

51746

UNITED NATIONS ECONOMIC AND SOCIAL COUNCIL



Distr.
LIMITED



E/CN.14/INR/132
11 November 1966

ENGLISH
Original: FRENCH

ECONOMIC COMMISSION FOR AFRICA
Sub-regional Meeting on Economic
Co-operation in West Africa
Niamey, 10-22 October 1966

THE REFRACTORY PRODUCTS INDUSTRY IN WEST AFRICA

M66-1177

THE REFRACTORY PRODUCTS INDUSTRY IN WEST AFRICA

I. INTRODUCTION

1. Industry and handicraft production require refractory products in all cases where use is made of temperatures above $800-1000^{\circ}\text{C}$. When a refractory product is required, use is made particularly of ceramic material in the form of bricks, stones, granular refractory material and refractory mortars. The chief consumers of refractory products are the metallurgical industry, the building materials industry, glasswork and energy. In principle, refractory products may be divided on the basis of their chemical composition or the raw materials used in their preparation. The commonest and most important are :-

- Refractory fire clay
- Magnesite in MgCO_3
- Chromium-magnesite (MgCO_3 with chromite)
- Quartz dinas or quartzite
- Dolomite (CaMgCO_3)
- Graphite

2. Less common but equally important are the refractory products from mullite, sillimanite (andalusite and disthene), silicium carbide and a few others of a special kind. The needs of the various industries are as follows :

Metallurgical industry	: fire clay, magnesite, chromium-magnesite, dolomite, dinas.
Cement and Limestone Industry	: fire clay and magnesite.
Glass industry	: fire clay, dinas.
Aluminium Industry	: fire clay.
Energy	: fire clay.

In certain cases, one type of refractory product may be substituted for another, up to a certain point.

3. Refractory products are divided into the BTN and SITC groups:

BTN	SITC	
60-01-00	662-3.(1)	Heat insulating bricks etc. of infusional earths of kieselgur and of siliceous earths.
69-02-00	662.3(2)	Other refractory bricks etc.
	662.3.(3)	Refractory cements or mortars.
69-03-00	663.7.	Refractory products other than refractory construction materials (e.g. retorts, crucibles, muffles, nozzles, plugs, supports, tubes, pipes, sheaths, rods).

II. THE PRESENT SITUATION

1. Refractory products are not at present made in West Africa, and the needs of the sub-region are over supplied with imported products alone with the partial exception of refractory bricks for the brick industry, which are actually produced at the brickworks, for making circular brick kilns of the Hoffmann type.

2. Imports in respect of groups 662.3(1); 662.3(2) and 663.7 are shown in the following table:

TABLE 1
Imports on the groups 662.3(1), 662.3(2) and 663.7

	662.3(1)		662.3(2)		663.7	
	1000\$	T	1000\$	T	1000\$	T
Dahomey	0.9	8.1	2.5	19.0	0.2	0.2
Ghana	-	-	208.2	859.5	213.4	127.6
Ivory Coast	1.2	2.8	9.4	64.1	2.4	2.6
Mali	-	-	0.2	0.4	-	-
Niger	0.4	1.7	1.2	3.5	0.1	...
Nigeria	564.5	3,197.4	609.5	3,571.3	24.0	99.3
Senegal	0.6	2.8	38.2	375.6	2.8	17.6
Togo	0.2	1.2	5.4	32.7	1.9	2.4
Upper Volta	...	...	0.2	1.3	1.4	2.6
Total 9 Countries:	567.8	3,214.0	874.8	4,927.4	246.2	252.3
Estimate for the sub-region:	621.2	3,516.4	956.5	5,390.0	269.4	276.2

It should be pointed out that in these import figures, refractory products for the building of new factories are not included in certain cases.

3. As regards group 662.3(1) - the insulating material is not a refractory product and the solution must be sought separately. For example, where metallurgy is concerned, slag fibre especially basaltic ones would be produced, and these might be substituted for infusional earth products up to a certain point.

4. As far as refractory products, strictly speaking, are concerned, the quantities imported for the period 1960-1965 are shown in Tables 2 and 3.

TABLE 2

Imports of refractory products for building purposes

(in tons)

	<u>1961</u>	<u>1962</u>	<u>1963</u>	<u>1964</u>	<u>1965</u>	<u>1960-64</u>
662.3(2)						
Dahomey	19.0 ^{1/}	...	12.8	44.2		19.0
Ghana	276.0	362.9	799.0	2,000.0		859.5
Ivory Coast	33.7	50.3	116.3	56.9	59.5	64.1
Mali	1.0 ^{1/}	0.4	...	...	3.7	0.4
Niger	1.1	2.7	0.1	10.1		3.5
Nigeria	3,754.4 ^{1/}	3,754.4 ^{1/}	3459.3	3,317.2	4,486.8	3,571.3
Senegal	269.9	440.5	450.2	341.8		375.6
Togo	19.9	8.2	55.9	46.6	124.8	32.7
Upper Volta	0.3	2.4	0.5	1.1		1.3
<u>Total</u>	<u>4,375.3</u>	<u>4,621.8</u>	<u>4894.1</u>	<u>5,817.0</u>		<u>4,927.1</u>
Estimate for the sub-region:	4,783	5,112	5415	6,441		5,390.0
Increase %	6.2%	5.9%	19.0%			7.7%

^{1/} This is merely an estimate.

TABLE 3

Imports of other refractory products

(in tons)

	<u>1961</u>	<u>1962</u>	<u>1963</u>	<u>1964</u>	<u>1965</u>	<u>1960-64</u>
663.7						
Dahomey	0.2 ^{1/}	-	0.1	0.6		0.2
Ghana	129.0	148.4	127.0	106.0		127.6
Ivory Coast	1.3	1.9	2.3	5.0	1.4	2.6
Mali	...	-	-	-	-	...
Niger	-	...	...	0.2		...
Nigeria	117.1 ^{1/}	117.1 ^{1/}	58.0	105.0	188.2	99.3
Senegal	57.5	5.2	4.1	3.7		17.6
Togo	0.1	0.1	4.7	4.8	0.7	2.4
Upper Volta	1.2	7.7	0.6	0.9		2.6
<u>Total</u>	<u>306.4</u>	<u>280.4</u>	<u>196.8</u>	<u>226.2</u>		<u>252.5</u>
Estimate for the sub-region:	339	312	220	247		276.2
^{1/} estimations.						

Group 662.3(2) reveals a rising tendency with a growth rate from 6-19 per cent with an annual average of 7.7 per cent. In the case of group 663.7, there is no steady rate of growth.

5. Up to the present, there are no factories in West Africa which make refractory products, and we are not aware of any study or project in this connexion for the establishment of a refractory products industry.

III. PROJECTION

1. To evaluate future needs in refractory products, two projection methods may be used in principle and these are given below:

(a) An evaluation may be made of the growth of industries using refractory products, and the projection of this evaluation may be used to ascertain the needs in refractory products.

(b) A direct computation may be made of the consumption in respect of industries making the greatest use of refractory products, and an estimate drawn up of the needs of other industries.

2. As regards method (a), the growth rate in industry in West Africa for the period 1963-1980 should be 14.3 per cent. Imports of refractory products in 1964 were:

662.3(2)	6.440 T/per year
663.7	247 T/per year
Total:	6.687 T/per year

If we assume that the growth rate for the requirements of refractory products is the same as for industry, the requirements in 1980 will be:

662.3(2)	54.570 T/per year.
663.7	2.090 T/per year
Total:	56.660 T/per year.

IV. DIRECT ASSESSMENT

The chief consumers of refractory products are the metallurgical industry, the building materials industry particularly the cement, glass, aluminium or alumina industries and energy. The needs of these industries in refractory products is as follows:

1. The cement industry: on the average we may reckon on the need per unit of about 1.5 - 1.7 kg of refractory products per ton of cement or clinker. The refractory products used are overwhelmingly of fire clay, and it is only in the baking zone that use is made in certain cases of magnesite or a type of fire clay stones with a high percentage of alumina, in other words, fire clay of the highest quality. Generally speaking, one can get by with refractory products based on fire clay, because in West Africa no deposits of the necessary raw materials are known apart from magnesite.
2. Cement production and the needs in fire clay are indicated in Table 4:

TABLE 4
Cement production and requirements in refractory products.

	<u>Clinker cement production</u>				<u>Consumption of refractory products</u>			
	in 1,000 tons				in tons			
	<u>1964</u>	<u>1970</u>	<u>1975</u>	<u>1980</u>	<u>1964</u>	<u>1970</u>	<u>1975</u>	<u>1980</u>
Ghana	-	-	250	600 ^{1/}	-	-	375	900
Dahomey	-	100	200	300	-	150	300	450
Guinee	-	-	200 ^{1/}	300 ^{1/}	-	-	300	450
Mali	-	60	100	160	-	90	150	240
Niger	-	75	45	90	-	68	68	135
Senegal	220	420	1,020	2,020	330	630	1,530	3,030
Upper-Volta	-	-	-	200	-	-	-	300
Liberia	-	-	-	200	-	-	-	300
Nigeria	950	1,250	2,450 ^{2/}	5,450 ^{3/}	1,425	1,875	3,525	7,725
<u>Total</u>	<u>1,170</u>	<u>1,875</u>	<u>4,265</u>	<u>9,320</u>	<u>1,755</u>	<u>2,813</u>	<u>6,248</u>	<u>13,530</u>

^{1/} 100 T Al-cement

^{2/} 200 T slag-cement

^{3/} 600 T slag-cement

3. Alumina: the development of alumina production has not yet been determined, but we can reckon on the following figures. Present production in Guinea is 65,000 tons a year. In 1980 alumina production in West Africa should reach 1.2 - 1.6 million tons a year, with Guinea responsible for 75 per cent of the total quantity, and Ghana 25 per cent. Because the production processing methods are not yet established, we may reckon on a need per unit of approximately 1.0 - 1.3 kg of refractory products per ton of clinker. The relation between clinker and Al_2O_3 is approximately 1:1; whereas the amount of refractory products required for a ton of alumina is about 2.0 - 2.6 kg per ton.

4. In Table 5 will be found the needs in refractory products where alumina is concerned:

TABLE 5

Alumina production and the amount of refractory products required

	Production of Al_2O_3		Amount of refractory products	
	in 1000 tons		in tons	
	1964	1980	1964	1980
Ghana	-	375	-	900
Guinea	65	1,125	156	2,700
<u>Total</u>	<u>65</u>	<u>1,500</u>	<u>156</u>	<u>3,600</u>

The total requirements in refractory products as far as alumina is concerned can be reckoned in fire clay.

5. Metallurgy: The refractory products required by the metallurgical industry are as follows:

Refractory products:	Requirements in 1000 tons per year in 1975			
	Liberia	Mali	Nigeria	Total
In dolomite	26.6	3.8	7.6	38.0
In magnesite	5.6	0.8	1.6	8.0
Dolomite Bricks	2.8	0.4	0.8	4.0
Chromium Magnesite Bricks	0.7	0.1	0.2	1.0
Total:	35.7	5.1	10.2	51.0

6. The refractory products required in West Africa so far as energy is concerned, in other words, for steam power stations, are not considerable. Existing steam power stations and their development:

Power Stations in MW			
	<u>Existing</u>	<u>Projected</u>	
Senegal Dakar - Bel Air	63.3		
- Cap de Biches	-	100	in 1966
Guinea Fria	34.6		
Nigeria Ibadan A+B	2.4		
Kano A+B	9.0		
Oji River	30.5		
Port-Harcourt	2.3		
Lagos Ijora A+B	107.0		
Liberia Bong County	34.0		

7. All the steam power stations have already been built or will be completed, before the erection of a factory for the production of refractory products. However, account must be taken of the maintenance of boilers. The average size of a boiler is approximately 43 MW, and its annual maintenance presupposes refractory products equivalent to what is required for an area of 3 x 4 sq. metres, 22 cm. thick, roughly 2.6 cu.m. per boiler and 23.4 cu.m. for the sub-region.

8. The total requirements for consumers of refractory products (fire clay):

<u>Fire Clay</u>	<u>1970</u>	<u>1975</u>	<u>1980</u>
Ghana	-	375	1,800
Dahomey	150	300	450
Guinea	5	305	3,155
Mali	90	150	240
Niger	70	70	135
Senegal	652	1,550	3,052
Upper Volta			300
Liberia	5	5	305
Nigeria	<u>1,896</u>	<u>2,546</u>	<u>7,776</u>
Total :	2,868	5,301	17,183

9. If we reckon these consumers as representing practically 70 per cent of all consumers, the total consumption in the sub-region should be: (in 1,000 tons)

	<u>1970</u>	<u>1975</u>	<u>1980</u>
Requirements in fire clay	4.1	7.6	24.5

The consumption of fire clay throughout the world is about 60 per cent of all refractory products. The other refractory products are: dinas, magnesite, chromium-magnesite, and dolomite. In Africa, for instance in the UAR, the relation between refractory products manufactured in 1964-65 and the future position is as follows:

	<u>1964/65</u>	<u>Production 1,000 T/per year after the execution of the development plans</u>	<u>In percentage 1964/65</u>	<u>subsequent years</u>
Quartz	1.5	3.0	3.4 %	4.8 %
Chromium- magnesite	2.0	4.0	4.5 %	6.4 %
Dolomite	10.0	14.0	22.7 %	22.2 %
Aluminous- Cement	2.5	5.0	5.7 %	7.9 %
Fire clay 40/47	8.0	12.0	18.2 %	19.0 %
Fire clay 25/39	20.0	25.0	45.5 %	39.7 %
Total :	44.0	63.0	100 %	100 %
		in fire clay	63.7%	58.7%

The requirements in fire clay in 1980 were estimated in this paragraph at 24,500 tons and the needs in other refractory products at 51,000 (para. 5). This amounts to 32.5 per cent fire clay and 67.5 per cent of other refractory products, leaving out of account the requirements in dinas. This disproportion is due to the fact that fire clay is not used in metallurgy.

Metallurgy supplies its own needs in refractory products, and generally imports raw materials or semi-finished products. This is particularly so in the case of Liberia.

10. Summary of this method:

Requirements in fire clay in 1980 25,000 tons per year 33 per cent

Requirements of other refractory products for metallurgy 51,000 tons per year 67 per cent

There is obviously not enough fire clay for metallurgy, and the result produced by these two methods is as follows:

ad i)	Total requirements	57,000 tons per year
	in fire clay	34,000 - 40,000 tons per year
	in other refractory products	23,000 - 17,000 tons per year
ad ii)	Total requirements	76,000 tons per year
	in fire clay	25,000 tons per year
	in other refractory products	51,000 tons per year

At present, the result obtained by method "ad ii" is more acceptable because it is based on a direct estimate. The requirements in fire clay in 1980 may be put between 25-35 thousand tons, with the exception of the requirements for metallurgy. So far as the metallurgical industry is concerned 51,000 tons may be reckoned, while the amount of the other unenumerated refractory products for industry may be put between 4 and 6 per cent of the requirements in fire clay, which is roughly 1,000-1,400-2,100 tons per year, that is 2,000 per year. The requirements in 1890 would be:

Fire clay	25-35 thousand tons
other refractory products	53 " "

Total of the various refractory products:

Fire clay	30,000 T
Chromium-magnesite and magnesite	9,000 T
Dolomite	42,000 T
Dinas	1,000 T
Graphite	1,000 T

83,000 tons/per year

It should be pointed out that these requirements relate only to general maintenance, investments not being included.

V. RAW MATERIALS

1. It will be seen that at present in West Africa deposits of raw material are not known, since the geological explorers did not concern themselves with that line of inquiry. Because of the geological formation, only negligible quantities of dolomite and magnesite deposits are to be found. However, it may be assumed that there are deposits of refractory clay, quartz, quartzites, as well as graphite, kyanite (disthene), sillimanite and kaolin deposits.

Graphite deposits are known to exist in the Upper-Volta at Korsimoro, in Sierra Leone in the Kasila System, in Nigeria in the province of Adamawa near Obudu in the east, near Ningi in the Bauchi province and at Birnin Gwari in the province of Zaria.

Kaolin deposits are known to exist in Ghamat Saltpond, in Mali in the Yanfolilla region and on the banks of the Sankarani river, in Nigeria in a few deposits, in the Niger over a vast territory that skirts the Niger river and in the Gogare-Tilco-Youri region, in Guinea in a place called Coyal and in the Ivory Coast in a place called Gounioubé.

Refractory clays are known to exist in Nigeria at Sokoto and Enugu. Kyanite and sillimanite may be found in deposits in Nigeria in the province of Zaria and in Ghana in Ashanti near Bekwai.

Present knowledge about deposits of refractory raw materials is inadequate and requires more thorough investigation, but in any case it may be assumed that in West Africa raw materials for fire clay and refractory clays exist almost certainly in Nigeria, Ghana, the Ivory Coast, the Niger and Guinea.

2. Judging from the estimate of the demand for refractory products in 1980, proposals should be put forward for setting up a refractory products industry in West Africa. In the first place, requirements so far

as the metallurgical industry is concerned should be met by the industry itself, and should be based upon imported raw materials. Proposals for setting up this factory are an integral part of Liberia's metallurgical industry products.

3. In order to insure the needs of other industries, such as the cement, alumina, glass, and other small consumer industries, a proposal must be put forward for establishing a refractory products industries. The consumption of refractory products per country is as follows:

	<u>Consumption in 1980</u>		<u>Proposed Factories</u>	
	Fire clay	other refractory products	metallurgy Total	Fire clay and other refractory products (in tons)
Ghana	2,570	260	2,830	
Dahomey	640	60	700	
Guinea	4,510	450	4,960	
Mali	340	40	5,100	5,480 6,000 + 6,000
Niger	200	20	220	
Senegal	4,360	440	4,800	
Upper-Volta	410	40	450	
Liberia	420	40	35,700	36,160 metallurgical factory of 35,700 tons
Nigeria	11,050	1,100	10,200	22,350 18,000 + 12,000
Total:	24,500	2,450	51,000	77,950 24,000 + 54,000

4. Proposals for meeting the requirements in refractory products:

(a) Mali or Guinea: starting with geological research to discover refractory clays, a refractory products works should be set up at the site where these deposits are located, with a capacity of 6,000 tons a year in fire clay based on local deposits, and 6,000 tons a year in magnesite, dolomite, dinas, using imported raw materials.

(b) Liberia: the establishment of a refractory products works with an adequate capacity is being planned in connexion with the proposed

metallurgical industry. The production of that factory should be 36,000 tons per year.

- c) Nigeria: in order to meet the requirements in refractory materials a refractory products works should be set up with a production of 12,000 tons per year, based on imported raw materials in general. It would be an advantage also to install in this factory plant for the manufacture of fire clay, with a capacity of 18,000 tons per year. It would appear to be an advantage to tie up the establishment of this factory with the refractory clay deposits at Enugu and the natural earth gas deposits, as well as the metallurgical industry between port-Harcourt and Enugu.

5. Before making any calculations, certain prerequisites must be laid down, because the deposits of raw material are not really known. It may be assumed that it is possible to find refractory clays, but one must be prepared to visualize the import of 10 per cent refractory clay to improve the quality of the local clay. The total quantity of dolomite, magnesite or chromium-magnesite required should be imported.

6. The price of electricity is:

Mali	97.2 \$/1,000 kWh
Guinea	38.1 \$/1,000 "
Nigeria	48.6 \$/ " "

The price of fuel oil in-

cluding transport:

Mali	58.5 \$/ton
Guinea	22.0 \$/ton

The price of natural earth gas:

Nigeria	6.25 \$/1,000 cu.m.
---------	---------------------

The cost of transport from Dakar to Bamako (over a distance of 1,200 km) is:

- for raw materials :	1.80 F/T km = 2,160 F/T = 8.75 \$/tons
- for fuel oil	7.50 " = 9,000 " = 36.46 "
- for refractory bricks.	2.20 " = 2,640 " = 10.7 "

The cost of transport from Enugu to Port-Harcourt (covering a distance of 130 miles) is:

- for raw materials : 29/- per ton = 4.06 \$/ton
- for refractory bricks: " " "

(According to railway tariffs, tariff No.6 of the Nigerian Railway).

7. Prices per unit :

Chromium-magnesite bricks	170 \$/tons
Burnt dolomite	80 "
Fire clay-bricks	70 "
Dinas bricks	90 "
Labour (including social amenities)	
High-level personnel	14,000 \$/per year
Junior personnel	7,500 "
Foremèn of works/superintendents	5,000 "
Skilled personnel	2,500 "
Semi-skilled personnel	650 "
Manual labourers	350 "
Electricity	0.006 \$/kWh
limestone (for comparing prices)	2.0 \$/tons
Fuel oil	0.22 \$/litre

(According to UNECA "The development of the steel industry in East and central Africa")

276,21 refractory bricks	15.7 - 22.5 \$/tons
276,23 dolomite	9.2 - 36.5 "
276,24 magnesite	43.5 - 63.0 "
662,32 refractory bricks	80.0 - 268.0 "
662,33 refractory mortars	42.4 - 225.0 "
663,7 other refractory products	132.0 - 505.0 "

(According to the 1963 UN World Trade Annual)

refractory clays	16 \$/tons
raw dolomite	12 "
raw Magnesite	40 "

8. Table 7 (Annex I) was drawn up in accordance with these prerequisites and the results of Table 6 which follows.

TABLE 6

Breakdown of manufacturing cost of refractory products

	<u>Mali</u>	<u>Guinea</u>	<u>Nigeria</u>
Amortization	165,360		445,200
Maintenance	56,940		153,300
Interest	23,400		63,000
Insurance	12,480		33,600
Salaries	88,290		162,640
Holidays, charges	17,660		32,530
Profits	218,400		588,000
Electricity	110,810	43,430	142,884
Fuel	105,300	39,600	26,250
Dolomite	119,700	68,400	182,400
Magnesite	204,820	167,200	367,840
Imported clay	16,500	10,560	39,600
Clay	59,400	59,400	178,200
Quartz	15,750	15,750	31,500
Total (cost price)	1,214,810	986,870	2,446,944
Price of fire clay	420,000		1,260,000
Price of dolomite	240,000		480,000
Price of magnesite	340,000		680,000
Price of dinas	90,000		180,000
Selling price: Conakry	1,090,000 \$		
Port-Harcourt	2,600,000 \$		

9. There are only two refractory products works with the exception of the one in Liberia for the Metallurgical industry. Consequently, bearing in mind the previous proposals made, the factory in Nigeria will have to supply the following countries: Ghana, Dahomey, the Niger, the Upper Volta and part of the needs of Senegal. The second factory, according to the

estimates, would be more favourably situated in Guinea than Mali, and should supply Guinea, Mali and part of the needs of Senegal.

10. Of course, these estimates and proposals are based on the condition that refractory clays can be found in Guinea and Nigeria. Should such clays be found in other countries on the coast, the proposals will have to be modified.

11. The foregoing indicates that the construction of refractory products works in West Africa is an advantage, and a thing to be desired. The indices of these factories are briefly as follows :

		<u>Guinea</u>	<u>Nigeria</u>
Total production	in thousands of tons	12.0	30.0
in fire clay	"	6.0	18.0
in magnesite	"	2.0	4.0
in dolomite	"	3.0	6.0
in dinas	"	1.0	1.0
Investments	millions of \$	1.56	4.2
Equipment	"	0.858	2.31
Buildings	"	0.702	1.89
Number of persons employed		109	214
<hr/>			
A. Salaries plus holidays	1,000 \$	105.95	195.17
B. Amortization	"	165.36	445.20
C. Gross profit	"	218.40	588.00
D. Maintenance	"	56.94	153.30
E. Financial Disbursements	"	23.40	63.00
F. Insurance, Miscellaneous	"	12.48	33.60
G. Fuel	"	39.60	26.25
H. Electricity	"	43.43	142.88
I. Raw Materials	"	321.31	799.54
Gross turnover	"	986.87	2,446.94
Value added	"	489.71	1,228.33
Selling price (at present)	"	1,090.00	2,600.00

12. Recommendation for carrying out this programme for developing the refractory product industry:

- (a) Geological exploration on the sub-region, particularly in Nigeria and in the countries on the coast, must be organized to discover deposits of refractory clays.
- (b) A refractory product centre must be set up with a laboratory, to test the samples and carry out research into refractory products.
- (c) An effort must be made to substitute fire clay and dinas refractory products for dolomite and magnesite refractory products since raw materials for the materials first named can be found in West Africa.

13. This report deals only with the needs of the sub-region and does not take account of export possibilities.

14. Finally, some attention must also be paid to group 662.3 (1) - insulating material. In 1964 the import of this merchandise was 3,516 tons at a cost of US \$ 621,000. The rate of industrial growth in the sub-region for the period 1963-1980 should be 14.3 per cent. When we apply this rate also to the consumption of this commodity, the needs in 1980 work out at 29,820 tons a year.

There is a proposal to have a built-in factory in the metallurgical industry in Liberia, to produce blast furnace slag fibres, with an annual capacity of 1,500 tons. Bearing in mind the fact that products in infusional earth may be replaced by these slag or basaltic fibres up to a point, the production of slag fibres is absolutely inadequate, and this subject should consequently be treated in the report on the metallurgical industry in Liberia.

TABLE 7

Breakdown of manufacturing expenses for refractory products in various countries

The manufacturing programme		6,000 T fire clay		18,000 T fire clay	
		2,000 T magnesite		4,000 T magnesite	
		3,000 T dolomite		6,000 T dolomite	
		1,000 T dinas		2,000 T dinas	
		12,000 T refractory-products		30,000 T refractory-products	
		<u>Mali</u>	<u>Guinea</u>	<u>Nigeria</u>	
Unit of investment	\$/T	130		140	
Investment equipment	%	55		55	
Total investment	\$	1,560,000		4,200,000	
Equipment	\$	858,000		2,310,000	
Buildings	\$	702,000		1,890,000	
Amortization 16%	\$	137,280		369,600	
+ 4%	\$	28,080		75,600	
Total	\$	165,360		445,200	
Maintenance + 5%	\$	42,900		115,200	
+ 2%	\$	14,040		37,800	
Total	\$	56,940		153,300	
Interest 1.5%	\$	23,400		63,000	
Insurance & miscellaneous	\$	12,480		33,600	
0.8%	\$				
Productivity	T/employee per year	110		140	
Persons Employed		109		214	
Average wage	\$/per capita, per year	810		760	
Annual wages	\$	88,290		162,640	
Holidays, charges					
20%	\$	17,660		32,530	
Total	\$	105,950		195,170	

TABLE 7 (Cont'd)

		<u>Mali</u>	<u>Guinea</u>	<u>Nigeria</u>
Profits	14 %	\$ 218,400		588,000
Electricity (95-98 kWh/T)	kWh/per year	1,140,000		2,940,000
Electricity	\$	110,810	43,430	142,884
Fuel	per unit,	150 kg/T		140 m ³ /T
Fuel	total T/ year	1,800		4,200,000 m ³
price per unit	\$/T, /\$/1000 m ³	58.5	22	6.25
Total	\$	105,300	39,600	26,250
Raw dolomite per unit	\$/T	21	12	16
Raw magnesite per unit	\$/T	49	40	44
Raw clay per unit	\$/T	25	16	20
Total price				
dolomite		119,700	68,400	182,400
magnesite		204,820	167,200	367,840
imported clay		16,500	10,560	39,600
local clay	(10\$/T)	59,400	59,400	178,200
quartz	(15\$/T)	15,750	15,750	31,500