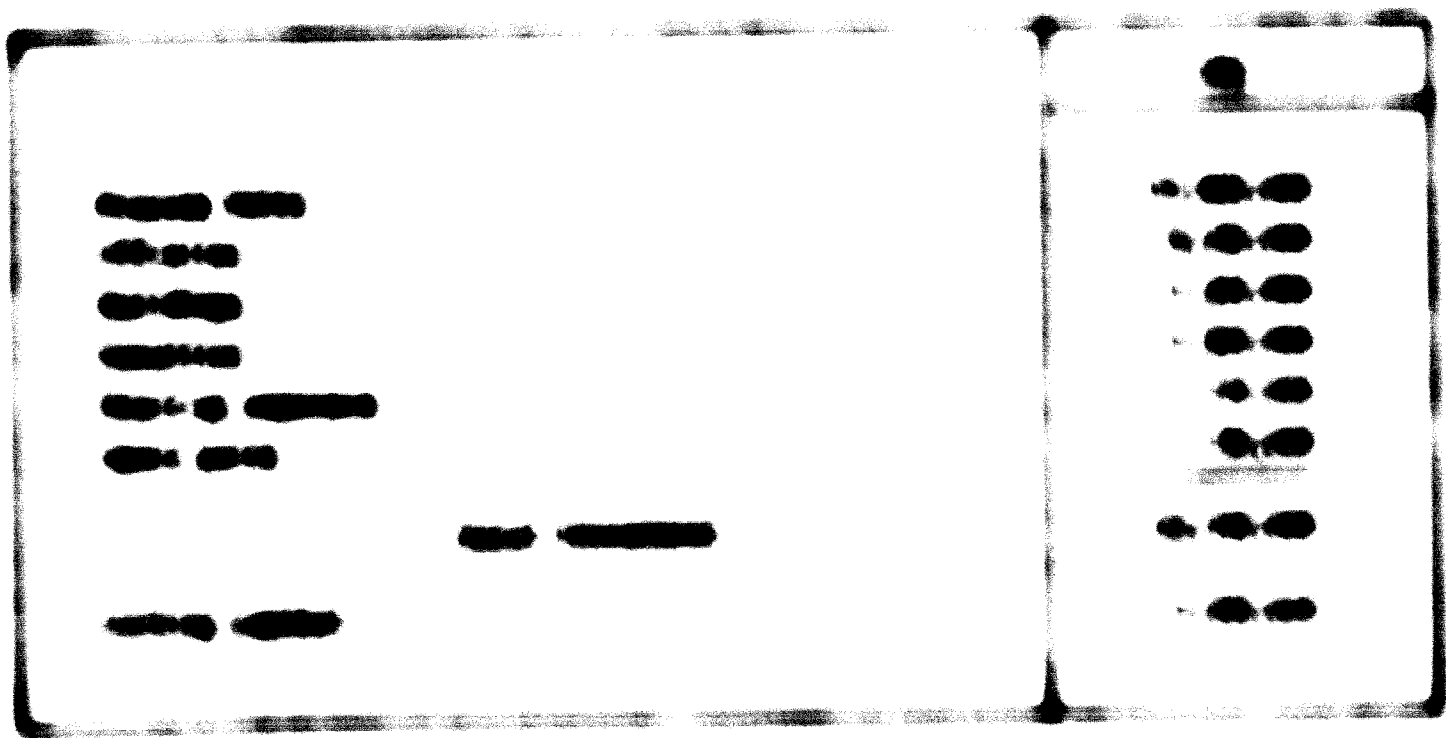
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**CHAPTER 1. INTRODUCTION TO THE THEORY OF GROUPS**

**1.1. DEFINITIONS AND NOTATION**

A group is a set  $G$  equipped with a binary operation  $\cdot$  satisfying the following axioms:

- Associativity:  $(a \cdot b) \cdot c = a \cdot (b \cdot c)$
- Identity: There exists an element  $e \in G$  such that  $e \cdot a = a \cdot e = a$  for all  $a \in G$ .
- Inverses: For each  $a \in G$ , there exists an element  $a^{-1} \in G$  such that  $a \cdot a^{-1} = a^{-1} \cdot a = e$ .

If  $a \cdot b = b \cdot a$  for all  $a, b \in G$ , the group is called abelian.

**1.2. SUBGROUPS**

A subset  $H$  of a group  $G$  is a subgroup if  $H$  is closed under the group operation and contains the identity and inverses of its elements.

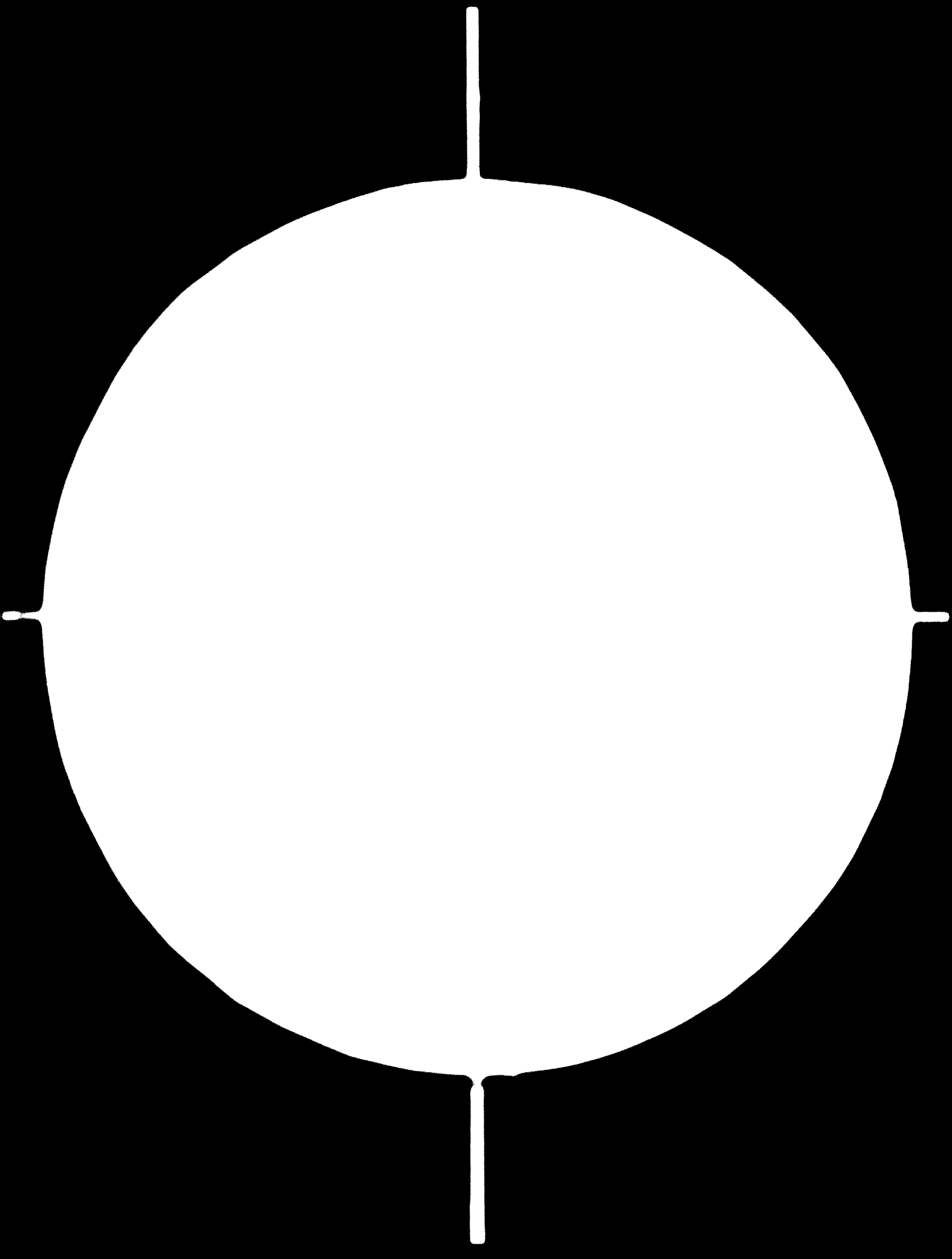
**1.3. QUOTIENT GROUPS**

If  $H$  is a normal subgroup of  $G$ , the quotient group  $G/H$  is defined as the set of cosets  $aH$  with the operation  $(aH) \cdot (bH) = (a \cdot b)H$ .

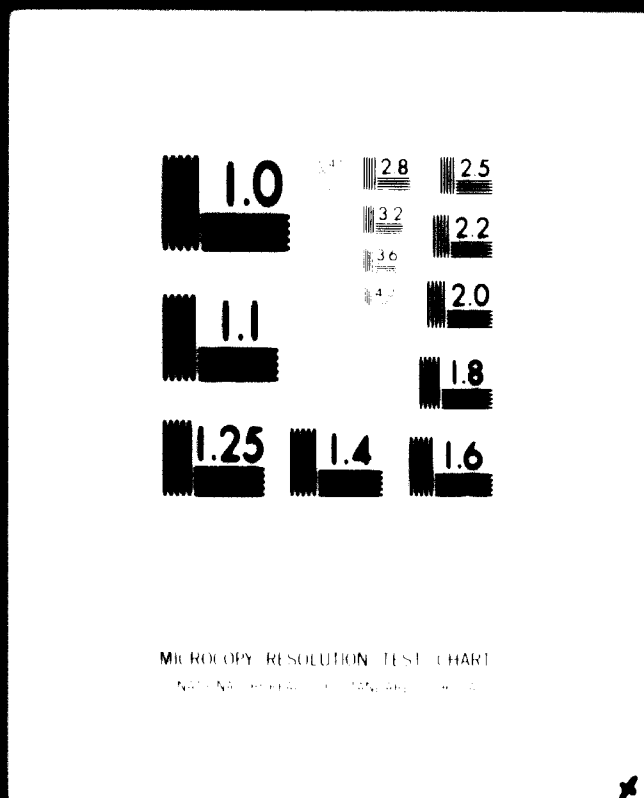
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# 3 OF 3



# 24 x E

**COMPLEX D<sub>4</sub> - MANUFACTURE OF 6,000 MT/YEAR NYLON 6 FIBRES**

producing :

- . Nylon 6 filaments : 5000 MT/year
- . Nylon 6 polyester (tyre cords) : 1,000 MT/year





COMPLEX D<sub>4</sub> - MANUFACTURE OF 6,000 MT/YEAR NYLON 6 FIBRES

Table 1  
Estimated Investment Cost

|                     | US\$              |
|---------------------|-------------------|
| Process Units       | 9,650,000         |
| Off-sites           | 3,100,000         |
| Buildings           | 1,100,000         |
| Royalties           | 300,000           |
| Start-up expenses   | 800,000           |
| Spare parts         | 150,000           |
|                     | <hr/>             |
| <b>Total</b>        | <b>15,100,000</b> |
| <br>Working capital | <br>950,000       |

COMPLEX D<sub>4</sub> - MANUFACTURE OF 6,000 MT/YEAR NYLON 6 FIBRES

Table 2  
Estimated Operating Cost

|   |                         |       | US\$/year        |
|---|-------------------------|-------|------------------|
| <b><u>Variable Charges</u></b>                  |                         |       |                  |
| <b>1. Utilities</b>                             |                         |       |                  |
| Electric power                                  | kw/hr                   | 2,850 |                  |
| Cooling water                                   | m <sup>3</sup> /hr      | 207   |                  |
| Inert gas                                       | m <sup>3</sup> /hr      | 198   |                  |
| Process water                                   | m <sup>3</sup> /hr      | 3.5   |                  |
| Steam   | t/hr                    | 2.06  |                  |
| Refrigeration                                   | 10 <sup>3</sup> kcal/hr | 420   |                  |
| Total utility consumption                       |                         |       | 300,000          |
| <b>2. Labor</b>                                 |                         |       |                  |
| Men/day   | 10                      |       |                  |
| Men/shift                                       | 460                     |       |                  |
| Total (including supervision at 25%)            |                         |       | 2,850,000        |
| <b>3. Consumption of catalyst and chemicals</b> |                         |       | 90,000           |
| Total variable charges                          |                         |       | <u>3,240,000</u> |
| <b><u>Fixed charges</u></b>                     |                         |       |                  |
| 1. Amortization at 10%                          |                         |       | 1,510,000        |
| 2. Interest on investment at 4%                 |                         |       | 640,000          |
| 3. Maintenance                                  |                         |       | 550,000          |
| 4. Interest on working capital                  |                         |       | 75,000           |
| 5. General plant overhead, taxes, insurance     |                         |       | <u>151,000</u>   |
| Total fixed charges                             |                         |       | 2,926,000        |
| Total operating cost                            |                         |       | <u>6,166,000</u> |

COMPLEX D<sub>4</sub> - MANUFACTURE OF 6,000 MT/YEAR NYLON 6 FIBRES

Table 3

Estimated Investment Profitability

|  | US\$/year  |
|--|------------|
| <b><u>Credit</u></b>                             |            |
| Product sales                                    |            |
| Nylon 6 filaments      5,000 MT x 1,900 US\$/ton | 9,500,000  |
| Nylon 6 polymers      1,000 MT x 1,000 US\$/ton  | 1,000,000  |
|  | <hr/>      |
| Total Credit                                     | 10,500,000 |
| <b><u>Debit</u></b>                              |            |
| Operating cost                                   | 6,166,000  |
| Raw material cost                                |            |
| Caprolactam              6,500 MT x 550 US\$/ton | 3,580,000  |
|  | <hr/>      |
| Total Debit                                      | 9,746,000  |
| <b><u>Profitability</u></b>                      |            |
| Benefit before taxes                             | 754,000    |
| Benefit after taxes at 50%                       | 377,000    |
| Amortization provides                            | 1,510,000  |
| Benefit after taxes plus amortization            | 1,887,000  |
| Pay-out time on total investment                 | 8 years    |

**Complex D<sub>3</sub> Manufacture of 3,000 and 6,000 MT/year polyester fibres**

a. raw materials : DMT produced in Complex D<sub>3</sub>

b. possible locations and supply :

- . 6,000 MT/year unit for the corresponding sub-region located in : Algeria (North Africa and North East Africa); Irak or Syria ( Middle East Arab Countries) and supplying local market for 1975.

Economics of such a project are presented in the following tables 1, 2 and 3.

- . 3,000 MT/year unit for the following countries : Algeria, Morocco, UAR, Irak and Syria and supplying the local market for 1975.

c. extension of polyester fiber manufacture

Additional units of capacities included in the same range might be provided for supplying 1980 local markets of the different sub-regions.

COMPLEX D<sub>3</sub> - MANUFACTURE OF 6,000 MT/YEAR POLYESTER FIBRES

**COMPLEX D<sub>3</sub> - MANUFACTURE OF 6,000 MT/YEAR POLYESTER FIBRES****Table 1****Estimated Investment Cost**

|                   | US\$      |
|-------------------|-----------|
| Process Units     | 4,200,000 |
| Off-sites         | 2,200,000 |
| Buildings         | 800,000   |
| Royalties         | 1,000,000 |
| Start-up expenses | 400,000   |
| Spare parts       | 80,000    |
|                   | <hr/>     |
| Total             | 8,680,000 |
| Working capital   | 650,000   |

COMPLEX D<sub>3</sub> - MANUFACTURE OF 6,000 MT/YEAR POLYESTER FIBRES

Table 2  
Estimated Operating Cost

|  |                         |      | US\$/year        |
|--|-------------------------|------|------------------|
| <b><u>Variable Charges</u></b>                 |                         |      |                  |
| 1. Utility consumption                         |                         |      |                  |
| Electric power                                 | 10 <sup>6</sup> kWh/hr  | 1055 |                  |
| Fuel   | 10 <sup>6</sup> kcal/hr | 1.25 |                  |
| Cooling water                                  | m <sup>3</sup> /hr      | 110  |                  |
| Inert gas                                      | m <sup>3</sup> /hr      | 46   |                  |
| Process water                                  | m <sup>3</sup> /hr      | 3.8  |                  |
| Compressed air                                 | nm <sup>3</sup> /hr     | 510  |                  |
| Steam  | tons/hr                 | 6.7  |                  |
| Refrigeration                                  | 10 <sup>3</sup> kcal/hr | 146  |                  |
| Total consumption                              |                         |      | 190,000          |
| 2. Labor                                       |                         |      |                  |
| Men/day  | 10                      |      |                  |
| Men/shift                                      | 184                     |      |                  |
| Total labor (including supervision at 25%)     |                         |      | 1,200,000        |
| 3. Catalyat and chemicals                      |                         |      | 185,000          |
| Total variable charges                         |                         |      | <u>1,575,000</u> |
| <b><u>Fixed charges</u></b>                    |                         |      |                  |
| 1. Amortization                                |                         |      | 868,000          |
| 2. Interest on investment                      |                         |      | 350,000          |
| 3. Maintenance                                 |                         |      | 258,000          |
| 4. Interest on workingcapital                  |                         |      | 52,000           |
| 5. General plant overhead, taxes and insurance |                         |      | 87,000           |
| Total fixed charges                            |                         |      | <u>1,615,000</u> |
| Total operating cost                           |                         |      | <u>3,190,000</u> |

COMPLEX D<sub>3</sub> - MANUFACTURE OF 6,000 MT/YEAR POLYESTER FIBRES

Table 3  
Estimated Investment Profitability

|  | US\$/year        |
|--|------------------|
| <b><u>Credit</u></b>                                     |                  |
| <b>Product Sales</b>                                     |                  |
| Polyester fibres            6,000 tons x 1,500 US\$/ton  | 9,000,000        |
| Methanol (low quality) 2,100 tons x 50 US\$/ton          | 105,000          |
|  | <hr/>            |
| <b>Total Credit</b>                                      | <b>9,105,000</b> |
| <br>   |                  |
| <b><u>Debit</u></b>                                      |                  |
| Operating cost   | 3,190,000        |
| <b>Raw material cost</b>                                 |                  |
| DMT                            7,000 tons x 550 US\$/ton | 3,850,000        |
| Ethylene glycol            2,700 tons x 150 US\$/ton     | 405,000          |
|  | <hr/>            |
| <b>Total Debit</b>                                       | <b>7,445,000</b> |
| <br>   |                  |
| <b><u>Profitability</u></b>                              |                  |
| Benefit before taxes                                     | 1,660,000        |
| Benefit after taxes at 50%                               | 830,000          |
| Amortisation provides                                    | 868,000          |
| Benefit after taxes plus amortisation                    | 1,698,000        |
| <br>   |                  |
| Pay-out time on total investment                         | 5.1 years        |



COMPLEX D<sub>1</sub> - MANUFACTURE OF 3,000 MT/YEAR POLYESTER FIBRES

COMPLEX D<sub>3</sub> - MANUFACTURE OF 3,000 MT/YEAR FIBRESTable 1Estimated Investment Cost

|                   | US\$      |
|-------------------|-----------|
| Process Units     | 3,050,000 |
| Off-sites         | 1,600,000 |
| Buildings         | 500,000   |
| Royalties         | 600,000   |
| Start-up expenses | 300,000   |
|                   | <hr/>     |
| Total             | 6,110,000 |
| Working capital   | 325,000   |

COMPLEX D<sub>2</sub> - MANUFACTURE OF 1,000 MT/YEAR POLYESTER FIBRES

Table 2  
Estimated Operating Costs

|  | US\$ / year |
|--|-------------|
| <b><u>Variable Charges</u></b>                 |             |
| 1. Utility consumption                         | 95,000      |
| 2. Labor                                       | 700,000     |
| 3. Catalyst and chemicals                      | 92,000      |
|  | <hr/>       |
| Total variable charges                         | 887,000     |
| <b><u>Fixed charges</u></b>                    |             |
| 1. Amortisation                                | 611,000     |
| 2. Interest on investment                      | 264,000     |
| 3. Maintenance                                 | 190,000     |
| 4. Interest on working capital                 | 26,000      |
| 5. General plant overhead, taxes and insurance | 61,000      |
|  | <hr/>       |
| Total fixed charges                            | 1,152,000   |
|  | <hr/>       |
| Total operating cost                           | 2,039,000   |

COMPLEX D<sub>3</sub> - MANUFACTURE OF 3,000 MT/YEAR POLYESTER FIBRESTable 3Estimated Investment Profitability

|  | US\$/year |
|--|-----------|
| <b><u>Credit</u></b>                                   |           |
| Product sales  |           |
| Polyester fibres           3,000 tons x 1,500 US\$/ton | 4,500,000 |
| Methanol (low quality)   1,050 tons x 50 US\$/ton      | 52,500    |
|  | <hr/>     |
| Total credit   | 4,552,500 |
| <b><u>Debit</u></b>                                    |           |
| Operating cost   | 2,019,000 |
| Raw material cost                                      |           |
| DMT                       3,900 tons x 530 US\$/ton    | 1,925,000 |
| Ethylene glycol         1,350 tons x 150 US\$/ton      | 202,000   |
|  | <hr/>     |
| Total debit  | 4,146,000 |
| <b><u>Profitability</u></b>                            |           |
| Benefit before taxes                                   | 406,500   |
| Benefit after taxes at 50%                             | 203,000   |
| Amortisation provided                                  | 611,000   |
| Benefit after taxes plus amortisation                  | 814,000   |
| Pay-out time on total investment                       | 7.5 years |

**VI.2.3. Projects based on export possibilities**

The large availability of natural gas in Arab Countries coupled with the growing demand of LNG for peak shaving operation and load gas supply allow to supply natural gas at very attractive prices for ammonia and methanol production.

Large size projects based on these low cost raw material and oriented towards export markets might compete favourably with European or US similar projects.

**Complex E 1,000 MT/day Ammonia based complex****a. possible location and supply :**

- . Middle East Arab Countries for Far East and East Africa market
- . Algeria and Libya for European Countries and West Africa and Mediteranean Countries

**b. economics**

Technical and economic data, estimated operating cost and ammonia selling prices are summarised in the following tables 1 and 2.

COMPLEX E - 1,000 MT/DAY AMMONIA BASED COMPLEX

**COMPLEX E - 1,000 MT/DAY AMMONIA BASED COMPLEX**

(330,000 MT/year)

Table 1

Technical and Economic Data

|   |                                      |             |
|---|--------------------------------------|-------------|
| <b>1. Estimated Investment Cost</b>                           | <b>10<sup>6</sup> US\$</b>           |             |
| (Grass roots plant)   |                                      |             |
| Process Units including royalties and initial catalyst charge |                                      | 18.8        |
| Offsites including utilities production and storage           |                                      | 8.4         |
| Start-up expenses   |                                      | 1.8         |
| Spare parts   |                                      | 0.8         |
|   |                                      | <hr/>       |
| <b>Total Investment</b>                                       |                                      | <b>29.8</b> |
| Working capital   |                                      | 0.8         |
| <b>2. Inputs</b>  |                                      |             |
| . Raw material and utility requirements                       |                                      |             |
| Natural gas (process and fuel)                                | 10 <sup>6</sup> m <sup>3</sup> /year | 384         |
| Boiler feed water   | 10 <sup>6</sup> m <sup>3</sup> /year | 1.12        |
| . Chemicals and catalyst consumption                          | US\$                                 | 430,000     |
| . Labor   |                                      |             |
| Men/shift   |                                      | 15          |

a. Units producing their own electricity and ready to start production  
Natural gas is used as feed-stock and for power generation

COMPLEX E - 1,000 MT/DAY AMMONIA COMPLEX

(330,000 MT/year)

Table 2Economics of Ammonia Production

|   | 10 <sup>3</sup> US\$/year |
|---|---------------------------|
| <b>1. Operating cost</b>  |                           |
| <b>A. Variable Charges</b>  |                           |
| Raw materials and utilities   |                           |
| Natural gas      384. 10 <sup>6</sup> m <sup>3</sup> x 0.2 ¢/m <sup>3</sup>                   | 768                       |
| Boiler feed-stock water      1.12 10 <sup>6</sup> m <sup>3</sup> x 0.25 ¢/m <sup>3</sup>      | 280                       |
| Chemicals and catalysts   | 430                       |
| Labor   |                           |
| Manpower salaries and wages      60 x 5,000 ¢/year  | 300                       |
| Supervision   | 75                        |
| <b>Total variable charges</b>   | <b>1,853</b>              |
| <b>B. Fixed Charges</b>   |                           |
| Amortization at 10% of investment   | 2,980                     |
| Interest at 4% of investment  | 1,190                     |
| Maintenance at 4% of Process Units + Offsites   | 1,100                     |
| General plant overhead, taxes and insurance   | 298                       |
| Interest on working capital   | 64                        |
| <b>Total fixed charges</b>  | <b>5,632</b>              |
| <b>Total operating cost</b>   | <b>7,485</b>              |
| <b>Unit operating cost                      US\$/ton</b>                                      | <b>23</b>                 |
| <b>2. Estimated selling price (for a five years pay-out with taxes<br/>on benefit at 50%)</b> |                           |
| Net income before taxes   | 5,960                     |
| Total sales   | 13,445                    |
| Ammonia selling price in US\$/ton   | 41                        |



Complex F 1,000 MT/day methanol based complex

a. possible locations and supply : Algeria or Libya for European markets

b. economics

Technical and economic data, estimated operating cost and methanol selling prices are summarized in the following tables 1 and 2.

COMPLEX F - 1,000 MT/DAY METHANOL BASED COMPLEX

**COMPLEX F - 1,000 MT/DAY METHANOL BASED COMPLEX**

(330,000 MT/year)

Table 1

Technical and Economic Data<sup>a</sup>

|  |                            |                        |
|--|----------------------------|------------------------|
| <b>1. Estimated Investment Cost</b>                      | <b>10<sup>6</sup> US\$</b> |                        |
| (Grass roots plant)                                      |                            |                        |
| Process Units<br>(including royalties)                   |                            | 13.0                   |
| Offsites (including utilities production<br>and storage) |                            | 5.0                    |
| Start-up expenses  |                            | 0.9                    |
| Initial chemical and catalyst charges                    |                            | 1.0                    |
| Spare parts  |                            | 0.3                    |
|  |                            | <hr/>                  |
| <b>Total Investment</b>                                  |                            | <b>20.2</b>            |
| <br>Working capital                                      |                            | <br>0.8                |
| <br><b>2. Inputs</b>                                     |                            |                        |
| . Raw materials and utility requirements                 |                            |                        |
| Natural gas feed/ton of methanol                         |                            | 5.10 <sup>6</sup> kcal |
| Natural gas fuel/ton of methanol                         |                            | 3.10 <sup>6</sup> kcal |
| . Electricity/ton of methanol                            |                            | 50 kWh                 |
| . Boiler feedwater                                       | m <sup>3</sup> /hr         | 40                     |
| . Cooling water (recirculating)                          | m <sup>3</sup> /ton        | 2                      |
| . Synthesis catalyst /ton of methanol                    | US\$                       | 0.7                    |
| . Other catalyst and chemicals / ton of methanol         | US\$                       | 0.4                    |

<sup>a</sup>. Based on LP methanol process using centrifugal compressors

**COMPLEX F - 1,000 MT/DAY METHANOL BASED COMPLEX**

(330,000 MT/year)

**Table 2**

**Economics of Methanol Production**

|   | US\$/year          |
|---|--------------------|
| <b>1. Operating cost</b>  |                    |
| <b>A. Variable charges</b>  |                    |
| <b>a. raw materials and utilities</b>   |                    |
| . natural gas : $8 \cdot 10^6$ kcal x 330,000 x 70 US¢/10 <sup>6</sup> kcal                     | 1,850,000          |
| . electricity : 50 kwh x 330,000 x 0.01 US\$/kwh  | 165,000            |
| . boiler feed-water : 40 m <sup>3</sup> /hr x 8,000 x 0.25 US\$/m <sup>3</sup>                  | 80,000             |
| . cooling water : 2 m <sup>3</sup> /ton x 330,000 x 6 \$/10 <sup>3</sup> m <sup>3</sup>         | 4,000              |
| <b>b. synthesis catalyst</b> 0.7 US\$ x 330,000   | 231,000            |
| <b>other catalysts and chemicals</b> 0.4 US\$ x 330,000   | 132,000            |
| <b>c. labor : manpower salaries and wages : 50 x 5,000 \$/year</b>                              | 250,000            |
| <b>supervision</b>  | 60,000             |
| <b>Total variable charges</b>   | <b>2,772,000</b>   |
| <b>B. Fixed charges</b>   |                    |
| <b>a. amortization at 10% of investment</b>   | 2,020,000          |
| <b>b. interest at 4% of investment</b>  | 800,000            |
| <b>c. maintenance at 4% of Process Units + Offsites</b>   | 720,000            |
| <b>d. general plant overhead, taxes and insurance</b>   | 200,000            |
| <b>e. interest on working capital</b>   | 64,000             |
| <b>Total fixed charges</b>  | <b>3,804,000</b>   |
| <b>Total operating cost</b>   | <b>6,576,000</b>   |
| <b>Unit operating cost</b>  | <b>US\$/ton 20</b> |
| <b>2. Estimated selling price (for a five years pay-out with t<br/>taxes on benefit at 50%)</b> |                    |
| <b>C Net income before taxes</b>  | <b>4,040,000</b>   |
| <b>Total Sales</b>  | <b>10,616,000</b>  |
| <b>Methanol selling price in US\$/ton</b>   | <b>32</b>          |

**VI.3. ANALYSIS OF THE ALTERNATE FEASIBLE PROJECTS AND PROFITABILITY  
CALCULATIONS : BASIS FOR THE SELECTION OF RECOMMENDED PROJECTS**

It has been possible to examine in the hereabove paragraph the economics of producing petrochemicals which might reasonably find outlets on the local market of the Arab Countries or for exports.

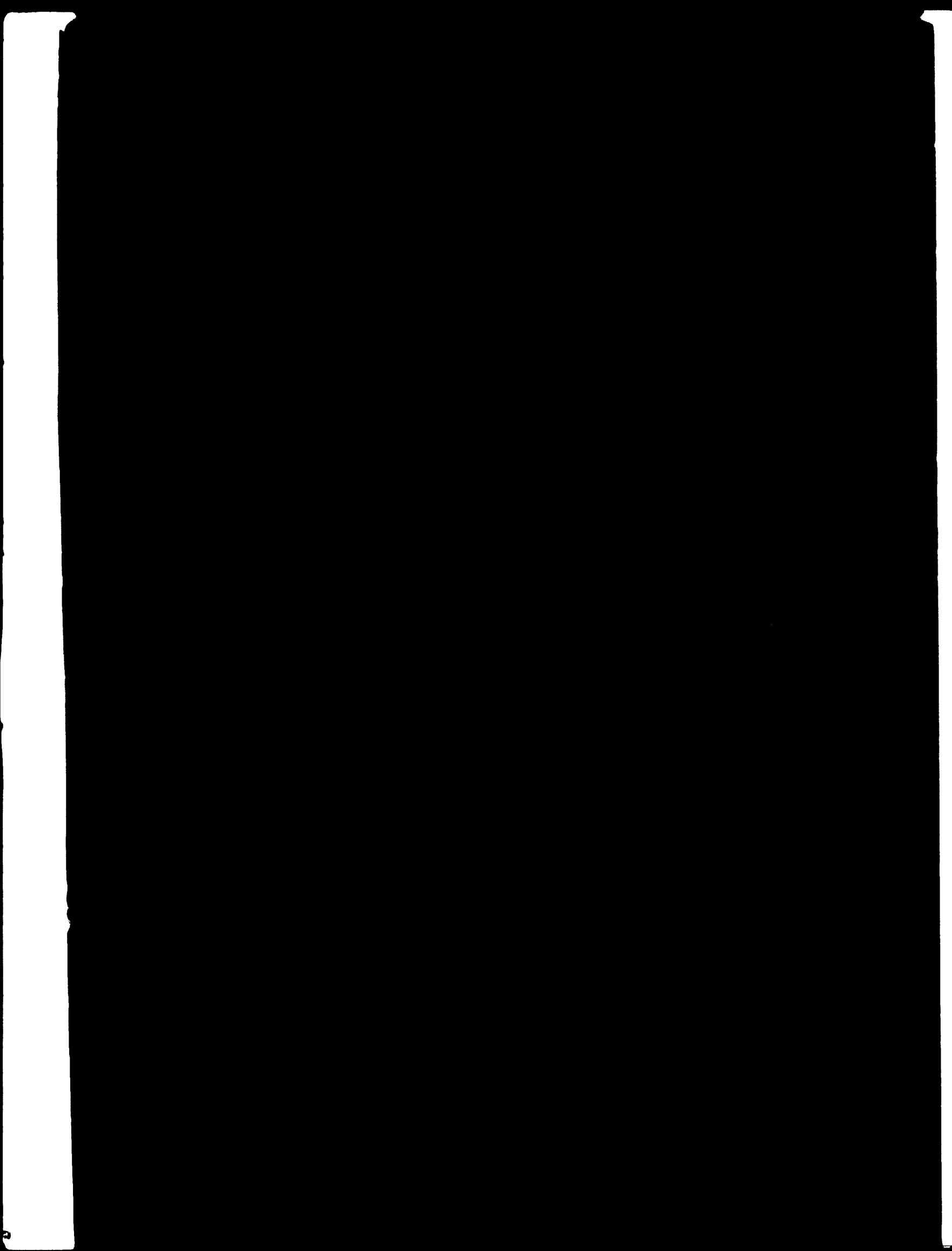
The feasibility studies which have been carried out show that conditions in Arab Countries are such that a petrochemical industry designed to satisfy a large part of the internal market in 1975 and 1980 and based on harmonization and cooperation between the Arab Countries can be a profitable venture.

Different alternates related to : process routes, size of projected plants, locations and schedule for realization have been presented and the influence of the different technical and economic factors on the profitability of the possible projects have been outlined in order to allow the participants of the meeting organized by IDCAS to evaluate the different alternates and to appraise the program of execution for recommended projects.

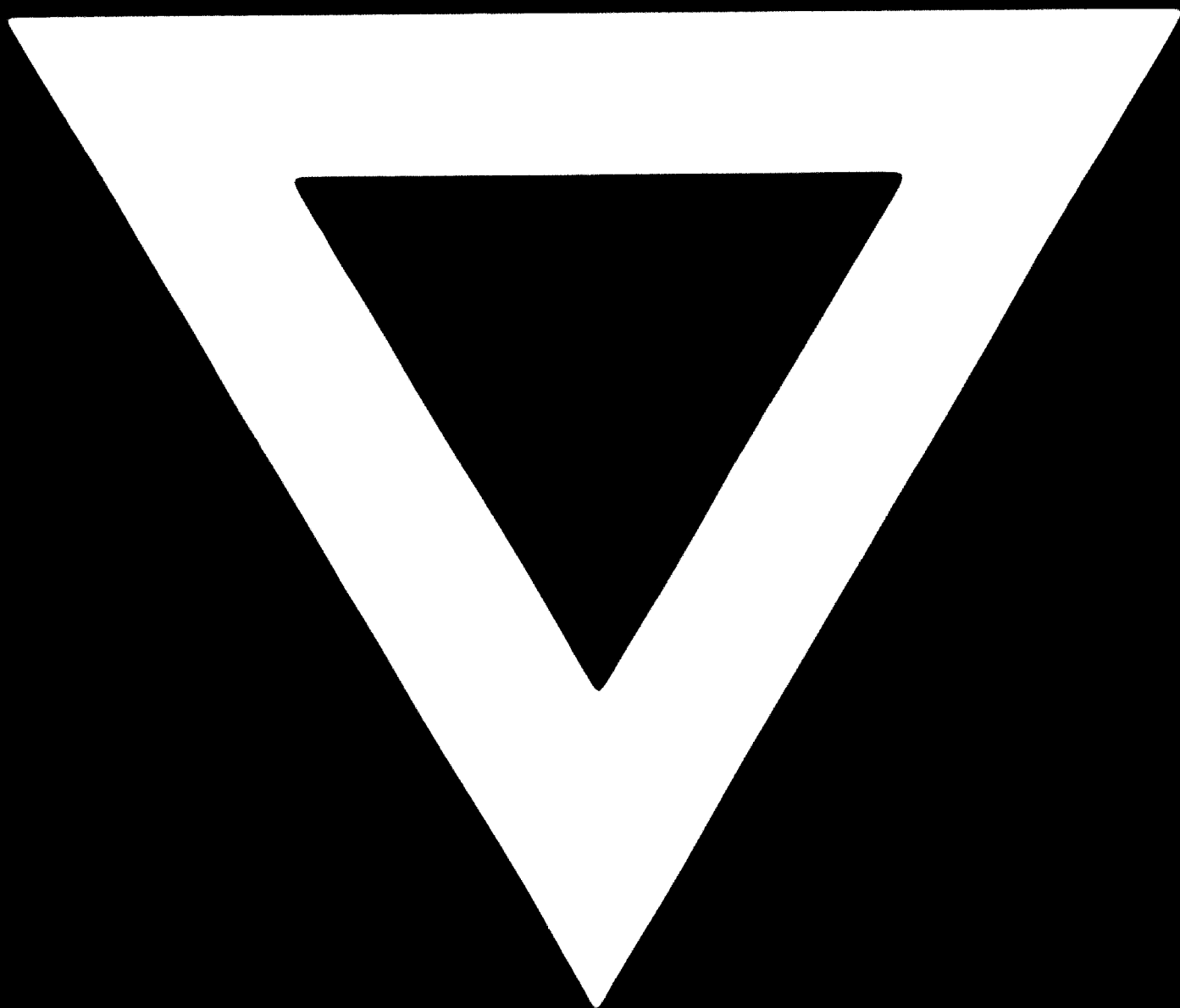


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