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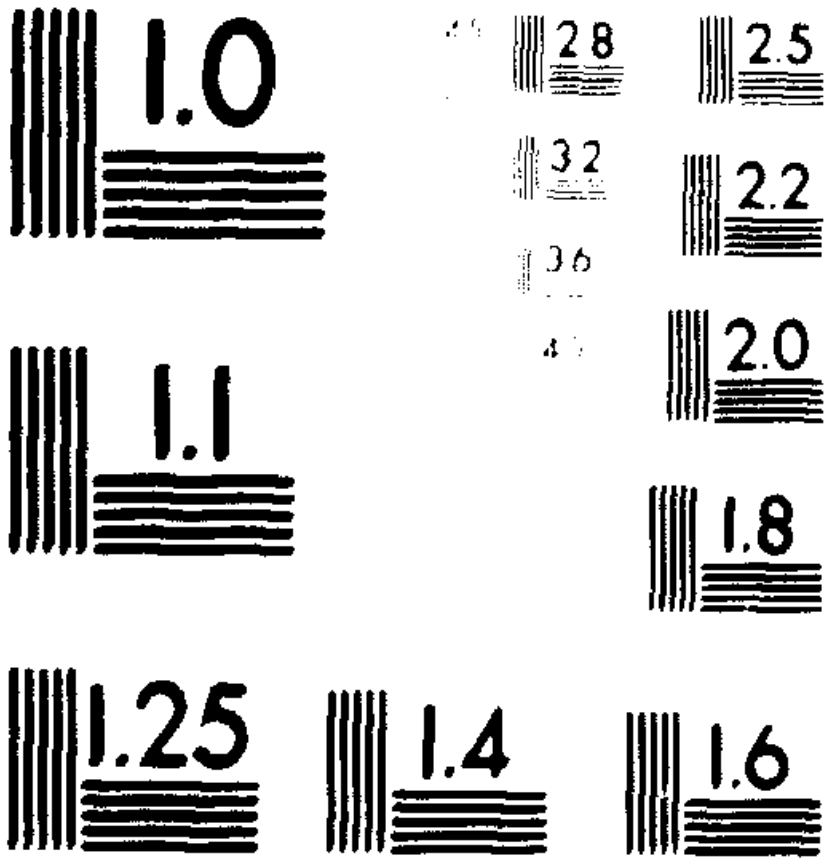

UNITED NATIONS INDUSTRIAL DEVELOPMENT PROGRAM

13202

CIMENT PLANT IN AMBOANIO, MADAGASCAR.

SI/MAG/82/801

FEASIBILITY STUDY

Prepared for the Government of Madagascar by the United Nations Industrial Development Organization.

POLYTECHNA PRAGUE
KERAMOPROJEKT TRENČÍN
Czechoslovakia

December 1983

INTRODUCTION

This Feasibility Study has been prepared on demand by UNIDO , Vienna .

The works were financed by UNIDO within the contract signed between UNIDO and PZO POLYTECHNA , Prague , Czechoslovakia .

In order to prepare this study , a mission composed from experts-consultants rendered to Madagascar in February/ March 1983 .

The mission was composed from the following members :

- Ivan T. Horvath , team leader , expert in cement industry and industrial economy
- Anton Mikula , technologist / mechanical engineer
- Igor Kostelný , industrial / mechanical engineer

During their stay in Madagascar the mission collected various data and made following investigations :

- Present and future cement supply and demand in Madagascar ;
- Existing geological and other data on raw materials and coal ;
- Yugoslav proposal on extension of the cement plant in Amboanio ;
- Examination of relevant studies concerning the situation in cement production , supply and demand , coal supply and market of cement ;

- Available documents and data provided by Malagasy authorities concerning to project financing and investment policy .

In order to obtain a genuine idea on cement industry of Madagascar , the UNIDO mission paid visit to the building site of the IBITY - ANTSIRABE cement plant and to the existing cement plant in AMBOANIO - MAHAJANGA .

The members of the UNIDO mission express their thankfullness to the engineers and specialists of the Ministère de l'Industrie et du Commerce , Direction des Mines et d' Energie as well as of other competent Malagasy authorities for their interest for the project and their amiability and cooperation .

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1.1.1. Promoter

Tanindrazana - Tolom - Piavotana - Fahafahana
Ministry of Industries and Commerce
Antananarivo
Democratic Republic of Madagascar

1.1.2. Project Orientation

Further exploitation of large deposits of good quality raw materials suitable for cement production : limestone and marl.

Increase of cement production capacity to meet local requirements for housing programme , social and industrial construction programme , development of infrastructure .

1.1.3. Market Orientation

Production of the planned cement plant is oriented to local market to meet local demands . Cement exportation is not envisaged.

1.1.4. Economic and Industrial Policies Supporting the Project

In order to accelerate industrialization of the Malagasy Democtratic Republic , it is essential to establish an adequate basis of construction materials , especially of cement .

Taking account of territorial distribution of cement production capacities , the Government adopted strategy to erect three new cement plants . The central part of the Island will by supplied with cement from the ANTSIRABE - IBITY plant , the northern part from the MAHAJANGA - AMBOANIO plant and the southern

part of the Island shall be supplied from the envisaged TOLIARY plant .

Implementation of the cement plant project in AMBOANIO is justified by the facts given below :

- In AMBOANIO , there are considerable deposits of essential raw materials suitable for cement production - - limestone and marl , both of good quality .

- The machinery and equipment of the existing cement plant in Amboanio is out - of - date and show a rather advanced degree of wear . There is a risk that the plant shall be shut down within 2 ÷ 3 years ..

- For operational purposes of the new cement plant , it is convenient to make use of the skill of personnel of the existing plant ..

- The new cement plant may use the auxiliary equipment and the infrastructure of the existing plant ..

1.1.3. Project Background

The Amboanio cement plant has been in operation since 1934 with initial production capacity of 30 000 tons of cement per year ..

The plant was rebuilt in 1956 to the production capacity of 70 000 tons per year ..

The machinery and equipment has been in operation till now and at present shows already an advanced degree of wear ..

The present production of 35 000 tons per year / 1982 / is very low and economically inefficient due to obsolete machinery and equipment .

Malagasy Government decided to extend the production capacity by an additional kiln installation , wet process , to a capacity of 1 250 tons per day .
The installation should have been supplied by the Yugoslav INGRA Company .

The Yugoslav project proposed production of 500 000 tons of cement per year , thereof 50 % for exportation .

The Malagasy Government abandoned the project because of high investment and production costs and unfavourable conditions for exportation in the region of the Indian Ocean.

This Study takes into consideration all the existing conditions and proposes an optimum plant capacity and up - to - - date technical and economical approach to the problem of cement production in Madagascar in two alternatives .

1.2. Market and Plant Capacity

1.2.1. Demand

Production of the planned Amboanio cement plant is expected to enter the market in 1988 . That year , total demand for cement in Madagascar is estimated to some 380 ÷ 440 thousand tons .

At that time , in Madagascar cement will be produced by :

- the Ibity - Antsirabé cement plant	180 000 tons per year
- the planned Amboanio cement plant	250 000 tons "
TOTAL	430 000 tons per year

This implies production of cement will meet expected demand for cement .

Exports of cement are not envisaged .

1.2.2. Production Programme

After reaching the designed parameters the planned cement plant will produce 250 000 tons of cement per year / 220 000 tons of clinker per year /.

Cement will meet the requirements of the French Standard - - AFNOR NF - P 15 - 301 / Dec. 1981 / , class 45 .

1.2.3. Plant Capacity

Production of 250 000 tons of cement per year may be provided by one of two alternatives of technical solution of the planned cement plant :

- Alternative 1 - rotary kiln with exchanger , 700 tons of clinker per day
- Alternative 2 - shaft kilns , 4 x 175 tons of clinker per day

Note :

There is also a possibility to implement the Alternative 2 in two stages :

- 1st stage : 2 shaft kilns 2 x 175 tons of clinker per day
- 2nd stage : further 2 shaft kilns 2 x 175 tons of clinker per day .

Evaluation of stage implementation of the project is , however , not taken into consideration hereinafter .

1.3. Materials and Inputs

Costs given hereinafter are in U.S. dollars / USD / with rate of exchange equivalent to :

1 USD = 400 MGF / Malagasy francs /

1.3.1. Raw Materials

Item	Requirement / tons per year /	Cost / thous. USD /
Limestone	166 640	own
Marl	203 375	own
Sand	11 109	69,43
Gypsum	10 500	614,25
Pozzolana	21 000	283,50
TOTAL COST		967,18

Limestone and marl are available in the quarry of the existing factory . Sand will be transported from Amborovy . Pozzolana is extracted at Antsirabé. Gypsum is imported from France .

1.3.2. Auxiliary Materials

Alternative 1

Item	Quantity / per year /	Unit	Cost / thous.USD /
Paper bags	5 300	1 000 pcs	1 033,5
Explosives	45	tons	324,0
Cap primers	6 000	pcs	3,9

Detonating fuse	10	1 000 m	4,6
Refractory	500	tons	307,5
Lining	60	tons	118,5
Grinding media	150	tons	150,0
TOTAL COST			1 942,0

Alternative 2

Item	Quantity /per year /	Unit	Cost /thous.USD/
Paper bags	5 300	1 000 pcs	1 033,5
Explosives	45	tons	324,0
Cap primers	6 000	pcs	3,9
Detonating fuse	10	1 000 m	4,6
Refractory	400	tons	246,0
Lining	40	tons	71,1
Grinding media	90	tons	90,0
TOTAL COST			1 753,1

Auxiliary materials will be imported .

1.3.3. Factory Supplies

Item	Quantity / per year/	Unit	Cost /thous.USD/
Lubricants	40	tons	60,0
Spare parts	120	tons	1 200,0
Other	50	tons	500,0
TOTAL COST			1 760,0

Lubricants and approximately one quarter of spare parts and other materials will be purchased in local market.

Approximately three quarters of spare parts and other materials will be imported.

1.3.4. Utilities

Alternative 1

Item	Quantity / per year /	Unit	Cost / thous.USD /
Diesel oil	500	1 000 l	175,0
Coal	43 530	tons	2 472,3
Electricity	27 500	1 000 kWh	2 075,0
Water	56 000	cu.m.	own
TOTAL COST			4 722,3

Alternative 2

Item	Quantity / per year /	Unit	Cost /thous. USD /
Diesel oil	500	1 000 l	175,0
Coal	33540	tons	2 247,18
Fuel oil	4 900	tons	1 470,0
Electricity	25 000	1 000 kWh	1 867,5
Water	63 000	cu.m.	own
TOTAL COST			5 759,68

Diesel oil will be purchased in local market from SOLIMA . Coal for Alt . 1 will be local from Sakoa deposits. Coal for Alt . 2 will have to be imported since local coal from Sakoa deposits is not suitable for burning in shaft kilns due to high content of volatiles . Fuel oil for Alt . 2 will be provided for drying of raw materials and will be purchased from SOLIMA .

Electricity will be supplied by two 20 kV power lines from the public electric grid / JIRAMA /.
Water will be supplied from the existing source /AMBATOMALAMA dam / situated 7 km from the site .

1.4. Location and Site

The cement plant will be constructed in the site of the existing cement plant in Amboanio where by the auxiliary and service buildings and offices as well as the existing infrastructure will be preserved and further utilized.

The existing production departments will be demolished and replaced by a new production installation .

It is proposed to restore operation of the abandoned port in Boanamary for the planned cement plant which will enable access of the cargo ships .

1.3. Project Engineering

1.5.1. Lay - out

The Feasibility Study of the new cement plant in Amboanio is prepared in two alternatives .

The alternative 1 features a short rotary kiln exchanger with capacity of 700 ton of clinker per day , dry process .

The alternative 2 features four shaft kilns installation with capacity of 4 x 175 tons of clinker per day , burning of clinker from black raw meal / ground raw mix and coal /.

The production equipment upstream of the kiln installation / crushing plant , stockpiling , raw grinding plant, homo silos / is designed for preparation of raw meal necessary for clinker burning .

The production equipment downstream of the kiln instalation / clinker and additives storage , cement grinding plant , cement silos and packing plant / is designed for manufacture of the final product - cement - and its despatching in 50 kg paper bags.

1.5.2. Selected Technology

Cement clinker , the essential semiproduct in cement production, will be burned from ground raw mix in the kiln .

Proposed composition of raw mix is , as follows :

Alt . 1		Alt . 2	
- limestone	45 %	- limestone	41,3 %
- marl	52 %	- marl	47,8 %
- sand	3 %	- sand	2,8 %
		- coal	8,1 %

In Alt . 1 , clinker is burned in a rotary kiln . Local black coal from Sakoa will be used as fuel . Imported coal is also utilizable .

In Alt. 2, clinker is burned from black raw meal in shaft kilns. Only imported black coal with content of volatiles less than 20 % may be used as fuel.

Clinker will be ground with 5 % addition of gypsum and 15 % addition of pozzolana.

Both production technologies are widely used in the world and have proved their better economy in consumption of fuel over the wet process.

No costs are required for acquisition of technology.

1.5.3. Selected Equipment

1.5.3.1. Production equipment

Item	Cost in thous. USD Alternative 1	Alternative 2
Limestone and marl quarry	643,6	643,6
Crushing plant and conveying	965,2	965,2
Stockpiling of raw materials	514,3	514,3
Raw grinding plant	2 921,2	3 400,8
Homogenization silos	651,0	753,8
Clinker burning	4 350,4	4 100,5
Clinker and additives storage	151,2	151,2
Coal storage	176,7	176,7
Coal grinding plant	442,5	-
Cement grinding plant	1 650,8	3 154,0
Cement silos	600,7	650,0
Packing and loading plant	600,4	615,9
Electrical equipment	960,0	1 060,0
Instrumentation and control	596,0	550,0
TOTAL COSTS	15 224,0	16 736,0

1.5.3.2. Auxiliary equipment

Item	Cost in thous. USD
Substation and power supply	1 150,0
Compressor unit	190,0
Water supply system	35,0
Lighting and communications	15,0
Port in Boanamary	632,0
Laboratory / extension /	25,0
Shops and warehouse /extension/	80,0
TOTAL COSTS	2 127,0

1.5.3.3. Service equipment

Item	Cost in thous. USD
Offices /extension /	15,0
Health centre	25,0
TOTAL COSTS	40,0

Cost of the complete machinery and equipment including spare parts, engineering, transport to the site, custom fees, and erections :

- Alternative 1 32 631,0 thousand USD
- Alternative 2 34 143,0 thousand USD

1.5.4. Civil Engineering Works

Total area of the site is 42 000 sq.m.
Built - up area is 16 450 sq.m.

- Total investment costs in civil engineering works	17 560 000 USD
thereof	
. in local currency	11 140 000 USD
. in foreign currency	6 420 000 USD
- Costs in land and site preparation	1 800 000 USD
- Costs in buildings	11 400 000 USD
- Costs in outdoor works	1 100 000 USD
- Additional costs / engineering, transport, custom /	3 260 000 USD

1.6. Plant Organization and Overhead Costs

1.6.1. Cement is produced in three individual groups of production departments :

- Raw materials preparation : includes extraction, crushing, stockpiling, grinding and drying and homogenization.
- Clinker burning : includes raw meal conveying, clinker burning, clinker and additives storage, coal storage and preparation.
- Cement production : includes grinding of clinker with additives, cement storage, packing and loading of cement.

1.6.2. Auxiliary and Service Departments

These departments are responsible for maintenance and trouble - free run of the machinery and equipment.

These are:
- shops and warehouse
- utilities
- laboratory
- offices, canteen, health centre, etc.

1.6.3. Overhead Costs

Item	Cost thous. USD Alt. 1	Alt. 2
Factory overhead	2 637,3	2 498,9
Administrative overhead	433,9	433,9
Depreciation	4 326,0	4 477,0
TOTAL COSTS	7 397,2	7 409,8

1.7. Manpower

1.7.1. Labour

Supervisors	20
skilled workers	116
semiskilled workers	14
unskilled workers	27
Total labour	177

Total wages	458 266 USD per year
thereof : - direct wages	191 818
- factory overhead	246 230
- administrative overhead	20 218

1.7.2. Staff

General manager	1
production manager	1
sales manager	1
secretary	1
technologist	4
accountant	2
purchaser	1
clerk	4
designer	2
typist	3
telephone operator	1
Total staff	21
Total salaries	113 724 USD per year

1.8. Implementation Scheduling

1.8.1. Duration of Plant Erection and Construction

1.8.1.1. Preparation period

- Precontractual and contractual negotiations :	5 months
- Contract enforcement :	2 months
TOTAL	7 months

1.8.1.2. Construction period

- project planning	12 months
- gross civil engineering works	9 months
- delivery of imported construction materials and supporting structures	6 months
- delivery of machinery and equipment	9 months
- erection of machinery and equipment	18 months
- final civil engineering works	18 months
- tests and trial run	3 months

Construction and erection of the cement plant will take 36 months .

1.8.2. Duration of Production Start - up

Start - up period will take two years until planned production capacity has been reached .

It is assumed that the plant will produce :

Average annual production rate during the first year of start - up will be 70 % .

Average annual production rate during the second year of start - up will be 90 % .

1.9. Financial and Economic Evaluation

1.9.1. Total Investment Costs

Item	in thous. USD Alt. 1	Alt. 2
Land	-	-
Site preparation	1 800	1 800
Civil engineering works	15 760	15 760
Machinery and equipment	32 631	34 143

Implementation incl. geological survey and interests during construction	10 872	11 187
Working capital	3 675	3 995
TOTAL	64 738	66 885

1.9.2. Project Financing

It is envisaged that the project will be financed, as follows:

- Local equity capital amounting to one third of the total investment costs.
- Long - term contractor's credit on a part of CIF Mahajanga deliveries on 8 years, repayment in annual instalments, interest rate 9,5 % p.a.
- Remaining investment costs will be financed by a local bank credit on 5 years, repayment in annual instalments, interest rate 10,5 %, 2 years grace period.

The proposed financing and the 2-year start - up period do not provide an active cash balance hence in the first year of implementation a government contribution amounting to 3 million USD is envisaged.

1.9.3. Production Costs

Item	in thous. USD Alt. 1	Alt. 2
Direct materials	4 982	6 226
Direct manpower	192	192
Factory overheads	4712	4 366

thereof - material	3 811	3 442
- wages	246	246
- other	655	678
Administrative overheads	434	434
thereof - salaries and wages	134	134
- materials	100	100
- other	200	200
Operating costs	10 320	11 218
Financial costs/interests/	1 594	1 643
Depreciation	4 326	4 477
Production costs	16 240	17 338
Sales revenue	21 250	21 250

The data as stated above provide projection for 100 % capacity, minus depreciation of costs during construction, plus variable interests on long - term loans.

1.9.4. Economic Evaluation

	Alt.1	Alt. 2
a - Commercial profitability analysis		
- simple rate of return	10,08 %	8,23 %
- net present value at 9 % in USD	2 818 000	- 3 665 000
- pay - back period in years	9,3	10,0
- internal rate of return	9,86 %	7,92 %
- liquidity analysis /cumulative net cash balance in USD /	46 861 000	35 294 000
- capital structure analysis /debt equity ratio /	2,0	2,0

b - National profitability analysis		
- net value added in USD	60 518 000	50 021 000
- net national value added in USD	52 239 000	41 309 000
- absolute efficiency test	3,428 l	1,338 l
- relative efficiency test	0,21	0,08
c - Uncertainty analysis		
- break-even point /in per cent of capacity utilization/	68,8 %	73,6 %
- sensitive analysis /in terms of IRR/		
1 - 5 % decrease of unit price	8,22 %	6,28 %
2 - 5 % increase of cash expenses	9,05 %	7,05 %
3 - 5 % decrease of investment cost	12,98 %	10,91 %
4 - a + b	7,40 %	5,37 %
5 - a + b + c	10,34 %	8,11 %

1.10. Conclusions

1.10.1. Construction of the new cement plant in Amboanio, Madagascar is both necessary and profitable project for development of the national economy.

1.10.2. The Feasibility Study has been prepared in two alternatives :

- Alternative 1 - cement plant with a rotary kiln, 700 tons of clinker per day, dry process
- Alternative 2 - cement plant with shaft kilns, 4 x 175 tons of clinker per day

1.10.3. Main Advantages of Proposed Project Alternatives

1.10.3.1. Alternative 1

- Possibility of utilization of local coal from Sakoa deposit
- Higher quality of burned clinker
- Lower investment costs
- Lower production costs
- Lower requirement of foreign currency
- Possibility of increase in clinker production by approx. 30 % by addition of a calcining exchanger to the rotary kiln
- Better results in terms of project economics .

1.10.3.2. Alternative 2

- Possibility of construction in stages /two and two kilns - model of the IBITY - - ANTSIRABÉ plant /
- Similar spare parts with the IBITY - - ANTSIRABÉ cement plant
- Lower specific consumption of electricity

1.10.4. Main Disadvantages of Proposed Project Alternatives

1.10.4.1. Alternative 1

- construction in one stage
- higher specific consumption of electricity

1.10.4.2. Alternative 2

- necessity of utilization of imported coal
- necessity of utilization of fuel oil for drying of raw materials in the grinding plant
- lower quality of burned clinker
- higher investment costs
- higher production costs
- higher foreign currency requirement
- less favourable results of economic evaluation

1.10.5. Possibility of Extension of the Planned Cement Plant

Extension is possible northward / area between the belt conveyor from the quarry and the plant itself / . Extension will require , however , increased costs in land preparation .

1.10.6. Recommendations

It is recommended to implement the Alternative One which has several essential advantages mostly of economical character .

Demand for cement in Madagascar as well as continuous increase of prices in the world market , requires immediate decision on construction of a new cement plant in Amboanio .

After the decision has been made , to set up an implementation team . To ask UNIDO for technical assistance for tendering and selection of a contractor as well as other consulting services .

2. PROJECT BACKGROUND AND HISTORY

2.1. Project Background

Cement demand of the Malagasy national economy is currently covered as follows :

- a cement plant in operation in AMBOANIO - MAHAJANGA with annual nominal capacity of 70 000 ton and with continuous decline in annual production due to outdated process equipment
- cement imports from Mozambique

At present the CIMENTERIE D'ANTSIRABÉ , S.A., finances in IBITY - ANTSIRABÉ a construction of a cement plant with annual production capacity of 125 000 tons of cement . Shaft kilns will be provided for burning of clinker . The process equipment has been supplied by the LOESCHE Company , FRG .

Facing the ever - increasing cement needs for development of the country a new cement plant in AMBOANIO - MAHAJANGA is under consideration .

The reasons for implementation of such a project are , as follows :

- in consequence of the age and condition of the production machinery of the existing cement plant in AMBOANIO there is risk of total operation stoppage within 2 or 3 years which will result in replacement of the production by imports ;
- in the vicinity of AMBOANIO there are raw material reserves available meeting cement production standards from both the quality and quantity points of view ;
- the cement plant employs a permanent personnel generally very well trained for cement production and adequate maintenance ;
- existence of necessary infrastructure .

2.2. Project Promoter / Initiator

Tanindrazana - Tolom - Piavotana - Fahafahana
Ministry of Industries and Commerce
Antananarivo
Malagasy Democratic Republic

2.3. Project History

The AMBOANIO Cement Plant was erected in 1934. Its initial nominal production capacity was 30 000 tons of cement per year.

Ever since the start - up till the end of the World War Two the cement plant production rate did not exceed, nevertheless, 30 % of its nominal capacity / E.g. the production during the period of the World War Two amounted to some 6 to 7 thousand tons per year/ This was due to the poor condition of the power plant, shortage of essential inputs such as coal, fuel, grinding media, refractories, spare parts, etc.

A new period of existence of the AMBOANIO Cement Plant has begun in 1956 when this was bought by the Belgian Cement Company and consequently the Malagasy Cement Company /C.C.M./ was founded on June 3, 1956 with governement participation.

The plant was rebuilt to obtain a nominal production capacity of 70 000 tons of cement per year. In the following years the plant produced 60-70 thousand tons of a good quality Portland cement. However, in spite of the increased capacity, the AMBOANIO Cement Plant has not been able to meet more than 50 % of total demand.

This fact initiated the idea of extension of the existing plant. In order to adopt a decision on extension of the cement plant, it was essential to analyse the present condition of the AMBOANIO Cement

Plant. In 1979 , the West - German Consortium WPW - PEG - - SIP undertook a study containing a detailed description of the existing equipment , its degree of wear , manpower and production efficiency . On the basis of conclusions of the study the Malagasy government made an agreement in 1980 with the Yugoslav firm INGRA for a supply of equipment for extension of the AMBOANIO Cement Plant up to annual capacity of 500 000 tons of cement wet process . The Yugoslav agreement considered exports of 50 % future production . With the capital costs of approx. 135 million dollars the Malagasy government found this project rather expensive and demanding in power requirements. Therefore the government asked UNIDO in Vienna for experts to study the proposed contract . In the meantime INGRA modified the agreement to a " turnkey " proposal .

The Government realized that the presumed capacity of 500 000 tons per year was rather over estimated and the unfavourable situation in cement exports in the Indian Ocean area pointed out advantages of small capacity cement plants , with vertical shaft kilns , such as that which is being erected in IBITY - - ANTSIRABE . At the time when UNIDO experts arrived at Madagascar in February '83 , the Malagasy government had already abandoned the Yugoslav contract proposal because of the reasons described above . The UNIDO experts aimed their field work at the objectives outlined in the Terms of Reference in order to make the most adequate selection of a new cement plant in AMBOANIO taking into account the actual conditions of Malagasy economy .

Most of the conclusions are based on data collected from various documents available at the Ministry of Industries and Commerce in Antananarivo .

2.4. Feasibility Study

FEASIBILITY STUDY ON CEMENT PLANT IN AMBOANIO , MADAGASCAR

was prepared by

PZO POLYTECHNA PRAGUE - PIO KERAMOPROJEKT TRENČÍN CZECHOSLOVAKIA

The Feasibility Study was financed by the UNIDO Vienna , therefore its cost is not included in the Investment Costs.

2.5. Cost of Preparatory Studies

The existing cement plant in AMBOANIO works with raw materials chemical properties of which have been verified by long term exploitation in cement production .

This study is based on data on raw materials provided by the AMBOANIO Cement Plant and those specified in the Study prepared by the West - German Consortium WPW - PEG - - SIP .

Estimation of reserves of the essential raw materials / limestone and marl / is based on a preliminary geological survey , therefore its results should not be taken for granted in implementation of the project in question . Therefore a more detailed geological survey of the raw material deposits is recommended for the purpose , as follows :

- verification of exploitable reserves of limestone and marl for at least 30 years of operation of the plant .

- tests of samples and of suitability of raw materials for dry - process cement plant .
- tests of crushability , grindability and burnability of the essential raw materials .
- determination of quality of clinker and of its grind - ability .

Conclusions of this geological survey shall be used , in their entirety , as basic data for all stages of project planning .

Cost estimate : 150 000 ,- USD

3. MARKET AND PLANT CAPACITY

3.1. Demand and Market Study

Cement consumption in Madagascar 1958 - 1980 :

Year	Cement consumption / tons /	Import	Local production
1958	88 000 3/		
1959	102 000		
1960	100 000		
1961	101 000		
1962	119 000		
1963	126 000		
1964	112 000		
1965	119 000	79 620	39 491 2/
1966	116 000	65 970	50 332
1967	111 000	50 245 1/	60 845
1968	128 000	60 678	67 743
1969	141 000	53 545	75 445
1970	148 000	72 680	75 216
1971	170 000	93 206	76 930
1972	126 000	61 632	64 177
1973	113 000	43 496	69 863
1974	88 000	26 891	61 447
1975	109 000	50 985	58 021
1976	92 000	23 892 1/	69 904
1977	95 000	38 473	52 229
1978	144 000 3/	48 706	66 000
1979	108 000	46 565	61 535
1980	126 560	66 548	60 014 2/
1981			36 357
1982			36 060 2/

Sources : 1/ Etude de Marché , Consortium
WPW - PEG - SIP
2/ Amboanio Cement Plant
3/ Compagnie des Ciments Malagasy
INSRE in 1/

Between 1958 ÷ 1971 the development in cement consumption was more or less regular and requirements in cement were met both by local production in the Amboanio Cement Plant and by imports . Maximum consumption of 170 thousand tons was reached in 1971 when the Amboanio Cement Plant achieved its top production of 77 thousand tons and imports of cement achieved its peak value of 93 thousand tons as well.

Political development in Madagascar in seventies had , nevertheless , impact on the implementation of new industrial projects and consequently affected the consumption of cement . In the period 1972 ÷ 1980 the Amboanio Cement Plant worked within 75 ÷ 90 % of its nominal capacity due to problems in maintaining the equipment in operation and irregularity in supplies of inputs . In the years 1981 and 1982 these problems caused a decrease in production of the Amboanio Cement Plant below 50 % of its nominal capacity .

In 1979 a construction of a new cement plant was initiated in IBITY situated approximately 190 km south of Antananarivo . The plant consists of 2 shaft kilns working with the " black - meal " technology , with capacity of 120 thousand tons per year . Start - up is expected in the middle of 1984 . An extension by the third kiln is envisaged hence the final capacity of the plant will be 180 thousand tons per year .

In August 1978 the Bureau de Développment et de Promotion Industriels - BDPI - prepared a study called " Cement Market in Madagascar " wherein two hypotheses were adopted ; one of

them based on cement consumption in the period 1959 ÷ 1978 , the other one based on cement consumption in the period 1959 ÷ 1971 .

The first hypothesis which may be considered as the minimum one , results in the equation :

$$Y = 117\,118 + 1\,324 \cdot t$$

whereof cement consumption in 1983 will be :

$$Y_{25} = 117\,118 + 1\,324 \times 25 = 150\,218 \text{ tons}$$

The second hypothesis , based on 13-year - period when the development of the national economy had its normal pace and which may be considered as the maximum one , results in the equation :

$$Y = 121\,462 + 4\,158 \cdot t$$

whereof cement consumption in 1983 will be

$$Y = 121\,462 + 4\,158 \times 25 = 225\,412 \text{ tons}$$

In April 1979 the Consortium WPW - PEG - SIP , Saarbrücken , Federal Republic of Germany , prepared the Etude de Factibilité d'une Cimenterie Dans la Province de Toliara - Etude de Marché .

This Study in a most expert way analysed cement demand in Madagascar by means of various techniques as well as possibility of export of cement , and clinker , if any .

The techniques and relating results were , as follows :

- Calculation of trend , following the total consumption of past years .

Consumption in 1983 :	minimum	150 000 tons
	maximum	225 000 tons
Consumption in 1990 :	minimum	160 000 tons
	maximum	225 000 tons

- Development following the evolution in population and gross national product / GNP / . The result of this technique is , as follows : " A realistic forecast of cement consumption till 1990 should include :

  - first , to assume that the actual consumption per capita - 14 kg in 1978 - will resume its former value of 25 kg/year by 1980 , i.e., the total consumption in 1980 shall be 25 kg x 8, 8 million inhabitants = 220 000 tons per year.

  - then , to accept increase proportional to that of GNP according to intentions of the Plan , i.e., 5 % rate per year which will amount to 376 000 tons in 1990 ". 1/

International comparisons

The result of this technique is that the total cement demand in 1990 will amount to 339 000 tons in a pessimistic evaluation or to 498 000 tons in a very optimistic estimation .

The Study proposes eventually following projection in cement demand , called a realistic evaluation :

1/ Consortium WPW - PEG - SIP , Etude de Marché , Avril 1979

	Millions of inhabitants	Potential demand		Effective consumpt.	
		kg per inhab. per year	tons per year	kg per inhab. per year	tons per year
1978	8,4	30	252 000	14	117 000
1980	8,8	30	264 000	18	160 000
1983	9,5	32	304 000	23	218 000
1985	10,0	33	330 000	25	248 000
1990	11,3	37	418 000	28	314 000

The forecasts were based on following assumptions :

- growth of real gross internal product per capita would be in average 1,5 % per year ;
- the State would accomplish the new housing programme / 28 000 flats per year till 1982 / ;
- relation between effective consumption and potential demand representing reduction in supply passes progressively from approx . 40 % in 1976 to 75 % in 1983 . This should have been ensured by local production of cement rating 60 to 70 thousand tons per year in the Amboanio cement plant and 115 000 tons per year in the Ibity - Antsirabé cement plant since 1982 .

The Study came also to conclusion that with actual world prices of cement and sufficient amounts offered by the existing cement exporters it is out of question for Madagascar to export economically its surplus cement , if any .

After the Study by the Consortium WPW-PEG-SIP had been completed , no remarkable change in cement consumption occurred , neither was noticed any resumption of normal pace of national economy . Thus , no modification of the results of the Study was needed .

On agreement with the Ministère de l' Industrie et du Commerce we accept fully the results of the Study and in order to decide on the capacity of the new plant , further facts and considerations were taken into account :

- The Amboanio Cement Plant is in a very bad condition due to wear hence it produced in 1981 and 1982 as little as 36 thousand tons of cement per year .

It may be expected that existing equipment enables operation for 2 or 3 years more and eventually its unfavourable economical results entail its shutdown . This fact even more emphasizes the necessity of establishment of a new plant instead of the old one .

- In 1984 the new Ibity Cement Plant will be commissioned with initial annual capacity 120 thousand tons and final capacity 180 thousand tons per year is envisaged . The plant is equipped with shaft kilns designed for the " black - - meal " technology , where only black coal with maximum content of volatiles up to 20 % may be used .

- Problems in transport and distribution of cement being essential for development of cement production in Madagascar , the Ministry of Industry and Commerce adopted a long - term strategy of a step - by - step construction of cement plants rated up to 250 thousand tons of cement per year , installed all over the Island .

This policy of decentralization should be paid closer attention to in view of the fact that the problems with transport and distribution of cement are becoming more and more acute .

The plants are to be built in the following order :

Ibity - Amboanio - Toliary - district of Antsiranana .

- Madagascar is rich in black coal deposits in the vicinity of Sakoa . Start - up of exploitation and preparation of coal is expected . Sorted - out coal by preparation with lesser quality will be used for firing in the cement industry .

- The new cement plant in Amboanio may be put into operation as late as in 1988 or 1989 provided that decision on the construction is made in 1984 .

Then , expected demand and production of cement will be as follows :

Year	Population /thous./	Consumption in kg per capita per year /	Demand /thous. tons /	Production / thous. tons /	Note
1988	10 820	39	380-440	430	Ibity , Amboanio
1990	11 420	45	510	430	Ibity, Amboanio importation
1995	13 000	50	650	680	Ibity, Amboanio Toliara

3.2. Sales Forecast and Marketing of Products

The existing " Code des Investissements " differs from those in other developing countries and provides minimum exoneration of taxes , customs and fees for construction of cement plant. This , together with further impacts by current conditions of international and national conjuncture and overall situation in cement market do not create favourable conditions for cement exports from Madagascar .

Taking into consideration this situation the Ministry of Industries and Commerce passed by the end of 1982 a long - - term strategy of cement production development based on construction of system of decentralized small capacity cement plants spread all over the territory and constructed in conformity with demand . Such cement plants are to be established in vicinity of local deposits of raw materials in following locations :

Boanamary - Amboanio , Toliary , Antsiranana . This strategy enables gradual investment within the programme of cement industry .

3.3. Sales and Distribution Costs

In an effort to enable a balanced development of the entire territory , the Malagasy government adopted a principle of standard selling price of cement all over the territory of Madagascar .

By Decree No. 7 - MEC / 3-0-2 from 10.02. 1979 , price of cement was fixed as follows :

Price ex works	13 180 MGF per ton
Wholesale price	21 200 MGF per ton
Retail price	24 000 MGF per ton

By Decree No. 2687/82 - MIC from June, 8 th, 1982 price of cement was modified as follows :

Price ex works	39 230 MGF per ton
Consumption tax	500 MGF per ton
Wholesale price	53 913 MGF per ton
Retail price	64 000 MGF per ton

It is to point out that prices of June 1982 are based on unfavourable production conditions in the Amboanio Cement Plant and are to be revised after putting into operation of new cement plants .

Lack of cement in Madagascar gives rise to its purchasing in black market in spite of considerably high prices .

3.4. Plant Capacity

Fluctuating cement market and problems in stabilization of national economy make impossible to select any of usual methods of projection of cement demand and the plant capacity in Amboanio could be based on following considerations :

- Current consumption of cement equals to approx. 120 thousand tons, i.e., 13-14 kg per capita per year ;
- Construction activity is very low and implementation of projects like Housing Programme, Art Public Works Programme and Industrial Constructions Programme must be postponed due to necessary imports of cement, these being subject to limitations ;
- Current high price of cement - 3 200 MGF per 50 kg bag / 162 USD per ton / applies prohibitive policy to utilization of cement and fixing of adequate price of cement after start - up of new cement plants will revive cement market ;

- Sufficient local production of cement will back up commencement of postponed construction programmes, will meet potential demand, thus eliminating black market;
- Start-up of the new cement plant will take 5 to 6 years since preparation of the Feasibility Study, so that contribution of the new unit in Amboanio could be visible as late as in 1988. That year population in Madagascar will reach 10,7 to 11 million of inhabitants.
Saturation of local demand of cement and necessity of faster construction may result in specific consumption of 35 to 40 kg per capita per year or 380 to 440 thousand tons per year provided the price is adequately modified.

Resulting from considerations explained above it is recommended to envisage in locality of Amboanio - Boanamary one of these two alternatives :

Alternative 1 - Cement plant with one rotary kiln, dry process, capacity 700 tons of clinker per day or 250 000 tons of cement per year.

Alternative 2 - Cement plant with four vertical shaft kilns, 4 x 175 tons of clinker per day or 250 000 tons of cement per year.

It is also recommended to prepare a separate study on possibility of bulk cement supply for great construction sites or concrete plants.
Possible supply centres, transport in special trucks, cement storage and other issues including adequate economical evaluation should be studied.

Main object of preparation of such a study is to decrease losses of bagged cement during transport and handling due to torn bags.

Schedule 3-1 ESTIMATE OF SALES REVENUES

Pièce 3-1 ESTIMATION DU PRODUIT DEVENTES

PRODUCTS PRODUITS			YEAR 1 1-RE ANNÉE				YEAR 2 ANNÉE 2				YEAR 3-10 ANNÉE 3-10			
	Unit price Prix unitaire		Quantities to be sold Quantités à vendre		Sales revenues Produit des ventes		Quantities to be sold Quantités à vendre		Sales revenues Produit des ventes		Quantities to be sold Quantités à vendre		Sales revenues Produit des ventes	
	exp.	loc.	exp.	loc.	exp.	loc.	exp.	loc.	exp.	loc.	exp.	loc.	exp.	loc.
Portland cement Ciment Portland	-	85	-	175.000	-	14,875.000	-	225.000	-	19,125.000	-	250.000	-	21,250.000

Unit / unité = 1 ton

price / prix = USD

loc. = local / marché local

exp. = export / exportation

Schedule 3-3 PRODUCTION PROGRAMME

Pièce 3-3 PROGRAMME DE PRODUCTION

PRODUCTS, BY-PRODUCTS, WASTES PRODUITS, SOUS-PRODUITS, DÉCHETS	UNITS AT 100 % CAPACITY UNITÉS À PLEINE CAPACITÉ /100 % /	YEAR 1 1-re année		YEAR 2 Année 2		YEAR 3-10 Année 3-10	
		CAPACITY % CAPACITÉ	UNITS UNITÉS	CAPACITY % CAPACITÉ	UNITS UNITÉ	CAPACITY % CAPACITÉ	UNITS UNITÉ
Portland cement **Ciment Portland**	250.000 t	70	175.000	90	1[illegible].125	100	250.000

4. MATERIALS AND INPUTS

4.1. Characteristics of Materials and Inputs

Clinker for cement production will be burned from a raw mix consisting of two essential components : limestone and marl. Silica module increase in the raw mix is feasible by addition of a small quantity of silica sand .
Gypsum and pozzolana will serve as additives .

4.1.1. Raw Materials and Composition

Deposits of the essential raw materials , i.e. limestone and marl , are located between the Morohogo and Berivotra rivers in an area of approx. 300 sq.km. Reserves of limestone and marl are sufficient and of good quality .

Quarry is located in a distance of approx.500 m from the existing cement factory . Limestone deposit is upper layer above marl formation with thickness from 14 to 18 m.
Exploitable strata of marl limestone amounts to approx. 11 m in thickness .

In order to verify the physico-chemical composition of the raw materials it is recommended to carry out a thorough geological survey of raw material deposits within a scope of the reserves necessary for 30 years of operation of a proposed cement plant .
In Annex No 1 is described the deposit area , in the map Annex No 2 are indicated boreholes No. 1-7 and in Annex No 3,4 are indicated borehole logs No. 4 and 5 with indication of deposit characteristics.
It is to note that the yield rate of the cores is very low , and the boreholes do not show exactly the composition of the deposit .
Exhaustive information on the deposit in all aspects can be provided by an additional detailed exploration .

Some data on physico-chemical properties of raw materials, additives and coal indicated hereinafter, were provided by the Ministère de l'Industrie et du Commerce, Cimenterie d'Amboanio and others were taken from the studies prepared by the Consortium WPW-PEG-SIP.

4.1.1.1. Limestone

Moisture natural limestone is less than 5 %.

Average of chemical composition of 5 analyses is as follows:

L.O.I.	42,64 %	Fe_2O_3	0,47 %
SiO_2	1,91 %	MgO	0,30 %
Al_2O_3	0,69 %	CaO	53,29 %
SO_3	0,02 %	TiO_2	0,01 %
K_2O	0,14 %	Cl	0,001 %
Mn_2O	0,02 %	Na_2O	0,07 %
P_2O_5	0,05 %		

4.1.1.2 Marl

Moisture natural marl is less than 10 %.

Average chemical composition of 8 analyses is as follows:

L.O.I.	33,87 %	K_2O	1,50 %
SiO_2	14,6 %	Mn_2O	0,28 %
Al_2O_3	4,31 %	P_2O_5	0,03 %
Fe_2O_3	2,25 %	TiO_2	0,03 %
MgO	1,00 %	Cl	0,002 %
CaO	40,44 %	Na_2O	0,06 %
SO_3	0,03 %		

Analyses proved a very good quality of marl limestone / 70 % $CaCO_3$ /.

4.1.1.3. Sand

Silica sand will be used for increasing the silica module.

Average chemical composition of 8 analyses is as follows :

SiO_2 ..... 87,4 %
R_2O_3 ..... 4,4 %
Residue ..... 8,2 %

4.1.1.4. Raw - Mix Composition

Average raw mix composition as a function of sand content :

Limestone	45 %	41 %	48,5 %
Marl	52 %	57 %	47,5 %
Sand	3 %	2 %	4 %

A raw - mix with 3% content of sand has been selected for the project . Such composition is best suitable in consideration of the extraction conditions in the quarry and enables efficient grinding .

Chemical composition of raw mix with 3 % sand content :

L.O.I.	..... 36,42 %	Titration	 77,4
SiO_2	..... 12,94 %	Ms	 2,37
R_2O_3	..... 5,45 %		
CaO	..... 43,41 %		

Lime content in raw mix is slightly increased in consequence of low lime content in coal ash in clinker .
Production of 1 ton of clinker requires approx . 1,6 ton of raw meal .
Influence of coal ash on chemical composition of clinker :

	raw meal / no ash /	clinker / ash included /
L.O.I.	37,53 %	36,95 %
SiO_2	18,93 %	20,18 %

R_2O_3	7,91 %	9,37 %
CaO	70,35 %	67,63 %
Titration	78,90 %	76,20 %
Ms	2,39 %	2,15 %

Mineralogical composition of clinker

C_3S ..... 59,8 % C_3A ..... 11,4 %
C_2S ..... 13,9 % C_4AF ..... 10,5 %

4.1.2. Inputs

4.1.2.1. Gypsum

Gypsum will be imported crushed from France .
SO_3 - content is within range from 40,7 to 42,5 % which means that $CaSO_4 . 2H_2O$ content is min. 87 % .
Gypsum/clinker ratio in cement shall be 5/95 .

4.1.2.2. Pozzolana

Pozzolana will be transported crushed from the Betafo deposit near Antsirabé .

Pozzolana shall be added to cement in an amount of 10 % .

Average chemical composition of 7 analyses is as follows :

L.O.I.	..... 10,50 %	MgO	..... 1,19 %
H_2O	..... 0,80 %	Fe_2O_3	..... 11,58 %
SO_3	..... 0,24 %	Al_2O_3	..... 13,60 %
SiO_2	..... 58,90 %	N.D.	..... 1,50 %
CaO	..... 2,50 %		

4.1.3. Coal

As fuel for clinker burning , black coal will be used .

Black coal of following origin has been taken into account :

- Sakoa , Madagascar / after exploitation start - up /
- Mozambique , Africa

4.1.3.1. Analysis of Sakoa Coal

Hydroscopic water	.....	2,86 %
volatiles	.....	29,84 %
ash	.....	28,07 %
flammable substance	.....	69,07 %
sulphur	.....	0,94 %
high calorific value	.....	5 296 kcal / kg
low calorific value	.....	5 079 kcal / kg

Analysis of ash made from 3 samples / values in % /

Sample	1	2	3
L.O.I.	1,06	-	-
SiO_2	52,47	53,03	44,40
Al_2O_3	25,02	25,29	15,10
Fe_2O_3	5,87	5,93	5,10
MnO	0,12	0,12	0,19
TiO_2	2,34	2,37	1,60
CaO	7,29	7,37	28,0
MgO	0,10	0,10	0,30
SO_3	3,96	4,00	4,40
Cl	0,01	0,01	-
Na_2O	0,11	0,11	0,06
K_2O	1,26	1,27	0,31
P_2O_5	0,46	0,46	0 - 0,8

4.1.3.2. Analysis of Black Coal from Mozambique

Moisture	.....	8 - 10 %
Ash	.....	17 - 20 %
volatiles	.....	15 %
sulphur	.....	1,5 - 1,8 %
calorific value	.....	6 000 kcal / kg

Analysis of ash :

SiO_2	42,2 %	CaO	11,3
Al_2O_3	24,6 %	MgO	2,2 %
Fe_2O_3	11,7 %	K_2O	1,4 %
P_2O_5	1,1 %	Na_2O	0,5 %
TiO_2	1,2 %	SO_3	3,8 %

Burning of clinker in a rotary kiln is possible with both coals . This alternative takes into account the Sakoa black coal .

For clinker burning in vertical shaft kilns a coal with content of volatiles less than 20 % is fit for use only , that is to say , that imported from Mozambique .

4.1.4. Unit Costs

Unit costs of raw materials , auxiliary materials and utilities are to be understood "delivery Amboanio " and were obtained from operating logs of the existing cement factory from 1982 .
Unit costs given below were calculated in conformity with the exchange rate stated by Bankin ' ny Indostria , as follows :

1 USD / U.S. dollar / = 400 FMG

Raw materials and additives	
limestone , marl	own source
sand	6,25 USD / ton
gypsum	58,50 USD / ton
pozzolana	13,50 USD / ton
paper bags / 5-fold /	195 USD / 1 000 pcs
lubricants	1 500 USD / ton
explosives	7 200 USD / ton

cap primers	650	USD / 1 000 pcs
detonating fuse	460	USD / 1 000 m
diesel oil	350	USD / 1 000 l
coal /local/-estimation	56,77	USD / ton
coal / imported /	67	USD / ton
light fuel oil	300	USD / ton
electricity	83	USD / 1 000 kWh
refractories	615	USD / ton
lining	1975	USD / ton
grindin g media	1 000	USD / ton
Spare parts	1 200 000	USD / year
Others	500 000	USD / year

4.2. Supply Programme

4.2.1. Production Programme

This Feasibility Study takes under study two cement plant alternatives :

- Alternative 1. - Rotary kiln - dry process of clinker burning with capacity of 700 tons per day
- Alterantive 2. - Shaft kilns /4/ - for clinker burning with capacity of 4 x 175 tons per day / 700 tons per day /

Time utilization factor	:	315 days
Clinker output per year	:	220 000 tons
Cement output per year	:	250 000 tons

4.2.1.1. Raw Materials

Consumption of raw materials in natural condition per year :

- limestone 166 640 tons
- marl 203 375 tons
- sand 11 109 tons
- gypsum 10 500 tons
- pozzolana 21 000 ton

4.2.1.2. Auxiliary Materials

- Paper bags	5 300 000 bags per year
- refractory	500 tons "
- lubricants	40 tons "
- explosives	6 000 pcs "
- detonating fuses	10 000 m "
- lining Alt. 1	60 tons "
Alt. 2	40 tons "
- grinding media Alt. 1	150 tons "
Alt. 2	90 tons "

4.2.1.3. Factory Supplies

- Spare parts	120 tons per year
- other	50 tons per year

4.2.1.4. Utilities

Alt. 1 - electric power	27 500 thous .kWh per year
- water	56 000 cu.m. "
- coal / local /	43 550 tons "
- diesel oil	500 000 litres "
Alt .2 - electric power	25 000 thous.kWh "
- water	63 000 cu .m. "
- coal / imported /	33 540 tons "
- fuel oil	4 900 tons "
- diesel oil	500 000 litres "

4.2.2. Availability of Supplies

4.2.2.1. Raw Materials

Limestone and marl are available in the existing quarry located approx. 500 m from the cement plant . Limestone forms the upper layer with thickness 14-18 m ;

Marl layer forms the lower layer bellow the limestone with extractable thickness of approx . 11 m .
Limestone and marl deposits practically cannot be depleted and spread in an area of approx . 300 sq.km .

Sand is available in Amborovy 45 km from the cement factory .

Sand will be transported to the factory by trucks.

Gypsum will be imported from France by sea transport .

Gypsum which is available in nearer deposits is not suitable for cement manufacture .

Pozzolana is available near Antsirabé in Betafo area and will be transported to the factory by truck over a distance of 730 km .

4.2.2.2. Auxiliary Materials

Paper bags , refractories , explosives , lining and grinding media will be imported .

Necessary oils and greases are available in Madagascar /SOLIMA /.

4.2.2.3. Factory Supplies

Spare parts and other materials will be mostly imported .
Certain amounts are available in Madagascar .

4.2.2.4. Utilities

The cement plant may be supplied with electricity alternatively either from a public network or from a diesel generating plant of its own . This study takes into consideration power supply from a public network since this is more economical both from the investment and from the operation points of view . One kW - hour from a public network is estimated to cost 0,083 USD over 0,12-0,14 USD from the diesel generating plant .

Connection of the cement plant to the JIRAMA network by two 20 kV overhead lines 20 - 25 km long is presumed .
Service and potable water will be delivered from a dam situated 7 km from the cement factory .
Water will be pumped into the existing tank whereof factory will be supplied by two separate branches for service and potable water respectively.
Reconstruction of the existing water supply system is a part of the project .
In Madagascar there is a deposit of black coal of good quality in Sakoa near Toliary which, however , by virtue of high content of volatiles / 30 % / may be applicable in the Alternative 1 - - Rotary Kiln only . The Alternative 2 - Shaft Kilns may work with coal imported from Mozambique only / max. content of volatiles up to 20 % /.
In order to dry raw materials in the raw grinding plant in Altern.2 - - Shaft Kilns , fuel oil will have to be used together with coal. This fuel oil is available in Madagascar / SOLIMA /. Transport to the factory is possible either by cabotage or by road .

Similarly , diesel oil is available in the local market .

4.2.3. Delivery Programme

Taking into consideration the availability of raw materials and inputs and location of the factory from the transport point of view , the following delivery programme is proposed :

- Limestone and marl will be regularly transported to the factory by means of a system of belt conveyors . Proposed storage capacity is designed for 2 x 5 days .
- 14-days storage capacity of sand will be supplemented by regular supplies by truck companies .
- Gypsum stock is intended for 6-month operation / necessity to import it from France /.
- Stock of pozzolana for plant operation will make for the 30-day period .

- Stock of imported or local coal is to provide for min. 35 days of operation.

Increase in proposed stock of coal may be provided for by open - - air storage.

- Fuel oil for Alter. 2 - Shaft Kilns - is proposed to be stored in two 150 cu.m. tanks. This stock is sufficient for 18 days.
- Stock of 1 500 000 paper bags is to meet the demand of 3-month production because of their importation.
- Spare parts, lining, grinding media, refractories will be imported, therefore one year reserves are necessary.
- Other imported materials - 3-month stock,
  local materials - 1-month stock.

4.2.4. Cost Estimate

Costs are calculated from the unit costs and their break-down presented in Schedule 4-1.

Raw materials and additives

limestone, marl	own sources
sand	69 431 USD per year
gypsum	614 250 USD "
pozzolana	283 500 USD "
Total	967 181 USD per year

Auxiliary materials

paper bags	1 033 500 USD per year
oils and greases	60 000 USD "
explosives	324 000 USD "
cap primers and detonating fuse	8 500 USD "
Total	1 426 000 USD per year

Power and fuel - Alt. 1

diesel oil	175 000 USD per year
coal	2 472 300 USD "
electricity	2 075 000 USD "
water	own source
Total	4 722 300 USD per year

Power and fuel - Alt. 2

diesel oil	175 000 USD per year
coal	2 247 180 USD "
light fuel oil	1 470 000 USD "
electricity	1 867 500 USD "
water	own source
Total	5 759 680 USD per year

Factory supplies - Alt. 1

refractories, insulations	307 500 USD per year
lining	118 500 USD "
grinding media	150 000 USD "
spare parts	1 200 000 USD "
other materials	500 000 USD "
Total	2 276 000 USD per year

Factory supplies - Alt. 2

refractories, insulations	246 000 USD per year
lining	71 100 USD "
grinding media	90 000 USD "

spare parts	1 200 000 USD per year
other materials	500 000 USD "
Total	2 107 100 USD per year

TOTAL MATERIAL COSTS - ALT. 1 9 391 481 USD per year
TOTAL MATERIAL COSTS - ALT. 2 10 259 961 USD per year

Schedule 4-1 ESTIMATE OF PRODUCTION COST : MATERIALS AND INPUTS

Pièce 4-1 ESTIMATION DES COUTS DE PRODUCTION: MATÉRIAUX ET FACTEURS DE PRODUCTION

USD

ESTIMATE OF PRODUCTION COST / ESTIMATION DES COUTS DE PRODUCTION							
MATERIALS AND INPUTS - ALT. 1 / MATÉRIAUX ET FACTEURS DE PRODUCTION - ALT. 1							
No.	Quantity Quantité	Unit Unité	Item description Designation		Unit cost Cout unitaire	Cost Cout		
						Foreing étrangère	Local Local	Total Total
1	11.109	ton	Sand	Sable	6,25	-	69.430	69.430
2	10.500	ton	Gypsum	Gypse	58,50	614.250	-	614.250
3	21.000	ton	Puzzolane	Pouzzolane	13,50	-	283.500	283.500
4	5.300	1000 pcs	Paper bags	Sacs	195,-	1,033.500	-	1,033.500
5	45	ton	Explosives	Explosifs	7.200,-	324.000	-	324.000
6	6	1000 pcs	Cap primers	Amorces	650,-	3.900,-	-	3.900,-
7	10	1000 m	Detonating fuse Cordeau détonnant		460,-	4.600,-	-	4.600
8	500	1000 l	Diesel oil	Naphte	350,-	-	175.000	175.000
9	43.550	ton	Coal	Charbon	56,80	-	2,473.640	2,473.640
	Direct materials and inputs Matériaux et facteurs de production directs					1,980.250	3,001.570	4,981.820
10	25.000	1000 kWh	Electricity	Electricité	83,-	-	2,075.000	2,075.000
11	40	ton	Lubricants	Lubrifiants	1.500,-	-	60.000	60.000
12	500	ton	Refractory	Réfractaire	615,-	307.500	-	307.500
13	60	ton	Armouring	Blindage	1.975,-	118.500,-	-	118.500
14	150	ton	Milling bodies		1.000,-	150.000	-	150.000
15			Spare parts Pièce de rechange			600.000	200.000	800.000
16[x/]			Supplies and utilities Fournitures et services publics			-	300.000	300.000
	Factory overhead materials and utilities Frais généraux des matériaux d'atelier					1,176.000	2,635.000	3,811.000
17			Supplies and utilities Fournitures et services publics			-	100.000	100.000
	Administrative overhead materials Frais généraux des matériaux d'administration					-	100.000	100.000
			Total Total			3,156.250	5,736.570	8,892.920

x/ Note :

Item 16 includes electricity - 2,500.000 kWh, i.e., 207.500,- USD

Roubrique 16 comprend l'électricité - 2,500.000 kWh, c.-a.-d., 207.500,- USD

Schedule 4-1 ESTIMATE OF PRODUCTION COST: MATERIALS AND INPUTS

Pièces 4-1 ESTIMATION DES COUTS DE PRODUCTION: MATÉRIAUX ET FACTEURS DE PRODUCTION USD

ESTIMATE OF PRODUCTION COST ESTIMATION DES COUTS DE PRODUCTION							
MATERIALS AND INPUTS - ALT. 2 MATÉRIAUX ET FACTEURS DE PRODUCTION - ALT. 2							
No.	Quantity Quantité	Unit Unité	Item description Designation	Unit cost Cout unitaire	Cost Cout		
					Foreign étrangère	Local Local	Total Total
1	11 109	ton	Sand Sable	6,25	-	69.430	69.430
2	10 500	ton	Gypsum Gypse	58,50	614.250	-	614.250
3	21 000	ton	Puzzolane Pouzzolane	13,50	-	283.500	283.500
4	5 300	1000 pcs	Paper bags Sacs	195,-	1,033.500	-	1,033.500
5	45	ton	Explosives Explosifs	7.200,-	324.000	-	324.000
6	6	1000 pcs	Cap primers Amorces	650,-	3.900	-	3.900
7	10	1000 m	Detonating fuse Cordeau détonnant	460,-	4.600,-	-	4.600
8	500	1000 l	Diesel oil Naphte	350,-	-	175.000	175.000
9	33 540	ton	Coal Charbon	67,-	2,247.180	-	2,247.180
10	4 900	ton	Fuel oil Fuel	300,-	-	1,470.000	1,470.000
	Direct materials and inputs Matériaux et facteurs de production directs				4,227.430	1,997.930	6,225.360
11	22 500	1000 kWh	Electricity Electricité	83,-	-	1,867.500	1,867.500
12	40	ton	Lubricants Lubrifiant	1.500,-	-	60.000	60.000
13	400	ton	Refractory Réfractaires	615,-	246.000	-	246.000
14	40	ton	Armouring Blindage	1.975,-	79.000	-	79.000
15	90	ton	Milling bodies	1.000,-	90.000	-	90.000
16			Spare parts Pièces de rechange		600.000	200.000	800.000
17[x]			Supplies and utilities Fournitures et services publics		-	300.000	300.000
	Factory overhead materials and utilities Frais généraux des matériaux d'atelier				1,015.000	2,427.500	3,442.500
18			Supplies and utilities Fournitures et services publics		-	100.000	100.000
	Administrative overhead materials Frais généraux des matériaux d'administration				-	100.000	100.000
			Total Total		5,242.430	4,525.430	9,767.860

x/ Note:

Item 17 includes electricity - 2,500.000 kWh, i.e., 207.500,- USD

Roubrique 17 comprend l'électricité - 2,500.000 kWh, c.-a.-d., 207.500,- USD

5. LOCATION AND SITE

5.1. Location

The new cement plant with capacity of 700 tons of clinker per day will be located in the area of the existing cement plant in Amboanio that is situated on the right bank of the Bombetoka Bay in the vicinity of the outlet of the Betsiboka River .

The cement plant will be located south to MAHAJANGA , air distance 15 km , road distance 35 km .

The proposed site for location of the cement plant can be characterized as an area suitable for construction of a new cement plant with convenient overall conditions .

Other possible localities were not taken into consideration since any other locality would require :

- take over of additional land and consequently elevated cost of land and its preparation ;
- decrease of exploitable raw materials reserves due to necessary location in the area of limestone and marl deposits ;
- construction of new auxiliary services ;
- construction of a new infrastructure ;

5.2. Site

The lay - out was influenced by a necessity to maintain and continue the operation of the existing auxiliary services as well as by raw materials availability and tie - in to existing networks.

The site is in an altitude of + 7 m above sea level .

In spite of the above mentioned limitations the lay - out is in conformity with the requirements of the technological process adopted .

Selection of the site fully respects accessibility of raw materials , utilities , manpower, and capital costs .

5.2.1. Geographical Conditions

The site of the new cement plant is situated in the area of the existing cement plant in Amboanio on the right bank of the Bombetoka Bay in the vicinity of the outlet of the Betsiboka River . Road distance among the site and MAHAJANGA is 35 km. The site surface is flat with minor vegetation , altitude 7 m.

5.2.2. Transport

At present the site is accessible by two ways , as follows:

- Access from the sea - by means of cargo ships anchoring 5 km away from the pier in the open sea and consequent transfer of cargo to boats twice a day in total duration of 2 x 3 hours . At the pier the cargo is transferred from the boats onto trucks or factory railway cars . The distance between the pier and the plant proper is about 500 m .

- Road access - 17 km long road connection to the ANTANANARIVO - MAHAJANGA highway . The distance between the site and the MAHAJANGA seaport is 35 km .

Implementation and operation of the cement plant will depend on considerable volume of transport of bulk and other materials either from and to the site which will be multiplied by a factor of 3,5 - 4 over the present state . The existing way of sea transport is unacceptable for this project from the technical , capacity and economical points of view . Road transport to and from MAHAJANGA is considered to be unfavourable both from

economical and ecological aspects .

It is proposed to include in the project a new transport system - reconstruction and putting into operation of an abandoned port in BOANAMARY with access from the cement plant by a road 7 km long .

The project includes costs of reconstruction and operation of the BOANAMARY port within the requirements of the cement plant only .
Access to the road network remains unchanged .

5.2.3. Extraction Conditions

Deposits of the essential raw materials / limestone and marl / are situated 500 - 1000 m west to the factory .
The existing open quarry will be used .

5.2.4. Cost Estimate

The proposed site presents no requirements in investment costs and production costs either .

5.3. Local Conditions

5.3.1. Climate

Temperature	:	- average	26 °C
		- maximum	32°C
		- minimum	18°C
Velocity of wind	:	- average	12,4 - 16,5 km / hour
		- maximum	36,5 - 57,7 km / hour

maximum wind velocity during cyclone 50 m / sec .

Earthquake : no		
Precipitations :	- total	1 566 mm per year
	- maximum	2 692 mm per year
	- minimum	1 002 mm per year

Rain period :	November	109, 2 mm	February	369,7 mm
	December	202,6 mm	March	282,7 mm
	January	465,3 mm		

Altitude		+ 7 m
Relative humidity :	- maximum	84 %
	- minimum	59 %

Data on climatic conditions were provided by A.S.E.N.C.N.A., Service Meteorologique , Centre de MAHAJANGA .

5.3.2. Transport Facilities

Access to the national road ANTANANARIVO - MAHAJANGA is possible by a branch road 17 km long .

Connection with the port of MAHAJANGA is possible by cabotage.

Distance by sea between the port of MAHAJANGA and a pier of the cement plant of Amboanio is approx. 15 km .

The pier is operational only during tide twice a day in duration of 3 hours .

This project takes into account the reconstruction of the abandoned Boanamary port which may be accessible by ships .

Following measures are to be adopted to restore operation of the port :

i / To remove sediments from the sea bottom

ii/ To install a mobile crane necessary for shipping of cement, and unloading of gypsum, coal and auxiliary material

iii/ To construct a handling platform

iv/ To fix up a road from the port to the cement plant. Transport between the port and the site will be provided by trucks.

5.3.3. Utilities

Service and potable water will be supplied from the existing water supply system.

The site is supplied with electricity from the diesel generating set of the existing cement plant until the overhead lines for the project have been put into service.

5.3.4. Manpower

Manpower for construction and operation of the new cement plant will be provided by the personnel of the existing cement plant and will be complemented by unskilled workers from Amboanio and Boanamary villages.

5.3.5. Fiscal and Legal Regulations

General and legal regulations in the Malagasy Democratic Republic are valid for construction and operation of the new cement plant.

5.3.6. Construction, Frection and Maintenance Facility

There are very well equipped workshops with skilled manpower, stores, offices, a laboratory and a diesel generating set in the area of the existing cement plant.

These facilities will be kept in use during construction and operation of the new plant .

5.4. Environmental Impacts

Construction of the new cement plant will entail no negative impacts either on environment or on housing since all activites are to be carried out within the area of the existing factory.

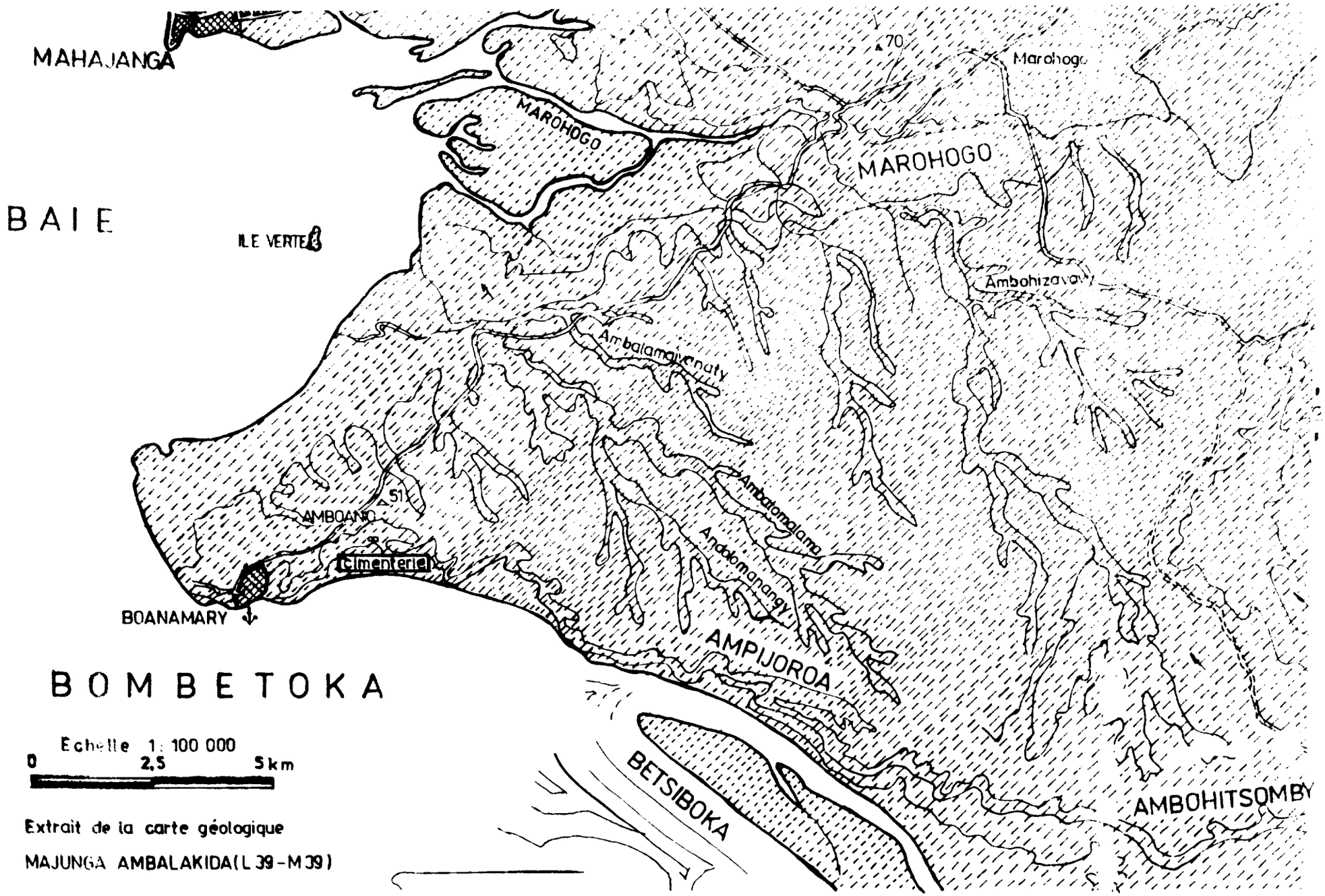
Operation of the new factory will have the following environmental impacts :

- increased traffic in both directions
- dust and gas pollution will be within the European standard limits and will , nevertheless , be lower than that of the existing plant ;
- considerable decrease in manpower requirement / by more than 50 % of the existing manpower / simultaneously with requirements on higher degree of skill .

5.5. Cost Estimate

The new plant will be situated in the area of the existing factory therefore there are no additional requirements on land. In reference to the existing social system and corresponding law regulations this study does not envisage any tax and legal expenses , contributions to be paid to the government .

It is supposed that the abandoned BOANAMARY port will be provided by the State authorities to the factory free of cost.



Extrait de la carte géologique

MAJUNGA AMBALAKIDA (L 39 - M 39)

6. PROJECT ENGINEERING

6.1. Project Layouts

6.1.1. Production Programme

Subject of the Feasibility Study is a cement plant project in Amboanio designed in two alternatives :

Alternative 1 features a short rotary kiln and an exchanger with output of 700 tons of clinker per day by dry process .

Alternative 2 features four shaft kilns working with " black - - meal " technology output of 175 tons of clinker per day each , i.e., 700 tons of clinker per day.

The cement plant will produce cement whose quality shall meet specifications of the French Standard AFNOR NF - P 15 - - 301 / Dec. 1981 / , class 45.
Fineness of grinding shall be 2 800 sq. cm/g by Blaine .
Minimum guarranteed compressive strength is to be

R_7 days min. 17,5 MPa

R_{28} days min. 35 MPa .

Specification accept maximum admissible content of additives 3 5 0 % , including gypsum .
Clinker will be ground together with following additives :

5 % of gypsum
10 % of pozzolana

Clinker production per year	: 220 000 tons
Cement production per year	: 250 000 tons

The annual production of cement will be packed in 50 kg paper bags and will be delivered in 40 % / 100 000 tons / by ship and in 60 % / 1500 000 tons / by road transport . The project takes also into consideration a provision for bulk cement loading .

6.1.2. Supply Programme

The production technology is based on essential raw materials - limestone and marl - whose deposits are located in the vicinity of the cement plant .

Other raw materials / gypsum , sand , pozzolana / and coal will be purchased .

6.1.2.1. Limestone and Marl

Total annual consumption of limestone in natural condition 5 % H_2O will be 166 640 tons .

Total annual consumption of marl in natural condition /10 % H_2O / will be 203 375 tons .

Limestone and marl are extracted in quarry located 500 m from the factory . The quarry is the cement plants property . They will be transported to the plant by belt conveyors to a storage area 2 x 6 150 tons .

6.1.2.2. Sand

Total annual consumption of sand in natural condition / 5 % H_2O / will be 11 109 tons . Sand stock represents 500 tons , i.e., for 14 days of continuous operation .

6.1.2.3. Gypsum

Annual consumption of gypsum in natural condition /5 % H_2O / will be 10 500 tons . Storage of gypsum will have a capacity of 3 000 tons which represents 6-month stock . Capacity of storage reflects the necessity to import gypsum from France .

6.1.2.4. Pozzolana

Annual consumption of pozzolana in natural condition / 5 % H_2O / will be 21 000 tons . Storage will have a capacity fo 2 700 tons which will be 30-day stock for operation of the cement plant .

6.1.2.5. Fuels

Alternative 1 - Rotary Kiln

Annual consumption of local coal from SAKOA with calorific value of 5 079 kcal per kg or 21 265 kJ per kg at 8 % H_2O will be 43 570 tons .

Alternative 2 - Shaft Kiln

Annual consumption of imported coal / Mozambique / with calorific value 6 000 kcal / kg or 25 120 kJ / kg and 8 % of H_2O content will be 33 540 tons .

Raw materials and coal will be dried during grinding by burning of light fuel oil with calorific value 9 000 kcal/kg or 37 681 kJ/kg . Annual consumption is estimated at 4 900 tons . The given quantity will meet requirements in drying of raw materials and coal even during most severe rainy periods .

Coal storage is 5 000 tons in both alternatives , i.e., stock of coal for 35 days at least ; light fuel oil tanks will have a capacity of 270 tons - stock for 18 days .

Coal will be stored in a sheltered stockyard . Capacity of storage may be increased by open - air storing .

6.2. Scope of Project

6.2.1. Cement plant delivery comprises :

a / Complete delivery of machinery and equipment including erection ;

b / Complete delivery of electrical installation , instrumentation and control equipment incl . erection ;

c / Necessary construction materials and civil works ;

d/ Topographic survey of the site ;

The cement plant deliveries include transport means for transport between the site and the BOANAMARY port . Other transport of materials will be provided by local transport companies .

6.2.2. This Study is based on data provided by Malagasy authorities :

a/ Long - term experience with raw materials and additives used during operation of the existing plant ;

b/ Chemical analyses of fuel , service and potable water ;

c / Climatic conditions of MAHAJANGA district .

6.2.3. Alternatives

The existing cement plant in Amboanio manufactures clinker by wet process .

Physical and mineralogical properties of essential raw materials permit , however , to use dry process of clinker manufacture . This is less demanding in power consumption and more efficient .

The study takes into consideration production of cement in two alternatives :

- Alternative 1 - rotary kiln ,capacity 700 tons of clinker per day ;
- Alternative 2 - shaft kilns , capacity 4 x 175 tons of clinker per day.

6.2.4. Production , Auxiliary and Service Departments

01 Limestone and marl quarry
02 Crushing plant and conveying to plant
03 Raw material storage

04 Raw grinding plant
05 Homogenization silos
06 Clinker burning
07 Clinker and additives storage
08 Coal storage
09 Coal grinding plant
10 Cement grinding plant
11 Cement silos
12 Packing plant
13 Substation and power supply
14 Compresor unit
15 Water supply system
16 Electrical installation
17 Instrumentation and control
18 Roads
19 Outdoor lighting and telecommunication
20 Rain drainage
21 Boanamary port
22 Offices and laboratory / extension /
23 Store of fuel / existing /
24 Store of lubricants / existing /
25 Workshops and stores / extension /
26 Gate house / existing /
27 Water distribution system / existing /
28 Emergency generating set / existing /
29 Sanitary facilities / extension /

6.3. Technology

6.3.1. Technologic data

Proposed composition of raw mix :

limestone	45 %
marl	52 %
sand	3 %

kiln output : 700 tons of clinker per day

time utilization factor : 315 days per year
annual production of clinker : 220 000 tons
annual production of cement : 250 000 tons
consumption of raw materials
on dry basis specific consumption
1,6 tons per 1 ton of clinker : 352 000 tons per year
or : 1120 tons per day

consumption of natural raw
materials /7,6 % H_2O / : 380 864 tons/year or
1 212 tons/day

consumption of raw materials
/moisture 10 % H_2O / : 391 000 tons /year or
1 244 tons / day

consumption of limestone on dry
basis : 158 400 tons/year or 504 tons/day

- in natural condition
/ 5 % H_2O / 166 640 tons/year , 530 tons/day

consumption of marl on dry
basis : 183 040 tons/year or 582 tons/day

- in natural condition / 10 % H_2O / : 203 375 tons/year or 646 tons/day

consumption of sand on dry basis : 10 560 tons/day or 34 tons/day

- in natural condition / 5 % H_2O / : 11 109 tons/day or 36 tons/day

consumption of gypsum on dry basis : 10 000 tons / year

- in natural condition / 5 % H_2O / : 10 500 tons / year

consumption of pozzolana on dry basis : 20 000 tons/year

- in natural condition / 5 % H_2O / : 21 000 tons /year

Consumption of coal :

Alternative 1 - Rotary Kiln :

Local coal from Sakoa low calorific value 5 079 kcal/kg

- clinker burning / specific consumption estimated at 800 kcal / kg of clinker / 3 350 kJ/ kg of clinker / - 34 650 tons/ year

- additional heat for the raw mill / raw mix moisture 10 %, moisture of dried raw mix 5 % / - 5 130 tons/year

- additional heat for the coal mill / moisture of coal 8 % / 720 tons/year

Total consumption of coal 30 500 tons/year
Consumption of coal /moisture 8% / 33 570 tons/year

Alternative 2 - Shaft Kilns

Only imported coal / MOZAMBIQUE/ can be used . Local coal from Sakoa is not suitable due to high content of volatiles .

- Estimated heat consumption : 850 kcal/kg of clinker , i.e., 3 560 kJ/kg .
- Consumption of imported coal with low calorific value 6 000 kcal /kg of coal 31 170 tons/year
  consumption of coal / moisture 8 % / 33 540 tons/year

- Consumption of fuel oil / for drying of raw mix and coal / low calorific value 9000 kcal/kg of oil 4 900 tons/year

Total consumption of fuels : 33 540 tons of coal/year
4 900 tons of fuel oil/year

Water consumption	Alt. 1.	Alt. 2.
circulation cooling water	60 cu.m./hour	30 cu.m./hour
evaporation , losses	6 cu.m./hour	3 cu.m./hour
service water	10 cu.m./hour	15 cu.m./hour

process water	76 cu.m./hour	48 cu.m./hour
water consumed in process	16 cu.m./hour	18 cu.m./hour
potable water	6 cu.m./day	6 cu.m./day

Electric power consumption

Specific power consumption per one ton of cement, in total :

- Alt. 1 - Rotary Kiln : 110 kWh
- Alt. 2 - Shaft Kiln : 100 kWh

Total annual consumption of electric power will be :

Alternative 1 - Rotary Kiln	27 500 MWhrs
Alternative 2 - Shaft Kilns	25 000 MWhrs

6.3.2. Description of Technology

Individual differences between the proposed alternatives are pointed out.

01 - Limestone and marl quarry

Raw materials - limestone and marl deposits - are located in a distance of 500 m from the cement plant. Deposits are formed by a plain terrain with surface of 300 sq.km. between Marohogo and Berivotra rivers. The deposits are opened by an open - pit quarry supplying the existing cement plant.

Limestone and marl extraction is estimated at 5 days a week by two shifts .
Effective work - 6 hours per shift .
Both raw materials are extracted in the same quarry where limestone formes the upper layer 14 - 18 m thick while marl limestone forms the lower layer with exploitable thickness of 11 m . Raw materials will be primarily separated by front--face blasting .
Drilling will be carried out by means of light weight drilling rigs and air - operated hammers . Secondary separation by minute blasting .

Blocks of raw materials /size up to 1 cu.m./ will be loaded onto medium capacity trucks / 15 tons/ by means of hydraulic loaders. The trucks will haul the raw materials to a crushing plant hopper . The crushing plant is located in the quarry , average transport distance being 500 m .

Extraction capacity requirements approx. 8 850 tons/week / provided that limestone moisture-5 % , marl - 10 % H_2O and exploitation losses - 5 % .

With 5 working days per week the daily extraction output will be 1 770 tons
With twoworking shiftsand effective time 6 hours per shift is the extraction output per hour 148 tons
output of one truck with capacity of 15 tons is ..... 50 tons/hour
output of one hydraulic loader with capacity 1,25 cu.m . is 200 tons / hour .

02 Crushing and Conveying to Plant

The crushing plant is situated in the quarry. The materials brought by trucks are discharged into a hopper under which a variable - speed apron feeder will be installed. Raw materials are fed into a hammer crusher specially designed for sticky materials with grain size of 0 - 50 mm. Crushed raw materials are conveyed by a belt conveyer 800 m long to the open raw materials storage area in the factory.

The crushing plant is rated at 200 tons per hour and is fully equipped with complete accessories including dust collection and a maintenance bridge crane.

Necessary quantity of raw materials /natural condition /	8 232 tons per week
Daily output of the crushing plant	1 647 tons per day
Required output with effective working time 2 x 6 hours	137 tons per hour
nominal output	200 tons per hour

03 Raw Material Storage

Raw material storage is designed as follows :

- limestone / marl mix in two pre - homo piles
- correction limestone in one pile
- silica sand in one pile

Limestone / marl mix is conveyed to the stockpile by a loom stacker piling the mix in layers and simultaneously pre - homogenizing.

Correction limestone is conveyed to the pile in a similar way . Silica sand will be transported to the factory by trucks and stocked directly in the open pile .
The whole storage area is situated in open space without roofing .

Storage capacity :
Capacity of limestone / marl , piles , with production of 700 tons of clinker per day is 2 x 6 150 tons / reserves for 2 x 5 days / .

Capacity of pile of correction limestone is 600 tons / reserves for 10 days / .
Capacity of pile of sand 500 tons / reserves for 14 days /.

04 Raw Grinding Plant

Alternative 1 - Rotary Kiln

The raw grinding plant is designed for drying and grinding of raw mix to raw meal suitable for clinker burning in a short rotary kiln equipped with a preheater .

Individual components of raw mix , i.e., limestone / marl mix , correction limestone and sand will be reclaimed from the stockpiles by means of a hydraulic reclaimer and fed into steel hoppers. Each hopper is equipped with an automatic weigher. Weighed components are then conveyed to the grinding plant .
The grinding plant comprises a drum mill Ø 3,7 x 9 m .
The grinding system works with mechanical circulation with air separator . At the mill inlet there is installed an impact crusher with a drying shaft . The exit gases from the rotary kiln as well as those from an additional hot gas generator, stream into the drying shaft . Dried and ground raw mix is conveyed into the air

separator by means of a bucket elevator . Coarses are returned to the mill .
Finished raw meal is conveyed to homogenization silos .

An electrostatic precipitator is provided for dedusting of both the raw grinding plant and the rotary kiln .

Grinding output is 70 tons per hour with final fineness of 12 - 15 % residue ∠ 900 mesh .

An automatic sampler will be installed in the raw meal conveying system . It is designed for automatic determination of raw mix chemical composition .

Raw meal consumption	7 840 tons per week
Grinding output	70 tons per hour
Effective working time of the plant	6 days , 20 hrs per day
Working hours per week	112 hours

Alternative 2 / Shaft Kilns /

The raw grinding plant is designed to dry and grind raw mix together with coal to black raw meal suitable for clinker burning in shaft kilns .

Individual raw meal components and black coal are reclaimed from the stockpiles by hydraulic reclaimers and fed into steel hoppers and by belt conveyors to bins. The weighers automatically control raw materials ratio .

Two separate grinding plants are designed for preparation of black raw meal . The grinding plant comprises the vertical LOESCHE mill , and dedusting equipment / electrostatic precipitator .

Raw mix will be dried in the mill by additional hot exit gases from a fuel oil fired hot gas generator .

Prepared black raw meal will be conveyed mechanically to homogenization silos .

Raw meal consumption per week	7 840 tons
Output	2 x 30 tons/hour
Effective working time	6 days , 22 hrs/day
Working time	131 hrs/week

In rainy season the Alternative 1 with the raw grinding plant consisting of the drum mill and the drying - shaft crusher upstream of the mill will be applied , to dry and grind raw mix of up to 14 % of moisture content with the same output . If moisture is within limits of 14 - 17 % , the output shall be cut down accordingly .

The Alternative 2 with the raw grinding plant consisting of the vertical mill is foreseer , to dry and grind raw mix of up to 18 % of moisture content , with the same output .

Both grinding plants are equipped with drying chambers suitably rated even for extra moist raw mix during rainy season .

In order to eliminate negative effects due to increased moisture of raw materials, the Consultants recommend to schedule major repairs during the rainy periods .

05 Homogenization Silos

Alternative 1

A through - flow - type homogenization system has been selected for raw meal homogenization . The system comprises two silos .

Raw meal is conveyed to the silos by means of airlifts and a system of airslides .

Homogenization process takes place in the lower parts of the silos by means of fluidizing air . Air is periodically blown inside the quadrants of the silo bottoms .

Homogenized raw meal is discharged from both silos simultaneously , and is proportioned through an automatic weighing device and by an airlift into a preheater of the rotary kiln .

Capacity of silos	2 x 2 800 tons
Daily demand of the kiln	1 120 tons
Stock of raw meal in the silos	5 days
Feed rate	max. 90 tons / day
Discharge rate	max. 55 tons / day

Alternative 2

A system of two - compartment silos has been selected for homogenization of black raw meal . The system comprises four silos .
Raw meal is conveyed to the silos by means of bucket elevators and airslides . Each silo is divided into two parts .
Raw meal is homogenized in the upper part by compressed air.
The lower part is designed for stocking .

Homogenized raw meal is discharged from the silos and weighed for pelletizers installed above the shaft kilns .

Capacity of silos	4 x 1 650 tons
Daily requirement of the kilns	1 120 tons

Stock of raw meal in the silos	5,8 days
Feed rate	max. 2 x 40 tons/hr
Discharge rate	max. 55 tons

06 Clinker Burning

Alternative 1 - Rotary Kiln

Clinker will be burned in a kiln system with capacity of 700 tons per day consisting of a suspension preheater and a short rotary kiln with planetary coolers .
Raw meal entering the upper part of the preheater is preheated by hot exit gases from the rotary kiln .

Preheated and partly calcined raw meal enters the rotary kiln where calcining and sintering processes are completed . Clinker is cooled in planetary coolers. Gases from the rotary kiln are dedusted by means of a conditioning and tower electric precipitator common for both the kiln and the raw mill . Precipitated dust is conveyed , as follows :

- with the rotary kiln and the raw grinding plant working together , dust is conveyed with raw meal to the homogenization silos .

- with the rotary kiln working alone , dust is stored in a bin from which it is added to raw meal when the raw grinding plant is in operation .

Production capacity in clinker	700 tons/day
Calorific consumption	800 kcal/kg of clinker
Rotary kiln	Ø 3,9 x 62 m

Planetary coolers	ϕ 1,5 x 11 m - ten pcs
Effective working time	315 days / year ; 24 hrs / day

Alternative 2 - Shaft Kilns

Clinker will be burned in four shaft kilns with total capacity 4 x 175 tons per day . Black raw meal is fed a pelletizer where pellets are prepared adding water in an amount of less than 15 % .

Pellets proceed through various zones / drying , calcining , sintering and cooling / of the kilns . Clinker is cooled by secondary air blown into the kilns .

Gases from the kilns pass through dust collectors . Precipitated dust is added to raw meal .

Production capacity in clinker	4 x 175 tons per day
Calorific consumption	850 kcal / kg clinker
Effective working time	315 days ; 24 hours / day

07 Clinker and Additives Storage

Cooled clinker is conveyed from the kilns by means a chain conveyor and a bucket conveyor to the storage pi

Storage area is roofed and comprises the piles of clinker, gypsum and pozzolana .

A grab crane / capacity 2,5 cu.m. / handles materials in the storage . Output per hour - up to 200 tons .

Gypsum and pozzolana will be transported to the storage area by means of trucks .

Capacity of storage :

Clinker pile capacity		14 000 tons
	or	20 days stock
Gypsum pile capacity		5 000 tons
	or	1/2 a year stock
Pozzolana pile capacity		2 700 tons
	or	30 days stock

08 Coal Storage

Coal will be delivered to the roofed storage area by trucks .

Coal will be handled within the storage are by means of a wheel loader with capacity of 150 tons per hour .

Storage capacity		approx. 5 000 tons
	or	35 days stocks

Increase in stock of coal , if necessary , may be obtained in open - air storage areas either inside the plant or on the pier.

09 Coal Grinding Plant

Alternative 1 / Rotary Kiln /

Coal is taken from the storage by means of a wheel loader , dumped to a hopper and conveyed by a belt conveyor to a bin in the coal grinding plant . Coal is fed from the bin to the tube mill Ø 2,5 x 35 m by means of a rotary table feeder .

Black coal is dried and ground in a air - circulation grinding plant . The plant is protected against explosion effects by security aluminium flaps .

Hot air from the satellite cooler and additional hot gases from the gas generator are draughted through the mill to an air separator and a separating cyclone . Separated coarse coal dust is fed back to the mill . Fine coal dust from the cyclone is fed into a steel bin . The steel bin has three outlets . The first one is designed for feeding and dosing of coal dust to the hot gas generator of the coal grinding plant . The second one is designed for feeding of coal dust to the hot gas generator in the raw grinding plant . The third one is for feeding and dosing of coal dust to the burner of the rotary kiln . The burner is also fed with primary air supplied from the air circulation system of the coal grinding plant .

Coal /SAKOA/ requirement per year /8 % humidity , 5 079 kcal/kg/	approx. 43 570 tons
Coal requirement per day	approx. 140 tons
Coal requirement per week	approx. 980 tons
Dry coal requirement per week	approx. 900 tons
Output in dry coal	7,5 tons/hour
Effective working time	6 days ; 20 hrs/day
Working time per week	120 hours

Alternative 2 / Shaft Kilns /

Installation of a coal - grinding plant is not taken into account since coal will be ground together with raw materials to black raw meal .

10 Cement Grinding Plant

Alternative 1 / Rotary Kiln /

The storage area for clinker and additives will comprise separate bins for clinker , gypsum and pozzolana .
The bins are filled by means of the grab crane .

Dosing devices are installed under each bin . The belt weigh feeders are designed for component proportioning .
Mechanical circuit two - compartment tube mill Ø 3,7 x 9 m is presumed .

After grinding , material is conveyed from the mill to a mechanical separator by means of a bucket elevator .
Coarses are returned to the mill feed . Finished product is conveyed to cement silos by means of a belt conveyor , airlift and airslides .

Air is draughted from the mill through a cyclone and a bag filter .
Precipitated dust is conveyed to a cement conveying system .

Clinker production per week	4 900 tons
Cement mill output / fineness 2 800 sq.cm./g according to Blaine/	55 tons
Cement production per week	approx.5 560 tons
Cement production per day	1 112 tons
Effective working time	5 days ; 21 hrs/day
Working hours per week	105 hrs .

Alternative 2 / Shaft Kilns /

Cement will be ground in two identical grinding plants with capacity 2 x 25 tons per hour , grinding fineness 2 800 sq.cm. / g according to Blaine .

The grinding system is similar to that of Alt. 1 except for that instead of the mechanical separator a cyclone separator will be provided . Finished product will be conveyed to the cement silos by means of a bucket elevator and air - slides .

Clinker production per week	4 900 tons
Cement production per week	5 560 tons
Cement production per day	1 112 tons
Output	2 x 25 tons/hour
Effective working time	5 days ; 22,5 hours/day
Working hours per week	113 hours

For the Alternative 1 / Rotary Kiln / , the optimum grinding unit has been selected . This solution is usual for production of one cement .

For the Alternative 2 / Shaft Kilns / , the Consultants have designed cement grinding plant according to an offer by LOESCHE similar to that adopted for the ANTSIRABE - IBITY cement plant .

11 Cement Silos

Alternative 1 / Rotary Kiln /

Cement will be stored in two silos .

Cement will be conveyed to the silos by means of an airlift and airslided . Cement will be discharged from the silos by means of extractors and conveyed to the packing plant by means of a screw conveyor and a bucket elevator . Side outlets for possible cement bulk loading are also provided .

The silos are dedusted by means of a bag filter .

Cement production per week	5 560 tons
Capacity of silos	2 x 3 600 t
or	9 - day working stock

Alternative 2 / Shaft Kilns /

Cement will be stocked in four silos . Cement will be conveyed to the silos by means of a bucket elevator and air - slides . Cement will be discharged by extractors and conveyed to the packing plant by screw conveyors and bucket elevators.

The silos are dedusted by means of a bag filter .

Cement production per week	5 560 tons
Capacity of silos	4 x 1 800 tons
or	9 day stock

12 Packing Plant

Alternative 1 / Rotary Kiln /

A rotary 8 - valve bagging machine will pack cement into 50 kg bags . Output of the machine will be 70 tons per hour or 1 400 bags per hour .

Cement discharged from the silos is conveyed by means of a bucket elevator to a rotary screen in order to remove impurities . Behind the screen there is a bin from which cement is fed to the packing machine .

Filled bags fall automatically onto a rotary table which directs the bags to further conveying. Spilled cement under the packing machine is conveyed by a screw conveyor and a bucket elevator to the bin . Bagged cement is conveyed by belt conveyors to a load -

ing station .
There the bags are loaded into trucks by means of two mobile belt conveyors . A provision is made for palletizing behind the packing machine .
The pallets may be stored in a sheltered store and then trucked to a store in the Boanamary port . The store in the port serves as a buffer stock .

Cement production per week		5 560 tons
	or	111 200 bags
Packing machine capacity		70 tons per hour
	or	1 400 bags per hour
Working hours per week		84 hours
Effective working time per week		6 days , 14 hours/day

Alternative 2 / Shaft Kilns /

Two 4-spout bag filling machines will be provided .
Output of the machines will be 2 x 20 tons per hour , i.e., 2 x 400 bags per hour .

Further description of the packing plant is similar to that of Alternative 1 , except that instead of the 8 - valve packing machine , two 4-valve packing machines will be provided .

Cement production per week		5 560 tons
	or	111 200 bags
Output of the machines		2 x 20 tons/hour
	or	2 x 400 bags/hour
Working hours per week		139 hours
Effective working time		6 days , 23 hrs / day

13 Substation and Power Supply

Data :

Installed kW	- process equipment	8 500 kW
	- other	300 kW
	TOTAL	8 800 kW
Effective kW		6 600 kW

Power consumption :

Alt. 1 — 110 kWh / ton of cement

or — 27 500 kWh

considering 250 000 tons of cement per year

Alt. 2 — 100 kWh / ton of cement

or — 25 000 kWh

considering 250 000 tons of cement per year .

Voltage : 3 x 6 000 V , 50 Hz for H.V. motors
3 x 380 / 220 V , 50 Hz for L.V. motors
220 V , 50 Hz for lighting
110 V , D.C. for emergency lighting

Shock protection :

- connection to neutral for L.V. equipment
- earthing for H.V. equipment

Electric power supply

The cement plant will be supplied with electricity from the public JIRAMA grid by two overhead 20 kV lines.

Substation

The substation will be equipped with two transformers , 20 / 6 kV , output 6 300 kV A and 20 kV inlet switchgear and 6 kV outlet switchgear . The 6 kV switchgear will feed 3 secondary substations .

A separate transformer , 6 000 / 380 V , will feed a lighting system and auxiliary equipment . In case of black - out the essential electrical equipment will be automatically switched over to the existing diesel generating set in the factory .

14 Compressor Unit

The compressor unit generates compressed air for fluidication of cement in the silos and control of the plant .

Fluidizing air pressure	0,3 MPa
Control air pressure	0,6 MPa
Consumption of compressed air / pressure 0,3 MPa /	1 500 cu.m.per hour
Consumption of compressed air /pressure 0,6 MPa /	300 cu.m. per hour

15 Cooling Tower and Water Supply System

This system ensures supplies of cooling and service water in the factory .

Service water will be supplied from the AMBATOMALAMA dam / distance 7,0 km / to an existing steel tank located 1,5 km

away from the plant whereof water will be supplied by a tubing.

Service water will be necessary for :

- Process purposes / water injection into the conditioning tower , pelletizing /
  and washing of cars and general clearing .
- Certain part of service water makes up for losses in the water cooling system .
- Certain part of service water is treated to potable water / as it is now / .

The water cooling circulation system consists of the pumping station , the cooling tower , the water tank and the distribution system .

	Alt.1	Alt.2
Quantity of cooling water	60 cu.m./hour	30 cu.m./hour
Consumption :		
- evaporation + losses	6 "	3 "
- process	10 "	15 "
Service water TOTAL	16 cu.m./hour	18 cu.m./hour
Potable water TOTAL	6 cu.m./hour	6 cu.m./hour

16 Electrical Installation

Secondary substations will be equipped with 6 kV switchgear for H.V . motors , one 6 000 / 380 V transformer and 380 V distribution boards for feeding of L.V . installations .

The substations will be installed in the raw grinding plant, the cement grinding plant, the quarry and the Boanamary port.

Electric motors will make part of machinery and will be designed for humid tropical conditions.

Cables connecting the substations with the departments will be laid in ducts. Inside the buildings they will be mounted on walls or laid in floor conduits.

Lightning protection system, metallic structures and bodies of machinery and equipment will be interconnected with the common earthing system.

17 Instrumentation and Control

Instrumentation and control equipment will be divided into three basic control centres:

- quarry, crushing plant
- nucleus of the plant, i.e., from raw material storage upto cement conveying to silos
- packing and loading plant.

The nucleus of the plant will consist of several control subcentres.

Remote motor control is envisaged with possible local out-of-sequence control from the control panel.

Measuring and control instrumentation will enable automatic pre-setting and stabilizing of essential process parameters / temperatures, pressure, flow etc./.

19 Lighting and Communications

Indoor and outdoor lighting will be installed in accordance with recommmendations of the IEC .

The cement factory will be equipped with a private branch exchange for 30 extensions , a public address system , a centralized intercommunication system and a private telex station .

21 Boanamary Port

The existing cement factory possesses a little port / pier 100 m long / which is situated about 750 m away from the factory . This port is accessible from sea during tide twice a day in duration of 3 hours only . Access is possible for chalands with capacity less than 90 ton only . Therefore coal , additives , cement and auxiliary materials must be transferred from ships to boats and vice versa in high sea .

Furthermore , in the port there are continuing problems with lateritic sediments from the river .

As mentioned earlier , it is proposed to renew operation of an abandoned seaport at the village of BOANAMARY which would be accessible for ships .

Following measures must be adopted to make this port accessible and opertional :

a/ To clean the port bottom and remove sediments
b/ To restore the handling platform and install a mobile derrick for loading the pallets of cement and unloading of coal , gypsum and auxiliaries

c/ To construct an interstorage platform partly
- open : for unloading of coal and gypsum
- roofed : for buffer stock of palletized cement

d/ To fix up the road from the factory to the port for trucking .

Transport requirements :

Black coal Sakoa - Alt. 1	43 570 tons per year
Black coal imported - Alt. 2	33 540 tons per year
Gypsum	10 500 tons per year
Auxiliary / refractories , spare parts , ... /	1 500 tons per year
Bagged cement / 40 % of total production /	100 000 tons per year

Truck requirements :

Transport distance - 7 km	
Transport output per hour per truck /load capacity 15 tons , 2 cycles per hour /	30 tons
Daily transport rate from the port to the factory	300 tons
Daily transport rate from the factory to the port	330 tons
Daily capacity of a truck /12hrs / day /	360 tons

TOTAL requirements of trucks :
3 including 1 standby .

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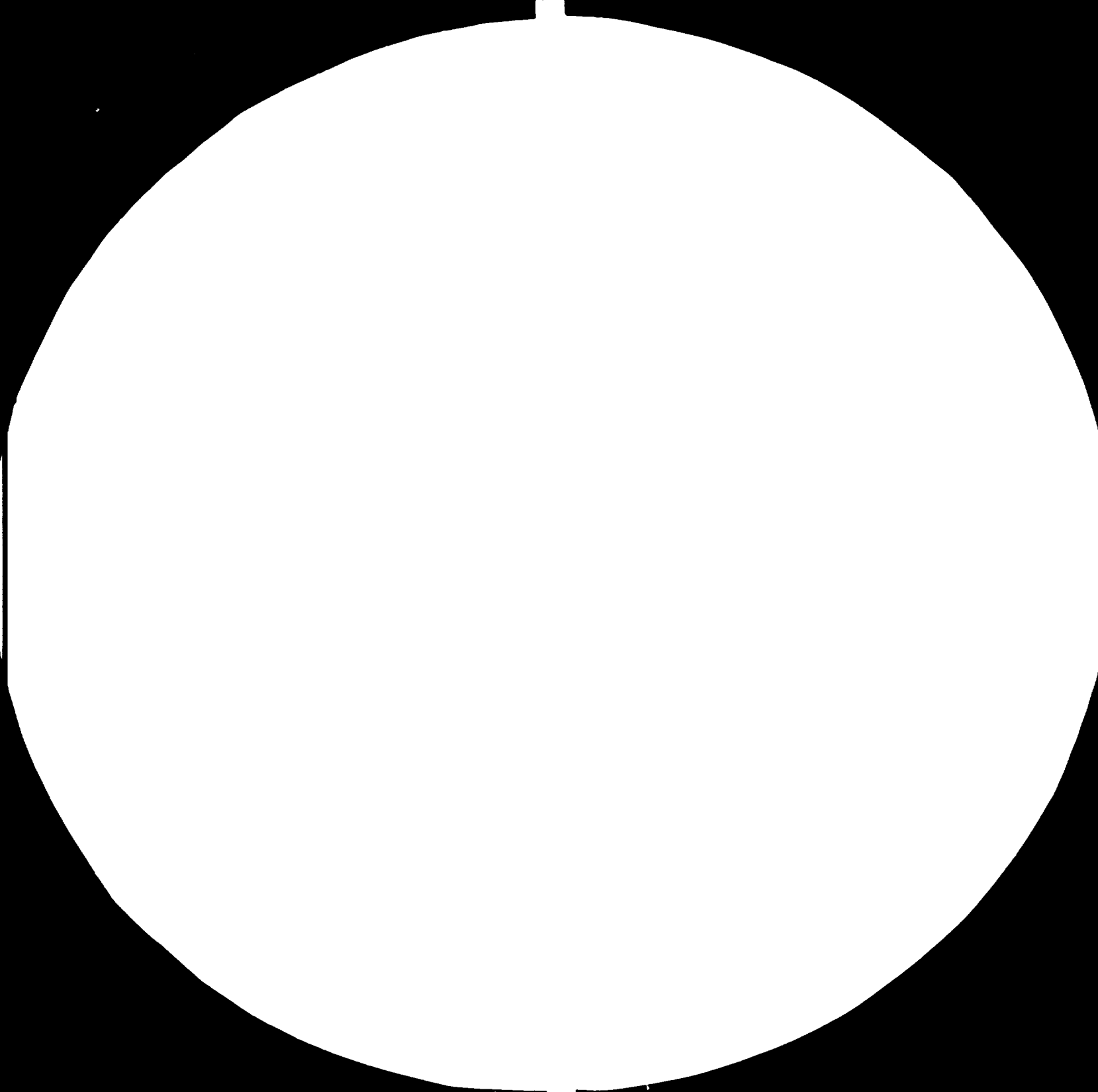
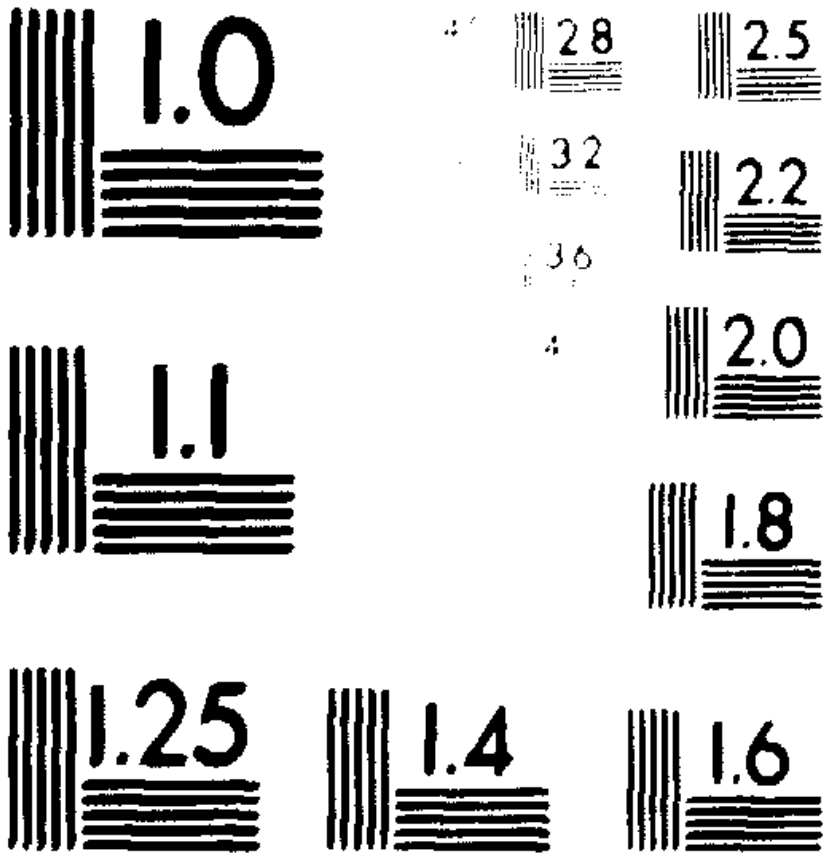




6.3.3. Cost Estimate

Cement production technology described in both alternatives is generally used in the world therefore its adoption is not subject to any patents, licenses and know-how.

6.4. Equipment

6.4.1. Equipment - Alternative 1/Rotary Kiln /

01 Limestone and marl quarry

01.01	1	Drilling rig
01.02	1	Mobile compressor unit
01.03	2	Air - operated hammer inc. accessories
01.04	2	Hydraulic excavator bucket capacity 1,25 cu.m.
01.05	3	Truck, capacity 150 kN / 15 tons /
01.06	1	Mobile diesel generating set
01.07	1	Bulldozer

Total weight : 102 160 kg

02 Raw Materials Crushing and Conveying

02.01	1	Apron feeder
02.02	1	Feeder side guides
02.03	1	Hammer crusher incl. driving unit
02.04	1	Hand - operated bridge - crane, lifting capacity 200 kN
02.05	1	Crane rails

02.06	1	Bag filter
02.07	1	Radial fan
02.08	1	Belt conveyor 800 x 620 000 mm
02.09	1	Belt conveyor 800 x 180 000 mm
02.10	1	Conveyor belt gantry
02.11	1	Set of hoppers and chutes
02.12	1	Set of structures
02.13	1	Set of dedusting pipes

TOTAL kW	435,9 kW
WEIGHT TOTAL	321 750 kg

03 Raw Material Storage

03.01	1	Stacker
03.02	2	Front loader
03.03	1	Apron feeder 800 x 6 400
03.04	1	Belt conveyor
03.05	2	Apron feeder 650 x 6 400
03.06	2	Belt conveyor 650 x 35 000
03.07	1	Belt conveyor 800 x 40 000
03.08	1	Set of hoppers and chutes
03.09	1	Set of structures

TOTAL kW	88 kW
TOTAL WEIGHT	135 350 kg

04 Raw Grinding Plant

04.01	1	Two - way valve gate
04.02	1	Impact crusher and drier
04.03	1	Hot gas generator
04.04	1	Battery of cyclones

04.05	1	Radial fan
04.06	1	Dust conveying system
04.07	1	Drum mill Ø 3,7 x 9 m incl. grinding media
04.08	1	Bucket elevator
04.09	1	Air separator
04.10	1	Airslide
04.11	1	Air separator
04.12	1	Belt conveyor 800 x 6 000
04.13	1	Airslide
04.14	1	Airslide
04.15	1	Steel dust bin
04.16	1	Dust bin fluidizing equipment
04.17	1	Turnstile discharger incl. sliding gate
04.18	2	Bag filter
04.19	2	Filter supporting structure
04.20	2	Single induced - draft fan
04.21	2	Screw conveyor Ø 250
04.22	1	Bucket elevator
04.23	1	Round bag filter
04.24	1	Steel bin , 50 cu.m.
04.25	1	Gate valve
04.26	8	Double oscillating valve
04.27	4	Hand - operated hoist
04.28	1	Double proportioning screw conveyor
04.29	1	Hot gas generator , 10 x 10^6 kcal/hr
04.30	1	Hand - operated bridge crane 160 kN
04.31	1	Mill fan
04.32	1	Conditioning tower Ø 6,5 x 19,5
04.33	1	Water injection system
04.34	1	Electrostatic precipitator
04.35	1	Fan for the filter 04.34
04.36	3	Single - phase silica rectifier
04.37	3	Screw conveyor

04.38	1	Bucket elevator
04.39	1	Set of piping
04.40	1	Set of hoist rails
04.41	1	Set of chutes and hoppers
04.42	1	Supporting structures
04.43	3	Grinding media container
04.44	1	Refractory lining and insulation
04.45	1	X - ray analyser complete with sample preparation

TOTAL kW	3 205,8 kW
TOTAL WEIGHT	1 188 024 kg

05 Homonogenization Silos

05.01	1	Airlift Ø 1 400
05.02	1	Piping
05.03	1	Expansion vessel
05.04	2	Rotary piston blower
05.05	1	Set of silo airslides
05.06	1	Fluidizinig system
05.07	1	Silo discharging set extraction equipment
05.08	1	Dosing device
05.09	1	Air lift Ø 1 400
05.10	2	Rotary piston blower
05.11	1	Bag filter
05.12	1	Filter supporting structure
05.13	1	Radial fan
05.14	1	Dust separation piping
05.15	1	Auxiliary structures

05.16	1	Air distribution piping
05.17	1	Set of hoppers and chutes
TOTAL kW		263,1 kW
TOTAL WEIGHT		72 330 kg

06 Clinker Burning

06.01	1	Kiln fan
06.02	1	Shaft preheater Ø 4,9 m
06.03	1	Rotary kiln Ø 3,9 x 62 m
06.04	1	Kiln driving unit
06.05	1	Set of satellite coolers
06.06	1	Radial fan
06.07	1	Double - toggle jaw crusher
06.08	1	Bag filter
06.09	1	Radial fan
06.10	1	Chain conveyor
06.11	1	Bucket conveyor , 800 x 55 000
06.12	1	Set of chutes and hoppers
06.13	1	Set of structures
06.14	1	Water distribution piping
06.15	1	Air distribution piping
06.16	1	Exit gas piping
06.17	1	Radial fan
06.18	1	Set of rotary kiln jacks
06.19	1	Refractory lining
06.20	1	Heat insulation
TOTAL kW		899 kW
TOTAL WEIGHT		2 275 000 kg

07 Clinker and Additives Storage

07.01	1	Bridge grab crane, loading capacity 80 kN, grab volume capacity 2,5 cu.m.
TOTAL kW		55 kW
TOTAL WEIGHT		25 200 kg

08 Coal Storage

08.01	1	Front loader
08.02	1	Belt conveyor 650 x 60 000
08.03	1	Conveyor bridge
08.04	1	Belt conveyor
08.05	1	Set of hoppers and chutes
08.06	1	Set of structures
TOTAL kW		14 kW
TOTAL WEIGHT		58 900 kg

09 Coal Grinding Plant

09.01	1	Steel bin 50 cu.m.
09.02	1	Gate valve
09.03	1	Rotary table feeder, Ø 800
09.04	1	Tube mill, Ø 2,5 x 3,5 m
09.05	1	Blade air separator
09.06	1	Separating cyclone, Ø 2 000
09.07	1	Double valve lock
09.08	1	Steel bin

09 .09	1	Gate
09 .10	2	Double proportioning screw conveyor
09.11	1	Radial fan
09 .12	1	Hot gas generator , 3×10^6 kcal / hr
09 .13	1	Set of steel chutes
09 .14	1	Metallic structures
09.15	1	Air distribution piping
09.16	2	Hand - operated hoist
09 .17	1	Set of control valves

TOTAL kW	426,5 kW
TOTAL WEIGHT	110 525 kg

10 Cement Grinding Plant

10.01	1	Belt feeder
10.02	2	Belt feeder
10.03	1	Belt conveyor 650 x 7 000
10.04	1	Drum mill , Ø 3,7 x 9 m incl. grinding corps
10.05	1	Bucket elevator
10.06	1	Air - operated conveying scuttle
10 .07	1	Air separator
10.08	1	Belt conveyor , 800 x 8 000
10.09	1	Belt conveyor , 800 x 8 000
10.10	1	Blade air separator
10.11	2	Bag filter
10.12	1	Double I. D. fan
10 .13	1	Bag filter
10.14	1	Radial fan
10.15	1	Screw conveyor Ø 250
10.16	1	Screw conveyor Ø 250

10.17	6	Oscillating valves
10.18	1	Hand - operated double - beam crane 160 kN
10.19	2	Hand - operated pulleywork 50 kN
10.20	1	Hand - operated pulleywork 32 kN
10.21	1	Set of rails
10.22	1	Cooling water unit
10.23	1	Set of hoppers and chutes
10.24	1	Set of supporting structures
10.25	1	Dust separation ducts
10.26	3	Grinding media container

TOTAL kW	2 259 kW
TOTAL WEIGHT	389 364 kg

11 Cement Silos

11.01	1	Airlift
11.02	1	Ducts
11.03	1	Expansion vessel
11.04	2	Rotary piston blower
11.05	1	Airslide
11.06	2	Fluidizing air system
11.07	2	Bottom discharger
11.08	2	Side discharger
11.09	1	Discharge control unit
11.10	1	Screw conveyor , Ø 630 x 25 000
11.11	2	Upper silo inlet
11.12	2	Side silo inlet
11.13	1	Bag filter
11.14	1	Bag filter
11.15	2	Radial fan

11.16	1	Suction piping
11.17	1	Auxiliary material
11.18	1	Air ducts
11.19	1	Set of chutes
11.20	1	Supporting structures

TOTAL kW	162,5
TOTAL WEIGHT	60 750 kg

12 Packing and Loading Plant

12.01	1	Bucket elevator
12.02	1	Security screen
12.03	1	Cement storage bin
12.04	1	Airslide
12.05	1	Control valve
12.06	1	Rotary 8-valve bag-filling machine
12.07	1	Storage bin under the machine
12.08	1	Screw conveyor
12.09	1	Belt conveyor 650 x 30 000
12.10	2	Air - operated bag diverter
12.11	2	Telescopic bag loading conveyor
12.12	1	Bag filter
12.13	1	Radial fan
12.14	1	Suction ducts
12.15	2	Cable winding reel
12.16	2	Conveyor track
12.17	1	Set of chutes and hoppers
12.18	1	Set of supporting structures
12.19	1	Set of air ducts

12.20	2	Hand - operated hoist
12.21	2	Diesel oil - operated fork - lift
TOTAL kW		136,75 kW
TOTAL WEIGHT		100 064 kg

14 Compressor Unit

14.01	2	Screw compressor , 1 500 cu.m. per hour , air pressure 0,3 MPa
14.02	2	Piston compressor , 350 cu.m. per hour , air pressure 0,7 MPa
14.03	2	Air cooler
14.04	4	Air tank
14.05	2	Automatic air drier
14.06	1	Air filter
14.07	1	Set of ducts
14.08	1	Set of fittings
TOTAL kW		417 kW
TOTAL WEIGHT		31 661 kg

21 BOANAMARY Port

21.01	1	Grab crane , grab volume 2,5 cu.m.
21.02	3	Truck , loading capacity 150 kN
21.03	2	Diesel oil - operated fork - lift truck , 2 500 kg
TOTAL kW		55 kW
TOTAL WEIGHT		105 400 kg

6.4.2. Equipment - Alternative 2 - Shaft Kilns

01 Limestone and Marl Quarry

01.01	1	Drilling rig
01.02	1	Mobile compressor unit
01.03	2	Air - operated compressor unit
01.04	2	Hydraulic loader, bucket 1,25 cu.m.
01.05	3	Truck, capacity 150 kN
01.06	1	Diesel generating set
01.07	1	Bulldozer

TOTAL WEIGHT 102 160 kg

02 Raw Material Crushing Plant and Conveying

02.01	2	Apron feeder
02.02	1	Hammer crusher
02.03	1	Hand - operated bridge crane, load. capacity 200 kN
02.04	1	Crane rails
02.05	1	Bag filter
02.06	1	I.D. radial fan
02.07	1	Belt conveyor 800 x 800 000
02.08	1	Conveyor bridge
02.09	1	Chutes and hoppers
02.10	1	Supporting structures
02.11	1	Dust separation ducts

TOTAL kW 435,9 kW
TOTAL WEIGHT 321 750 kg

03 Raw Materials Storage

03.01	1	Stacker
03.02	2	Reclaimer
03.03	1	Apron feeder
03.04	1	Belt conveyor 800 x 40 000
03.05	1	Belt conveyor 800 x 12 000
03.06	2	Reversible belt conveyor 800 x 7 000
03.07	1	Sand reclaimer
03.08	1	Belt conveyor 650 x 35 000
03.09	1	Belt conveyor 650 x 30 000
03.10	2	Reversible belt conveyor 650 x 7 000
03.11	2	Raw material storage bin
03.12	2	Correction limestone storage bin
03.13	2	Sand storage bin
03.14	2	Coal storage bin
03.15	1	Set of chutes and hoppers
03.16	1	Set of supporting structures

TOTAL kW	88 kW
TOTAL WEIGHT	135 350 kg

04 Raw Grinding Plant

04.01	2	Raw materials dosing device
04.02	2	Correction limestone dosing device
04.03	2	Sand dosing device
04.04	2	Coal dosing device
04.05	2	Belt conveyor 650 x 17 200
04.06	2	Belt conveyor
04.07	2	Vertical mill
04.08	2	Separator
04.09	2	Cyclone separator

04.10	2	Dust collecting unit
04.11	2	Mill fan
04.12	2	Dust conveying
04.13	2	Bucket elevator
04.14	2	Set of airslides
04.15	2	Hot gas generator 5×10^6 kcal per hour
04.16	2	Bridge crane 200 kN
04.17	1	Set of chutes and hoppers
04.18	1	Set of supporting structures
04.19	1	Set of air ducts
04.20	1	Refractory lining and insulation

TOTAL KW	3 005,8 kW
TOTAL WEIGHT	650 000 kg

05 Homogenization Silos

05.01	4	Upper part fluidification system
05.02	4	Upper part discharging system
05.03	4	Lower part fluidification system
05.04	4	Lower part discharging system
05.05	2	Set of screw conveyors
05.06	2	Dust collection system
05.07	2	Set of dust ducts
05.08	1	Set of supporting structures
05.09	1	Set of chutes

TOTAL kW	363,1 kW
TOTAL WEIGHT	90 000 kg

06 Clinker Burning

06.01	1	Set of screw conveyors
06.02	2	Dosing storage bin
06.03	2	Bucket elevator
06.04	2	Chain conveyor
06.05	4	Raw meal weigh feeder
06.06	4	Pelletizer
06.07	4	Vertical shaft kiln
06.08	4	Blower
06.09	1	Clinker conveyor , 32 m
06.10	1	Clinker crusher
06.11	1	Bucket conveyor
06.12	1	Conveying bridge
06.13	4	Dust collecting unit
06.14	4	Set of dust ducts
06.15	1	Set of chutes
06.16	1	Set of supporting structures
06.17	1	Lining
06.18	1	Insulation

TOTAL kW 799 kW
TOTAL WEIGHT 1 840 000 kg

07 Clinker and Additives Storage

07.01	1	Bridge grab crane , 80 kN , grab volume 2,5 cu.m.

TOTAL kW 55 kW
TOTAL WEIGHT 25 200 kg

08 Coal Storage

08.01	1	Reclaimer
08.02	1	Belt conveyor 650 x 98 000
08.03	1	Conveying bridge
08.04	1	Belt conveyor 650 x 96 000
08.05	1	Conveyor belt gantry
08.06	1	Set of hoppers and chutes
08.07	1	Supporting structures
TOTAL kW		30 kW
TOTAL WEIGHT		140 000 kg

10 Cement Plant

10.01	2	Bucket elevator
10.02	2	Belt conveyor
10.03	2	Reversible belt conveyor
10.04	6	Storage bins for clinker and additives
10.05	2	Clinker dosing device
10.06	2	Gypsum dosing device
10.07	2	Pozzolana dosing device
10.08	2	Cement mill
10.09	2	Bucket elevator
10.10	2	Airslide
10.11	2	Cyclone air separator
10.12	2	Airslide / coarse material /
10.13	2	Airslide / cement /
10.14	2	Bucket elevator
10.15	2	Airslide
10.16	2	Dust collection system of mill circuit

10.17	2	Dust collection system of conveying
10.18	2	Dust ducts
10.19	1	Set of chutes and hoppers
10.20	1	Set of supporting structures
10.21	2	Bridge crane 100 kN
10.22	4	Hand - operated hoist
TOTAL kW		2 559 kW
TOTAL WEIGHT		650 000 kg

11 Cement Silos

11.01	4	Fluidification system
11.02	4	Silo discharging system
11.03	2	Dust collection system
11.04	2	Set of dust ducts
11.05	1	Supporting structures
TOTAL kW		262,5 kW
TOTAL WEIGHT		76 000 kg

12 Packing and Loading Plant

12.01	2	Fuller pump
12.02	2	Screw conveyor
12.03	2	Bucket elevator
12.04	2	Security screen
12.05	2	Storage bin
12.06	2	Rotary dosing device
12.07	2	4-valve bagging machine
12.08	2	Dust collection system
12.09	4	Belt conveyor
12.10	2	Bag cleaner

12.11	2	Bag diverter
12.12	2	Reclaiming table
12.13	2	Loading belt conveyor
12.14	2	Dust conveying system
12.15	2	Set of dust ducts
12.16	2	Set of chutes and hoppers
12.17	1	Supporting structures
12.18	2	Diesel oil - operated fork - lift truck 2 500 kg
12.19	2	Hand - operated hoist

TOTAL kW 186,7 kW
TOTAL WEIGHT 110 000 kg

14 Compressor Unit

14.01	2	Screw compressor , 1 500 cu.m. per hour air pressure 0,3 MPa
14.02	2	Piston compressor , 350 cu.m. per hour air pressure 0,7 MPa.
14.03	2	Air cooler
14.04	4	Air tank
14.05	2	Automatic air drier
14.06	1	Air filter
14.07	1	Set of ducts
14.08	1	Set of fittings

TOTAL kW 417 kW
TOTAL WEIGHT 31 661 kg

21 BOANAMARY Port

21.01	1	Grab crane , grab volume 2,5 cu.m.

21.02	3	Truck , loading capacity 150 kN
21.03	2	Diesel - oil operated fork - lift truck 2 500 kg
TOTAL kW		55 kW
TOTAL WEIGHT		105 400 kg

6.4.3. Cost estimate

6.4.3.1.	Production equipment - Alternative 1	15 224 000 USD
	- Alternative 2	16 736 000 USD
6.4.3.2.	Auxiliary equipment	2 127 000 USD
6.4.3.3.	Service equipment	40 000 USD
6.4.3.4.	Spare parts , tools	1 600 000 USD
6.4.3.5.	Engineering , transport , custom fees , erection	13 640 000 USD
6.4.3.6.	TOTAL equipment - Alternative 1	32 631 000 USD
	TOTAL equipment - Alternative 2	34 143 000 USD

A detailed break - down of the costs indicated in Schedule 6.2.

Cost of the production equipment in the Alternative 1 , is based on the average costs of similar equipment in the world market .

Cost of the production equipment in the Alternative 2, is based on an indicative offer by the LOESCHE company , obtained by the Consultants during their stay in Madagascar .

Difference in costs between the two alternatives is derived from the fact that the Alternative 1 is designed as

a single line system whereas the Alternative 2 is a two - line system similar to that currently being implemented in the ANTSIRABE - IBITY project .
Different design of the grinding plants , especially the cement grinding plant , contribute decisively to difference between the individual costs .

6.5. Civil Engineering

Attention was paid to using of majority of building materials from local market such as stone , bricks , cement , reinforced concrete ,etc .

These materials shall adequately enable appropriate architectural design of individual buildings .

6.5.1. Data

Total area of the site	45 000 sq m.
Area of networks	4 500 sq.m.
Production departments	11 250 sq.m.
Landscaping	4 300 sq.m.
Auxiliary departments	5 200 sq.m.
Roads and compacted areas	8 400 sq.m.
Total built - up area	212 400 cu.m.

6.5.2. Description of Civil Engineering Works

Reinforced concrete monolitic structures will be used for construction of production buildings , such as :

crushing plant , raw mill , kiln , coal preparation , cement mill , packing and loading plant etc .

Brick structures will be used for auxiliary buildings , as follows :

compresser house , substation , control rooms , etc .

Combined structures comprising reinforced concrete structures and steel roofs will be used for hall buildings :

storage of raw materials , storage of clinker and additives , storage of coal .

Special construction methods / i.g. slide shuttering / will be used during construction of homogenization and cement silos .

Existing buildings such as offices , laboratory , fuel store , lubricants store , stores and workshops , loading station , sanitary facilities will be reconstructed in an adequate way .

In the civil works there are included roads and concrete platforms , rain sewerage , service and cooling water supply system ,electric cables ducts .

Site levelling includes land preparation and diversion of a brook .

6.5.3. Cost estimation

6.5.3.1. Total investment costs in civil engineering	17 560 000 USD
- in local currency	11 140 000 USD
- in foreign currency	6 420 000 USD
6.5.3.2. Site and land preparation costs	1 800 000 USD
6.5.3.3. Buildings	11 400 000 USD
6.5.3.4. Outdoor works	1 100 000 USD
6.5.3.5. Other costs / project planning, transport, custom fees /	3 260 000 USD

Schedule 6-2 ESTIMATE OF INVESTMENT COST: EQUIPMENT
Piece 6-2 ESTIMATION DES COUTS D'INVESTISSEMENT: ÉQUIPMENT

USD

ESTIMATE OF INVESTMENT COST EQUIPMENT	ESTIMATION DU COUT D'INVESTISSEMENT EQUIPEMENT			
No.	ITEM DESCRIPTION DÉSIGNATION	COST FOREIGN ÉTRANGÈRE	COUT LOCAL LOCAL	 TOTAL TOTAL
	Production equipment - Alt. 1 Equipment de production - Alt. 1			
01	Limestone and marl quarry Carrière du calcaire et de marne	643.600		643.600
02	Crushing plant and conveying Concassage et transport	965.200		965.200
03	Raw material storage Magasinage des matières premières	514.300		514.300
04	Raw grinding plant Broyage de matières premières	2.921.200		2.921.200
05	Homogenization silos Silo de homogénéisation	651.000		651.000
06	Clinker burning Cuisson du klinker	4.350.400		4.350.400
07	Clinker and additives storage Magasinage du klinker et d additifs	151.200		151.200
08	Coal storage Magasinage du charbon	176.700		176.700
09	Coal grinding Broyage du charbon	442.500		442.500
10	Cement grinding plant Broyage du ciment	1.650.800		1.650.800
11	Cement silos Silo du ciment	600.700		600.700
12	Packing plant Emballage	600.400		600.400
16	Electrical installation Installation électrique	960.000		960.000
17	Instrumentation and control Instruments et commande	596.000		596.000
	Total Total	15,224.000		15,224.000
	Production equipment - Alt. 2 Equipement de production - Alt.2			
01	Limestone and marl quarry Carrière du calcaire et de marne	643.600		643.600
02	Crushing plant and conveying Concassage et transport	965.200		965.200
03	Raw material storage Magasinage des matières premières	514.300		514.300
04	Raw grinding plant Broyage	3,400.800		3,400.800

USD

No.	ITEM DESCRIPTION DÉSIGNATION	COST COUT		
		FOREIGN ÉTRANGÈRE	LOCAL LOCAL	TOTAL TOTAL
05	Homogenization silos Silos de homogénéisation	753.800		753.800
06	Clinker burning Cuisson du clinker	4,100.500		4,100.500
07	Clinker and additives storage Magasinage du clinker et d'additives	151.200		151.200
08	Coal storage Magasinage du charbon	176.700		176.700
10	Cement grinding plant Broyage du ciment	3,154.000		3,154.000
11	Cement silos Silos du ciment	650.000		650.000
12	Packing plant Emballage	615.900		615.900
16	Electrical installation Installation électrique	1,060.000		1,060.000
17	Instrumentation and control Instruments et commande	550.000		550.000
	Total Total	16,736.000		16,736.000
	Auxiliary equipment Equipement auxiliaire			
13	Substation and power supply Poste de transformation et électricité	1,150.000		1,150.000
14	Compressor unit /extension/ Compresseur /extension/	190.000		190.000
15	Water supply system Adduction d'eau	35.000		35.000
19	Outdoor lighting and telecomunication Eclairage extérieure et communications	15.000		15.000
21	Boanamary port Port de Boanamary	632.000		632.000
22	Laboratory /extension/ Laboratoire /extension/	25.000		25.000
25	Workshops and stores /extension/ Ateliers et magasins /extension/	80.000		80.000
	Total Total	2,127.000		2,127.000

No.	ITEM DESCRIPTION DÉSIGNATION	COST COUT		
		FOREIGN ÉTRANGÈRE	LOCAL LOCAL	TOTAL TOTAL
	Service equipment Equipement de service			
22	Offices /extension/ Bureaux /extension/	15.000		15.000
22	Health centre Service medical	25.000		25.000
	Total Total	40.000		40.000
	Primary stock of spare parts, wear and tear parts, tools Stock initial de pieces de rechange, remplacement des pieces usées, outils			
	- Alt. 1	1,600.000		1,600.000
	- Alt. 2	1,600.000		1,600.000
	Subtotal - Alt. 1	18,991.000		18,991.000
	Sous-total Alt. 2	20,503.000		20,503.000
	Project planning Planifications du projet	1,000.000		1,000.000
	Sea transport costs Couts du transport maritime	3,000.000		3,000.000
	Custom fees Frais de douane		7,000.000	7,000.000
	Inland transport Transport local		400.000	400.000
	Erection Montage		2,240.000	2,240.000
	Subtotal Sous-total	4,000.000	9,640.000	13,640.000
	Total - Alt. 1	22,991.000	9,640.000	32,631.000
	- Alt. 2	24,503.000	9,640.000	34,143.000

Schedule 6-4 ESTIMATE OF INVESTMENT COST: CIVIL ENGINEERING WORKS
Tiece 6-4 ESTIMATION DES COUTS D'INVESTISSEMENT: TRAVAUX DE GENIE CIVIL

USD

ESTIMATE OF INVESTMENT COST / ESTIMATION DU COUT D'INVESTISSEMENT							
CIVIL ENGINEERING WORKS / TRAVAUX DE GENIE CIVIL							
	QUANTITY QUANTITE	UNIT UNITE	ITEM DESCRIPTION DESIGNATION	UNIT COST COUT UNITAIRE	COST COUT		
					FOREIGN ETRANGERE	LOCAL LOCAL	TOTAL TOTAL
1			Site preparation Préparation de l'emplacement				
			Demolition Demolition			800.000	800.800
			Site preparation Préparation de l'emplacement			500.000	500.000
			Boanamary port Port de Boanamary			500.000	500.000
			Total Total		-	1,800.000	1,800.000
2			Buildings Batiments				
	140 000	cu.m	Production buildings Batiments de production	75	4,700.000	5,800.000	10,500.000
	11 000	cu.m	Not - production buildings Batiments de non-production	60	100.000	560.000	660.000
	3 000	cu.m	Reconstruction Réconstruction	80	-	240.000	240.000
			Total Total		4,800.000	6,600.000	11,400.000
3			Outdoor works Aménagements extérieurs				
			Networks Réseaux			660.000	660.000
			Roads Routes			440.000	440.000
			Total Total		-	1,100.000	1,100.000
			Subtotal Sous-total		4,800.000	9,500.000	14,300.000
			Project planning Planification du projet		800.000	-	800.000
			Sea transport costs Cout du transport maritime		720.000	-	720.000
			Custom fees Frais de douane			1,440.000	1,440.000
			Inland transport Frais de transport local			300.000	300.000
			Subtotal Sous-total		1,520.000	1,740.000	3,260.000
			Total Total		6,320.000	11,240.000	17,560.000

Schedule 6-6 ESTIMATE OF PRODUCTION COST : EQUIPMENT

Piece 6-6 ESTIMATION DES COUTS DE PRODUCTION: EQUIPEMENTS

US/

ESTIMATE OF PRODUCTION COST / ESTIMATION DES COUTS DE PRODUCTION							
EQUIPMENT / EQUIPEMENT							
No	QUANTITIY QUANTITÉ	UNIT UNITE	ITEM DESCRIPTION DESIGNATION	COUT UNITAIRE UNIT COST	COST COUT FOREIGN ETRANGER	COST COUT LOCAL LOCAL	COST COUT TOTAL TOTAL
			Maintenance and repair of works of :				
			Entretien et réparation concernant :				
1			Production equipment Equipement de production				
	1,5	%	- Alt. 1	152.240	228.400		228.400
	1,5	%	- Alt. 2	167.360	251.000		251.000
2	1	%	Auxiliary and service equipment Equipement auxiliaire et de service	21.670		21.700	21.700
			Total - Alt. 1		228.400	21.700	250.100
			Total - Alt. 2		251.000	21.700	272.700

Schedule 6-8 ESTIMATE OF PRODUCTION COST: CIVIL ENGINEERING WORKS

Pièce 6-8 ESTIMATION DES COUTS DE PRODUCTION : TRAVAUX DE GENIE CIVIL

USD

ESTIMATE OF PRODUCTION COST / ESTIMATION DES COUTS DE PRODUCTION							
CIVIL ENGINEERING WORKS / TRAVAUX DE GENIE CIVIL							
No.	QUANTITY QUANTITE	UNIT UNITE	ITEM DESCRIPTION DESIGNATION	UNIT COST COUT UNITAIRE	COST / COUT		
					FOREIGN ETRANGER	LOCAL LOCAL	TOTAL TOTAL
			Maintenance and repair of works of : Entretien et réparation concernant de :				
1	8	%	Site preparation Préparation de l'emplacement	18 000	-	144 000	144 000
2	2	%	Buildings Batiments	114 000	-	228 000	228 000
3	3	%	Outdoor works Aménagements extérieurs	11 000	-	33 000	33 000
			Total Total		-	405 000	405 000

7. PLANT ORGANIZATION AND OVERHEAD COSTS

Organizational set - up of the new cement plant is adequate for the selected capacity and is generally adopted in European conditions .

This set - up takes into consideration :

- production capacity
- adopted technology and physico - chemical transformations of materials and inputs during processing
- required labour to operate the equipment .

The aim is to minimize the production costs and to obtain a good quality of cement .

With regard to the flow - sheet , the production can be divided from the point of view of physical and chemical trans - formations of materials into three separate departments :

- Preparation of raw materials
- Clinker burning
- Cement manufacturing

7.1. Cost Centres

7.1.1. Production Departments

7.1.1.1. Preparation of raw materials

This department comprises following operations :

- Raw materials exploitation
- Raw materials crushing
- Storage and prehomogenization

- Drying and grinding
- Homogenization and storage of raw meal

Overhead costs include supervisor's salary , auxiliary materials and cost of electric lighting .

7.1.1.2. Clinker burning

This department comprises following operations :

- Raw meal conveying to kiln /s/
- Burning of clinker in the kiln /s/
- Conveying and storage of clinker and additives
- Storage and preparation of coal .

Overhead costs include supervisor's salary , auxiliary materials , utilities / electric light / .

7.1.1.3. Cement manufacturing

This department comprises following operations :

- Grinding of clinker and additives
- Cement storage in silos
- Packing and loading of cement

Overhead costs include supervisor's salary , auxiliary materials , and utilities / electric light / .

7.1.2. Service and Auxiliary Departments

7.1.2.1. Maintenance shops and Operating Maintenance

This department is responsible for operation and maintenance of the production equipment . Overhead costs include supervisor's

salary , spare parts consumed , auxiliary materials and utilities .

7.1.2.2. Utilities

This department is responsible for availability of :

- Electricity
- Water
- Compressed air

Overhead costs include supervisor's salary , auxiliary materials and electric light.

7.1.2.3. Other services

Other services include storage of auxiliary and overhead materials , sanitary facilities , canteen , health service , laboratory , gatemen , watchmen and laboratory .

7.1.3. Administration

Factory management , production management and economic management are included in administration .

The cost in salaries of management staff / for more details see Chapter 8 / as well as office materials , auxiliary materials and lighting are regarded as administrative overheads .

7.2. Overhead Costs

7.2.1. Factory Overheads

- Wages of 94 non - production labour
  / refer to Schedules 8-1 , 8-2 / 246 200 USD / year

- Materials , products , utilities
  / refer to Schedule 4-1 / ... Alt.1 3 811 000 USD / year
  ... Alt.2 3 442 000 USD / year

- Repairs and maintenance
  / refer to Schedules 6-6 , 6-8
  ... Alt.1 655 100 USD / year
  ... Alt.2 677 700 USD / year

Factory overheads TOTAL ... Alt.1 4712 300 USD / year
... Alt.2 4365 900 USD / year

7.2.2. Administrative Overheads

- Wages of non - production labour
  /refer to Schedules 8-1 ,8-2 / 20 200 USD / year

- Salaries of administration staff
  / refer to Schedule 8-3 , 8-4 / 113 700 USD / year

- Overhead materials /refer to Schedule
  4 - 1 / 100 000 USD / year

- Expenses in insurance , travel ,
  communication 200 000 USD / year

Administrative overheads TOTAL 433 900 USD / year

7.2.3. Depreciation / thousand USD /

	Alt. 1	Alt. 2
a / Buildings, civil works		
5 % of 17 560 000 USD	878	
b / Machinery and equipment		
- equipment		
10 % of 30 781 000 USD	3 078	
of 32 293 000 USD		3 229
- transport and mobile equipment		
20 % of 1 850 000 USD	370	
Depreciation total	4 326	4 477

Schedule 7 Overhead COSTS

Piece 7 FRAIS GENERAUX USD

No	Item Cost	OVERHEAD COSTS FRAIS GENERAUX	
		FACTORY SERVICES	ADMINISTRATIVE ADMINISTRATION
1.	Wages and salaries Salaires et traitements	246.200	133.900
2.	Materials and utilities Matériaux et services publics		
	Alt. 1	3,811.000	100.000
	Alt. 2	3,442.000	
3.	Maintenance Entretien		
	Alt. 1	655.100	
	Alt. 2	677.700	
4.	Insurance, communication, travel Assurances, communications, voyages		200.000
5.	Total Alt. 1	4,712.300	433.900
	Alt. 2	4,365.900	
6.	Depreciations Amortissement		
	Alt. 1	4,326.000	-
	Alt. 2	4,477.000	-

8. MANPOWER

It is assumed that personnel for the new factory will be available from the manpower of the existing factory. Since a different technology of cement manufacture will be adopted, the workers of essential occupations will have to be trained in similar plants, by the supplier of the equipment. In case of the Alt. 1 - Shaft Kilns it will also be possible to train the personnel in the new IBITY - ANTSIRABE cement plant.

The number of staff and labour was determined by calculations where by working hours of the equipment per year, as well as the DECRET No. 74 083 from May 1st, 1974 were taken into consideration.

40 working hours per week and 173,33 working hours per month, i.e. 2 080 w.h. per year are envisaged.
Net working hours / 240 hrs/year of holiday substracted /:
1 840 hours per person per year.

All jobs will be occupied by Malagasy people. Technical assistance of foreign experts during start - up is indicated in Chapter 9.

8.1. Labour

8.1.1. Operating Hours

Department	hours/day	days/week	days/year
Quarry and crusher	16	5	225
Raw mill	24	6	270
Clinker burning	24	7	315

Coal preparation	24	6	270
Cement mill	24	5	225
Packing , loading	16	6	270

8.1.2. Jobs

Quarry and Crushing Plant	qualification	1.shift	2.shift	3.shift	4.shift	Total
Supervisor	0P2	1	1	-	-	2
Driller	0S2	2	2	-	-	4
Blaster	0S2	1	1	-	-	2
Compressor	0S2	1	1	-	-	2
Face shovel	0S2	2	2	-	-	4
Driver	A4	3	3	-	-	6
Crusher operator	0S3	1	1	-	-	2
Hopper attendance	M2	1	1	-	-	2
Stacker operator	0S2	1	1	-	-	2
Maintenance	0S2					
TOTAL		15	13	-	-	28

Raw Mill						
Reclaimer operator	0S2	1	1	1	1	4
Mill operator	0S3	2	2	2	1	7
TOTAL		3	3	3	2	11

Clinker Burning

Control attendant	OP3	2	2	2	3	9
Kiln operator	OS3	1	1	1	1	4
Crane operator	OS1	1	1	1	1	4
TOTAL		4	4	4	5	17

Coal Preparation

Coal mill operator	OS3	1	1	1	1	4
Coal handling	OS3	1	1	1	-	3
TOTAL		2	2	2	1	7

Cement Production

Cement mill operator	OS3	1	1	1	-	3

Packing and Loading

Packer	OS3	2	2	-	1	5
Bag handling	M2	1	1	-	-	2
Auxiliary	M2	3	3	-	2	8
TOTAL		6	6	-	3	15

Boanamary Port

Crane operator	OS2	1	1	-	-	2
Driver	A4	3	3	-	-	6
Auxiliary	M1	1	1	-	-	2
TOTAL		5	5	-	-	10

Laboratory

Technician	OP2	2	2	1	1	6
Sample preparation	OS2	1	1	1	1	4
Sample taking	OS1	1	1	1	1	4
TOTAL		5	4	3	3	14

Operating Maintenance

Supervisor	OP2	1	-	-	-	1
Fitter	OS2	2	2	2	2	8
Electrician	OS2	2	2	2	2	8
TOTAL		5	4	4	4	17

Maintenance Workshops

Supervisor	OP2	1	-	-	-	1
Machine-tools	OS2	6	4	-	-	10
Fitter	OS2	2	2	-	-	4
Electrician	OS2	2	2	-	-	4
Car maintenance	OS2	2	-	-	-	2
TOTAL		13	8	-	-	21

Utility Services

Supervisor	OP2	1	-	-	-	1
Substation	OS2	1	1	1	1	4
Compressor and Emergency set	OS2	1	1	1	1	4
Water supply	OS2	1	1	1	1	4
TOTAL		4	3	3	3	13

Warehouse						
Chief storekeeper	OS2	1	-	-	-	1
Storekeeper	OS1	1	1	-	-	2
Auxiliary	M1	2	2	-	-	4
TOTAL		4	3	-	-	7
Others						
Car driver	A4	1	-	-	-	1
Labourers	OS1	2	2	-	-	4
Janitor	M1	1	1	-	-	2
Canteen	M2	1	-	-	-	1
Guard	M2	1	1	2	2	6
TOTAL		6	4	2	2	14
Labour Total /Ref.to Schedule 8-1/		72	60	22	23	177
Production Labour						69
Non - production Labour						108

8.1.3. Cost Estimate / Refer to Schedule 8-2 /

Cost of production labour per year	191 818 USD
Cost of non - production labour per year	266 488 USD
divided into : - factory overheads	246 230 USD
- administrative overheads	20 218 USD

8.2. Staff / Refer to Schedule 8-3 /

8.2.1. Administration

General manager	HC	1
Secretary	4B	1
Typist	3A	1

8.2.2. Production Department

Production manager	HC	1
Process engineer/mechanic	5B	1
Process engineer/chemist	5B	1
Electrical engineer	5B	1
Geologist	5B	1
Designer	4B	2
Typist	3A	1

8.2.3. Sales dept. and Bookkeeping

Sales manager	HC	1
Accountant	5B,4B	2
Purchaser	4B	1
Invoice clerk	4A	1
Cashier	4A	1
Administration service	4A	1
Chief of transport	4A	1
Typist	3A	1
Telephone operator	2B	1
Staff total		21

The new cement plant will employ in total 198 persons .

Envisaged productivity rate / provided that net working hours are 1 840 hours / man / year and 250 000 tons of produced cement per year / :

/ 1 840 x 198 / : 250 000 = 1,45 hours / ton of cement

8.2.4. Cost estimate / Refer to Schedule 8-4 /

Annual costs in staff salaries will amount to 113 724 USD .

Schedule S-1 MANNING TABLE - LABOUR

Pièce S-1 TABLEAU DES EFFECTIFS - PERSONNEL D'EXECUTION

Wage Category: Supervisory-A, Skilled-B, Semiskilled-C, Unskilled-D
Catégorie de salaire: Chef-A, Spécialisé-B, Ordinaire-C, Débutant-D

MANNING TABLE - LABOUR: VARIABLE AND FIXED
TABLEAU D'EFFECTIFS - PERSONNEL D'EXECUTION: VARIABLE ET FIXE

Department Département	Function Fonctions	Shift Equipe	Wage Category Cat. de salaire				Total Total
			A	B	C	D	
Raw Material Preparation Préparation des matières premières	Supervisor Contremaître	1 2	1 1				1 1
	Driller Opérateur de forage	1 2		2 2			2 2
	Blaster Boute-feu	1 2		1 1			1 1
	Compressor operator Compresseur	1 2		1 1			1 1
	Crusher operator Concasseur	1 2		1 1			1 1
	Raw mill operator Station de broyage	1 2 3 4		2 2 2 1			2 2 2 1
	Face shovel Pelle chargeuse	1 2 3 4		4 4 1 1		1 1	5 5 1 1
	Driver Camions	1 2		3 3			3 3
	Maintenance Entretien	1		2			2
	Total Department Total département	-	2	35	-	2	39
Clinker Burning Cuisson du clinker	Control Engineer Ingénieur de commande	1 2 3 4	2 2 2 3				2 2 2 3
	Kiln Operator Operateur du four	1 2 3 4	1 1 1 1				1 1 1 1

Department Département	Function Fonctions	Shift Equipe	Wage Category Cat.de salaires				Total Total
			A	B	C	D	
	Crane Operator Grue	1 2 3 4			1 1 1 1		1 1 1 1
	Coal Mill Operator Broyeur du charbon	1 2 3 4			1 1 1 1		1 1 1 1
	Coal Loader Chargeur du charbon	1 2 3			1 1 1		1 1 1
	Total Department Total département	-	9	11	4	-	24
Cement Production Production du ciment	Cement Mill Operator Operateur du broyeur	1 2 3		1 1 1			1 1 1
	Packer Emballeur	1 2 3		2 2 1			2 2 1
	Bag handling Manutention des sacs	1 2 3				4 4 2	4 4 2
	Total Department Total département	-	-	8	-	10	18
Auxiliary and Service Auxiliaire et service	Maintenance Supervisor Contre-maitre d'entretien	1	2				2
	Operation Maintenance Entretien marche	1 2 3 4		4 4 4 4			4 4 4 4
	Workshop Atelier	1 2		12 8			12 8
	Laboratory Laboratoire	1 2 3 4	2 2 1 1	1 1 1 1	1 1 1 1	- - - -	4 4 3 3
	Power Engineer Ingenieur puissance	1	1				1

Department Département	Function Fonctions	Shift Equipe	Wage Category Categ.de salaires				Total Total
			A	B	C	D	
	Utility Operator Opérateur-services publics	1 2 3 4		3 3 3 3			3 3 3 3
	Warehouse Emmagasinage	1 2		1	1 1	2 2	4 3
	Boanamary Port Port de Boanamary	1 2		4 4		1 1	5 5
	Janitor Service social	1 2		1	2 2	2 1	5 3
	Guard Guardien	1 2 3 4				1 1 2 2	1 1 2 2
	Total Department Total département	-	9	62	10	15	96
	T O T A L		20	116	14	27	177
	Divided into: Divisé en :						
	- production labour personnel de production		9	52	4	4	69
	- non-production labour personnel autre que de production		11	64	10	23	108
	/factory overhead- frais généraux d'atelier/		11	63	6	14	94
	/administrative over- head- frais généraux d'administration/		-	1	4	9	14

Case Study 8-2 ESTIMATE OF PRODUCTION COSTS : WAGES

Etude de cas 8-2 ESTIMATION DES COUTS DE PRODUCTION : SALAIRES

WAGE CATEGORY: SUPERVISOR-A, SKILLED-B, SEMISKILLED-C, UNSKILLED-D

CATEGORIE DE SALAIRE: CHEF-A, SPÉCIALISÉ-B, ORDINAIRE-C, DÉBUTANT-D

DEPARTMENT DÉPARTEMENT	VARIABLE COSTS FRAIS VARIABLES				TOTAL	FIXED COSTS FRAIS FIXES				TOTAL
	WAGE CATEGORY CATEGORIES DE SALAIRES					WAGE CATEGORY CATEGORIES DE SALAIRES				
	A	B	C	D		A	B	C	D	
Raw material preparation Préparation des matières premières	-	33	-	2	35	2	2	-	-	4
Clinker burning Cuisson du klinker	3	11	4	-	24	-	-	-	-	-
Cement production Production du ciment	-	8	-	2	10	-	-	-	8	8
Auxiliary and service Auxiliaire et service	-	-	-	-	-	9	62	10	15	96
Total workers Nombre total d'ouvriers	3	52	4	4	69	11	64	10	23	108
Working hours/day Heures de travail par jour	8	8	8	8	-	8	8	8	8	-
Working days/week Jours de travail	5	5	5	5	-	5	5	5	5	-
Working hours/year Heures par an	2080	2080	2080	2080	-	2080	2080	2080	2080	-
Wages per hour Salaire horaire	2,25	1,00	0,65	0,50	-	2,25	1,00	0,65	0,50	-
Surcharges /social/ Charge %	20%	20%	20%	20%	-	20%	20%	20%	20%	-
Wages per year Salaires par an	50544	129792	6490	4992	191818	61776	159744	16224	28704	266448
Divided into : Divisés en :										
- direct manpower costs frais directs du personnel					191818					
- factory overhead costs frais généraux de l'usine										246 230
- administrative overhead costs frais généraux administratifs										20 218

Note:

Wages are in USD

Traitements sont en USD

Schedule 6-3 MANNING TABLE - STAFF
Piece 6-3 TABLEAU DES EFFECTIFS - PERSONNEL D'ENCADREMENT

MANNING TABLE - STAFF	TABLEAU D'EFFECTIFS - PERSONNEL D'ENCADREMENT							
DEPARTMENT DÉPARTEMENT	FUNCTION FONCTIONS		CATÉGORIE DE TRAITEMENT SALARY CATEGORY						TOTAL TOTAL
			1	2	3	4	5	6	
Management Direction	Manager	Directeur	1						1
	Secretary	Secretaire			1				1
	Typist	Dactylo					1		1
Production Production	Production Manager Directeur de production		1						1
	Technologist	Téchnologue		2					2
	Electrical engineer Ingénieur Electrique			1					1
	Geologist	Géologue		1					1
	Designer	Dessinateur			2				2
	Typist	Dactylo					1		1
Economy Economie	Economical manager Directeur d'économie		1						1
	Accountant	Comptable		1	1				2
	Purchaser	Acheteur			1				1
	Clerk	Officier			1	3			4
	Typist	Dactylo					1		1
	Phone operater Centrale télephonique							1	1
Total Total			3	5	6	3	3	1	21

Schedule 8-4 ESTIMATE OF PRODUCTION COSTS - SALARIES

Pièce 8-4 ESTIMATION DES COUTS DE PRODUCTION: TRAITEMENTS

ESTIMATE OF PRODUCTION COSTS - SALARIES ESTIMATION DES COUTS DE PRODUCTION - TRAITEMENTS							
DEPARTMENT DÉPARTEMENT	SALARY CATEGORY CATÉGORIE DE TRAITEMENT						TOTAL
	1	2	3	4	5	6	
Management Direction	1		1		1		3
Production Production	1	4	2	-	1	-	8
Economy Economie	1	1	3	3	1	1	10
Total Total	3	5	6	3	3	1	21
Manmonths/year Hommesmois par an	36	60	72	36	36	12	252
Salary/month Traitements par mois	780	500	265	200	150	125	-
Surcharge in % Charge /%/	25	20	20	20	20	20	-
Salaries/year Traitements par an	37908	36000	22896	8640	6480	1800	113724
Note: Note: Salaries are in USD Traitements sont en USD							

9. IMPLEMENTATION SCHEDULING

Project implementation period is estimated at 36 months since decision until commercial start.

Essential stages of implementation comprise following activities:

- Project team recruitment
- Preparation of tender documents, evaluation of bids and selection of contractor
- Contracting
- Detailed engineering / site survey, planning of technology, machinery and equipment, civil engineering /
- Civil engineering works
- Erection of metallic structures, machinery and equipment, final civil engineering works, tests, trial run
- Start-up and commissioning

Project implementation schedule is indicated in Schedule 9.1.

Note: A detailed survey of raw materials must be made before the contract has come into force.

9.1. Data and Activities

9.1.1. Tendering

After the decision on implementation of the new Amboanio cement plant project has been made, the project implementation

team will be set up to prepare tender documents on delivery of the cement plant on " turn - key " basis .

The team will evaluate submitted bids and will make a decision on contractor selection .

9.1.2. Contracting

The contract will be awarded to successful bidder .

9.1.3. Site Preparation

These are activities related to site preparation including necessary pull - down of the existing production buildings.

9.1.4. Site Survey

In order to determine most suitable way of foundation of industrial buildings and to check the level of under ground water , soil survey should be carried out within the scope specified in the contract .

9.1.5. Planning of Basic Civil Engineering Works

Plans of foundations of the buildings , roads and networks based on the results of the site survey will be prepared .

9.1.6. Planning of Machinery , Equipment and Civil Engineering Works

Project implementation includes also detailed planning of machinery and equipment in respect to civil engineering .

Plans of electrical installations, instrumentation and control equipment will be initiated while machinery planning is in progress.

9.1.7. Basic Civil Engineering Works

Construction of the new cement factory will be carried out on three sites :

- Amboanio cement plant
- quarry and crushing plant
- Boanamary port

Civil engineering works comprise activities enabling to begin with erection of metallic structures and machinery and equipment.

9.1.8. Erection of Metallic Structures and Machinery and Equipment

Erection works will advance, as follows :

In the first place supporting metallic structures will be erected.

Next, erection of machinery and equipment simultaneously with erection of electrical equipment will be carried out.

Electrical cabling and erection of instrumentation and control apparatuses can be accomplished after erection of machinery has finished.

Erection works will be carried out by the trained staff from the existing factory under contractor's supervision.

Erection works include also individual tests of the machines.

9.1.9. Final Civil Engineering Works

These works will be carried out in order to ensure continuous progress of erection .

9.1.10. Trial Run

Machinery and equipment will be put into service step by step with material , in separate groups .

9.1.11. Start - up

After trial runs have successfully been accomplished , the plant will be started - up which means beginning of production . Achievement of full production capacity is expected at the end of start - up period , i.e., after 24 months . During start - up period the guarantee tests will be performed .

9.1.12. Training

A part of operating staff will be trained to handle similar machinery on contractors expenses . Other operating staff will be trained either in Antsirabé or in Amboanio during erection and start - up .

9.2. Selection of Project Implementation Programme and Time Schedule

Implementation time schedule is indicated on the Table 9.1.

9.2.1. Decisive activities

- Set - up of implementation team and selection of contractor : 5 months
- Beginning of project implementation : within 7 months after decision on implementation
- Gross engineering works must be finished within 15 months since beginning of project implementation
- Erection of machinery and equipment must be completed within 33 months since beginning of project implementation
- Start - up within 36 months since beginning of project implementation .

9.2.2. Other Activities

Activities influencing implementation schedule are , as follows :

- Delivery of metallic structures shall be accomplished between 12-th and 15-th month since beginning of project implementation
- Deliveries of machinery and equipment shall be accomplished between 12-th and 18-th month
- Deliveries of electrical installations , instrumentation and control apparatuses shall be accomplished between 15-th and 18-th month
- Staff training / abroad or in Antsirabé / shall be accomplished within 25 months
- Managerial staff recruitment shall be accomplished within 15 months
- Recruitment of other manpower shall be accomplished step by step till the end of erection

- Raw materials stocks, fuel, utilities and other material necessary for production shall be available at the site one month before the end of erection.

9.2.3. Implementation Manpower and Qualification

9.2.3.1. Civil engineering works

Civil engineering works will be carried out by local contractors under supervision of the Contractor. Supervising staff will consist of a chief and 5 specialists.

Total foreign staff : 5

Approximately 275 persons of local contractors will take part in civil engineering works.

Total civil engineering manpower requirement : 281

9.2.3.2. Erection

Erection will be supervised by following experts provided by the contractor :

Chief mechanical engineer	1
Chief electrical engineer	1
Mechanical supervisors	4
Electrical supervisors	2
Total foreign staff	8

Erection works will be carried out by approx. 130 skilled workers from the existing cement factory.

9.2.3.3. Trial run , start - up

The cement plant will be put into operation under supervision of following contractor's staff :

Chief engineer	1
Engineers	2
Chemists	2
Kiln operators	4
Mill operators	3
Total foreign staff	12

Complete manpower of the new cement plant will also take part in putting into operation , i.e., 198 persons plus 18 auxiliary labour .

9.2.3.4. Training of local manpower

Following staff of the new cement plant will take part in training in contractor's plants :

Production manager	1
Technologist	1
Mechanical engineer	1
Electrical engineer	1
Kiln operator	2
Mill operator	2
Total staff	8

9.2.4. Arrangement for Supplies

Within the framework of civil engineering works it will be necessary to make accessible the Boanamary port to sea ships in order to provide for efficient unloading and transport of machinery and equipment .

The construction contractor will ensure necessary storage area for deliveries at the site . Existing auxiliary and service buildings / workshops , warehouse , diesel generating set , etc./ will be used during construction as contemporary constructional plant .

All equipment and auxiliary materials for construction will be delivered by contractors .

9.3. Cost Estimate of Project Implementation

9.3.1. Project Implementation Team

Salaries :	500 USD per man per month	
	240 man months	120 000 USD
Travel and other expenses		40 000 USD

9.3.2. Detailed Engineering and Tendering

Expenses in engineering services during preparation of tender documents and evaluation of bids , salaries and travel	50 000 USD

9.3.3. Supervision and Coordination

Supervision of erection and construction	
200 man months	800 000 USD
allowance	300 000 USD
travel	40 000 USD
Total	1 140 000 USD

9.3.4. Testing, Trial runs, Start - up and Commissioning

Participation of foreign experts	
- 36 man months	144 000 USD
allowance	55 000 USD
travel	16 000 USD
Total	215 000 USD

9.3.5. Materials, Supplies, Utilities during Start - up

Costs during start - up	600 000 USD

9.3.6. Salaries and Wages of Site Staff

Costs during start - up	155 000 USD

9.3.7. Training of Staff and Labour

Salaries and wages during training in Madagascar	30 000 USD

9.3.8. Interests on Loans during Construction

Alternative 1	8 372 000 USD
Alternative 2	8 687 000 USD

Total cost in implementation

Alternative 1	10 872 000 USD
Alternative 2	11 187 000 USD

Indicated cost in implementation together with cost in geological survey /Chapter 2 - 150 000 USD / will be depreciated during the first 4 years of operation .

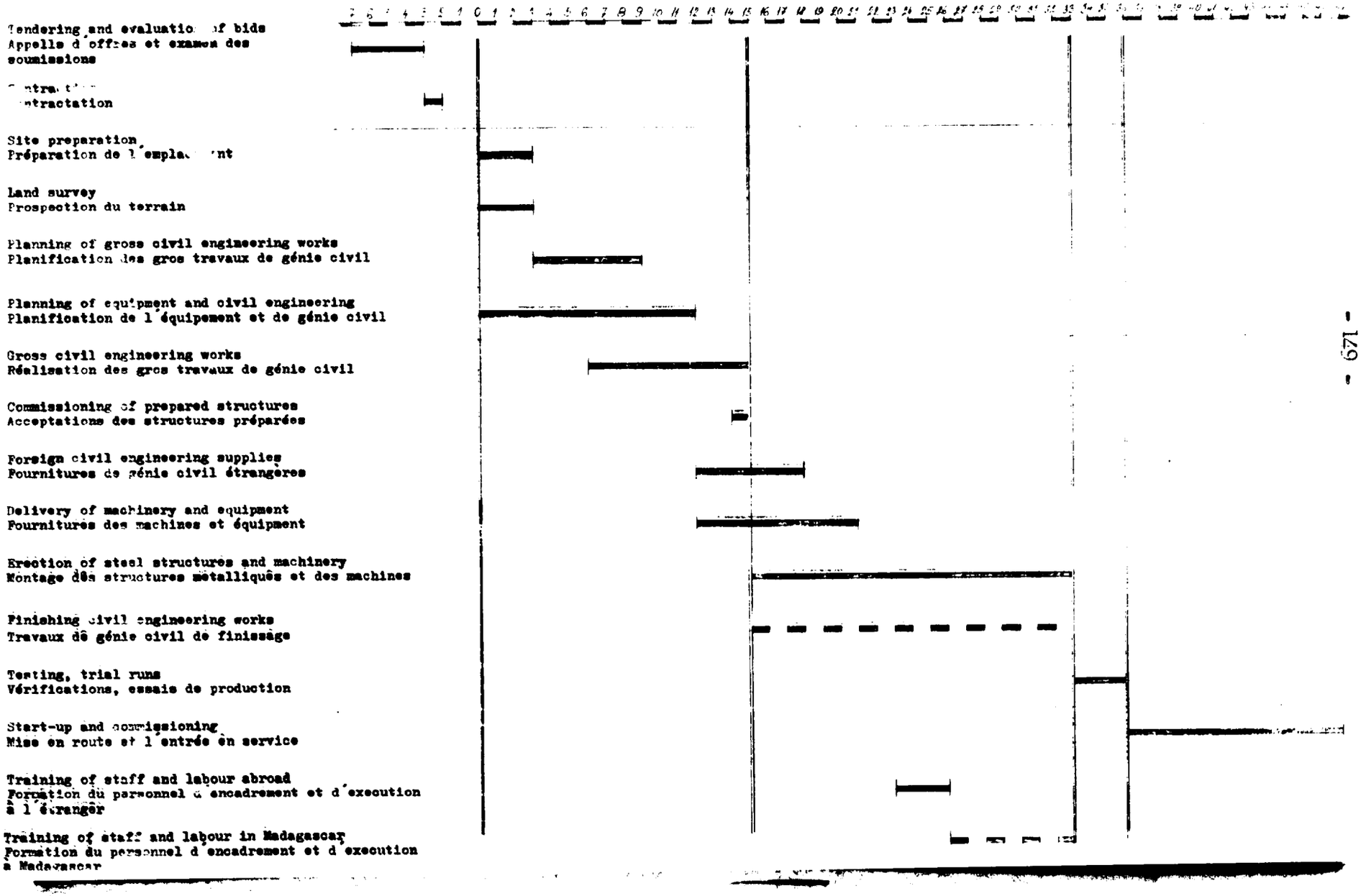
Schedule 9 ESTIMATE OF INVESTMENT COST: PROJECT IMPLEMENTATION

Pièce 9 ESTIMATION DU COUTS D'INVESTISSEMENT: MISE EN OEUVRE DU PROJET

ESTIMATE OF INVESTMENT COST ESTIMATION DU COUT D'INVESTISSEMENT				
Project implementation Mise en oeuvre du projet				
No	Item description Designation	Cost Cout Foreign Etrangere	Local Local	Total Total
1	Project implementation management Direction de la mise en oeuvre du projet	-	120	120
	Travel and other expenses Transport et autres dépenses	-	40	40
2	Detailed engineering, tendering, evaluation of bids, contract Organisation technique détaillée, appel d'offres examens d'offres, contrat	50	-	50
3	Supervision and coordination Surveillance et coordination	840	300	1.140
	Testing, trial runs, start-up and commissioning essais, mise en route, reception	160	55	215
	Materials, supplies and utilities Matériaux, fournitures et services publics	210	390	600
	Salaries and wages of site staff Traitements et salaires du personnel	-	155	155
4	Training of staff and labour Formation du personnel	-	30	30
	Subtotal	1.260	1.090	2.350
5	Interest during construction Intérêt pendant la construction			
	alternative 1	4.567	3.805	8.372
	alternative 2	4.867	3.820	8.687
	Total - alt. 1	5.827	4.895	10.722
	alt. 2	6.127	4.910	11.037
	Note : Costs are in thousands USD Coute sont en milliers USD			

Table 9.1
Tableau 9.1

IMPLEMENTATION SCHEDULE
CALENDRIER DE MISE EN OEUVRE



10. FINANCIAL AND ECONOMIC EVALUATION

10.1. Total Investment Cost

The structures of total investment costs is indicated in the Table 1 - Investment.

Break - down of these costs is as follows :

Thousand USD

Item	Foreign currency	Local currency	Total
Alternative 1			
Land	-	-	-
Civil engineering works	6 420	11 140	17 560
Machinery and equipment	22 991	9 640	32 631
Implementation, including interests during construction	5 877	4 995	10 872
Working capital	-	3 675	3 675
TOTAL	35 288	29 450	64 738
% in percent	54,5	45,5	100
Alternative 2			
Land	-	-	-
Civil engineering works	6 420	11 140	17 560
Machinery and equipment	24 503	9 640	34 143

Implementation, including interests during construction	6 177	5 010	11 187
Working capital	-	3 995	3 995
TOTAL	37 100	29 785	66 885
% in per cent	55,5	44,5	100

Individual items share in the total investment cost as follows :

	Alt. 1	Alt. 2
Total investment costs consisting of :	100 %	100 %
- civil engineering works	21,1 %	26,3 %
- machinery and equipment	50,4 %	51,0 %
- implementation	16,8 %	16,7 %
- working capital	5,7 %	6,0 %

10.1.1. Working Capital

Calculation of working capital relies on optimization of stocks with regard to the requirements of operation of the plant and availability of necessary inputs and supplies.

Calculation is made in accordance with the technique indicated in the "Manual for Evaluation of Industrial Projects", paragraph 4.2.1. - Working Capital Requirements, and the following data have been used :

- operating cash expenses in the Table 5 . Annual Operating Costs , item 4 , 100 per cent production
- storage time weighted of raw materials litives and supplies is estimated at 80 days
- period since the raw materials have been racted until production and loading of cement taking account of storage capacity , is estimated at 30 days in average
- period covering storage of cement until its loading is included in the previous item
- payment allowance between purchase and sales is estimated at 20 days in average . This is the period since acceptance of supplies and payment of accounts payable until shipment of cement and receiving of accounts receivable .

Calculation of working capital gives the following results provided that the above - mentioned data and the given technique have been adopted :

Alternative 1

/ 10 320 : 365 / x / 80 + 30 + 20 / = 3 675 thousand USD

Alternative 2

/ 11 218 : 365 / x / 80 + 30 + 20 / = 3 995 thousand USD

10.2. Project Financing

Sources of financing are indicated in the Tal - Capital Structure and in the Table 7 - Financial Obligations .

The selected way of financing takes into account obtained information on financing of similar projects in Madagascar .

10.2.1. Equity

One third of the total capital investment will be covered by equity with min. 51 per cent participation of the Government. Equity is intended to cover costs both in foreign and in local currencies.

4 per cent dividend on equity capital is envisaged.

10.2.2. Long-term-Loans

In addition to the equity capital the project will be also financed by long-term loans from the Contractor and a local bank under current conditions of the capital market.

Following loans are being under consideration:

- Contractor's loan in foreign currency for purchasing of machinery, equipment and construction materials amounting to 85 per cent of the CIF deliveries, payable in 8 years, repayment in annual instalments, interest rate 9,5 % p.a.,
- Loan from a local bank to cover the rest of the investment capital in local currency, payable in 5 years by annual installments, interest rate 10,5 % p.a., 2 years grace period.

The way and conditions of financing as indicated above is not favourable from the point of view of cash flow balance, as it is shown in the Table 9 - Liquidity Analysis.

In order to obtain a positive cumulative net cash balance, a Government's contribution amounting to 3 million USD is envisaged in cash in flows in the 4-th year of the project,

i.e. in the year of start - up. For comparison the amount of contribution is the same for both Alternatives .

It is obvious this fact has influenced the evaluation results , on the other hand it may be expected that the Government's contribution may not be necessary / especially in Alt. 1 / if more convenient price and loan conditions over those envisaged herein , are obtained .

10.3. Production Cost

Calculation of total production costs is based on the data indicated in the Table 5 - Annual Operating Costs and in the Table 7 - Financial Obligations and those indicated in the Chapter 4 .

10.3.1. Production costs per ton of cement in USD

/ 100 per cent production , minus depreciation of the pre-production capital costs , plus average interests on loans /

	Alt.1	Alt.2
- Direct materials and inputs	19,93	24,90
- Direct manpower	0,77	0,77
- Factory overheads	18,84	17,46
- Administrative overheads	1,74	1,74
Operating costs	41,28	44,87
- Financial costs	6,38	6,57
- Depreciation	17,30	17,91
Production costs	64,96	69,35

10.3.2. Break - down of costs / % from production costs /

	Alt.1	Alt.2
- Raw materials and additives	5,96	5,58
- Fuel	16,30	22,45
- Other direct materials	8,42	7,87
- Direct wages	1,19	1,11
- Factory overheads	29,00	25,18
including : electric power	14,05	11,97
- Administrative overheads	2,68	2,51
- Depreciation , interests	36,45	35,30
TOTAL	100,00	100,00

10.4. Financial Evaluation

10.4.1. Commercial Profitability Analysis

10.4.1.1. Simple rate of return

$$R = \frac{F + Y}{I} \cdot 100 \quad \text{or} \quad Re = \frac{F}{Q}$$

where :

R = simple rate of return on total investment
Re = simple rate of return on equity capital
F = average annual net profit
Y = average annual interest charges on loans
I = total investment
Q = equity capital invested .

then

Alternative 1

$$R = \frac{/49\,315 + 15\,939\ /\ :10}{64\,738} \cdot 100 = 10,08\ \%$$

$$Re = \frac{49\,315 : 10}{21\,600} \cdot 100 = 22{,}83\,\%$$

Alternative 2

$$R = \frac{/\ 38\,646 + 16\,432\ /\ : 10}{66\,885} \cdot 100 = 8{,}23\,\%$$

$$Re = \frac{38\,646 : 10}{22\,300} \cdot 100 = 17{,}33\,\%$$

The data are taken from the Table - Integrated Financial Analysis .

10.4.1.2. Pay - back period

ITEM	Alternative 1		Alternative 2	
	Nominal amount	Capital at the end of a year	Nominal amount	Capital at the end of a year
1. Total investment	64 738		66 885	
Year 1	12 389		12 610	
2	36 798		39 026	
3	11 876		11 254	
4	2 835		3 095	
5	645		680	
6	195		220	
2. Annual net cash earnings				
Year 1	-	12 389	-	12 610
2	-	49 187	-	51 636
3	-	61 063	-	62 890
4	9 886	54 012	9 218	56 767
5	9 605	45 052	8 787	48 660
6	10 930	34 317	10 032	38 848
7	10 930	23 387	10 032	28 816
8	10 930	12 457	10 032	18 784
9	9 080	3 377	8 182	10 602
10	10 930	+ 7 553	10 032	570
11			10 032	+ 9 462
Pay-back period	9,3 years		10 years	

10.4.1.3. Net present value

$$NPV = \sum_{t=1}^{n} / Cl - CO /_t a_t$$

where

$\sum_{t=1}^{n}$ = a sum total for the whole lifetime of the project from year 1 to year 13

Cl_t = cash inflow in the year t

CO_t = cash outflow in the year t

a_t = discount factor in the year t corresponding to the selected rate of discount.

NPV at 9 % discount rate / see the Table / :

Alternative 1	+ 2 818 000 USD
Alternative 2	- 3 665 000 USD

NET PRESENT VALUE RATIO / at 9 % discount rate /

$$NPVR = \frac{NPV}{P / I /}$$

where

NPC = net present value of a project

P/I/ = present value of total investment

$$NPVR_{alt.1} = \frac{2\ 818}{58\ 906} = 0{,}05\ \%$$

$$NPVR_{alt.2} = \frac{-3\ 665}{60\ 886} = -0{,}06\ \%$$

CALCUL DE LA VALEUR ACTUELLE NETTE

Alternative 1

Thousand U[illegible]
Milliers des U[illegible]

Item Rubrique	Year Année													Total Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	
I. CASH INFLOWS /CI/ ENTRÉES DE CAISSE				17875	19135	21250	21250	21250	21250	21250	21250	21250	33705	
1. Sales revenue Recettes de ventes				14875	19135	21250	21250	21250	21250	21250	21250	21250	21[illegible]	
2. Residual value Valeur résiduelle				-	-	-	-	-	-	-	-	-	12455	
3. Subsidy Subventions				3000	-	-	-	-	-	-	-	-	-	
II. CASH OUTFLOWS /CO/ SORTIES DE CAISSE	1[illegible]	23748	11876	10824	10[illegible]	1[illegible]	10320	1[illegible]	10320	10320	10320	10320	10320	
4. Investment Investissement	12389	23748	11876	2835	645	195								
5. Cash expenses Dépenses de caisse				7989	9520	10320	10320	10320	10320	10320	10320	10320	10320	
6. Taxes Impots				-	-	-	-	-	-	-	-	-	-	
III. NET CASH FLOWS /NCF/ FLUX NETS DE TRESORERIE	-12389	-23748	-11876	7051	8960	10735	10930	10930	10930	10930	10930	10930	23385	
IV. DISCOUNT FACTORS AT 9 % COEFFICIENT D'ACTUALISATION de 9%	1	0,917	0,842	0,772	0,708	0,650	0,596	0,547	0,502	0,460	0,422	0,388	0,356	
V. PRESENT VALUES AT 9 % VALEUR ACTUELLE au 9 %	-12389	-33744	-10000	5443	6344	6978	6514	5979	5487	5028	4612	4241	8325	2810

CALCULATION OF NET PRESENT VALUE
CALCUL DE LA VALEUR ACTUELLE NETTE

Alternative 2

Thousand USD
Milliers des USD

Item Rubrique	Year Année													Total Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	
I. CASH INFLOWS /CI/ ENTREE DE CAISSE				17875	19125	21250	21250	21250	21250	21250	21250	21250	34025	
1. Sales revenue Recettes de ventes				14875	19125	21250	21250	21250	21250	21250	21250	21250	21250	
2. Residual value Valeur résiduelle				-	-	-	-	-	-	-	-	-	12775	
3. Subsidy Subventions				3000	-	-	-	-	-	-	-	-	-	
II. CASH OUTFLOWS /CO/ SORTIES DE CAISSE	12610	35787	11254	11752	11018	11438	11218	11218	11218	11218	11218	11218	11218	
4. Investment Investissement	12610	35787	11254	3695	630	220								
5. Cash expenses Dépenses de caisse				8057	10388	11218	11218	11218	11218	11218	11218	11218	11218	
6. Taxes Impots				-	-	-	-	-	-	-	-	-	-	
III. NET CASH FLOWS /NCF/ FLUX NETS DE TRESORERIE	-12610	-35787	-11254	6123	8107	9812	10032	10032	10032	10032	10032	10032	22807	
IV. DISCOUNT FACTORS AT 9 % COEFFICIENT D'ACTUALISATION de 9 %	1	0,917	0,842	0,772	0,708	0,650	0,596	0,547	0,502	0,460	0,422	0,388	0,356	
V. PRESENT VALUES AT 9 % VALEUR ACTUELLE au 9 %	-12610	-35787	-9476	4727	5740	6378	5979	5488	5036	4615	4234	3892	8119	-3665

10.4.1.4. Internal rate of return

$$i_r = i_1 + \frac{PV\ /i_2 - i_1\ /}{PV + NV}$$

where

i_r = internal rate of return of a project
PV = positive value of NPV at the lower discount rate
NP = negative value of NPV at the higher dicount rate
i_1 = lower discount rate at which NPV is still positive but close to zero
i_2 = higher discount rate at which NPV is already negative but close to zero.

Alternative 1

$$i_r = 9 + \frac{2\,818\ /\ 10 - 9\ /}{2\,818 + 477} = \underline{9,86\ \%}$$

Alternative 2

$$i_r = 7 + \frac{3\,468\ /\ 8 - 7\ /}{3\,468 + 285} = \underline{7,92\ \%}$$

10.4.1.5 LIQUIDITY ANALYSIS OF THE PROJECT — Alternative 1 — Thousand USD
ANALYSE DES LIQUIDITES DU PROJET — Alternative 1 — Milliers des USD

Item / Rubrique	Year / Année 1	2	3	4	5	6	7	8	9	10	11	12	13
I. CASH INFLOWS /CI/ ENTREES DE CAISSE	12389	36798	11876	17710	19770	21445	21250	21250	21250	21250	21250	21250	33705
1. Sales revenue / Recettes des ventes				14875	19125	21250	21250	21250	21250	21250	21250	21250	21250
2. Residual value / Valeur résiduelle													12455
3. Financing of investment / Financement de l'investissement	12389	36798	11876	2835	645	195							
3.1 Equity / Capital-actions	6272	7865	3738	2835	645	195							
3.2 Loans / Prets	6117	28933	8088										
II. CASH OUTFLOWS /CO/ SORTIES DE CAISSE	12389	36798	11876	18752	17823	21150	20277	19597	20768	18238	14296	11184	11184
1. Investment incl. replacement / Investissement y.c. remplacement	12389	36798	11876	2835	645	195			1850				
2. Cash expenses excl. interest / Décaissements, interets non compris				7989	9520	10320	10320	10320	10320	10320	10320	10320	10320
3. Taxes / Impots				-	-	-	-	-	-	-	-	-	-
4. Financial obligations / Engagements financiers				7928	7658	10635	9957	9277	8598	7918	3976	864	864
4.1 Repayment instalment / Remboursements échelonnés				3113	3113	6761	6761	6760	6760	6758	3112	-	-
4.2 Interest charges / Versements d'intérets				3985	3689	3010	2332	1653	974	296	-	-	-
4.3 Dividends / Dividendes				830	856	864	864	864	864	864	864	864	864
III. NET CASH BALANCE /NCB/ ENCAISSE NETTE /NCB/	-	-	-	-1042	1947	295	973	1653	482	3012	6954	10066	22521
IV. CUMULATIVE NET CASH BALANCE ENCAISSE CUMULATIVE NETTE	-	-	-	-1042	905	1200	2173	3826	4308	7320	14274	24340	46861

10.4.1.5 LIQUIDITY ANALYSIS OF THE PROJECT
ANALYSE DES LIQUIDITES DU PROJET

Alternative 2

Thousand USD
Milliers des USD

Item Rubrique	Year Année												
	1	2	3	4	5	6	7	8	9	10	11	12	13
I. CASH INFLOWS /CI/ ENTREES DE CAISSE	13610	39026	11254	17970	19805	21470	21250	21250	21250	21250	21250	21250	34025
1. Sales revenue Recettes des ventes				14875	19135	21250	21250	21250	21250	21250	21250	21250	21250
2. Residual value Valeur résiduelle													1.775
3. Financing of investment Financement de l'investissement	13610	39026	11254	3095	680	220							
3.1 Equity Capital-actions	6433	8247	3575	3095	680	220							
3.2 Loans Prets	7177	30779	7679										
II. CASH OUTFLOWS /CO/ SORTIES DE CAISSE	13610	39026	11254	19991	18973	21382	21465	20767	21920	1937	15385	12710	14111
1. Investment incl. replacement Investissement y.c. remplacement	13610	39026	11254	3095	680	220			1350				
2. Cash expenses excl. interest Décaissements, intérets non compris				8657	10338	11218	11218	11218	11218	11218	11218	11218	11218
3. Taxes Impots				-	-	-	-	-	-	-	-	-	-
4. Financial obligations engagements financiers				8239	7955	10244	10247	9549	8852	8155	4167	892	892
4.1 Repayment instalment Remboursements échelonnés				3275	3275	6952	6952	6952	6952	6952	3275	-	-
4.2 Interest charges Versements d'intérets				4108	3797	3100	2403	1705	1008	311	-	-	-
4.3 Dividends Dividendes				856	883	892	892	892	892	892	892	892	892
III. NET CASH BALANCE /NCB/ ENCAISSE NETTE /NCB/	-	-	-	-2021	832	-912	-215	483	-670	1877	5865	9140	21915
IV. CUMULATIVE NET CASH BALANCE ENCAISSE CUMULATIVE NETTE	-	-	-	-2021	-1189	-2101	-2316	-1833	-2503	-626	5239	14379	36294

10.4.1.6. Capital structure analysis

$$R_{de} = \frac{L}{Q}$$

where

R_{de} = debt equity ratio

L = long - term loans

Q = equity capital

Alternative 1

$$R_{de} = \frac{43\ 138}{21\ 600} = 66,7 / 33,3$$

Alternative 2

$$R_{de} = \frac{44\ 585}{22\ 300} = 66,7 / 33,3$$

10.4.2. National Profitability Analysis

10.4.2.1. Value added

$$\sum_{t=1}^{13} NVA = \sum O_t - \sum / MI + I /_t$$

where

$\sum_{t=1}^{13} NVA$ = net value added generated by the project throughout its economic life from year 1 to year 13 / plant equipment economic life is 10 years /

$\sum_{t=1}^{13} O_t$ = expected value of output throughout the projects life incl. residual value

$\sum_{t=1}^{13} /MI + I/_t$ = expected current material inputs MI and investment I throughout the projects life

Alternative 1

NVA = 219 455 - / 92 349 + 66 588 /
= 60 518 000 USD

Alternative 2

NVA = 219 775 - / 101 019 + 68 735 /
= 50 021 000 USD

NET NATIONAL VALUE ADDED

$$\sum_{t=1}^{13} NNVA = \sum_{t=1}^{13} O_t - \sum_{t=1}^{13} /MI + I + RP/_t$$

where
RP = repatriated payments

Alternative 1

NNVA = 219 455 - / 92 349 + 66 588 + 8 279 /
= 52 239 000 USD

Alternative 2

NNVA = 219 775 - / 101 019 + 68 735 + 8 712 /
= 41 309 000 USD

Note : In calculation the data from the Table - Integrated Value Added Analysis , have been used .

10.4.2.2. Absolute efficiency test

$$E = \sum_{t=1}^{n} VA_t \cdot a_t \geqslant \sum_{t=1}^{n} W_t \cdot a_t$$

where

E = absolute efficiency test of a project on the basis of the discounted values of value added and of wages

$\sum_{t=1}^{n} VA_t \cdot a_t$ = present value of the expected value added for the whole lifetime of a project / plant equipment / from year 1 to year n

$\sum_{t=1}^{n} W_t a_t$ = present value of the expected wages for the whole lifetime of a project from year 1 to year n excluding expatriated wages

a_t = discounting factor in year t

Alternative 1

$E_{at\ 6\%}$ = 12 838 000 USD $>$ 3 745 000 USD

Alternative 2

$E_{at\ 6\%}$ = 5 012 000 USD $>$ 3 745 000 USD

Source of calculation - table " Absolute Efficiency Test at Market Prices " .

ABSOLUTE EFFICIENCY TEST AT MARKET PRICES
TEST D'EFFICACITE ABSOLUE AUX PRIX DU MARCHE

Alternative 1

Thousand U.C.
Milliers des U.C.

Item Rubrique	Year Année													Total Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	
1. Value of output Valeur de la production	-	-	-	17875	19125	21250	21250	21250	21250	21250	21250	21250	33765	
2. Value of material inputs Valeur des intrants matériels	12389	36798	11876	10052	9393	9743	9548	9548	11398	9548	9548	9548	9548	
3. Net domestic value added Valeur ajoutée nette sur le plan intérieur	/12389/	/36798/	/11876/	7823	9732	11507	11702	11702	9852	11702	11702	11702	24157	
4. Repatriated payments Rapatriements de fonds				2070	1774	1478	1183	887	591	296	-	-	-	
5. Net national value added Valeur ajoutée sur le plan national	/12389/	/36798	/11876/	5753	7958	10029	10519	10815	9261	11406	11702	11702	24157	
5.1 Wages Salaires				572	572	572	572	572	572	572	572	572	572	
5.2 Social surplus Excédent social				5181	7386	9457	9947	10243	8689	10834	11130	11130	23585	
6. Discount factors at 6% discount rate Coefficients d'actualisation au taux d'actualisation de 6%	1	0,943	0,890	0,840	0,792	0,747	0,705	0,665	0,627	0,592	0,558	0,527	0,497	
7. Discounted values of NNVA Equivalent actuel de la valeur ajoutée	-12389	-34701	-10570	4833	6303	7492	7416	7192	5807	6752	6530	6167	12006	12838
7.1 Discounted values of wages Valeur actuelle de salaires				480	453	427	403	380	359	339	319	301	284	3745
7.2 Discounted values of social surplus Valeur actuelle de l'excédent social	-12389	-34701	-10570	4353	5850	7065	7013	6812	5448	6413	6211	5866	11722	9093

ABSOLUTE EFFICIENCY TEST AT MARKET PRICES
TEST D'EFFICACITE ABSOLUE AUX PRIX DU MARCHE

Alternative 2

Thousand USD
Milliers des USD

Item Rubrique	Year Année													Total Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	
1. Value of output Valeur de la production	-	-	-	17875	19125	21250	21250	21250	21250	21250	21250	21250	34085	
2. Value of material inputs Valeur des intrants matériels	12610	39026	11254	10580	10246	10666	10446	10446	12296	10446	10446	10446	10446	
3. Net domestic value added Valeur ajoutée nette sur le plan intérieur	/12610/	/39026/	/11254/	6895	8879	10584	10804	10804	8954	10804	10804	10804	23579	
4. Repatriated payments Rapatriements de fonds				2187	1867	1556	1245	933	622	311	-	-	-	
5. Net national value added Valeur ajoutée sur le plan national	/12610/	/39026/	/11254/	4717	7012	9028	9559	9871	8332	10493	10804	10804	23579	
5.1 Wages Salaires				572	572	572	572	572	572	572	572	572	572	
5.2 Social surplus Excédent social				4145	6440	8456	8987	9299	7760	9921	10232	10232	23007	
6. Discount factors at 6% discount rate Coefficients d'actualisation au taux d'actualisation de 6%	1	0,943	0,890	0,840	0,792	0,747	0,705	0,665	0,627	0,592	0,558	0,527	0,497	
7. Discounted values of NNVA Equivalent actuel de la valeur ajoutée	-12610	-36802	-10016	3962	5554	6744	6739	6564	5224	6211	6029	5694	11719	5012
7.1 Discounted values of wages Valeur actuelle de salaires				480	453	427	403	380	359	339	319	301	284	3745
7.2 Discounted values of social surplus Valeur actuelle de l'excédent social	-12610	-36802	-10016	3482	5101	6317	6336	6184	4865	5872	5710	5393	11435	1267

10.4.2.3. Relative efficiency test / at capital scarcity /

$$E_c = \frac{P\ /VA/}{P\ /I/}$$

where

E_c = relative efficiency test / at capital scarcity /
P /VA/= discounted value added
P/I/ = present value of total investment

Alternative 1

$$E_c = \frac{12\ 838}{60\ 698} = 0,21$$

Alternative 2

$$E_c = \frac{5\ 012}{62\ 731} = 0,08$$

Source of calculation - the Table " Absolute Efficiency Test at Market Prices ".

10.4.3. Uncertainty Analysis

10.4.3.1. Break - even analysis

1. In terms of physical units :

$$BEP = \frac{FC}{SP - VC}$$

2. In terms of sales revenue :

$$BEP = SP \frac{FC}{SP - VC}$$

where

FC = annual total fixed costs including average interest charges in a normal operating year ,

SP = selling price per unit of output ,

VC = variable costs per unit of output estimated at production level of 100 per cent of installed capacity .

Alternative 1

$$BEP_1 = \frac{11\,066\,000}{85 - 20,696} = 172\,100 \text{ tons of cement}$$

$$BEP_2 = 85 \frac{11\,066\,000}{85 - 20,696} = 14\,627\,550 \text{ USD}$$

BEP = 68,8 % capacity utilization

Alternative 2

$$BEP_1 = \frac{10\,920\,000}{85 - 25,672} = 184\,100 \text{ tons of cement}$$

$$BEP_2 = 85 \frac{10\ 920\ 000}{85 - 25,672} = 15\ 645\ 000\ USD$$

BEP = 73,6 % capacity utilization

10.4.3.2. Sensitivity analysis / in terms of IRR /

Change 1 - decrease of unit price by 5 % per ton of cement
2 - increase of cash expenses by 5 %
3 - decrease of investment by 5 %
4 - change 1 + 2
5 - change 1 + 2 + 3

Alternative 1

$$IRR_1 = 8 + \frac{733\ /9-8/}{733 + 2\ 598} = 8,22\ \%$$

$$IRR_2 = 9 + \frac{149\ /10-9/}{149 + 3\ 057} = 9,05\ \%$$

$$IRR_3 = 12 + \frac{2\ 541\ /13-12\ /}{2\ 541 + 45} = 12,98\ \%$$

$$IRR_4 = 7 + \frac{1\ 390\ /8-7/}{1\ 390 + 2\ 113} = 7,40\ \%$$

$$IRR_5 = 10 + \frac{915\ /11-10\ /}{915 + 1\ 759} = 10,34\ \%$$

Alternative 2

$$IRR_1 = 6 + \frac{1\ 052\ /7-6/}{1\ 052 + 2\ 704} = 6,28\ \%$$

$$IRR_2 = 7 + \frac{165\ /8-7/}{165+3\ 377} = 7,05\ \%$$

$$IRR_3 = 10 + \frac{2\ 596\ /\ 11-10\ /}{2\ 596 + 272} = 10,91\ \%$$

$$IRR_4 = 5\ \frac{1\ 433\ /6-5/}{1\ 433 + 2\ 480} = 5,37\ \%$$

$$IRR_5 = 8\ \frac{318\ /9-8/}{318 + 2\ 373} = 8,11\ \%$$

10.5. Conclusions

10.5.1. Investment Costs

The investment costs are based on actual prices in the technology market with regard necessary civil engineering works for Amboanio area.

Although dry process of cement production proposed in both alternatives is more expensive in investment costs than wet process actually applied in the existing cement plant in Amboanio the former one shows significant savings in manpower and consumption of fuel and energy.

It is to note that the investment costs are considerably impacted by high custom fees applied to imported machinery, equipment and materials.

10.5.2. Production Costs

Individual items of production costs either are estimated according to the data obtained in Amboanio or are based on actual prices in local market .

The reserves how to cut down production costs may be found within the scope of depreciation and financial costs , i.e. in cutting down of investment costs and in limitation of loan financing or in providing of better loan repayment conditions .

10.5.3. Financial Sources

Debt / equity ratio 66,7/33,3 is not very favourable since the additional financial supports or contribution are necessary in order to obtain a positive cash flow balance . Therefore it is recommended to review project financing from the point of view both of economical demand and of effectiveness for development of the national economy .

10.5.4. Economic Criteria

Taking into account the demanding investment and operation conditions of the new cement plant in the economical situation of Madagascar as they are estimated or envisaged in this Study , the results obtained from evaluation are adequate to similar projects in other developing countries .

10.6. TABLES

Basic information on project evaluation

TABLE 1 INVESTMENT - Alternative 1

TABLEAU 1 INVESTISSEMENT

/Thousand USD/
Milliers les USD

Item Roubrique	Construction year Année de construction									Operation year Année d'exploitation									Total Total		
	1			2			3			4			5			6					
	FC	LC	Tt	FC	LC	Tt	FC	LC	Tt	FC	LC	Tt	FC	LC	Tt	FC	LC	Tt	FC	LC	Tt
1. FIXED ASSETS FAVOIRS FIXES	4628	6870	11498	22933	9915	32848	1850	3995	5845	-	-	-	-	-	-	-	-	-	29411	20780	50191
1.1 Equipment Equipement	3448	1110	4558	17693	5695	23388	1850	595	2445	-	-	-	-	-	-	-	-	-	22991	7400	30391
1.2 Installation cost Cout d'installation	-	-	-	-	900	900	-	1340	1340	-	-	-	-	-	-	-	-	-	-	2240	2240
1.3 Land development Aquisition et mise en valeur des terrains	1180	5760	6940	5240	3320	8560	-	2060	2060	-	-	-	-	-	-	-	-	-	6420	11140	17560
2. PRELIMINARY EXPENSES DEPENSES PRELIMINAIRES	100	150	250	240	260	500	970	780	1750	-	-	-	-	-	-	-	-	-	1310	1190	2500
3. WORKING CAPITAL CAPITAL D'EXPLOITATION	-	-	-	-	-	-	-	-	-	-	2835	2835	-	645	645	-	195	195	-	3675	3675
4. INITIAL INVESTMENT INVESTISSEMENT INITIAL	4728	7020	11748	23173	10175	33348	2820	4775	7595	-	2835	2835	-	645	645	-	195	195	30721	25645	56366
5. INTEREST DURING CONSTRUCTION INTERETS PENDANT CONSTRUCTION	11	630	641	2190	1260	3450	2366	1915	4281	-	-	-	-	-	-	-	-	-	4567	3805	8372
6. TOTAL INVESTMENT INVESTISSEMENT TOTAL	4739	7650	12389	25363	11435	36798	5186	6690	11876	-	2835	2835	-	645	645	-	195	195	35286	29450	64736

NOTE: FC = foreign currency
devises étrangéres

LC = local currency
monnaie locale

Tt = total
total

TABLE 1 INVESTMENT - Alternative 2 /Thousand USD/
TABLEAU INVESTISSEMENT Milliers des USD

Item Roubrique	Construction year Année de construction									Operation year Année d'exploitation									Total Total		
	1			2			3			4			5			6					
	FC	LC	Tt	FC	LC	Tt	FC	LC	Tt	FC	LC	Tt	FC	LC	Tt	FC	LC	Tt	FC	LC	Tt
1. FIXED ASSETS AVOIRS FIXES	4850	6868	11718	24779	10121	34900	1294	3791	5085	-	-	-	-	-	-	-	-	-	30923	20780	51703
1.1 Equipment Equipement	3670	1108	4778	19539	5901	25440	1294	391	1685	-	-	-	-	-	-	-	-	-	24503	7400	31903
1.2 Installation cost Cout d'installation	-	-	-	-	900	900	-	1340	1340	-	-	-	-	-	-	-	-	-	-	2240	2240
1.3 Land development Aquisition et mise en valeur des terrains	1180	5760	6940	5240	3320	8560	-	2060	2060	-	-	-	-	-	-	-	-	-	6420	11140	17560
2. PRELIMINARY EXPENSES DEPENSES PRELIMINAIRES	100	150	250	240	260	500	970	780	1750	-	-	-	-	-	-	-	-	-	1310	1190	2500
3. WORKING CAPITAL CAPITAL D'EXPLOITATION	-	-	-	-	-	-	-	-	-	-	3095	3095	-	680	680	-	220	220	-	3995	3995
4. INITIAL INVESTMENT INVESTISSEMENT INITIAL	4950	7018	11968	25019	10381	35400	2264	4571	6835	-	3095	3095	-	680	680	-	220	220	32233	25965	58198
5. INTEREST DURING CONSTRUCTION INTERETS PENDANT CONSTRUCTION	12	630	642	2366	1260	3626	2489	1930	4419	-	-	-	-	-	-	-	-	-	4867	3820	8687
6. TOTAL INVESTMENT INVESTISSEMENT TOTAL	4962	7648	12610	27385	11641	39026	4753	6501	11254	-	3095	3095	-	680	680	-	220	220	37100	29785	66885
NOTE: FC = foreign currency devises étrangères			LC = local currency monnaie locale					Tt = total total													

TABLE 2 DEPRECIATION, REPLACEMENT AND RESIDUAL VALUES Alternative 1 /Thousand USD

TABLEAU AMORTISSEMENT, REMPLACEMENTS ET VALEURS RESIDUELLES Milliers des USD/

Item Rubrique	Investment Investissement	Expected lifetime Durée de vie	Annual depreciation Amortissement annuel	Replacements - Remplacements													Residual values Valeurs résiduelles
				1	2	3	4	5	6	7	8	9	10	11	12	13	
1. FIXED ASSETS AVOIRS FIXES	50191	-	4326	-	-	-	-	-	-	-	-	1850	-	-	-	-	8780
1.1 Machinery and equipment Biens de production	30781	10	3078	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.2 Trucks and quarry equipment Camions et équipement de carriere	1850	5	370	-	-	-	-	-	-	-	-	1850	-	-	-	-	-
1.3 Land Terrains	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.4 Civil enginneering works Batiments	17560	20	878	-	-	-	-	-	-	-	-	-	-	-	-	-	8780
2. PRELIMINARY EXPENSES DEPENSES PRELIMINAIRES	10872	4	2718	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3. WORKING CAPITAL CAPITAL D'EXPLOITATION	3675	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3675
4. TOTAL TOTAL	64738	-	7044	-	-	-	-	-	-	-	-	1850	-	-	-	-	12455

TABLE 2 DEPRECIATION, REPLACEMENT AND RESIDUAL VALUES Alternative 2 /Thousand USD
TABLEAU AMORTISSEMENT, REMPLACEMENTS ET VALEURS RESIDUELLES Milliers des USD/

Item Rubrique	Investment Investissement	Expected lifetime Durée de vie escomptée	Annual depreciation Amortissement annuel	Replacements - Remplacements													Residual values Valeurs résiduelles
				1	2	3	4	5	6	7	8	9	10	11	12	13	
1. FIXED ASSETS AVOIRS FIXES	51703	-	4477	-	-	-	-	-	-	-	-	1850	-	-	-	-	8780
1.1 Machinery and equipment Biens de production	32293	10	3229	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.2 Trucks and quarry equipment Camions et équipement de carrière	1850	5	370	-	-	-	-	-	-	-	-	1850	-	-	-	-	-
1.3 Land Terrains	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.4 Civil enginneering works Batiments	17560	20	878	-	-	-	-	-	-	-	-	-	-	-	-	-	8780
2. PRELIMINARY EXPENSES DEPENSES PRELIMINAIRES	11137	4	2718	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3. WORKING CAPITAL CAPITAL D'EXPLOITATION	3995	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3995
4. TOTAL TOTAL	66885	-	7274	-	-	-	-	-	-	-	-	1850	-	-	-	-	12775

TABLE
TABLEAU 3

ANNUAL EMPLOYMENT REQUIREMENT
BESOINS ANNUELS DE MAIN-D'ŒUVRE

USD

	Number of personnel Effectif du personnel			Average annual wages Salaires annuels moyens		
	Skilled Qualifié	Unskilled Non qualifié	Total Total	Skilled Qualifié	Unskilled Non qualifié	Total Total
1. Manufacturing personnel Personnel affecté a la production	134	18	152	353 808	22 464	376 272
1.1 Direct operating personnel Directement	65	4	69	186 826	4 992	191 818
1.2 Indirect operating personnel Indirectement	69	14	83	166 982	17 472	184 454
2. Marketing personnel Personnel de commercialisation	-	-	-	-	-	-
3. Supervisory personnel Personnel de maitrise	11	-	11	61 776	-	61 776
4. Administrative personnel Personnel administratif	26	9	35	122 710	11 232	133 942
5. Grand total Total général	171	27	198	538 294	33 696	571 990
5.1 National personnel Personnel du pays	-	-	-	-	-	-
5.2 Foreign personnel Personnel étranger						

TABLE 4 ANNUAL INCOME Thousand USD
TABLEAU REVENU ANNUEL Milliers des USD

Item Rubrique	Year 4 Année		Year 5 Année		Year 6-12 Année		Year 13 Année	
	Q	V	Q	V	Q	V	Q	V
1. ANNUAL SALES VENTES ANNUELLES	175000	14875	225000	19125	250000	21250	250000	21250
Portland cement	175000	14875	225000	19125	250000	21250	250000	21250
Ciment Portland	175000	14875	225000	19125	250000	21250	250000	21250
Local - Marché local	175000	14875	225000	19125	250000	21250	250000	21250
Export- Exportation	-	-	-	-	-	-	-	-
2. SUBSIDY		3000		-		-		-
SUBVENTIONS		3000				-		-
3. RESIDUAL VALUE		-		-		-		12455
VALEUR RESIDUELLE		-		-		-		12775
4. TOTAL INCOME	-	17875	-		-	21250	-	33705
REVENU TOTAL	-	17875	-		-	21250	-	34025

Q = Quantity in tons Quantité en tonneaux
V = Value in thousand USD Valeur en milliers des USD

TABLE 5 ANNUAL OPERATING COSTS Alternative 1 /Thousands USD
TABLEAU FRAIS ANNUELS D'EXPLOITATION Milliers des USD/

Item Rubrique	Year 4 Année 4			Year 5 Année 5			Year 6-7 Année 6-7			Year 8-13 Année 8-13		
	Variable Variables	Fixed Fixes	Total Total	Variable Variables	Fixed Fixes	Total Total	Variable Variables	Fixed Fixes	Total Total	Variable Variables	Fixed Fixes	Total Total
1. MANUFACTURING CASH EXPENSES DECAISSEMENT AU TITRE DE LA FABRICATION	3853	3702	7555	4721	4365	9086	5174	4712	9886	5174	4712	9886
1.1 Material - Fournitures matérielles	3661	2801	6462	4529	3464	7993	4982	3811	8793	4982	3811	8793
1.1.1 Imported - Importées	1455	864	2319	1800	1069	2869	1980	1176	3156	1980	1176	3156
1.1.2 Local - Locales	2206	1937	4143	2729	2395	5124	3002	2635	5637	3002	2635	5637
1.2 Wages - Salaires												
1.2.1 Foreign - Personnel étranger	-	-	-	-	-	-	-	-	-	-	-	-
1.2.2 Local - Personnel local	192	246	438	192	246	438	192	246	438	192	246	438
1.3 Other expenses - Autres dépenses	-	655	655	-	655	655	-	655	655	-	655	655
2. MARKETING CASH EXPENSES DECAISSEMENT AU TITRE DE COMMERCIALISATION	-	-	-	-	-	-	-	-	-	-	-	-
3. ADMINISTRATIVE CASH EXPENSES DECAISSEMENT AU TITRE DE L'ADMINISTRATION	-	434	434	-	434	434	-	434	434	-	434	434
3.1 Material - Fournitures matérielles	-	100	100	-	100	100	-	100	100	-	100	100
3.2 Wages - Salaires												
3.2.1 Foreign - Personnel étranger	-	-	-	-	-	-	-	-	-	-	-	-
3.2.2 Local - Personnel local	-	134	134	-	134	134	-	134	134	-	134	134
3.3 Other expenses - Autres dépenses	-	200	200	-	200	200	-	200	200	-	200	200
4. OPERATING CASH EXPENSES DECAISSEMENT	3853	4136	7989	4721	4799	9520	5174	5146	10320	5174	5146	10320
5. DEPRECIATION AMORTISSEMENT	-	7044	7044	-	7044	7044	-	7044	7044	-	4326	4326
6. TOTAL COSTS TOTAL DES COUTS	3853	11180	15033	4721	11843	16564	5174	12190	17364	5174	9472	14646

TABLE 5
TABLEAU

ANNUAL OPERATING COSTS
FRAIS ANNUELS D'EXPLOITATION

Alternative 2

/Thousands USD
Milliers des USD/

ITEM RUBRIQUE	Year 4 Année			Year 5 Année			Year 6-7 Année			Year 8-13 Année		
	Variable Variables	Fixed Fixes	Total Total	Variabl. Variab.	Fixed Fixes	Total Total	Variabl. Variabl	Fixed Fixes	Total Total	Variabl. Variabl	Fixed Fixes	Total Total
1. MANUFACTURING CASH EXPENSES DECAISSEMENT AU TITRE DE LA FABRICATION	4769	3454	8223	5351	4055	9904	6418	4366	10784	6418	4366	10784
1.1 Material - Fournitures matérielles	4577	2530	7107	5659	3129	8788	6226	3442	9668	6226	3442	9668
1.1.1 Imported - Importées	3108	746	3854	3843	923	4766	4228	1015	5243	4228	1015	5243
1.1.2 Local - Locales	1469	1784	3253	1815	2206	4022	1998	2427	4425	1998	2427	4425
1.2 Wages - Salaires												
1.2.1 Foreign - Personnel étranger												
1.2.2 Local - Personnel local	192	246	438	192	246	438	192	246	438	192	246	438
1.3 Other expenses - Autres dépenses	-	678	678	-	678	678	-	678	678	-	678	678
2. MARKETING CASH EXPENSES DECAISSEMENT AU TITRE DE COMMERCIALISATION	-	-	-	-	-	-	-	-	-	-	-	-
3. ADMINISTRATIVE CASH EXPENSES DECAISSEMENT AU TITRE DE L'ADMINISTRATION	-	434	434	-	434	434	-	434	434	-	434	434
3.1 Material - Fournitures matérielles	-	100	100	-	100	100	-	100	100	-	100	100
3.2 Wages - Salaires												
3.2.1 Foreign - Personnel étranger	-	-	-	-	-	-	-	-	-	-	-	-
3.2.2 Local - Personnel local	-	134	134	-	134	134	-	134	134	-	134	134
3.3 Other expenses - Autres dépenses	-	200	200	-	200	200	-	200	200	-	200	200
4. OPERATING CASH EXPENSES DECAISSEMENT	4769	3888	8657	5851	4487	10338	6418	4800	11218	5418	4800	11218
5. DEPRECIATION - AMORTISSEMENT	-	7274	7274	-	7274	7274	-	7274	7274	-	4477	4477
6. TOTAL COSTS TOTAL DES COUTS	4769	11162	15931	5851	11761	17612	6418	12074	18492	6418	9277	15695

TABLE 6 — CAPITAL STRUCTURE — Alternative 1 — Thousand USD
TABLEAU — STRUCTURE DES DEPENSES EN CAPITAL — Milliers des USD

Item / Rubrique	Year / Année 1			2			3			4			5			6			Total / Total		
	FC D	LC L	Tt T	FC D	LC L	Tt T	FC D	LC L	Tt T	FC D	LC L	Tt T	FC D	LC L	Tt T	FC D	LC L	Tt T	FC D	LC L	Tt T
1. INVESTMENT / INVESTISSEMENT	4739	7650	12389	25363	11435	36798	5186	6690	11876	-	2835	2835	-	645	645	-	195	195	35288	29450	64738
1.1 Initial investment / Investissement Initial	4728	7020	11748	23173	10175	33348	2820	4775	7595	-	2835	2835	-	645	645	-	195	195	30721	25645	56366
1.2 Interest during construction / Intérets pendant la période de construction	11	630	641	2190	1260	3450	2366	1915	4281	-	-	-	-	-	-	-	-		4567	3805	8372
2. FINANCING / FINANCEMENT	4739	7650	12389	25363	11435	36798	5186	6690	11876	-	2835	2835	-	645	645	-	195	195	35288	29450	64738
2.1 Equity / Participations	4622	1650	6272	2430	5435	7865	3336	452	3788	-	2835	2835	-	645	645	-	195	195	10388	11212	21600
2.2 Loans / Prets	117	6000	6117	22933	6000	28933	1850	6238	8088										24900	18238	43138
2.2.1 Domestic / Intérieurs	-	6000	6000	-	6000	6000	-	6238	6238	-	-	-	-	-	-	-	-	-	-	18238	18238
2.2.2 Foreign / Etrangers	117	-	117	22933	-	22933	1850	-	1850	-	-	-	-	-	-	-	-	-	24900	-	24900
3. ADDITIONAL FINANCING NEEDED / FINANCEMENT SUPPLEMENTAIRE NECESSAIRE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE 6 CAPITAL STRUCTURE Alternative 2 Thousand USD

TABLEAU STRUCTURE DES DEPENSES EN CAPITAL Milliers des USD

Item / Rubrique	Year / Année 1			2			3			4			5			6			Total / Total		
	FC D	LC L	Tt T	FC D	LC L	Tt T	FC D	LC L	Tt T	FC D	LC L	Tt T	FC D	LC L	Tt T	FC D	LC L	Tt T	FC D	LC L	Tt T
1. INVESTMENT INVESTISSEMENT	4962	7648	12610	27385	11641	39026	4753	6501	11254	-	3095	3095	-	680	680	-	220	220	37100	29785	66885
1.1 Initial investment Investissement initial	4950	7018	11968	25019	10381	35400	2264	4571	6835	-	3095	3095	-	680	680	-	220	220	32233	25965	58198
1.2 Interest during construction Intérets pendant la période de construction	12	630	642	2366	1260	3626	2489	1930	4419	-	-	-	-	-	-	-	-	-	4867	3820	8687
2. FINANCING FINANCEMENT	4962	7648	12610	27385	11641	39026	4753	6501	11254	-	3095	3095	-	680	680	-	195	195	37100	29785	66885
2.1 Equity Participations	4835	1648	6483	2606	5641	8247	3459	116	3575	-	3095	3095	-	680	680	-	220	220	10900	11400	22300
2.2 Loans Prets	127	6000	6127	24779	6000	30779	1294	6385	7679										26200	18385	44585
2.2.1 Domestic Intérieurs	-	6000	6000	-	6000	6000	-	6385	6385	-	-	-	-	-	-	-	-	-	-	18385	18385
2.2.2 Foreign Etrangers	127	-	127	24779	-	24779	1294	-	1294	-	-	-	-	-	-	-	-	-	26200	-	26200
3. ADDITIONAL FINANCING NEEDED FINANCEMENT SUPPLEMENTAIRE NECESSAIRE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE 7 FINANCIAL OBLIGATIONS — Alternative 1 — Thousand USD

TABLEAU ENGAGEMENTS FINANCIERS — Milliers des USD

Item Rubrique	Year Année													Total Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	
1. LOANS PRETS	641	3450	4281	7098	6802	9771	9093	8413	7734	7054	3112	-	-	67449
/repayment instalments/ /remboursements échelonnées/	-	-	-	3113	3113	6761	6761	6760	6760	6758	3112	-	-	43138
/interests/ /intérets/	641	3450	4281	3985	3689	3010	2332	1653	974	296	-	-	-	24311
1.1 Domestic loans Prets intérieurs														
1.1.1 Repayment instalments Remboursements échelonnés	-	-	-	-	-	3648	3648	3648	3648	3646	-	-	-	18238
1.1.2 Interest Intérets	641	1450	1915	1915	1915	1532	1149	766	383	-	-	-	-	11465
1.2 Foreign loans Prets étrangers														
1.2.1 Repayment instal-ments Remboursements échelonnés	-	-	-	3113	3113	3113	3113	3112	3112	3112	3112	-	-	24900
1.2.2 Interests Intérets	11	2190	2366	2070	1774	1478	1183	887	591	296	-	-	-	12846
2. DIVIDENDS DIVIDENDES	-	-	-	830	856	864	864	864	864	864	864	864	864	8598
3. OTHERS AUTRES ENGAGEMENTS	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4. TOTAL TOTAL	641	3450	4281	7928	7658	10635	9957	9277	8598	7918	3976	864	864	76047

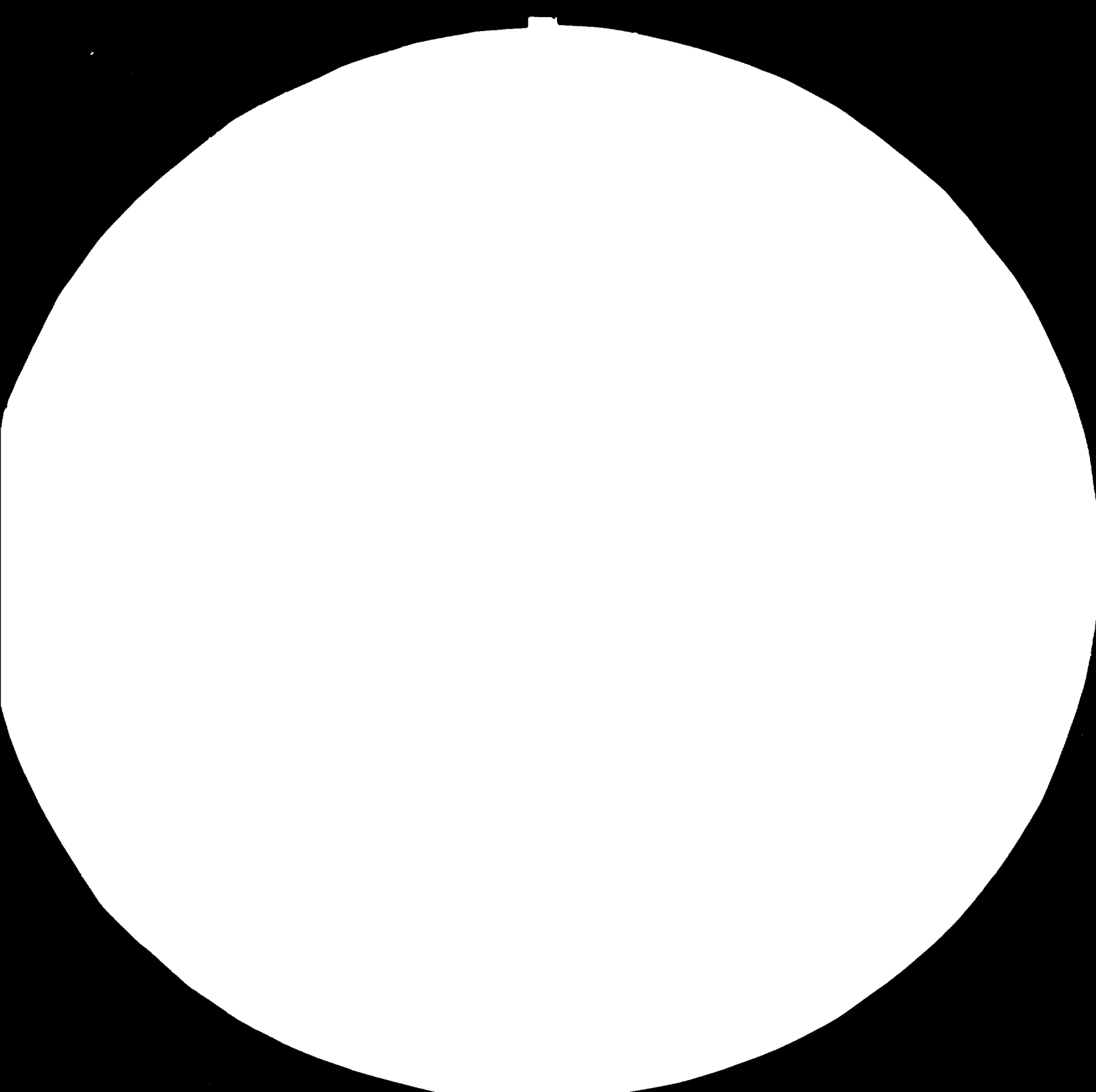
TABLE
TABLEAU 7

FINANCIAL OBLIGATIONS
ENGAGEMENTS FINANCIERS

Alternative 2

Thousand USD
Milliers des USD

Item Rubrique	Year Année													Total Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	
1. LOANS PRETS	642	3626	4419	7383	7072	10052	9355	8657	7960	7263	3275	-	-	69704
/repayment instalments/ /remboursements échelonnées/	-	-	-	3275	3275	6952	6952	6952	6952	6952	3275	-	-	44585
/interests/ /intérets/	642	3626	4419	4108	3797	3100	2403	1705	1008	311	-	-	-	25119
1.1 Domestic loans Prets intérieurs														
1.1.1 Repayment instalments Remboursements échelonnés	-	-	-	-	-	3677	3677	3677	3677	3677	-	-	-	18385
1.1.2 Interests Intérets	63	196	1930	1930	1930	1544	1158	772	386	-	-	-	-	11940
1.2 Foreign loans Prets étrangers														
1.2.1 Repayment instal-ments Remboursements échelonnés	-	-	-	3275	3275	3275	3275	3275	3275	3275	3275			26200
1.2.2 Interests Intérets	12	2366	2489	2178	1867	1556	1245	933	622	311	-	-	-	13579
2. DIVIDENDS DIVIDENDES	-	-	-	856	883	892	892	892	892	892	892	892	892	8875
3. OTHERS AUTRES ENGAGEMENTS	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4. TOTAL TOTAL	642	3626	4419	8239	7955	10944	10247	9549	8852	8155	4167	892	892	78579



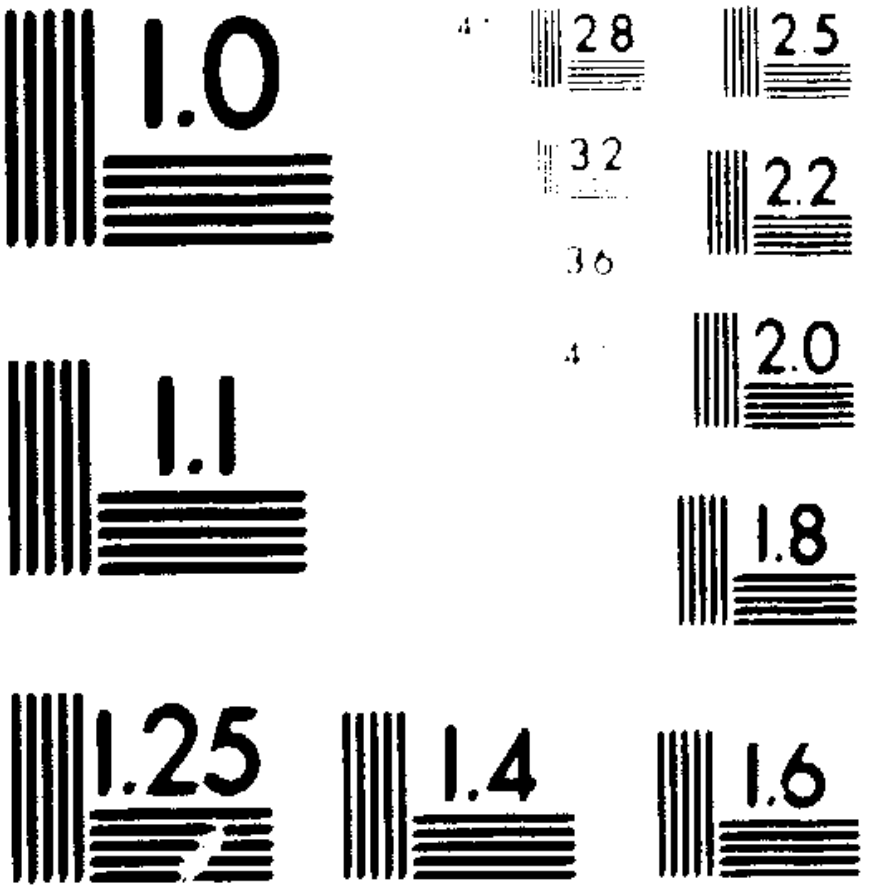


TABLE 8 INTEGRATED FINANCIAL ANALYSIS Alternative 1 Thousand USD
TABLEAU ANALYSE FINANCIERE INTEGREE Milliers des USD

Item Rubrique	Year Année												
	1	2	3	4	5	6	7	8	9	10	11	12	13
1. INVESTMENT INVESTISSEMENT	12389	36798	11876	2835	645	195							
Initial investment Investissement initial	11748	33348	7595	2835	645	195							
2. OPERATING COST COUT D'EXPLOITATION				19018	20253	20374	19696	16299	15620	14942	14646	14646	14646
2.1 Cash expenses Décaissement	-	-	-	7989	9570	10320	10320	10320	10320	10320	10320	10320	10320
2.2 Depreciations Amortissement	-	-	-	7044	7044	7044	7044	4326	4326	4326	4326	4326	4326
2.3 Interest Intérets	-	-	-	3985	3689	3010	2332	1653	974	296	-	-	-
3. INCOME REVENU				17875	19125	21250	21250	21250	21250	21250	21250	21250	33705
3.1 Sales revenue Recettes des ventes	-	-	-	14875	19125	21250	21250	21250	21250	21250	21250	21250	21250
3.2 Subsidies Subventions	-	-	-	3000	-	-	-	-	-	-	-	-	-
3.3 Residual value Valeur résiduelle	-	-	-	-	-	-	-	-	-	-	-	-	12455
4. NET CASH EARNINGS RECETTES NETTES DE CAISSE													
4.1 Taxable profit Bénéfice imposable	-	-	-	-1143	-1128	876	1554	4951	5630	6308	6604	6604	19059
minus taxes moins impots	-	-	-	-	-	-	-	-	-	-	-	-	-
4.2 Net profit Bénéfice nette	-	-	-	-1143	-1128	876	1554	4951	5630	6308	6604	6604	19059
plus interest plus intérets	-	-	-	3985	3689	3010	2332	1653	974	296	-	-	-
4.3 Net profit before interest after taxes													
Bénéfice net avant intérets apres imposition	-	-	-	2842	2561	3886	3886	6604	6604	6604	6604	6604	19059
plus depreciation-plus amortissement	-	-	-	7044	7044	7044	7044	4326	4326	4326	4326	4326	4326
minus replacement-moins remplacement	-	-	-	-	-	-	-	-	1850	-	-	-	-
Total Total	-	-	-	9886	9605	10930	10930	10930	9080	10930	10930	10930	23385
5. NET CASH FLOWS MOUVEMENTS NETS DE TRESORERIE	-	-	-	7051	8960	10735	10930	10930	9080	10930	10930	10930	23385

TABLE 8
TABLE

INTEGRATED FINANCIAL ANALYSIS
ANALYSE FINANCIERE INTEGREE

Alternative 1

Thousand USD
Milliers des USD

Item Rubrique	Year Année												
	1	2	3	4	5	6	7	8	9	10	11	12	13
6. FINANCIAL SOURCES SOURCES DE FINANCEMENT	12389	36798	11876	2835	645	195							
6.1 Equity Participations	6272	7865	3788	2835	645	195							
6.2 Loans Prets	6117	28933	8088										
6.3 Others Divers	-	-	-	-	-	-							
7. FINANCIAL OBLIGATIONS ENGAGEMENTS FINANCIERS	-	-	-	7928	7653	10035	9957	9277	8598	7918	3976	864	864
7.1 Repayment instalments Remboursements échelonnés	-	-	-	3113	3113	6761	6761	6760	6760	6758	3112	-	-
7.2 Interest charges Intérets	-	-	-	3989	3689	3610	2332	1653	974	296	-	--	-
7.3 Dividends Dividendes	-	-	-	826	856	864	864	864	864	864	864	864	864
8. NET CASH BALANCE ENCAISSE NETTE				1958	1247	495	973	1693	482	3012	6954	10066	22921
9. CUMULATIVE NET CASH BALANCE ENCAISSE CUMULATIVE NETTE				1958	3205	4200	5173	6866	7348	10360	17314	27380	49461

TABLE 8 INTEGRATED FINANCIAL ANALYSIS
TABLEAU ANALYSE FINANCIERE INTEGREE

Alternative 2

Thousand USD
Milliers des USD

Item Rubrique	Year Année												
	1	2	3	4	5	6	7	8	9	10	11	12	13
1. INVESTMENT INVESTISSEMENT	12610	39026	11254	3095	680	220							
Initial investment Investissement initial	11968	35400	6835	3095	680	220							
2. CASH COSTING COUT D'EXPLOITATION				20039	21469	21592	20895	17400	16703	16006	15695	15695	15695
2.1 Cash expenses Décaissement				8657	10338	11218	11218	11218	11218	11218	11218	11218	11218
2.2 Depreciations Amortissement				7274	7274	7274	7274	4477	4477	4477	4477	4477	4477
2.3 Interest Intérets				4108	3797	3100	2403	1705	1008	311	-	-	-
3. INCOME REVENU				17875	19125	21250	21250	21250	21250	21250	21250	21250	34025
3.1 Sales revenue Recettes des ventes				14875	19125	21250	21250	21250	21250	21250	21250	21250	21250
3.2 Subsidies Subventions				3000	-	-	-	-	-	-	-	-	-
3.3 Residual value Valeur résiduelle				-	-	-	-	-	-	-	-	-	12775
4. NET CASH EARNINGS RECETTES NETTES DE CAISSE													
4.1 Taxable profit Bénéfice imposable				-2164	-2284	-342	355	3850	4547	5244	5555	5555	13330
minus taxes moins impots				-	-	-	-	-	-	-	-	-	-
4.2 Net profit Bénéfice nette				-2164	-2284	-342	355	3850	4547	5244	5555	5555	13330
plus interest plus intérets				4108	3797	3100	2403	1705	1008	311	-	-	-
4.3 Net profit before interest after taxes Bénéfice net avant intérets apres imposition				1944	1513	2758	2758	5555	5555	5555	5555	5555	13330
plus depreciation-plus amortissement				7274	7274	7274	7274	4477	4477	4477	4477	4477	4477
minus replacement-moins remplacement				-	-	-	-	-	1850	--	-	-	-
Total Total				9218	8787	10032	10032	10032	8182	10032	10032	10032	22807
5. NET CASH FLOWS MOUVEMENTS NETS DE TRESORERIE				6123	8107	9812	10032	10032	8182	10032	10032	10032	22807

TABLE 8 INTEGRATED FINANCIAL ANALYSIS
TABLEAU ANALYSE FINANCIERE INTEGREE

Alternative 2

Thousand USD
Milliers des USD

Item Rubrique	Year Année												
	1	2	3	4	5	6	7	8	9	10	11	12	13
6. FINANCIAL SOURCES													
SOURCES DE FINANCEMENT	12610	39026	11254	3095	680	220							
6.1 Equity Participations	6483	8247	3575	3095	680	220							
6.2 Loans Prets	6127	30779	7679	-									
6.3 Others Divers	-	-	-										
7. FINANCIAL OBLIGATIONS													
ENGAGEMENTS FINANCIERS	-	-	-	8239	7955	10944	10247	9549	8852	8155	4167	892	892
7.1 Repayment instalments Remboursements échelonnés				3275	3275	6952	6952	6952	6952	6952	3275	-	-
7.2 Interest charges Intérets				4108	3797	3100	2403	1705	1008	311	-	-	-
7.3 Dividends Dividendes				856	883	892	892	892	892	892	892	892	892
8. NET CASH BALANCE ENCAISSE NETTE	-	-	-	979	832	-912	-215	483	-670	1877	5865	9140	21915
9. CUMULATIVE NET CASH BALANCE ENCAISSE CUMULATIVE NETTE				979	1811	899	684	1167	497	2374	8239	17379	39294

TABLE 9 — INTEGRATED VALUE ADDED ANALYSIS — Alternative 1 — Thousand USD
TABLEAU — ANALYSE INTEGREE DE LA VALEUR AJOUTEE — Milliers des USD

Item / Rubrique	Year / Année												
	1	2	3	4	5	6	7	8	9	10	11	12	13
1. VALUE OF OUTPUT VALEUR DE LA PRODUCTION	-	-	-	17875	19125	21250	21250	21250	21250	21250	21250	21250	33705
1.1 Exports Exportations	-	-	-	-	-	-	-	-	-	-	-	-	-
1.2 Domestically marketed Pour le marché local	-	-	-	14875	19125	21250	21250	21250	21250	21250	21250	21250	21250
1.3 Residual value Valeur résiduelle	-	-	-	-	-	-	-	-	-	-	-	-	12455
1.4 Others Divers	-	-	-	3000	-	-	-	-	-	-	-	-	-
2. VALUE OF MATERIAL INPUTS VALEUR DES INTRANTS MATERIELS	12389	36798	11876	10052	9393	9743	9548	9548	11398	9548	9548	9548	9548
2.1 Investments in rel. replacement Investissements	12389	36798	11876	2835	645	195	-	-	1850	-	-	-	-
2.1.1 Imported Capitaux importés	4739	25363	5186	-	-	-	-	-	1400	-	-	-	-
2.1.2 Domestically procured Capitaux locaux	7650	11435	6690	2835	645	195	-	-	450	-	-	-	-
2.2 Current material inputs Intrants matériels courants				7217	8748	9548	9548	9548	9548	9548	9548	9548	9548
2.2.1 Imported Importés				2319	2869	3156	3156	3156	3156	3156	3156	3156	3156
2.2.2 Domestically procured D'origine locale				4243	5224	5737	5737	5737	5737	5737	5737	5737	5737
2.2.3 Infrastructural services Services d'infrastructure				655	655	655	655	655	655	655	655	655	655
3. NET DOMESTIC VALUE ADDED VALEUR AJOUTEE NETTE SUR LE PLAN INTERIEUR	/12389/	/36798/	/11876/	7823	9732	11507	11702	11702	9852	11702	11702	11702	24157
4. REPATRIATED PAYMENTS REPATRIEMENTS DE FONDS				2070	1774	1478	1183	887	591	296	-	-	-
4.1 Wages Salaires				-	-	-	-	-	-	-	-	-	-
4.2 Profits Bénéfices				-	-	-	-	-	-	-	-	-	-
4.3 Interest Intérets				2070	1774	1478	1183	887	591	296	-	-	-
4.4 Others Divers				-	-	-	-	-	-	-	-	-	-

TABLE 9 INTEGRATED VALUE ADDED ANALYSIS Alternative 1 Thousand USD
TABLEAU ANALYSE INTEGREE DE LA VALEUR AJOUTEE Milliers des USD

Item Rubrique	Year Année												
	1	2	3	4	5	6	7	8	9	10	11	12	13
5. NET NATIONAL VALUE ADDED VALEUR AJOUTEE NETTE SUR LE PLAN NATIONAL	/12389/	/36798/	/11876/	5753	7958	10029	10519	10815	9261	11406	11702	11702	24157
5.1 Wages Salaires				572	572	572	572	572	572	572	572	572	572
5.2 Social surplus Excédent social				5181	7386	9457	9947	10243	8689	10834	11130	11130	23585

TABLE 9
TABLEAU

INTEGRATED VALUE ADDED ANALYSIS
ANALYSE INTEGREE DE LA VALEUR AJOUTEE

Alternative 2

Thousand USD
Milliers des USD

Item Rubrique	Year Année												
	1	2	3	4	5	6	7	8	9	10	11	12	13
1. VALUE OF OUTPUT VALEUR DE LA PRODUCTION				17875	19125	21250	21250	21250	21250	21250	21250	21250	34029
1.1 Exports Exportations				-	-	-	-	-	-	-	-	-	-
1.2 Domestically marketed Pour le marché local				14875	19125	21250	21250	21250	21250	21250	21250	21250	21250
1.3 Residual value Valeur résiduelle				-	-	-	-	-	-	-	-	-	12779
1.4 Others Divers				3000	-	-	-	-	-	-	-	-	-
2. VALUE OF MATERIAL INPUTS VALEUR DES INTRANTS MATERIELS	1761	39026	11254	10980	10446	10446	10446	10446	12296	10446	10446	10446	10446
2.1 Investments incl. replacement investissements	1761	39026	11254	3095	540	0	-	-	1850	-	-	-	-
2.1.1 Imported Capitaux importés	1062	27385	4753	-	-	-	-	-	1400	-	-	-	-
2.1.2 Domestically procured Capitaux locaux	7648	11641	6501	3095	540	0	-	-	450	-	-	-	-
2.2 Current material inputs Intrants matériels courants				7885	9906	10446	10446	10446	10446	10446	10446	10446	10446
2.2.1 Imported Importés				3854	4706	5243	5243	5243	5243	5243	5243	5243	5243
2.2.2 Domestically procured D'origine locale				3353	4122	4525	4525	4525	4525	4525	4525	4525	4525
2.2.3 Infrastructural services Services d'infrastructure				678	678	678	678	678	678	678	678	678	678
3. NET DOMESTIC VALUE ADDED VALEUR AJOUTEE NETTE SUR LE PLAN INTERIEUR	/1761/	/39026/	/11254/	6895	8879	10804	10804	10804	8954	10804	10804	10804	23579

TABLE
TABLEAU 9

INTEGRATED VALUE ADDED ANALYSIS
ANALYSE INTEGREE DE LA VALEUR AJOUTEE

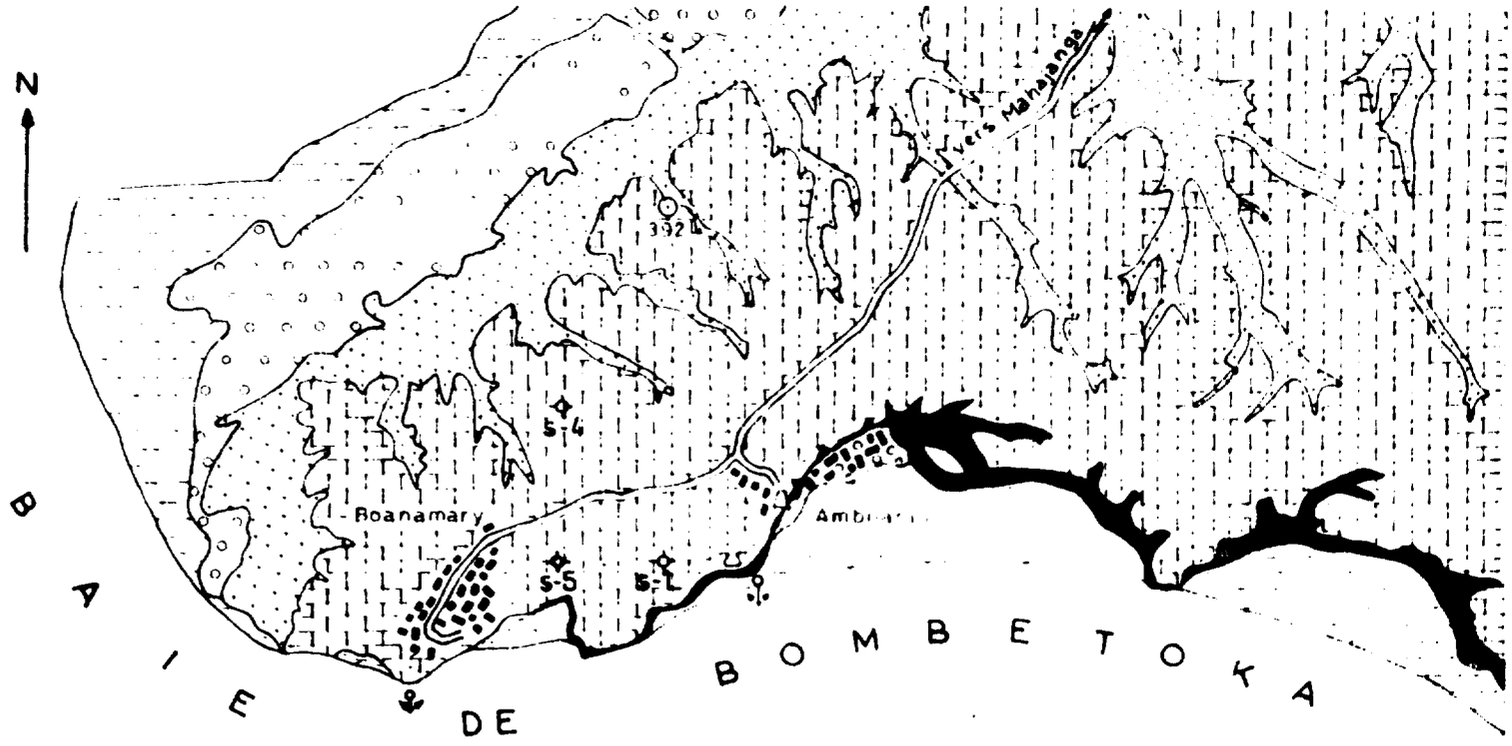
Alternative 2

Thousand USD
Milliers des USD

Item Rubrique	Year Année												
	1	2	3	4	5	6	7	8	9	10	11	12	13
4. REPATRIATED PAYMENTS REPATRIEMENTS DE FONDS				2178	1867	1556	1245	933	622	311	-	-	-
4.1 Wages Salaires				-	-	-	-	-	-	-	-	-	-
4.2 Profits Bénéfices				-	-	-	-	-	-	-	-	-	-
4.3 Interest Intérets				2178	1867	1556	1245	933	622	311	-	-	-
4.4 Others Divers				-	-	-	-	-	-	-	-	-	-
5. NET NATIONAL VALUE ADDED VALEUR AJOUTEE NETTE SUR LE PLAN NATIONAL	/12613/	/39026/	/11254/	4717	7612	9028	9559	9871	9932	10493	10804	10804	23579
5.1 Wages Salaires				572	572	572	572	572	572	572	572	572	572
5.2 Social surplus Excédent social				4145	6440	8456	8987	9299	7760	9921	10232	10232	23007

ANNEXES

ANNEX N° 2



ETUDE LITHOLOGIQUE DES CALCAIRES ET MARNES DE BOANAMARY

(Photo-avion Nº 392 - Mission 012)
Echelle : ≠ 1/40 000

Mangrove
Sable argileux
Alluvions argileuses
Localité
Route
Formation calcaire
Marne ± homogène (4 à 20m)
Carrière
Cimenterie
Port
392 Nadir de photo-avion

Sommet Parfois calcaire crayeux massif et marne calcaire ± crayeuse (1à>2m)

Intermédiaire épais Alternance des bancs de calcaire marneux et de marne calcaire (10 à 20m)

Base Calcaire grumeleux en miches sans litage défini (2 à 5m)

RAZAFIMANANTSOA
1979

17

ANNEX N° 3

SONDAGE S.4

LOCALISATION

X : 1.140,320

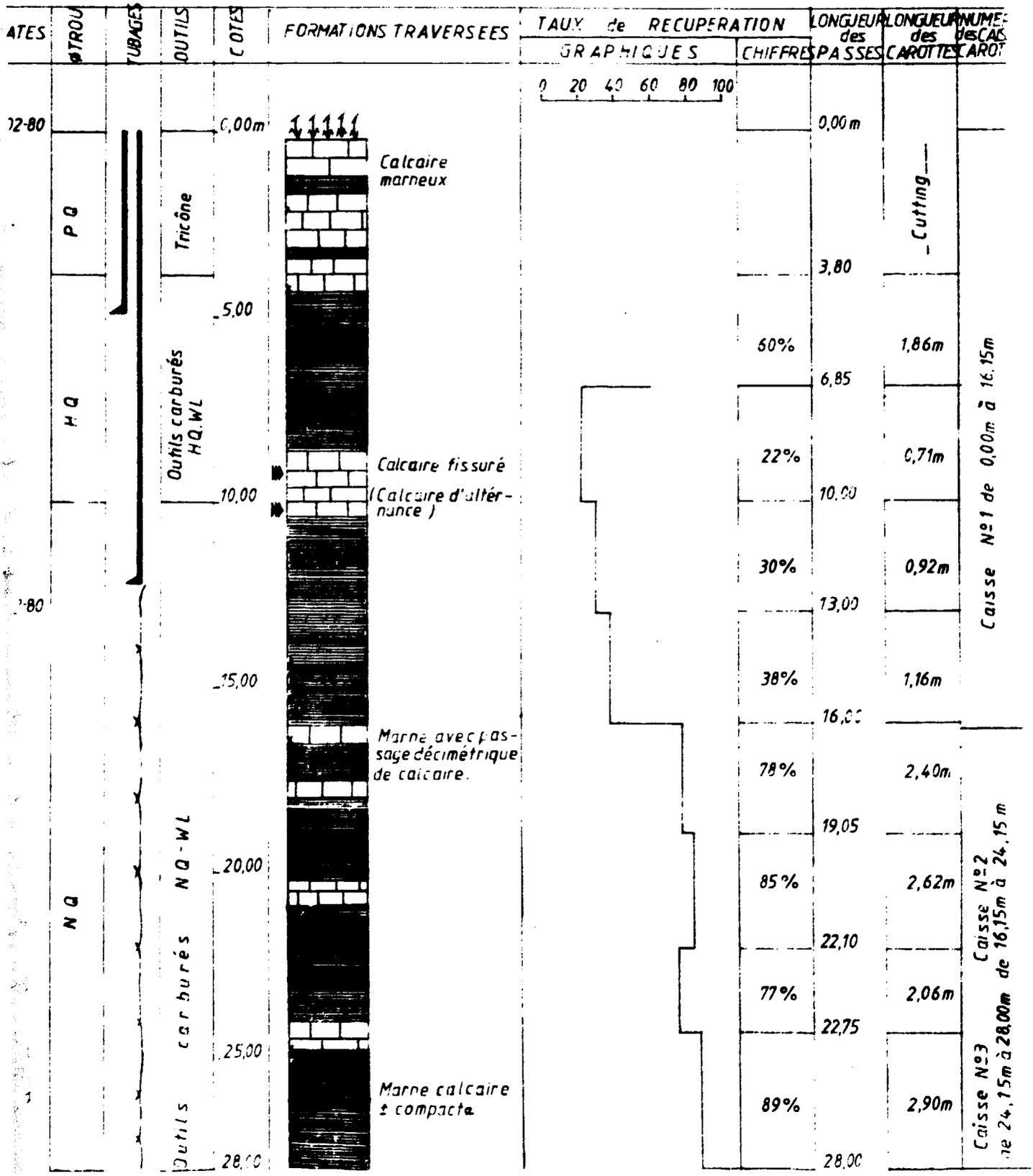
Y : 388,100

Z

Date d'éxécuti

Echelle de Profondeur : 1/100

Profondeur totale 29,00m



CHAN

ANNEX N° 4

SONDAGE S5

LOCALISATION

X 1139,650

Y 388,170

Z = 22,00 m

Commencé le

Date d'exécution

Terminé le

...le de profondeur 1/100.

...deur totale 25,10 m

S	ØTROU	TUBAGES	OUTILS	CÔTES	FORMATIONS TRAVERSEES	TAUX de RECUPERATION GRAPHIQUES 0 20 40 60 80 100	CUMUL	LONGUEUR des CAROTTES	LONGUEUR des CAROTTES	NUMEROS de CAISSES CAROTTES
	P G		Tricône	0,00m	Terre végétale 0,30m			3,80 m	Cutting	
	H Q	N W	H Q Wire line	3,80						
				5,00	Alternance calcaire et marne jaunâtre		22%	0,68m		
								8,80		
					Perte totale circulation à 9,15 m		37%	1,14m		
				9,85				9,85		
					12,90m		28%	0,88m		Caisse N°1 de 0,00 à 22,00m
								12,90		
				13,00	marne jaunâtre		11%	0,35m		
								13,95		
	N Q		H Q Wire line				25%	0,87m		
					19,00m			19,00		
				20,00	Perte totale de circulation à 20 m		33%	1,00m		
					calcaire + marneux			22,00		
							9,1%	2,85m		Caisse N° 2 de 22,00 à 25,10m
					25,00 m Arrêt de sondage			25,10		

CHANTIE

A N N E X E S

ANNEX N° 1

Aspect quantitatif et qualitatif du gisement calcareo - marneux du secteur d'Amboanio. par J.R. Ratsimbazafy Ingénieur - Géologue.

(Rapport technique préliminaire - Mars 1981).

Les formations calcaréo - marneuses (Maestrichtion - Danien) constituent les plateaux bordant la berge droite de la baie Bombatoka, allant de la pointe de Bounamary jusqu'à la rivière Vavaranoniberivotra.

Du point de vue pétrographique, c'est une série superposée de "marne"et de"Calcaire"dont les détails pourraient être observés au niveau de la carrière actuelle pour cimenterie d'Amboanio.

A ce niveau, on pout apercevoir, de bas en haut:

- un ensemble dit marneux, mais analytiquement de nature marno-calcaire (avec 41 % de CaO) et dont la partie affleurante (visible au - dessus du niveau de la mer) mesure 7 m d'épaisseur.

- un ensemble calcaire constitué en réalité de 3 sous - ensembles superposés de couches calcaires - marneuses totalisent une épaisseur moyenne (vue sur carrière) de 18 m.

En fait, raboté par l'érosion, le plateau calcaire sommital présente une morphologie inclinée du côté de la carrière (côté Est). Ainsi, plus à l'Ouest, à 200 metres du front de taille actuel, cet ensemble calcaire aurait - il une épaisseur de 24 m à lui seul

(d'après notre carte géologique au 1 / 2000).

Les ensembles calcaréo - marneuses précités constituent les matières premières pour cimenterie exploitées par l'usine d'Amboanio. Ils sont reconnus peu dolomitiques (2 %) le long de cette bordure du bassin de Mahajanga (H. Besairie), au moins sur une bande de 2 000 m de large.

Aspect quantitatif :

En considérant 3 zones exploitables à proximité de la cimenterie actuelle, en peut chiffrer les réserves gélogiques en matériaux de calcaires et de marnes comme suit :

Zone 1 : (entre le village de Boanamary et la limite du permis d'exploitation de la cimenterie actuelle) pour une superficie de l'ordre de 200 000 m2 Calcaire :
10 à 11 millions de tonnes, Marne
1,5 à 2 millions de tonnes , total
11,5 à 13 milions de tonnes.

Zone 2 : (la zone couverte par le permis d'exploitation de la cimenterie actuelle) pour une superficie de l'ordre de 200 000 m2

Calcaire	9 à 10 millions de tonnes	
Marne	2,5 à 3	-"-
Total	11,5 à 13	-"-

Zone 3 (Secteur au Nord - Est de la zone 2) pour une superficie de l'ordre de 800 000 m2 :

Calcaire	30 millions de tonnes	
Marne	13	-"-
Total	43	-"-

Ces estimations concernent les tones exploitables situées a l'Est de la routs desservant de village Boanamary et délimitées sur le schéma joint. Ce qui nous fournissent pour les alenteurs immédiat de l'usine actuelle, un total de 69 millions de tonnes de réserve gélogique en matériaux calcaréomarneux réparti an 18 millions de tonnes de marnes et 51 millions de tonnes de calcaires pour une superficie de 1 200 000 m2.

Ces estimations tiennent compte des détails euivants :

- les formations calcaréo - marneuses, mis à part des détails tectoniques à rejets mineurs, présentent un léger pendage géologique vers l. Ouest ce qui entrafne les conséquences suivantes :

  . dans la zone 1, la partie affleurante des marnes n'[illegible] servées que sur 2 à 5 m seulement. Les calcaires [illegible]ient atteindre au contraire une épaisseur allant jusqu'un maximum de 26 m

  . dans la zone 2, l'épaisseur des marnes accessibles en surface varie de 5 m à 10 m et celle du calcaire peut aller jusqu'à 28 m aussi

  . dans la zone 3, l'épaisseur des marnes irait jusqu'au delà de 10 alors que celle des calcaires atteindrait 20 m en moyenne.

Aspect qualitatif.

Les études minutieuses n'ont pu être menées qu'au niveau de la carrière ouverte seulement.

Les matières premières precitées ont été reconnues aptes a faire du ciment Portland depuis longtemps déja. Aussi les contrôles chimiques effectués par le laboratoire de chimie de la Cimenterie actuelle prennent - ils une apparence routiniére. Nous avons remarqué que l'abattage se fait par blocs que les prélevements pour analyse sont effectués sur une partie quelconque des blocs, sans tenir compte des différentes natures lithologiques que nous avons définies auparavant. Par contre un contrôle plus serré se passe au niveau de la pâte en vue de la rectification du mélange.

Les résultats d'analyse au niveau des vues nous paraissent dons peu représentatifs, surtout pour les calcaires.

En 1979 - 1980, des équipes de la Division Géologie ont été envoyées pour des levers topographiques et gélogiques de l'ensemble du secteur. Des études analytiques du front ouvert autuallement ont été menées en vus d'acquérir des dounées sur la composition réelle dee formatiens en présence et leure variations éventuelles. D'où les resultate qu euivent :

a) Composition lithologieue

- La formation de base dite marneuse est constituée en faite de 2 séries marno - calcaires superpascés. La partie basale (affleurant sur 5 m d'épaisseur) est de nature

plus alumineuse, plus carbonatée mais moins siliceuse que la partie supérieure (4 m d'épaisseur).

- La partie dite calcaire est constituée de 3 séries calcaréc - marneues que nous appelerons successivement :

  calcaire inférieur (celui en contact avec les marnes)

  calcaire moyen et calcaire supérieur

- Le calcaire inférieur est relativement compact d'aspect grumeleaux avec 53 % de CaO. On peut l'observer sur 4 m d'épaisseur environ.

- Le calcaire moyen est formé d'une série alternative de bancs décimétriques de calcaire - marneux et de marne - calcaire. On peut l'observer sur 10 m d'épaisseur au total.

- Le calcaire supérieur est une formation de calcaire marneux à tendance crayeuse en surface(en moyenne 51 % de CaO). On peut l'observer sur 4 m environ au niveau de la carrière. Si le front s'étend vers l'Ouest, c'est cette formation qui augmenterait d'épaisseur compte tenu de l'aspect morphologique du plateau.

b) Composition chimique.

Les tableaux ci - dessous donnent la moyenne des résultats d'analyses effectuées sur des prélévements à maille régulière au niveau de la carrière. Les échantillons ont été analysés aussitôt au laboratoire de la cimenterie d'Amboanio.

Tableau 1 : caractéristiques chimiques de l'ensemble "Calcaire"

	SiO_2	R_2O_3	CaO	MgO	Titre
Calcaire supérieur :					
	3,51	2,59	50,82	0,54	95,95
Calcaire moyen	8,93	5,04	45,35	0,34	86
Calcaire inférieur	1,77	1,44	52,85	0,42	96,39
Moyenne calculés	4,73	3,01	49,66	0,45	92,08

Tableau 2 : variation de composition des calcaires dans le sens latéral (les chiffres présentant la moyenne les résultats d'analyse de rainurage effectué tous les 40 m au niveau des calcaires).

Maille	SUD M1	M2	M3	M4	M5	NORD M6	Moyenne calculée
SiO_2	4,74	1,86	6,70	3,67	1,11	5,08	3,86
R_2O_3	3,08	1,29	4,15	3,44	1,92	2,41	2,71
CaO	50,48	52,49	48,36	46,92	53,17	49,57	50,16
MgO	0,66	0,44	0,32	0,68	0,43	0,25	0,46
titre	89,60	97,70	90,53	93,03	97,50	90,38	93,12

Tableau 3 : Caractéristiques chimiques de l'ensemble marneux.

	SiO_2	R_2O_3	CaO	MgO	titre
Niveau supérieur	22,17	11,47	35,66	0,77	58,43
Moyenne calculée	17,93	9,40	58,65	0,83	64,98
Niveau inférieur	13,77	7,34	41,65	0,89	71,53

Tableau : Moyenne de composition chimique des 2 niveaux marneux tous les 40 m latéralement :

	SUD					NORD	Moyenne calculés
Maille	M1	M2	M3	M4	M5	M6	
SiO_2	17,59	23,31	17,62	15,20	16,54	17,69	17,97
R_2O_3	9,80	11,19	10,02	7,84	8,45	9,17	9,41
CaO	39,47	36,92	37,63	40,06	40,62	37,28	38,66
MgO	1	0,72	0,87	0,65	0,72	1,07	0,83
titre	67,60	57,70	66,95	63,10	69,69	64,60	64,94

Tableau 5 : mesure d'humidité effectuée sur des prélèvemnts à maille de 20 m le long du front ouvert et tous les 3 m verticalement.

(Les points laissés en blanc sur le tableau s'avérent difficilement accessibles d'où prélèvemnts abandonnés). La période était de 16 au 18 août 1979.

	A	B	C	D	E	F	G	H	I	J	K	L	Moyenne
1.	2,51	0,87	1,09	1,38	-	-	-	-	-	-	0,54	-	1,28
2.	-	,22	1,47	-	-	-	-	-	-	-	2,27	1,69	1,91
3.	-	2,00	1,53	1,50	-	1,16	0,65	-	-	-	-	0,23	1,18
4.	0,71	6,05	1,57	0,95	1,42	0,24	0,14	3,26	0,57	0,37	0,30	1,90	1,46
5.	2,22	0,59	0,90	2,74	0,11	2,34	1,98	3,99	0,44	0,80	4,96	3,24	2,02
Moyenne calcaire	1,81	2,34	1,31	1,64	0,76	1,24	0,92	3,63	0,58	0,68	2,01	1,76	
6.	-	6,55	7,96	7,44	4,61	2,95	2,48	3,90	1,92	0,63	2,70	2,83	4,18
7.	-	2,80	4,96	3,45	-	3,34	3,60	3,88	5,11	3,88	2,70	3,57	3,65
8.	-	5,04	5,06	7,28	3,40	3,07	1,61	-	-	-	-	-	4,24
Moyenne marne	4,79	5,99	5,72	4,02	3,12	2,56	3,89	3,51	3,25	2,70	3,29		

Sables : les sables utilisés actuellement par la cimenterie d'Amboanio sont pris du côté d'Amborovy (à une trantaine

de kilomètres de l'usine(sur les formations dites sables rouges. Les dernières analyses (1980) sur ces sables donnent :

SiO_2	Fe_2O_3	Al_2O_3	CaO	MgO	P D
89,75	2,09	3,01	1,04	0,96	3,15

Ces sables rétablissent bien le déficit en silice du mélange.

Conclusion :

Ces résultats offrent des vues détaillées sur les constituants lithologiques observés au niveau de la carrière ouverte actuellement. Ils permettent de faire des rapprochements et comparaison avec les résultats d'analyse faites jusqu'alors par la cimenterie d'Ambomio qui, rappelons - le, ne considere pas les sous - ensembles de couches séparément tel qui nous l'avons faits.

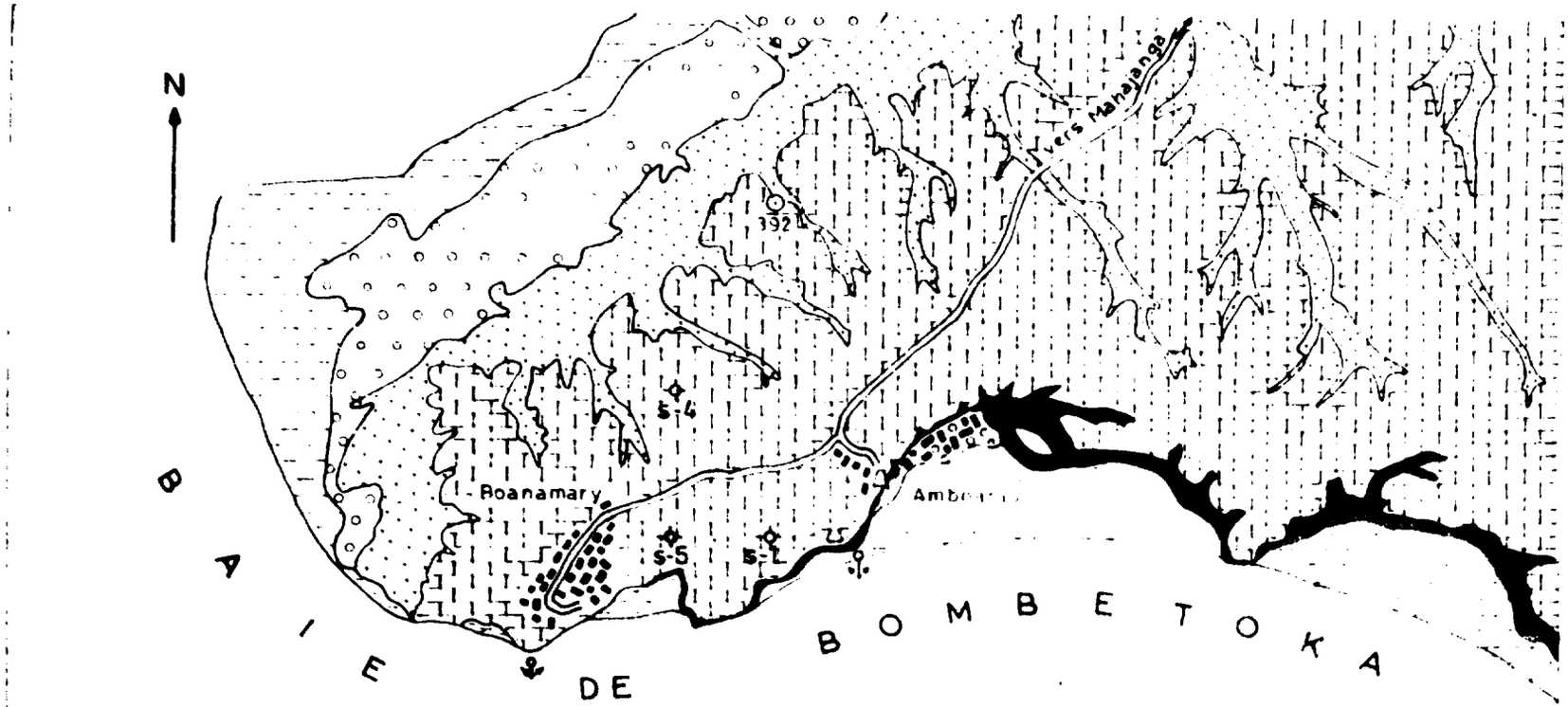
Notons que chaque sous - ensemble est succeptible de varier en épaisseur (forme légèrement) lenticulaire) et en composition chimique, ce qui entraînerait des variations notables au niveau composition du mélange cru (ces variations ont été vérifiées auprès des responsables de l'usine qui a dû recourir à des rectifications du mélange par ajustement).

Toutefois le rattrapage des écarts semble rentrer jusqu ici dans la fourchette du"possible"(ce qui caractérise les matériaux pour cimenterie de cette région) d'où la production incessante de ci-

ment juqu'a ce jour.

Le mélange des crus pour atteindre la norme réquise en modules varie depuis 1956 à l'usine entre 35 % à 45 % de calcaire pour 55 % à 65 % de marne.

26 Mars 1981



ETUDE LITHOLOGIQUE DES CALCAIRES ET MARNES DE BOANAMARY

(Photo-avion Nº 392 - Mission 012)
Echelle : ≠ 1/40 000

Mangrove

Sable argileux

Alluvions argileuses

Localité

Formation calcaire

Marne ± homogène (4 à 20m)

Route

Carrière

Cimenterie

Port

Sommet : Parfois calcaire crayeux massif et marne calcaire ± crayeuse (1à > 2m)

Intermédiaire épais : Alternance des bancs de calcaire marneux et de marne calcaire (10 à 20m)

Base : Calcaire grumeleux en miches sans litage defini (2 à 3m)

392 Nadir de photo-avion

RAZAFIMANANTSOA 1979

17

ANNEX N° 3

SONDAGE S.4

LOCALISATION

X : 1.140,320

Y 388,100

Z

Date d'éxécuti

helle de profondeur 1/100

ofondeur totale 28,00m

TES	TROU	TUBAGES	OUTILS	COTES	FORMATIONS TRAVERSEES	TAUX de RECUPERATION GRAPHIQUES (0 20 40 60 80 100)	CHIFFRES	PASSES	LONGUEUR des CAROTTES	LONGUEUR des CAROT	NUME des CAS
2-80	P Q		Tricône	0,00m	Calcaire marneux			0,00 m	Cutting		
				3,80			60%	3,80	1,86m		
	H Q		Outils carburés HQ.WL	5,00			22%	6,85	0,71m		
				10,00	Calcaire fissuré (Calcaire d'alternance)		30%	10,00	0,92m		
-80								13,00			
				15,00			38%		1,16m		
					Marne avec passage décimétrique de calcaire			16,00			
							78%		2,40m		
	N Q		N Q - W L	20,00				19,05			
							85%		2,62m		
								22,10			
							77%		2,06m		
				25,00				22,75			
			Outils carburés		Marne calcaire ± compacte		89%		2,90m		
				28,00				28,00			

Caisse N°1 de 0,00m à 16,15m

Caisse N°2 de 16,15m à 24,15 m

Caisse N°3 de 24,15m à 28,00m

CHAN

ANNEX N° 4

SONDAGE.S5

LOCALISATION

X 1139.650

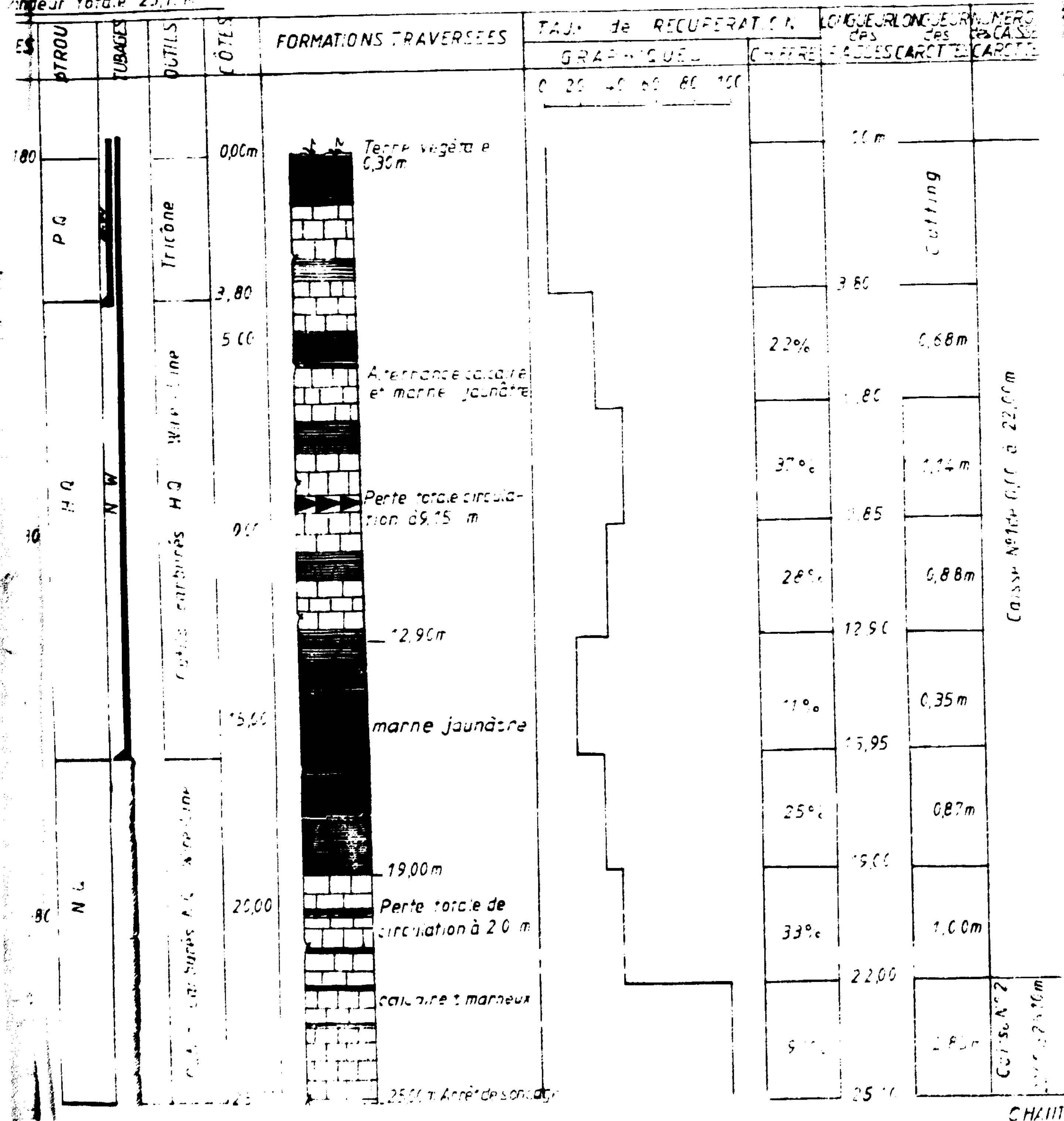
Y 388.[illegible]

Z = 22.0[illegible] m

Date d'exécution: Commencé / Terminé

Échelle de profondeur 1/100.

Profondeur totale 25,10 m



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