V.

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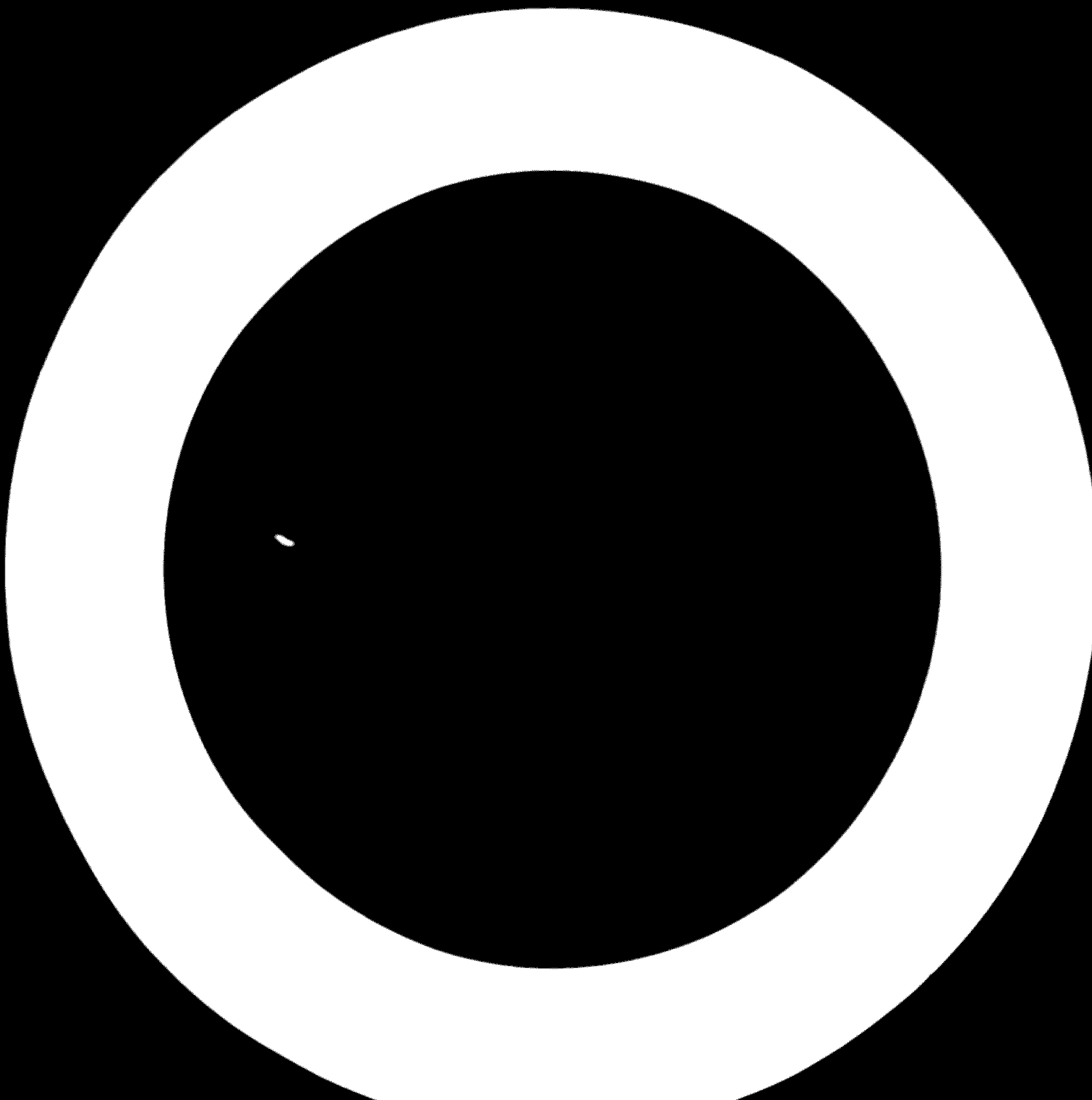


[illegible]

List of Figures:

List [illegible]

Annex 1 - [illegible] situated at [illegible] Port

Annex 2 - [illegible] - Oil [illegible] Port

I - INTRODUCTION

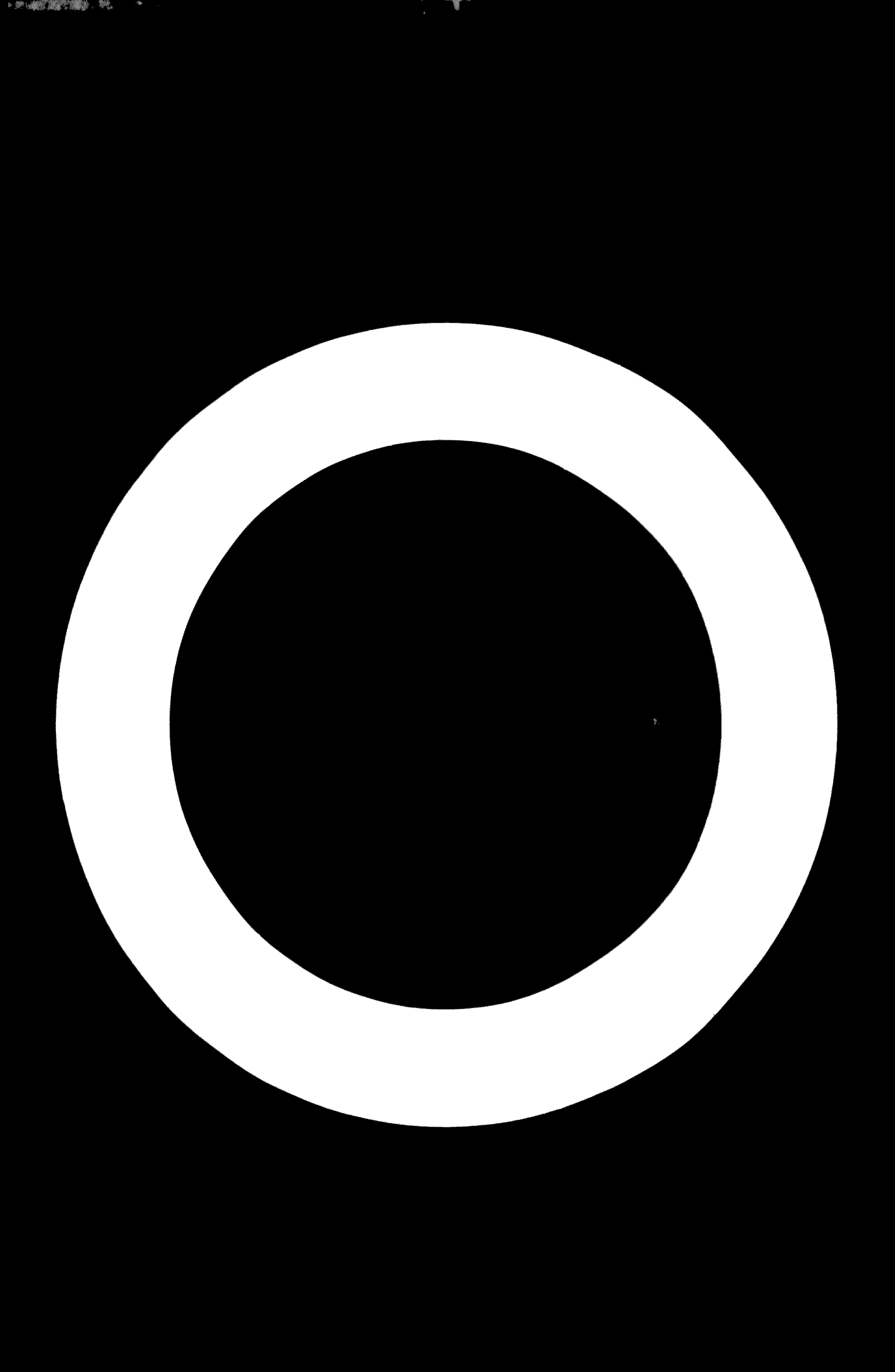
The present study comprises an examination [illegible] suitability of the proposed urea production [illegible], and production cost, the availability of [illegible] imported raw materials, [illegible] those for imported urea.

After the beginning of this study it was [illegible] already made in the past. The [illegible] in their very extensive report. Beside this [illegible] viewpoints, there exists also a correspondence with [illegible] contracting firms in rather initial stage. [illegible] background papers will be analysed [illegible].

The estimated return on investment, production [illegible], by-product [illegible] and other economic indices introduced in this report, [illegible] reviewed and revised after the final proposal for plant construction is [illegible]. The review of sub-regional marketing shown in Part "[illegible]" of this report, [illegible] then to be supplemented by definitive plans for urea export.

In making this study, the background knowledge of fertiliser production plants and costs was availed of. The utilities and estimated operational labour costs reflect the conditions found in Madagascar.

Every effort was taken to conceive simultaneously balanced UNDP projects which may contribute optimally to the development of the economy of Madagascar.



III - EVALUATION OF [illegible]

PRODUCTION OF FERTILIZERS [illegible]

[illegible]

[illegible]

Economic [illegible]

196[illegible] :

- [illegible]

  [illegible]

  ([illegible]

  [illegible]

- Volume II

  P[illegible]

  ([illegible]

  [illegible].

[illegible]

[illegible]

[illegible], it will

[illegible] it [illegible]

Volume II of [illegible].

Messrs. SEDES [illegible]:

I. Size of the [illegible]

II. Raw materials [illegible]

III. Selling price [illegible] fertilizer [illegible] the current C & F price [illegible] fertiliz[illegible].

I. Size of the [illegible]

Messrs. S[illegible]S [illegible] only [illegible] brief appreciation of [illegible] possibilities of eventual Madagascar fertilizer [illegible] to [illegible] African countries and came to conclusion that this [illegible] further consideration. On the other hand, they stre[illegible] upon the [illegible] possibilities in Réunion and Mauritius for fertilizers produced in Madagascar as it seemed to them that there was not much chance to produce any fertilisers th[illegible]. [illegible] scientific [illegible] at Réunion on [illegible] at [illegible] the other hand, [illegible] 50 [illegible] 10 [illegible] Mauritius [illegible] fertilizer [illegible] industry, at the [illegible] rate of growth of [illegible] apart from [illegible] shown below:

Consumption of N (in metric tons)	1960	1970	Rate of growth	Exports
Madagascar	940	18,500	190 [illegible]	
Réunion	4,[illegible]	7,[illegible]	5 [illegible]	3,500
Mauritius	9,[illegible]	12,300	2[illegible]	1,230
TOTAL	14,[illegible]40	37,[illegible]	-	4,730

It has been, however, [illegible] confirmed by estimates presented in this study that the overall consumption of N in Madagascar is expected to be about 7,170 tons/year by the [illegible] of 1970, i.e. nearly one third of Messrs. S[illegible] projection. Their [illegible] thus seem to be very unrealistic, requiring about 190 [illegible] rate of growth of the local market based on consumption in 1960 to attain the consumption figure of 18,500 tons of N by 1970.

The report of Messrs. S[illegible] does not specify very clearly that N nutrient required for rice cultivation in Madagascar is to be supplied by urea, meanwhile this fertilizer is to be gradually introduced in Réunion and Mauritius for sugar cane plantation in the future.

II. Raw materials available

Messrs. SALLES, after careful thought, suggested two possibilities for manufacture of nitrogen fertiliser in Madagascar:

- to produce calcium cyanamide;
- to produce ammonium sulphate, urea or ammonium nitrate based on ammonia synthesis.

They support the idea of calcium cyanamide by the fact that there is electricity available at [illegible], CO_3Ca at AMBOTOMIRASAKA and charcoal made locally from eucalyptus tree. On the other hand, they put forward also the [illegible] lution. [illegible] requires 14 kw[illegible] [illegible] 4 [illegible] only 20 [illegible] [illegible] It's justin [illegible] CO_3Ca [illegible] [illegible] imported.

Further views of [illegible] based on ammonia synthesis [illegible] hydrogen and nitrogen.

Messrs. S[illegible] took int[illegible] stock for [illegible] [illegible] that even in those countri[illegible] [illegible] compete as raw material economically with liquid or [illegible] petroleum materials. After this [illegible] utilisation of heavy fuel oil from the Oil Refinery in [illegible] most prospective source for [illegible] production i[illegible]

It should be noted that in 1964, i.e. when their report appeared, it was not yet been sure whether the refinery would be built at all. It is questionable why they considered as an alternative source, in case the oil refinery would not be built, the importation of the heavy fuel-oil. In such a case it would be better to import straight run naphtha which was become already in 1962 one of the most important raw materials for ammonia synthesis.

Messrs. S[illegible] envisage the price of fuel oil at Tamatave, coming from the future oil refinery, to be of the order of US $ 14.00/ton. According to the latest information received, this price is higher, amounting to US $ 18/ton. On the other hand, it has to be realised that this price based on FOB Tamatave fuel-oil resale value includes, at present, the additional costs resulting from closing of Suez Canal and taxes of importation and transaction, i.e. US $ 1,7 which normally should not be levied if fuel-oil were used for fertiliser manufacture. Deducting US $ 3,3 from US $ 18.00, we obtain

US $ 14,70 which [illegible] Messrs. SHIS assumption.

Even if the problem of usage of fuel oil for manufacture of nitrogen fertiliser is [illegible] more in details at a later stage of this study, it has to be noted here [illegible] comparative advantage of two different raw materials for ammonia production [illegible] Messrs. SHIS report:

- Natural gas as raw material
  (21,000 cubic ft/ton of NH_3 at $ 0,10 per thousand cubic feet) — US $ 2,10
- Fuel oil
  (0,845 ton / ton NH_3 at $ 14,70 per ton) — US $ 1[illegible]

  Difference in favour of gas/ton NH_3 — US $ 1[illegible]

If other utilities and operating cost are taken into consideration this difference becomes even much greater in favour of process using natural gas as a raw material. As a matter of fact, the electricity consumption for ammonia synthesis should be mentioned here to be compared with Messrs. SHIS assumptions.

Messrs. SHIS considered the electrical consumption to be of the order of 2,000 kWh/ton of fixed N. Actually this figure is very high and should be about 1500 kWh/ton of fixed N. On the other hand, the estimated cost for 1 kWh of US $ 0,02 (2 cents) was checked there and seems to be correct. Nonetheless, it is very high compared with the average cost of 1 kWh in the United States which is about US $ 0,01 (1 cent or 10 mills).

After having reviewed the consumption estimates for the future raw materials available, kind of fertilizers most suited to cultivations of rice, other specific conditions in Madagascar, etc., Messrs. SHIS recommended to produce urea (especially for cultivation of rice), nitric acid and ammonium nitrate (including explosives). Consequently they suggested the partial recycle process for urea manufacture, where part of ammonia and carbon dioxide can not be recycled and must be used in the production of a co-product nitrogen material, as in the once-through process. The production capacities were conceived in two alternatives as it is apparent form the following table:

	Alternative I	Alternative II		
	Urea (46 %)	Urea (46 %)	Ammonium nitrate (33,5%)	Explosives (34,8 %)
NH_3 - 75 t/day	127.5	8[illegible]	44.8	13.6
/year	42,075	27,060	14,8[illegible]	4,[illegible]
NH_3 - 100/day	170	110	64.3	13.6
/year	56.100	36,300	21,[illegible]	4,[illegible]

apart from [illegible] seems [illegible] a rise in [illegible] fertilizer [illegible] in Madagascar [illegible]. As a matter [illegible] parison, [illegible] prices [illegible] bargain [illegible]. In addition to it, [illegible] amounted to [illegible] respectively which is [illegible] especially [illegible].

B. [illegible] fertilizer [illegible].

To get [illegible] industry in Madagascar [illegible] this field. The [illegible] operate [illegible] tations [illegible] that the size of market [illegible] establishment of an industry of scale.

EDPI took further [illegible] actions [illegible] experience of other organisations i.e. consulting firms and specialised contractors. Among [illegible] it is worthwhile to [illegible] ITF, [illegible]C, SOC[illegible], PC [illegible] IS [illegible] (F C), Institut Français d'Organisation [illegible] Productivité, [illegible], SYBETRA etc. Most of these contacts are in initial stage of development, when companies ask for basic data to be able to offer their [illegible]. Nevertheless, it is apparent that the discussion is concentrated on the following main aspects:

(a) Should ammonia be produced in Madagascar or imported as liquid anhydrous ammonia;

(b) Should nitric acid and ammonium nitrate and/or urea, or both be produced;

(e) Should ammonia [illegible] the major ammonium sulphate only be produced.

Irrespective of what [illegible] be preferred, the main subject of interest is the estimated demand for nitrogenous fertilisers in Madagascar by 1970 and 1975, which is decisive for determination of the production capacity and economy of [illegible] fertiliser [illegible] in this country.

The foregoing salient features are continuously pursued throughout this feasibility report including the final recommendations and therefore are not referred to in this particular chapter.

III - [illegible] MADAGASCAR'S [illegible]

Urea as a fertiliser is steadily gaining importance marked by a steep growth in the world's consumption. It has high nitrogen content, small wash-away loss, leaves no residual [illegible] in the soil and may be easily applied to the soil. Urea is especially used in the cultivation of rice, wheat, tobacco, tomato, potato, cotton, sugar cane, coffee, pasture, and maize. Under certain conditions, urea may be used as a material for compound fertilisers.

Urea is [illegible] herbicides. A new product, called PCP-Na (sodium pentachlorophenol) is currently known as a weed-killing chemical and successfully used in paddy fields (Japan).

Urea is [illegible] as cattle food for ruminant animals, for resin manufacture as a softener for various cellulosic products, and finally, has many uses in the chemical industry.

It goes without saying that urea will find its major application in Madagascar as a fertiliser, a component of the synthetic additional cattle food, and [illegible] weed-killing element in mixture with herbicide.

IV - AVAILABLE PROCESSES FOR UREA MANUFACTURE

The choice among several available processes for Urea Manufacture depends upon products to be obtained and the location of the plant. The Once-Through process and the Partial Recycle Process may have distinct advantages where all or part of the off-gas ammonia is to be used in the production of nitric acid or for the reaction with the specific acid to form its ammonium salt, i.e., sulphuric, nitric [illegible].

The principal advantage [illegible] Once-Through Process [illegible] comparatively low capital investment [illegible] equipment, [illegible] install equipment for [illegible] off-gas [illegible].

In the Partial Recycle Process, [illegible] reactor which [illegible] Once-Through Process.

In the Total Recycle Process [illegible] to the Partial Recycle Process [illegible] off-gases [illegible] completely recovered and [illegible] to the synthesis reactor.

As in Madagascar [illegible], the Total Recycle Process has to be used [illegible].

There are several major processes [illegible]

Chemico, Stamicarbon, Toyo Koatsu, [illegible], Lonza, [illegible] etc. Most of these processes are [illegible] Once-Through, Partial Recycle or Total Recycle basis. The principal difference between the above mentioned processes is the manner in which [illegible] are returned from the ammonium carbamate decomposition [illegible] synthesis reactor.

Process description in general of urea manufacture [illegible] flow sheet is shown at a subsequent part [illegible] this Report.

V - Raw Materials for Urea Production

Generally, it is not recommended to produce ammonia in Madagascar due to economic reasons. One ton of ammonia manufactured from locally available residual heavy fuel oil (Bunker "C") would cost about $ 95/ton which compares unfavourably with anhydrous ammonia imported from Gulf area amounting to about $ 40/ton only.

It is envisaged that the most suited source of the ammonia required in Madagascar would be the Persian Guld area. The nitrogen from Gulf area to Madagascar is about half the distance as from Europe or Trinidad. The result of it will be reduced freight rates. Another important factor would be the possible coordinated ammonia supply with other East African Sub-regional countries which also consider the use of anhydrous ammonia for fertilizer production, (Kenya, Mauritius etc.) In such a case, ammonia could be imported more frequently and in larger quantities. This in turn would result in lower sea freight rates, lower capital investment for ammonia storage facilities and reduced amount of the required working capital.

Beside ammonia, carbon dioxide is the most important raw material for urea production. Ammonia and carbon dioxide are normally available at the same time, since carbon dioxide is a by-product of ammonia synthesis plants. The purity of carbon dioxide gas produced in the synthesis section of an ammonia plant depends largely on the CO_2 removal process employed in that section. Generally, the least content of inert gases and sulphur is required from both the process and corrosion reasons, allowing for about maximum 2 percent inerts and 25 ppm of sulphur.

In the case of Madagascar, carbon dioxide will be produced locally from the residual fuel oil from the Oil Refinery in Tamatave.

The carbon dioxide, in the required purity for urea synthesis, will be produced from boiler house flue gases where the process steam is generated.

SPECIFICATION OF RAW MATERIALS

Liquid Ammonia:

NH_3	min	99.8 %	by weight
H_2O	max	0.2 %	by weight
Oil		10	ppm
Temperature		20° C	
Pressure		10	Kp/cm^2

Carbon Dioxide:

CO_2	min.	98.5 %	by volume
Inerts	max	1.5 %	by volume
Sulphur		20	ppm
Water saturated at		30° C	
Temperature	max	30° C	
Pressure		200	mm water column

Raw Materials and Utility Requirements (Quantities per Mt prilled urea)

UREA	Liquid NH_3 (ton)	0.58
	Gaseous CO_2 (ton)	0.77
	Steam (kg)	1.400
	Electricity (kWh)	140 (additional quantity mentioned in the estimate of production costs is reserved for ammonia storage)
[illegible]	Steam (kg/hour)	11,000
	Cooling Water (m^3/t)	470 (out of which 320 m^3 could be circulated)
	Electricity (kWh)	300 /h
	Chemicals: Na_2CO_3	250 kg/h
	Alkacid	1,75 kg/h

VI DESCRIPTION OF THE TOTAL RECYCLE PROCESS OF UREA MANUFACTURE

PRODUCTION OF UREA

Urea is produced by the highly exothermic reaction of ammonia and carbon dioxide at a high pressure and temperature. The reaction takes place in two stages according to the following equations:

$$CO_2 + 2\,NH_3 \longrightarrow NH_4COONH_2 \qquad (1)$$

$$NH_4COONH_2 \longrightarrow NH_2CONH_2 + H_2O \qquad (2)$$

The result of the first reaction (1) is ammonium carbamate. The reaction is immediate and exothermic and the released reaction heat maintaines the temperature of reaction mixture at a necessary level. A part of ammonium carbamate according to equation (2) converts to urea. This reaction is slightly endothermic and goes on till the balance is achieved.

Further important reaction is the biuret formation according to equation (3):

$$2\,NH_2CONH_2 \longrightarrow NH_2CONHCONH_2 + NH_3 \qquad (3)$$

The formation of biuret is influenced by temperature and reaction time. The higher the temperature and the longer its effect, the larger is the formation of biuret. For this reason, the solution of urea should be kept under high temperature at a minimum possible time, in order to limit the formation of biuret.

At a urea synthesis, carried in stoichiometric ratio of reacting components, more heat is released than it is necessary for maintaining of operation temperature and arises the problem how to remove such a heat. This is not necessary in our case because the excessive ammonia is used for the synthesis and a certain portion of heat has to be added to the reaction by ammonia preheating. This enables the precise setting of reaction temperature without using the complicated equipment for heat exchange in the reactor.

In addition to that, the presence of excessive ammonia influences favourably the conversion of ammonia carbamate into urea.

The urea synthesis is carried out at a pressure 190-200 kg/cm² and the temperature of 180-190 °C. The mol. ratio of NH_3 and CO_2 is about 4:1.

As it was already mentioned, the conversion of ammonium carbamate into urea is not complete and consequently, the mixture coming out of the reaction contains urea, water, ammonium carbamate and unreacted materials. The last two named components have to be separated from urea solution and returned back into the reactor.

Subsequent processing involves the equipment for the decomposition of ammonium carbamate and recycling of separated unreacted raw material back into the reaction.

The reaction mixture, after leaving the reactor, is expanded in two stages to the pressure near to one atmosphere. Each expansion stage comprises decomposing exchanger, separator of gaseous and liquid phase and condenser.

From the first expansion stage is obtained both pure ammonia which is, along with added ammonia, dosed to the reactor, and recycle solution also returned to the synthesis reactor.

From the second expansion step is taken urea solution, and weak recycle solution is pumped back to the first expansion stage where its thickening is taking place.

The produced urea solution, concentrated to about 80 percent, is thickened by two stage evaporations to obtain melted urea. As it has been already noted, formation of biuret increases with temperature effect and that is why the evaporation has to be carried out quickly at lowest possible temperatures which could be achieved by vacuum evaporation. The melted urea with low water content is sprayed into the prilling tower where prills are formed.

FLOW SHEET

The production flow is schematically shown in Figure 1 : The Flowsheet of Urea Manufacture. For the convenience of explanation, the urea production can be divided into six sections, namely carbon dioxide compression and feeding of ammonia, urea synthesis, reaction mixture recycle, evaporation, urea prilling.

CARBON DIOXIDE COMPRESSION

Gaseous carbon dioxide is fed from storage tank into a multistage compressor (1) and from there, by means of high pressure piping, supplied directly to the synthesis reactor.

FEEDING OF AMMONIA

Liquid ammonia is continuously fed to the NH_3 reservoir (2) where it is mixed with ammonia recycle which comes to the reservoir (2) from the ammonia condenser (9). Ammonia from the reservoir (2) is dosed by high pressure plunger pump (3) through the ammonia preheater (4) to the synthesis reactor (5).

UREA SYNTHESIS

At the bottom of the reactor (5) where ammonia, carbon dioxide and recycle solution are brought, the exothermic reaction takes place with formation of ammonium carbamate followed by sharp increase of temperature. Reactor is lined with a special stainless steel. The reaction mixture is detained for such a time in the reactor (5) to achieve a high yield from the conversion of ammonium carbamate into urea.

RECYCLING

The reaction mixture leaving the reactor at a pressure of about 200 kg/cm^2, is subject to two stage pressure expansion. First pressure relief takes place in a special valve to ca. 18 kg/cm^2; the mixture is then conveyed to the decomposing exchanger (6) where, under heat, the unconverted ammonium carbamate is decomposed. In a pressure separator (7) the released superfluous gaseous ammonia, ammonia and carbon dioxide from the decomposed ammonium carbamate as well as a part of evaporated steam, are separated from the liquid phase.

The separated gaseous mixture is fed to the pressure absorber (8); the liquid phase continues further to the second expansion stage.

The liquid phase, after leaving the pressure separator (7) is subject to further pressure relief before entering the decomposing exchanger (11). The liquid mixture is in the decomposing exchanger (11) exposed to heat in order to achieve the decomposition of the remaining part of ammonium carbamate. In the low pressure separator (12) the gaseous ammonia and carbon dioxide is separated from the [illegible] solution. The [illegible] separator (12) [illegible] to the low pressure absorber (13) [illegible], [illegible] solution is formed. The solution from the low pressure [illegible], by means of a pump (14) into the pressure absorber ([illegible]). [illegible] the separator (12) flows to the [illegible] (17). I[illegible] ([illegible]), the ammonium is obtained by washing out [illegible] in the low pressure absorber (13). Obtained weak ammonia [illegible] pump (15) to the low pressure absorber (13).

EVAPORATION

The urea solution from the stor[illegible] tank (17) i[illegible] pump (1[illegible]) to the first stage of the [illegible] (19). [illegible] the thick[illegible] urea solution i[illegible] the separator ([illegible]) [illegible] condensor (21). The separation system is [illegible] ejector (22). Urea solution from the separator ([illegible]) is [illegible] second stage evaporator ([illegible]) [illegible] vapors [illegible] separator (24) are taken to be condensed i[illegible] condensor (25). [illegible] is maintained under deep vacuum by a steam ejector (26). [illegible] is conveyed to the suction head of the pump (27) to be pumped [illegible] top of the prilling tower.

The condensed vapors from both evaporators are [illegible] tank (28) and supplied by a pump (29) to the [illegible] washer.

PRILLING

The melted urea coming from the evaporators enters the centrifu[illegible] (30). The drops of urea discharged from the centrifuge are falling against counter-currently blown air by fans (31). The drops are cooled, hardened and [illegible] form prills raked out from the bottom of the tower by a special raker (32) on to a belt conveyor (33). The produced prills are supplied by means of an elevator (34) to the classifier (35) where the off-sized particuls are sorted out. The sorted out urea is supplied by a belt conveyor to the store room, to the bagging unit or for despatch in bulk. Sorted out particles of urea are melted in the melting tank (36) and returned to the production by a pump (37).

VII Description of carbon dioxide manufacture from boiler house flue gases.

The flue gas from the boiler house is passed through a waterwash tower (1) before entering a Na_2CO_3 wash tower (2) for the removal of SO_2. The spent Na_2CO_3 solution is discarded at the bottom of the tower (2). The flue gas then enters two CO_2 wash towers in series (3 and 4) for the removal of CO_2. Lean alkacid lye is used to absorb CO_2 from the flue gas. Rich alkacid lye from the bottom of the absorber (3) is pumped through heat exchanger (8) to the top of the desorption tower (5). This rich lye exchanges heat with the regenerated lye from the bottom of the desorption tower (5). The regenerated lye is pumped through heat exchanger (8) and cooler ([illegible]) to the top of the absorption tower (4). From absorption tower (4) the partly absorbed lye is pumped to the top of the absorption tower (3). This completes the circulation of the lye in the system. A part of the lye is passed through a lye filter (7) for the removal of solids in the lye. The steam required for desorption of CO_2 from the lye is passed through reboiler (10). The recovered CO_2 from the top of the desorption tower is cooled in a condenser (9). To get the required purity, the CO_2 is passed through activated carbon filters (11 and 12) before entering the CO_2 gas holder (13).

The production of CO_2 from boiler flue gases is shown schematically in FIGURE 2 - The Flowsheet of Carbon Dioxide Manufacture.

VIII Location of the Urea Manufacturing Plant

Another important factor from the technical and economic point of view is the location of the urea manufacturing plant. Preliminary discussions were held with the representative of the Tamatave Port Authority and with the advisor in charge of the Tamatave "Industrial Zone" in MEPI to get the site of about 7 hectares right in the harbour area within the security fence. If this is not possible, the ammonia terminal must be situated at least adjacent to the deep water harbour facilities. It is imperative to keep the anhydrous ammonia tanker's distance from the terminal tank as close as possible to avoid unnecessary costs in pumping through the longer line. The pipe friction and mechanical work would otherwise result in a temperature rise and a flashing of the ammonia when pumped into the terminal tank. These vapors must be recompressed and returned to the storage tanks as liquids, thus increasing the operating cost of the terminal refrigeration system.

Approximately 0,5 hectares of land is required for a 3000 ton terminal. The soil bearing capacity has been reported to be satisfactory enabling to do without the costly piling.

If the Urea Plant itself is located in so-called " Industrial Zone" of Tamatave, it will enjoy an easy access to the fresh water facilities, sewerage system, electricity and water mains. In such a case, the Urea Plant will be located opposite the existing Tamatave oil refinery at a site with a good soil bearing capacity. (See FIGURE 3 - Location of the Urea Manufacturing Plant).

As this location is situated in the town of Tamatave, no special housing facilities need to be constructed at this site.

IX - CAPITAL COSTS

Estimated Fixed Capital Costs of Urea Production Demonstration Plant in Madagascar at Tamatave

I - Plant Capacity: 33,000 tons/year of prilled urea (46 % N) in three shifts, 330 stream days per year.

II- Plant Location: Industrial Area of the Port of Tamatave in Madagascar.

(in thousands US$ and FMG)

Kind of Costs	Foreign Currency US $	Local Currency FMG	In Total US $
1. Land improvement (ha of flat land without obstructions below and above surface)		5,000	20
2. Fencing , roads and sewers	30	7,500	60
3. Foundations and buildings	50	95,000	430
4. Engineering, machinery and process equipment (incl. boilers)	1,900		1,900
5. Freight and insurance	150		150
6. Construction and erection	250	62,500	500
7. Ammonia storage (3000 tons)	450	12,500	500
8. Storage for Urea and Chemicals	50	87,500	400
9. Utility equipment (water, compressed air, electricity)	300		300
10. Bagging unit	30		30
11. Spare parts	80		80
12. Safety and laboratory equipment	85		85
13. Moving, handling and maintenance equipment	130		130
14. Putting on steam	70	6,500	96
15. Fellowship	42	7,500	72
16. Other miscellaneous	25		25
17. Contingency	100		100
	3,742	284,000	4,878

Basis for depreciation: For urea plant only $ 3,885,000 (depreciation and other production cost for CO_2 manufacture are included in CO_2/ton cost)

X - ESTIMATED COST OF PRODUCTION OF PRILLED UREA

Plant Capacity 100 metric t/day

Value Added ($)	Variable Costs	Quantity	Unit Cost ($)	Cost/Urea ton ($)	Cost/year ($)
-	Liquid NH_3 Feed	0.58 t	40.00	23.20	
7.40	Gaseous CO_2 Feed	0.77 t	18.80	14.50	
5.00	Electricity (incl. NH_3 storage)	250 KWh	0,02	5.00	
1.20	Cooling Water	150 m^3	0,008	1.20	
2.00	Others (including bags)			7.00	
15.60				50.90	1,679,700
	Semivariable Costs				
7.00	Operating Labour & Supervision			9.50	
1.40	Maintenance (3% of fixed capital costs)			3.00	
3.00	Plant Overhead (40% of labour)			3.80	
11.40				16.30	537,900
	Fixed Costs				
1.00	Taxes and insurance (1% of fixed capital costs)			1.00	
3.00	Depreciation (10% of fixed capital costs)			11.00	
4.00				12.00	396,000
31.00	Total Cost of Production			79.20	2,613,600
= 40 % of total cost of production	Total Sales - Alternative I (present CIF prices)			90.30	2,979,900
	Total Sales - Alternative II (future marginal CIF prices)			84.30	2,780,000
	Total Profit (before major taxes and interest on total invested capital) A-I			11.10	366,300
	Total Profit (before major taxes and interest on total invested capital) A-II			5.10	166,400

XI - Estimated Profitability of Production of Prilled Urea in polyethylene bags

1. - [illegible] production rate - calculation of break-even point on annual basis.

(a) Costs

Variable costs	US$ 1,679,000
Semivariable costs	US$ 537,900
Fixed costs	US$ 396,000
Total cost of production	US$ 2,613,000

(b) Sales

33,000 tons of urea in bags at US$ 90,30 (alternative I)	US$ 2,979,900
33,000 tons of urea in bags at US$ 84,30 (alternative II)	US$ 2,780,000

(c) Total Profit

Alternative I - (before major taxes and interest)	US$ 366,000
Alternative II - (before major taxes and interest)	US$ 166,000

2. - Calculation of Value Added on Plant Basis — US$ [illegible] = 40 % of total costs of production.

(Remark: The calculation of the Value added was made from the National Economy point of view, i.e. inclusive all components of costs accruing in [illegible])

3. - Economic Evaluation

Alternative I - The percent return on invested capital $\frac{366,000}{4,070,000}$ = [illegible] %

Alternative II - The percent return on invested capital $\frac{166,000}{4,070,000}$ = [illegible] %

Alternative I - Break-even point 60 % = 19,800 ton/year capacity

Alternative II - Break-even point 76 % = 25,000 ton/year capacity

4. - Foreign Exchange Saving on 1 ton Urea produced locally

Alternative I — US$ 31.00 plus . 11.10 = US$ 42.10

Alternative II — US$ 31.00 plus . [illegible].10 = US$ [illegible]5.10

5. - Total Annual Foreign Exchange Savings

Alternative I — US$ 1,309,000

Alternative II — US$ 1,19[illegible],300

6. - Price advantage on 1 ton Urea produced locally:

Alternative I — US$ 11.10

Alternative II — US$ [illegible].10

XII Cost of Production, Profitability and Economic Features

From the discussions held in Madagascar an apprehension was frequently felt that the price of locally produced urea would be higher, than the price of imported urea. Reasons for this fear were:

- Relatively low production capacity envisaged for the urea plant in Madagascar, which has an significant effect on both the fixed capital investments and the operating costs per ton of installed capacity;
- Insufficiency in most of the suitable raw materials for urea manufacture;
- Declining trend of CIF Tamatave prices for imported fertilisers in the past.

All this is true and difficult to argue with, but on the other hand, Madagascar in its remote geographical location may take advantage of the elimination of shipping costs if the fertilisers are not imported from Europe or other distant sources. Messrs. A.D. Little in their study of proposed fertiliser plant in Mauritius offered the following brief analyses which applies similarly to Madagascar:

"Mauritius, in its isolated location, provides a convenient dumping ground for the fertilisers of European Companies which have excess stock in the off-season. Purchasing fertiliser in this way allows Mauritius to take advantage of distressed merchandise in some years, but also forces it to pay premium prices when European markets are good".

In other words, there is to be expected a great instability of fertiliser prices instead of continously decreasing price trend for imported fertilisers usedin Madagascar.

If urea is produced in Madagascar, the manufacturing plant will make readily available fertilisers at stable prices with a certain price advantage which may be also used as a potential resource for government fertiliser subsidy. Supposing the market price of imported urea declines in the future, there will still be about 40 percent value added of production costs accrued in Madagascar, if urea is produced locally.

This in turn means an important saving of foreign exchange for the economy of Madagascar.

There are two very important components of urea production cost in Madagascar, i.e. imported ammonia and locally available bunker "C" fuel oil, which is to be used for production of process steam and process carbon dioxide from flue gas.

The problem of the economy of obtaining [illegible] from [illegible] Gulf urea has already been discussed. The [illegible] oil refinery in Trentuwe is not only [illegible], but [illegible] also [illegible] the higher percentage of sulphur ([illegible] 3.[illegible] by weight). This [illegible] difficult problem of sulphur removal [illegible] in higher investment and operation cost of [illegible] the profitability of urea manufacture could be attained if [illegible] obtained [illegible] and with a less content of sulphur.

Besides the production cost, [illegible] the selling price is an important factor for the profitability calculation. Therefore, two alternatives were conceived, I and II, [illegible] differing from the other by the level of estimated urea selling price. In the first alternative, the lowest CIF Trentuwe price of prilled urea in bags of [illegible], [illegible] the government's evaluation of the [illegible] for international [illegible] supplies of fertilizers, was taken into account. In the second alternative, the CIF Trentuwe price of prilled urea in bags of [illegible] 84,[illegible] as a basis for economic evaluation. The price of [illegible] 84,[illegible]/ton prilled urea was taken as a marginal from the viewpoint of the plant's profitability. Nonetheless, it cannot be said by sure that this 6.6 percent below the existing market price of imported urea is sufficient to make up with possible future decrease of international urea prices.

There is still some profit margin available, upto the extent of production cost of $ 79.[illegible]/ton of prilled urea, when the selling price would equal the production cost allowing for no profit [illegible]. This issue was discussed at length with the government's officials in [illegible]. The leading economic advisors to the government expressed their views that it would be acceptable to establish the urea production plant, even if its selling price of urea for the local market would be higher than the urea CIF import price. In their opinion, the advantage of the urea production plant to be constructed in [illegible] should be measured from the national economy's point of view, i.e., taking into account the aspect of value added and subsequent foreign exchange savings as well as other unmeasurable benefits. These should be the guiding factors whether to erect this plant or not.

As it has already been mentioned before, the production cost of prilled urea in bags, using imported ammonia at $ 40.00/ton CIF Tamatave and locally produced gaseous carbon dioxide at 18.80/ton, would be $ 79.20/ton. This price compares favourably with the lowest present CIF price of imported urea of $ 90.30/ton (Alternative I) allowing thus for an estimated price advantage of about $ 11.10, i.e. 12.3 percent. Foreign exchange saving on 1 ton locally produced urea would be $ 42.10, which turns out to be $ 1,389,000 annually. The return on invested capital before taxes and interest would be 7.4 percent and the break-even point 60 percent of the full design capacity.

If the lower selling price of $ 84.30/ton of prilled urea (Alternative II) is taken into account, the estimated price advantage would be $ 5.10/ton = 6 percent. Foreign exchange saving on 1 ton of locally produced urea would be $ 36.10 which makes $ 1,191,300/year. The return on invested capital before taxes and interest would be 3.4 percent and the break-even point 75 percent of the full design capacity.

To be on the safer side, the Alternative II with estimated CIF Tamatave price of $ 84.30/ton of prilled urea will be taken as a basis for the subsequent conclusions and recommendations.

All above mentioned estimated profitability indices were assumed at the plant full design capacity, i.e. 33,000 tons/year of prilled urea. The effect of the variation of production rate on production cost, profits before taxes and interest etc. is apparent from Figure 4 Break-even Point of Prilled Urea Manufacturing Plant in Madagascar.

XIII - ORGANISATION CHART - STAFFING OF THE PROJECT

- General Manager (1)
- Office (2)
- Secretariat (2)
- Works Manager (1)
- Personnel (1)
- Public Relations (1)
- Transport (1) — 9

- Maintenance and Safety (4)
  - Mechanical (8)
  - Electrical (4)
  - Instrumentation (4)
  - Workshop (5)
- Production (5)
  - Operators (16)
- Chemical Control (2)
  - Chemists (4)
- Commercial (1) — 12
  - Purchase (2)
  - Sales (3)
  - Stores (1)
  - Account (3)
  - Admini. (3)
  - Typists (5) — 56

In total	77
Daily labour-maintenance	20
Workshop	10
Production	24
Storage	4
Laboratory	4
Transport	6
Grand Total	145

XIV. - FELLOWSHIPS

FELLOWSHIPS OR TRAINING OF MADAGASCAR NATIONALS.

Number	Profession	Man-months
1	Works Manager	6
2	Maintenance	24
3	Production	27
1	Process	12
1	Workshop	6
1	Instrumentation	6
2	Commercial	12
11	in total	93

US$ 31,000
travel $ 11,000
total US$ 42,000

LOCAL SALARIES OF FELLOWS SENT ABROAD FOR TRAINING

Number	Profession	Months	Rate $/month	In total $
1	Works Manager	6	500	3,000
2	Maintenance	24	300	7,200
3	Production	27	300	8,100
1	Process	12	350	4,200
1	Workshop	6	200	1,200
1	Instruments	6	250	1,500
2	Commercial	12	400	4,800
		93		30,000

FELLOWS PRESENT DURING THE CONSTRUCTION AND TRIAL RUN OF UREA PLANT

Number	Profession	Months	Rate $/month	In total $
1	Works Manager	24	500	12,000
2	Maintenance	32	300	9,600
3	Production	36	300	10,800
1	Process	12	350	4,200
1	Workshop	16	200	3,200
1	Instruments	12	250	3,000
2	Commercial	10	400	4,000
		144		47,800

XV **Comments on Supply of N-P-K slurries from Mauritius to Madagascar**

In part A of this Report the possibility of supply to Madagascar of N-P-K slurries produced in Mauritius was raised. This certainly interesting idea is primarily beneficial to Mauritius. All depends on the level of the CIF Tamatave prices for selected N-P-K slurries shipped from Mauritius to Madagascar and on overall aspects of the development of Madagascar's economy. It is believed, in spite of even lower prices for N-P-K slurries than the mentioned ones in Part A of this Report, this proposal does not meet with the conditions prevailing in Madagascar. Madagascar is a big country with excellent prospects of almost unlimited development of agriculture which merits its own fertiliser manufacture.

Until the local nitrogen fertiliser and synthetic cattle feed market develop to the extent of supporting the construction of an urea manufacturing plant, it is recommended to maintain and increase the capacity of the proposed N-P-K dry mixing units by using locally produced bone phosphate.

Later on, locally produced urea could be used as a synthetic cattle feed component, straight fertiliser and N-P-K mixing component. The shift to the ammoniated mixed fertilisers by wet mixing of fertiliser primary elements, should be the third stage of development.

A different situation is encountered in Réunion. This mountainous island has got only limited land suitable for agriculture, which has already been under plough and well fertilised. The future fertiliser use could be slightly raised but only to certain limits. In such a case, it is for Réunion worth to analyse the idea of importing N-P-K slurries from Mauritius to convert them locally into granulated bagged N-P-K fertilisers.

XVI **PROJECT DEVELOPMENT**

Throughout this Report it has been stressed that Madagascar is not placed ideally for nitrogen based fertiliser manufacture. The liquid ammonia has to be imported and when manufacturing urea, carbon dioxide must be produced on the spot from the expensive residual fuel oil. The economic evaluation on venture basis is not very optimistic, especially if CIF Tamatave price of imported urea decreases in the future. On the other hand, convincing advantages of urea manufacture in Madagascar from the national economy's point of view are evident.

Another important aspect is the volume of the local fertiliser consumption market which would substantiate the manufacture of urea in Madagascar. From Table 11 - Consumption of Fertiliser in Madagascar (on rice and other cultures) and Figure 4 - Break-Even Point of Prilled Urea Manufacturing Plant in Madagascar, it is apparent that the consumption of fertiliser is still low in Madagascar. The break through in fertiliser consumption should take place during the years 1968 and 1969 with an active support from the Government of Madagascar. If the quantities of fertiliser mentioned in the government's call for international bids were really consumed in such a period, then the chief target would be accomplished.

After that it would be up to the government's officials to follow the abovementioned Table 11 and see whether the projected nitrogen nutrient consumption was met or not. In this connexion it should be further observed that the nitrogen consumption is fully met by urea, i.e. urea should replace all other straight or complex fertilisers containing nitrogen nutrient to be consumed in Madagascar. If these prerequisitions are met and the actual nitrogen nutrient consumption follows the projections made in this Report, the urea plant could be put on stream in 1972, leaving about 6,360 tons of urea for export and cattle breeding at a break-even point of , percent of the plant's annual design capacity. If the local nitrogen nutrient consumption is less than projected in this report, or if the export outlets are not prospective, or if the urea is not used for cattle breeding, then the establishment of the plant should be postponed at a later date.

The confrontation of projected nitrogen nutrient consumption including break-even point charts, with the actual consumption and more accurate CIF Tamatave prices for urea known at a time of such a comparison, will enable the government's officials to take a proper decision about the timing of the plant's construction.

It has to be noted that if all indices are considered to be favourable, the decision to start with the construction of the plant should be taken 2 to 3 years ahead of the target date for the putting on stream of the plant.

This because the preparatory steps as design, supply and construction of the plant take about 2 to 3 years.

XVIII CONCLUSIONS AND RECOMMENDATIONS

The conclusions and recommendations presented here are to be considered as complementary to those expressed in Part "A" of the Report and are as follows:

1) Madagascar is not very well placed for the production of nitrogenous fertilisers, lacking both in most advantageous raw materials and larger local consumption market for these fertilisers. This makes it necessary to conceive the urea plant almost exclusively for local consumption only. Thus limiting the production capacity much below the elsewhere at present built similar production facilities. Consequently, the costs of production are higher than those in the more favourably placed countries which are already benefitting from economies of scale.

2) On the other hand, Madagascar in its remote geographical location may take advantage of the elimination of shipping costs, if the fertilisers are not imported from Europe or other distant sources.

3) If urea is produced in Madagascar, the manufacturing plant will make readily available fertilisers at stable prices with a certain price advantage under present market conditions.

4) The urea produced locally will certainly have a considerable impact on a steady development of Madagascar's agriculture, namely stepping up the paddy yields and providing the big cattle population with additional protein intake (see separate cursory report on using urea for cattle feeding).

5) Consequently, the advantage of an urea production plant in Madagascar should be measured not only on plant basis but from the national economy's point of view, taking into account the value added and all other ancillary measurable and unmeasurable benefits accruing in the country.

6) Much attention was paid to the production and/or importation of ammonia. The foreign exchange requirements for importing capital equipment for ammonia plant was weighed against the foreign exchange costs of importing ammonia. After careful consideration and arriving at the

conclusion that 1 ton of locally produced ammonia would cost about $ 95.oo, the importation of ammonia from countries with large and cheap resources (Gulf area) of raw materials for ammonia production is recommended.

7) If ammonia is imported, both the quantity required and the time schedule of ammonia shipments will affect the pertaining freight costs. The price of shipped ammonia should be on CIF Tamatave basis, keeping the eventual supplier responsible for finding tankers for shipment of ammonia to Madagascar. In such a case, the plant administration, in its role of a buyer, would not be bothered to find ammonia transport facilities and the supplier will be free to find other buyers in the area to take the remainings of a full tanker load.

In spite of this primary responsibility of the supplier, it may help considerably, if other potential buyers of ammonia in the area co-ordinate their purchases to strengthen their negotiation position. Furthermore, it will be easier for the administration of the plant to get short or medium term credits from the supplier than to obtain local credit to finance the freight component of the CIF price. The interest of the supplier and to some extent also of the buyer, will be to contract the shipments of ammonia on a long term basis (upto 10 years). This will enable the supplier to plan in advance the load of ammonia tankers aiming at the lowest possible freight cost. The buyer, however, must be protected against the loss he may suffer if ammonia becomes available from other suppliers or at a lower price during the term of the contract.

A remedy to such an event may be a clause which makes it possible for the buyer to re-open the price negotiations with the supplier at specified dates in the future after the contract is signed. It is obvious, that the conditions of the contract will be more favourable to the buyer if there would be a so-called "buyers market", i.e. a fair competition in ammonia supply. It is recommended to the administration of the plant to pay serious attention and get first class advisory assistance when formulating the supply contract for ammonia.

8) The production costs of carbon dioxide are largely dependable on the price of the residual fuel oil from the next door oil refinery. It would be beneficial to the project if the government or the administration of the plant could negotiate a lower price of fuel oil to be used for steam generation and carbon dioxide manufacture. The ultimate price of fuel oil should be less than $ 12/M ton without any dues and taxes.

9) If the project is coming through, it is essential to negotiate with the next door oil refinery which utilities may be available to the urea plant from there. The oil refinery is reported to be expanded, and co-ordinated action with urea project may save some investment costs for both interested parties.

10) A capacity of 33,000 tons/year of prilled urea, in 330 stream days, three shift operation is recommended.

11) The capital cost of the project is estimated at US $ 4,878,000 out of which the foreign component is about US $ 3,742,000.

12) The cost of production of prilled urea using imported ammonia at US $ 40/ton CIF Tamatave and locally produced gaseous carbon dioxide at US $ 18.80/ton, would be US $ 79.20/ton at a full design capacity, compared to at present imported CIF price of US$ 90.30. Consequently, for 1 ton of prilled urea produced locally and destinated to be consumed in Madagascar itself, there will be a price advantage of about US$ 11.10. Foreign exchange saving on 1 ton locally produced urea would be US $ 42.10, which turns out to be US $ 1,389,000 per year. The return on invested capital, before taxes and interest, would be 7.4 percent and the break-even point 60 percent of the full design capacity.

13) The working capital will be largely influenced by the frequency of ammonia supply, and the quantity of stored finished urea. The other components of the working capital are of much less importance.

14) The type of industry is new to the country and therefore will give rise to various problems, especially in the operation phase of the project, purchase of ammonia and marketing of the product. The involvement of a firm having experience in this field and in the marketing of the same or similar product should be very carefully considered. The project management should be associated with the preparation and erection of the plant from the very beginning (contract negotiations, selection of successful contractor, programming and control of the implementation of the project, etc.), and should enjoy maximum support and stability.

15) The plant should be located in Tamatave Harbour Area or at least, in the industrial zone, opposite the existing oil refinery. The storage of imported ammonia must be situated right in the harbour area as close as possible to the berth of anchoring of the ammonia tanker. The soil bearing capacity is reported to be 2.5 kg per sq/m which is satisfactory. As the plant location is close to the Tamatave city, all employees can live in Tamatave and no housing needs to be constructed at the site. Transport of personnel will also not be a problem.

16) The project will train engineers, operators, chemists and skilled workmen and will thus lay further foundations to the development of chemical industry in the country.

17) The utilisation of the industrial area of the port and port facilities will help the economy of the country.

18) At the present stage it is difficult to propose the procedure of the development of this project.

It is not yet known which will be the kind of approach of the government to this project. Nevertheless, there are three possibilities available:

a) The project will be fully integrated into the public sector;
b) The project will be a joint venture of the public and private sector with government's major equity participation;

e) The project will be a joint venture of the public and private sector with government's minor equity participation.

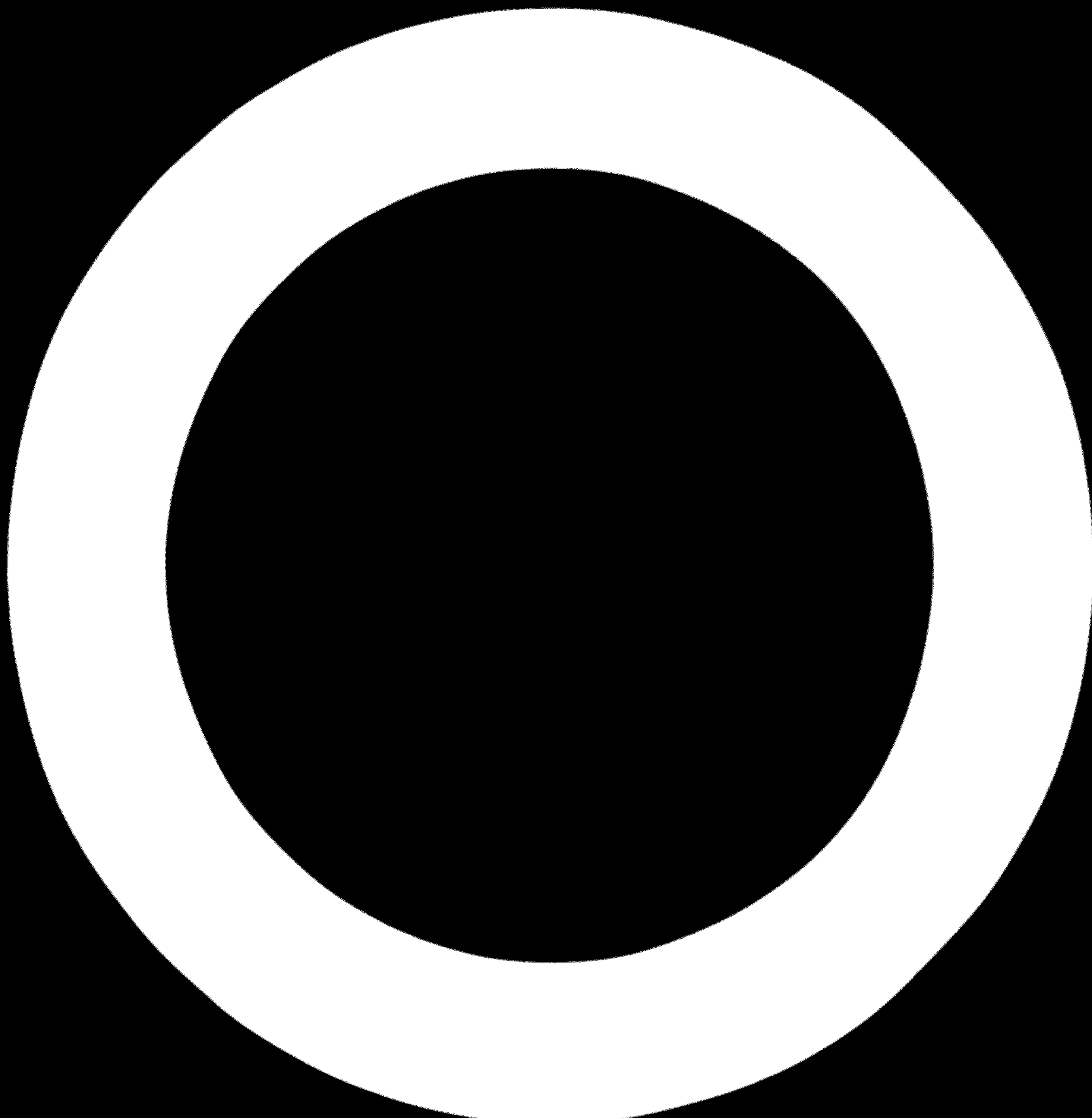
The desired alternative will have a bearing on any further possible involvement of United Nations in helping to develop this Project.

Whatever is the outcome of the set-up of the plant, one thing must be realised:

i) Locally produced urea must replace all other straight or complex fertilisers imported at present;

ii) The plant has to be guaranteed of a monopoly position in Madagascar if its production costs are competitive with CIF imported prices, seen from the national point of view;

iii) If the aspect of value added is accepted as a leading factor for the decision to build or not to build the plant, a local market price of urea has to be fixed in a way as to allow for a reasonable profit. Otherwise, there would be a limited chance to attract private capital participation. This is not something new but rather an usual practice, even in developed countries.



NOTES ON OIL REFINERY IN MADAGASCAR SITUATED AT TAMATAVE PORT

The Oil Refinery at Tamatave is operated by the Company called "Société Malgache de Raffinage" which has a [illegible] capital of US$ 3 million in March 1966.

The Government of Madagascar holds 15 percent equity and the balance of the share capital is divided as follows:

- 8 % Société des Pétroles de Madagascar (SPM)
- 27 % Groupement des Exploitants Pétroliers (GEP)
- 13.7 % Esso Standard Eastern Inc. (ESSO)
- 12.1 % California Texas Oil Corporation (CALTEX)
- 12.9 % Bataafsche Petroleum Maatschappij (SHELL)
- and British Petrol (BP)
- 6.5 % Compagnie Française des Pétroles and Desmarais Frères (TOTAL)
- 4.8 % Agenzia Generale Italiana Petrolii (AGIP)

85.0 %

The above mentioned companies provide the refinery with crude oil (65 percent from Qatar, 18 percent from Kuwait, 17 percent from Saudi Arabia), undertake the processing of crude oil and distribution of final products in Madagascar, Réunion and Comores. They undertake, at the same time, the exportation of surplus residual fuel oil. The only other surplus product is refinery gas (about 5,000 tons/year).

The delivery contract on turn-key basis was signed with the French contractors Messrs. TECHNIP who won this job in international competition. The refinery was put on stream on 10 October 1966 after a construction period of about 18 months.

The refinery is situated along the railway line Tamatave–Tananarive, near the port on the surface of 30 hectares. The capacity of the refinery is 540,000 tons/year of processed Middle East crude. At present, the refinery is working at full design capacity and there are plans to expand the production after 1970. The refinery is composed of an atmospheric distillation (capacity 540,000 tons/year) which turns out light cuts, gas oil and fuel oil. Besides the atmospheric distillation there is also a hydrodesulphurisation unit (capacity 160,000 tons/year) which takes out the sulphur compounds from light cut mentioned above, fractionating unit (capacity 160,000 tons/year) producing gases utilised in the refinery, butane being commercialised after sweetening treatment. Stabilised light gasoline and heavy gasoline are to be further treated in the catalytic reforming unit to increase substantially its octane number (capacity 70,000 tons/year). The designed capacity of the refinery corresponds to the "Light Arabian Crude" but the "Hassi Messaoud Crude" could be processed as well at a little decreased production capacity.

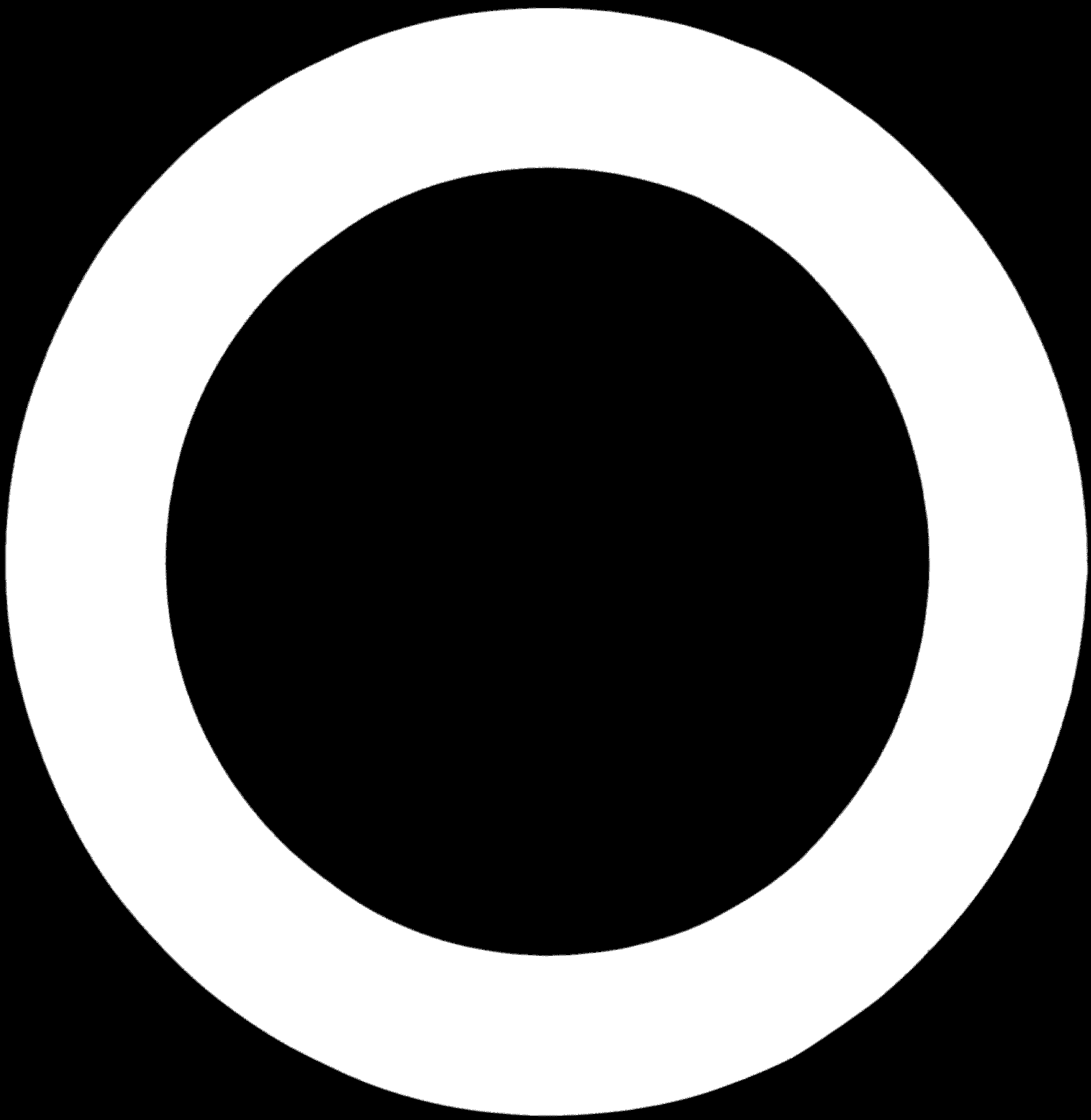
The total capacity of the tank farm is 130,120 cubic meters (75,750 cubic meters for storing crude oil, 6,010 cubic meters for intermediary products, 48,240 cubic meters for finished products and 120 cubic meters for butane).

The refinery products are loaded on RTC (railway transport cars) road tankers and barges. A certain quantity of products is pumped through product pipelines to the port of Tamatave to be loaded on ships and transported to Réunion and Comores. The fuel oil in excess (150,000 tons/year) is exported by crude oil tankers using for this purpose the facilities for discharging the crude oil.

The refinery has further got its own utilities' system which contains:

- 1 sweet water pumping station including the water treatment for boilers (capacity 15 cubic meters/hour);
- 2 boilers for production of high pressure steam (capacity 16 tons/hour each);
- 3 diesel generating sets 220/380 V (capacity 900 KVA each);
- 1 electric distribution system with the possibility of connection to the city grid, if necessary;
- 3 air compressors for instrumentation air and other services (total capacity 1,200 cubic meters/hour);
- 1 pumping station for cooling water (capacity 130 cubic meters/hour);
- 1 waste water purification system (capacity 350 cubic meters/hour)
- 1 maintenance workshop with the spare parts storeroom.

In 1966, the refinery personnel were composed of 21 expatriated experts (7 engineers, 14 foremen, 1 technician and 5 highly qualified workers), and 163 locally recruited persons, (3 engineers, 13 foremen, 64 skilled workers and 83 semiskilled and unskilled workers). Many workers have received in-plant training and a professional school was opened in Tamatave which is attended by 19 fellows at present.



ANNEX 2

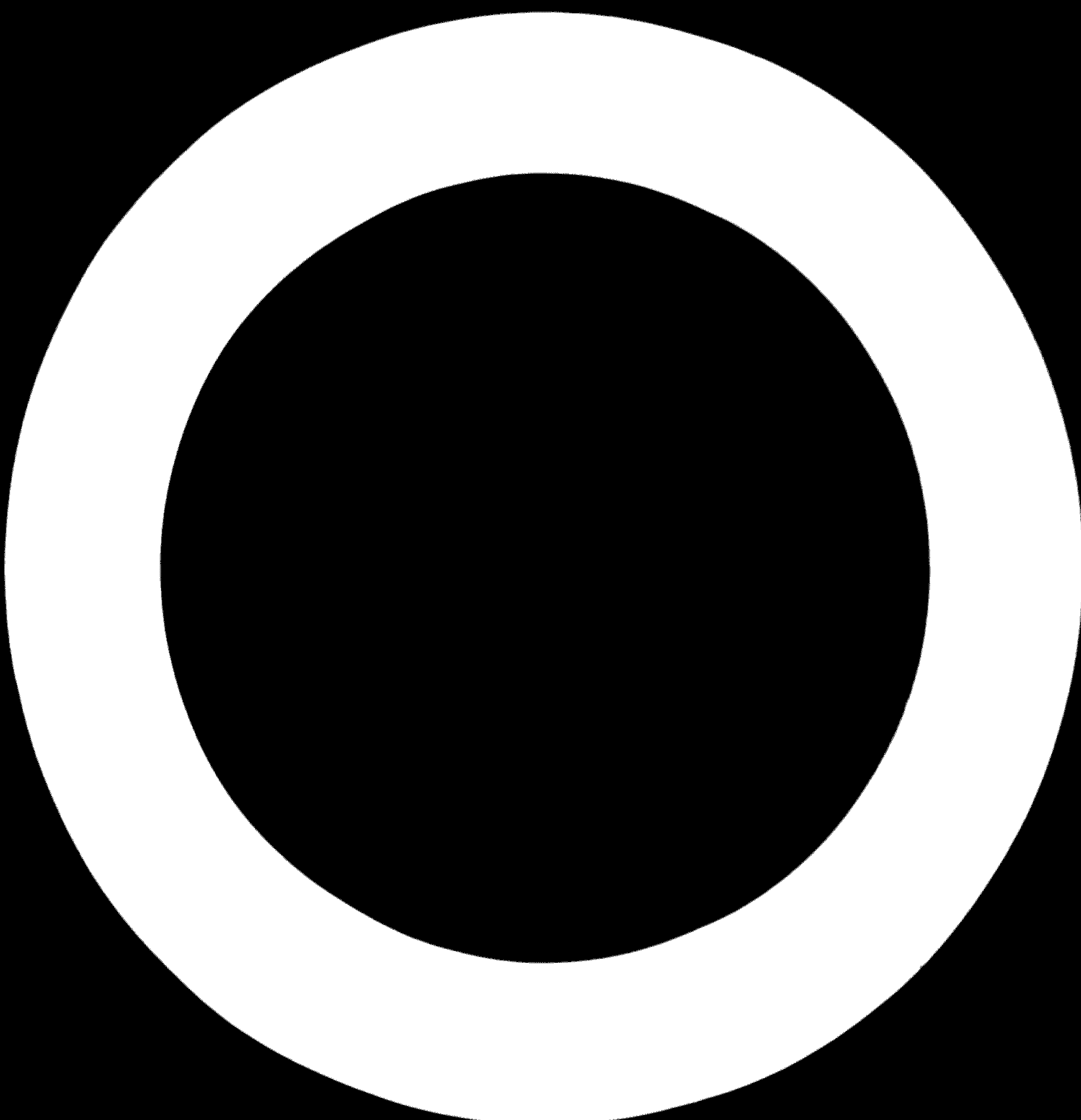
ANNEX 2

TECHNICAL DATA

OIL REFINERY AT [illegible]

Light Gasoline –	density at 15 °C	0.[illegible]
	IP 38 °C,	FP 115°
	% S	0.00[illegible] by weight
Residual fuel Oil	density	0.930 upto 0.940
	viscosity 200 upto 300 cst at 30 °C	
	pourpoint	+20 °C
	heating value	10,000 Kcal/kg
	% S	3.[illegible] by weight
Refinery Gas	H_2	35 – 45 %
	C_1	10 – 15 %
	C_2	10 – 15 %
	C_3	20 – 25 %
	iC_4	4 – [illegible] %
	nC_4	[illegible] – [illegible] %
	Heating value	12,000 Kcal/kg.

The soil conditions are satisfactory, no piling is necessary.



[illegible]

[illegible]

Item	Description
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Item	Description
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18	[illegible]

[illegible]

Item	Description
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26	[illegible]
27	[illegible]

Item	Description
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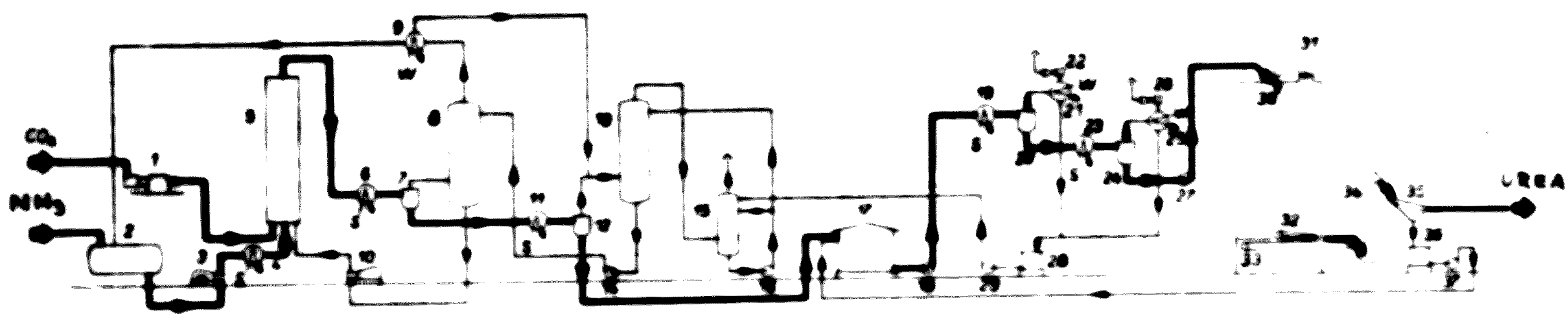

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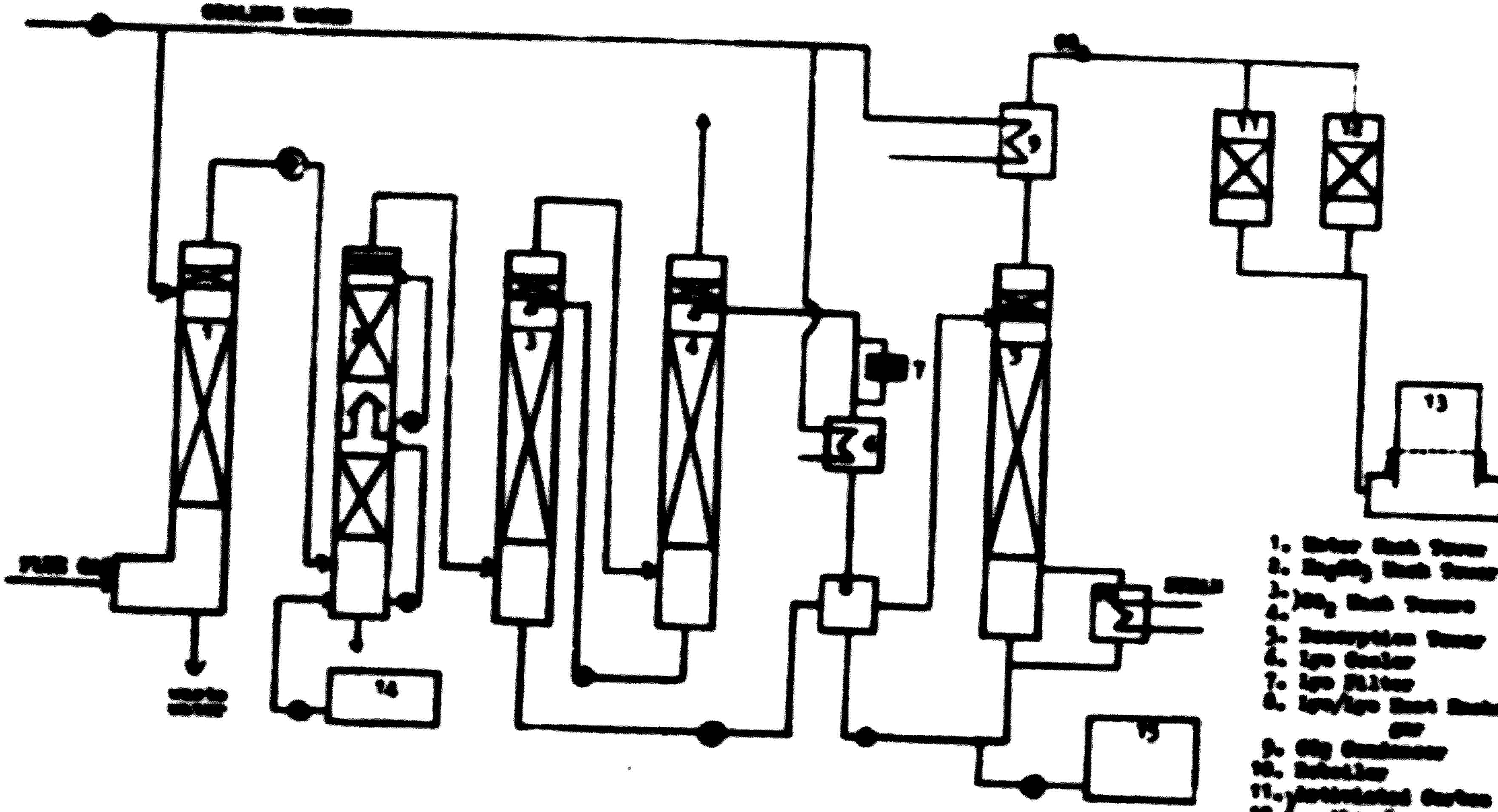
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TAMATAVE

[illegible]

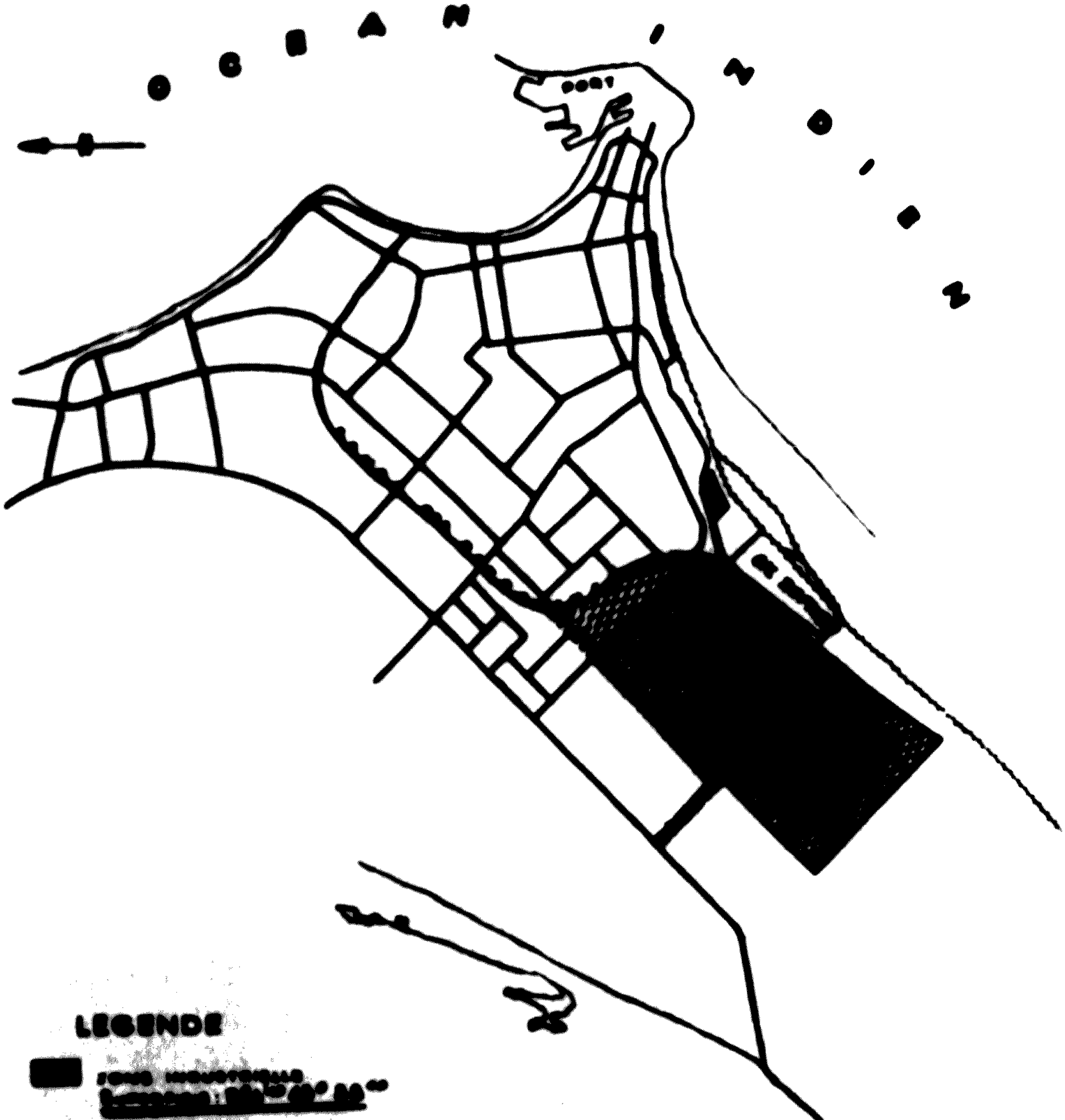
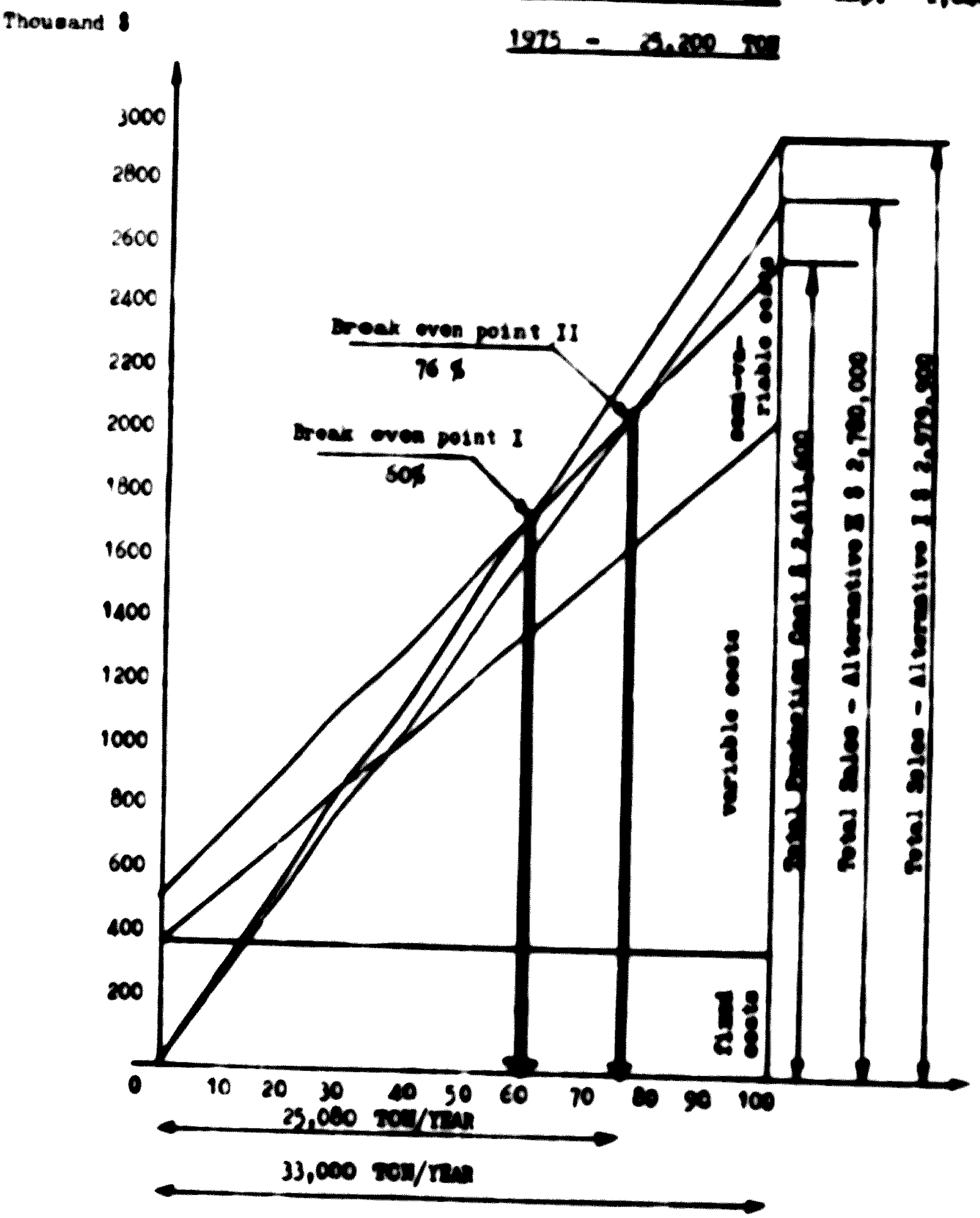


FIGURE 4 **BREAK-EVEN POINT OF PRILLED UREA MANUFACTURING PLANT IN MADAGASCAR**

ANNUAL CONSUMPTION

1969 - 11,900 TON		
1970 - 14,400 "		
	Imp.	10,680 TON
1971 - 16,560 TON		
1972 - 18,720 "	Imp.	6,360 TON
1973 - 20,880 TON	Imp.	4,200 TON
1974 - 23,040 TON	Imp.	2,040 TON
1975 - 25,200 TON		



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