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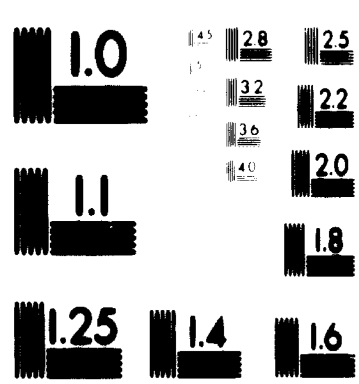

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PREFEASIBILITY STUDY OF THE IRON AND STEEL INDUSTRY IN MALI

1972

TECNIBERIA

Madrid-Spain

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TECNIBERIA

Madrid-Spain

This report has been carried out by the following Tecniberia's experts:

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Madrid, 1.972

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A. INTRODUCTION

A. INTRODUCTION

This pre-feasibility study for the future development of the Republic of Mali's iron and steel industry was performed by TECNIBERIA under the auspices of the UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION (UNIDO).

To collect the necessary information and in agreement with the contract, a team, formed by two engineers, Mr. Miguel Angel Artáacos (Team Leader) and Mr. Jerónimo Villagarcía, stayed at Mali during the month of January 1972.

The organisation placed at their disposal to collect information was a truely remarkable and it can be stated that practically all existing data in respect to Mali's iron and steel industry have been obtained.

The local organisations visited and the informations obtained are the following:

- SONAREM (National Society of Mining Research)

  Data on Mali's iron ore deposits, and on research and prospecting work already performed.

- DIRECTORATE OF ELECTRICAL ENERGY

  Data concerning present production capacities as well as the present and past production and consumption rates.

  Projects for the construction of new plants; costs and prices of the country's electrical energy.

  Data concerning the location of drinking and industrial water in the country.

- DIRECTORATE OF RAILWAYS

  Data on present railroad capacity and foreseeable plans for its expansion of service.

  Transportation prices for the zone of Mali and of Senegal.

- MINISTRY OF PLANING

  Data concerning the exact knowledge of Mali's infrastructure. Details of Mali's Three year Plan for economic development.

- DEPARTMENT OF STATISTICS

  Annual statistics concerning Mali from 1964 to 1969.

- CHAMBER OF COMMERCE

  Current legislation concerning mutual commercial exchanges with other countries.

  Current custom duties and their practical application in various - cases.

- SOMIEX (Society for importation and exportation)

  Imports of iron and steel products, during recent years according to categories.

  Tariffs and selling prices of various iron and steel products.

- MINISTRY OF INDUSTRY

  All complementary information necessary for the study.

  This Body made also available a permanent office for the team of engineers during their stay at Bamako.

At the same time several meetings were held with private enterprises for a better knowledge of the distributive channels within the country but it must be stressed that the importance of private initiative is on a small scale.

We would like to emphasize that the collaboration obtained has been very important at any time, and greatly eased the compilation of necessary informations.

Lastly, various conferences were held with the representatives of PNUD in Bamako and later on the return trip of the mission with the resident representative of UNIDO in Dakar who is also in charge of Mali.

During these meetings, ideas gathered during the stay were discussed and a positive correlation was found on general matters with the representative of PNUD at Bamako, as well as on the technical aspects with the UNIDO's representative at Dakar.

The writing of the study was done in complete agreement with all the terms of the contract.

Certain aspects of the study, however, which at the beginning were thought to be of a major importance resulted in having only a minor role due to the specific conditions of the country.

On the contrary, once having determined the plant to be presently built a detailed preliminary project has been done, including investments, production costs, and exploitation program.

To this end bid calls were made for the equipment to be installed. The necessary waiting time for the reply, have lengthneded the duration of the study, but also increased, in our opinion, its exactness.

The comparative study of the prices to be obtained with those currently practiced for imported products is very interesting and clearly shows that in addition to representing a marked industrial progress to Mali, the installation of the proposed plant can reach interesting economical results at present prices.

Finally, and at the request of the authorities in Mali, a preliminary project for the construction of a new plant with a projected production capacity of 25,000 tons of steel bars per year was added to the report. (see paragraph D. 2.).

Apparently, this type of plant and since long time ago, is contemplated by the Malian authorities and even it has been once and again stated its lack of practical and economical usefulness, we have agreed to perform an orientative study for such a plant, taking into account the insistence of the Malian authorities.

B. CONCLUSIONS AND RECOMMENDATIONS

B. CONCLUSIONS AND RECOMMENDATIONS

The conclusions drawn from the study and which should condition the future development of the iron and steel industry of Mali are the following:

a) Domestic market

The domestic market of the country at the moment does not exceed a total of 10,000 tons of steel per year, including all the categories of the products.

On the other hand, the country's infrastructure and the growing trends of the estimated demand do not indicate that at 1980 the domestic consumption will exceed a figure of 18,000 tons per year, including all types of iron and steel products.

b) Neighbouring markets

These countries located within the sphere of possible influence of Mali are generally at a higher level of development to that of Mali.

Possible exports to these countries are viewed as unlikely for the following reasons:

b. 1. Due to the impossibility of use of Mali's raw materials in the production of steel (for reasons named below), their importation is necessary and primarily by a maritime route. As a consequence, the price of transport is practically doubled contributing to the end result of a product with a price superior to that obtainable from Europe.

b. 2. These countries with the highest rate of consumption - (the Ivory Coast and Senegal) have their own steel producing plants or at least, projects in more advanced - phase of realisation than those of Mali.

c) <u>Raw materials and sources of energy</u>

c. 1. In spite of the knowledge of an iron ore deposit at Balé in Mali with good quality and sizeable reserves, the low estimates production capacity of the plant does not allow for the utilisation of iron ore as a raw material.

Even known the exploitation of this deposit has never been taken into consideration, because of the high necessary infrastructure investments and above all the exorbitant costs of developping a transportation network.

The exploitation studies of the deposit aimed to export have indicated that the price of transportation makes this ore not competitive with other near existing ores (Liberie, Mauritanie).

c. 2. The existence of coal mines is not known. This necessitates the importation of all the coke if the iron ore of Balé was to be used. This is an additional reason that hinders such use.

c. 3. The domestic production of scrap is estimated at some where around 1,000 tons per year. In addition to this figure, there is a certain quantity in reserve difficult to measure but to the order of nearly 10,000 tons. Principally a product with a rather low price, this scrap -

could be used as a raw material in the electric furnaces whose supplementary needs would be covered by importations.

c. 4. The production of electrical energy at present is so nearly in balance with its demand that it can be considered to be insufficient.

Plans for the construction of new plante have not yet - been specified, what makes difficult to foresee their realisation. Only these plans for additions to be made to the already existing power stations seem to be of a fairly inmediate state of realisation.

Because of the high cost per kwh in Mali, products of those industries with a high consumption rate cannot compete against those imported.

c. 5. The supplying of water to the zones at a distance from the Niger and Senegal rivers is practically non-existent or at a exorbitant cost. Any kind of plants must be installed near one of the rivers, and with their own systems for the pumping and drainage of the water.

d) Transportation and secondary factors

d. 1. The Dakar-Koulikoro railway is the recommended mode of transportation of the raw materials from the exterior.

To this conclusion the following factors have been taken into consideration by order of importance:

- Transportation costs
- Transportation capacity
- Regularity of shipments

d. 2. The distribution of the finished products to the interior of the country will use according to sone and season of the year the following means by order of importance.

- Rail (Bamako and Kayes are the principal consumption center)
- Road (Transportation to Segou)
- River (From Koulikoro to Mopti)

d. 3. Experience in the production of iron and steel does not exist within the country.

This suggests the necessity for the training of personnel who would work under the supervision of a team of tech nicians to reside in the country which would have to be for a rather long period of time.

Nevertheless, the possibility of using the railroad and truck repair shops for the maintenance of the equip-- ments of the steel plant has been confirmed. This fact is considered as of paramount importance for a satis- factory development of the industry.

e) Manufacturing process to be installed

e. 1. The following manufacturing processes have been disre- garded, by the reasons stated below:

- An integral plant including blast furnace for the manu- facture of steel.

The only positive point in its favor is the presence of an iron ore deposit with reserves and characteristics deemed as adequate. The negative factors are the follo wing:

- The iron ore deposit to be exploited would call forth very costly investments since it is still in a virgin state.
- Lack of communication between the deposit and the centers of consumption.
- Absence of coal within the country, which necessitates the importation of coke.
- Insufficient electrical energy for a plant of this type.
- The consumption of steel of the country, the growing of the demand, and the impossibility for exportation to neighboring countries are such that the minimal production capacities of a plant of this sort are superior to the conditions in Mali.

- A semi-integrated plant (with electric arc furnace).

The price of domestic scrap is very reasonable but its rate of production at 1,000 tons per year is too low to meet the needs of a plant of around 7,000 tons per year, estimated as convenient, 1 at shift per day.

The price of electricity is so high that it is impossible to consider this process.

e. 8. The following program to be adopted progressively has been suggested.

- Immediate installation of a bar rolling mill for products 6 to 30 mm of Ø, with a capacity of 7,000 tons per year of finished products.

The raw material would be 100 x 100 mm billets imported and taken from Dakar to Bamako by rail.

With this plant, which is to begin operations in 1976, would be satisfied the total demand of the country for the most important product and which has the biggest foreseable increment consumption rate up to 1980.

The location of the plant should be Bamako, where 80% of the country's consumption takes place.

- The same rolling mill working at 2 shifts by day, with a production capacity of 14,000 t/year.

  The initial layout will be designed to make possible such expansion with a low investment. The estimated date for this expansion is 1980.

- Installation of an electric furnace plant for scrap melting, with a production capacity of 25,000 t/year.

  The location of this plant, should be Kayes, but it is always conditioned to the installation of the Manantali power plant, which commissioning date cannot be precised for the time being.

Under the present conditions, the estimates installation time for the steel plant is about 1983.

f) Main recommendation

The first step for the development of the steel industry of Mali, should be the implementation of a detailed techno-economic survey on the feasibility of a rolling mill plant, with a capacity of 7,000 t/year at 1 working shift.

Such survey should set, at least, the following aspects:

a) **Location**: Determination of the exact locating point of the plant according with foreseable expansions.

b) **Project**: Detailed project with all elements to be included in the plant.

c) **Investments**: Exact determination of new investments, not only of the equipments, but of civil work, auxiliary services (water, electric power, etc.) which cannot be defined until the exact location is known.

d) **Billets purchasing**: Determination of purchasing price of foreign billets through possible long term contracts.

e) **Profitability**: As a consequence of all aforementioned paragraphs

C. ANALYSIS OF THE EXISTING INFORMATION

C. ANALYSIS OF THE EXISTING INFORMATION

1. RAW MATERIALS

1.1. Iron ore

1.1.1. Introduction

The existing information, concerning the deposits of iron ore in Mali, are very ancient and have a value very relative in some cases.

Among others, the following can be distinguished as the most ancient:

- M. HUBERT. Geological Map of the AOF (Year 1920)
- GUERIN DESJARDINS. Geological Reconnaissance in the West of Mali (year 1962)
- C. BENSE. Sedimentary formations in South Mauritania and the Northwest portion of Mali (year 1964).

Likewise, the existence of a series of survey works, carried out by the French society Pechiney, is known but said works were taken to Paris without a single copy of them in Mali.

In the conference of representatives of the countries of Western Africa (Mauritania, Senegal and Mali) in October 1964, it was decided to create an steel plant of 200,000 t/year in the west of Mali with the energy of the waterfall of Guinea.

In this manner the necessity was determined of carrying out a new and more ample geological and survey work at the earliest date, to detect, as soon as possible, the existence of 15-20 million tons of iron ore in the western zone of the country.

This work, the most important performed up to the present time, has been carried out by a group of soviet geologists, GLEBOV A. V. and SAFRONOV V. S., giving rise to a report entitled "Report on the Investigation and Survey Works of the Iron Mission from 1964-1967".

From the analysis of this documentation the necessary information was obtained giving knowledge of the iron ore reserves in Mali, which at the present state is considered sufficient.

1.1.2. Characteristics of the Studied Zones

The zones in which the existence of ore has been stated are the following:

a) Diamou deposit

Research and investigation works have been realised 60-100 Km. to the southwest of Kita, over a surface of 3,600 Km^2.

The deposit is sedimentary of hematite-siliceous ore with important reserves, but of a poor quality (43% of SiO_2), which makes impossible its industrial usage.

b) Djidian-Kenieba deposit

The deposit is located in the zone of the N-NE, with volcanic-sedimentary country rocks, dislocated with extrusions.

The distance from the deposit to the railroad line Bamako-Dakar (Mamaa station) is about 120 Km.

The quality of the ore is good, and reserves, with a content of 66.9% iron, are estimated at 8-10 millions tons.

The deposit presents the following problems concerning its development.

- Irregular structure
- Not important reserves
- Irregular mineralisation
- Lack of transportation

Because of this it is considered of little interest the development of this deposit.

c) The Bafing-Bakoye Basin

Large iron region with a surface of approximately 2,000 Km^2. The country rocks of the deposit are of sedimentary nature.

The reserve possibilities are great, the probable reserves being estimated at 100 million tons and the possible reserves at 500 million tons.

Of the entire region, the most investigated zone is the deposit of Balé, where the studies of the Soviet Mission were centered.

Given its importance, and although it belongs geographically to the Basin of Bafing, it will be treated as an independent deposit.

d) The Balé deposit

It is found at a distance of 100 Km. from the railroad of Bamako to Dakar, the closest point being the Kita station, but without a direct communication route between both points (railroad or road).

The deposit extends some 18 Km. in length and a width of approximately 6 Km., the elevation above sea level being about 400-440 m.

For the survey, the zone was divided into 5 sectors, which were investigated separately.

The sectors, which from the beginning were considered the most interesting, were I and III, and they were the ones where the investigation of the deposit was concentrated.

The works performed were the following:

d. 1.) Topography

A topographical plan on the scale of 1/5,000 was carried out on Sectors I and III of Balé with its corresponding altimetric and planimetric linkage.

d. 2.) Drilling

In the zone of Balé a total of 60 drillings were performed with a depth of 6 to 75.5 m. and of which 57 reached the ore layer.

14 of the drillings were carried out in Sector I at a depth of 6-40 m. and 44 in Sector III with depths of 8.4 to 57.5 m.

d. 3.) **Analysis**

The samples obtained in the drillings were analysed by chemical and spectrographic means.

As a result of these works it was found that the iron could be beneficiated from its ores or from the ferriferous laterites that are also found in the deposit.

The average chemical analysis obtained were the following:

	Laterites	Magnetic Minerals	
	Balé	Sector I	Sector III
FeO_3	45.97	80.19	81.05
SiO_2	18.84	8.01	8.26
Al_2O_3	21.04	7.09	6.15
$FeO + FeO_2$	0.31	0.39	0.46
TiO_2	0.83	0.21	0.34
MgO	0.05	0.05	0.05
CaO	0.05	0.05	0.05
MnO	0.03	0.08	0.03
P_2O_5	0.11	....	....
S	0.01	0.01	0.08
Remainder	....	0.04	....
Fire losses	12.85	3.94	3.59
Of these which, H_2O	1.80	0.37	0.41
TOTAL	100.09	100	100

The average iron content of the laterites was determined at 38.04% in Sector I and 34.79% in Sector III.

d.4.) Mineral reserves

The reserves which are estimated as existent in the Balé zone are in agreement with the minimum demands of the blast furnace, which are the following:

Fe	50-55%
S + P	0.3%
As	0.07%
Cu	0.2%
Pb + Zn	0.1%

In this way the reserves are:

In magnetic minerals of iron:

- Sector I .... 19,326,000 t.
- Sector III ...... 79,390,000 t.

In iron minerals contained in laterites:

- Sector I........ 26,000,000 t.
- Sector III ...... 50,289,000 t.

1.1.3. Total reserves and exploitation feasibility

In agreement with the preceding points, the following figures of iron ore reserves known to exist in the country, can be given.

Diamou

Reserves are not known, but given its bad quality (43% of

SiO_2) its exploitation is not feasible.

<u>Djidian-Kenieba</u>

The known reserves are of 8-10 million tons of good quality ore (66.9% of Fe) but of difficult exploitation, given the irregularity of the zone.

<u>Bafing-Bakoye</u>

Known reserves of mineral high quality: 58 million tons.- probable reserves: 100 million tons.- possible reserves: 500 million tons. Given its great splitting it would be a difficult mineral to exploit.

<u>Balé</u>

Known reserves of 97.7 million tons in magnetic mineral and 76.3 million tons in laterites. The probable reserves in magnetic mineral are estimated up to 130 million tons. Being the most studied one, it would be the deposit with the greatest possibility of exploitation.

1.2. <u>Coal</u>

Concerning this raw material, basic along with iron ore in an steel plant endowed with a blast furnace, no information was found concerning its existence in the country.

Therefore, it must be estimated that the knowledge of any coal deposit does not exist, as in the investigations for other minerals there were no traces found.

Because of this, it is necessary to foresee in case of installation of an integral steel production plant (endowed with a blast furnace) the use of totally imported coke as reducing agent.

Charcoal use must be rejected by the following reasons:

a) Mali is a country of desert and savannah, without the availability of forests which may allow a substantial - production of charcoal. In case of producing it, the - country would be condemned to deplete in a few years its not very abondant vegetation.

b) In order to start the exploitation of the Balé orebodies (those considered as exploitable) substantial investments are necessary, that will be considered later on, and such possibility cannot be considered at short term.

c) The installation of a charcoal blast furnace will need the consequent installation of an electric furnace for pig iron processing (and power is lacking) or converters, with a much higher investment as that of the proposed solution.

1.3. Market prices

At the present time, knowledge of market prices of siderurgical raw materials is not known, given the non-existence of interior commerce of these materials.

Concerning iron ore, its existence is known, and also the possibility for its development from a chemical and location point of view of the deposit, but without the idea of beginning its exploitation.

In the case of coal, the case is even more limited, because of the lack of its probable existence in the country, not existing the consumption of it as a reducing agent or in a fuel usage.

Therefore, it is practically impossible to -- speak about prices of those materials in the country. Nevertheless, some indicative figures are given below, but it should be taken into account that to determine the price of the ore worked from Balé in an accurate manner, the following studies should be previously performed:

a) Study of the exploitation plan of the orebody
b) Investment program in working equipment
c) Study of the ore concentration plant
d) Study of transportation costs from Balé to Kita

Each one of the above studies has a much wider scope than the present study.

In any case and as orientation figures, the following values could be adopted (with no compromise whatsoever) for a production of 1,000,000 t/yr.

- Exploitation costs	1.50	$/t
- Concentration costs	2.50	"
- Transport to Kita (100 Km)	1.50	"
- Transport from Kita to Dakar (1,000 Km)	16.00	"
- Machinery depreciation (5 years)	3.20	"
- Railroad depreciation (20 years)	1.10	"
- Taxes, General Expenses and Benefits	3.00	"
- Total price at Dakar	28.80	$/t

The obtained price is extraordinarily high, even considering an European transport price, and not the present one in Mali which is much higher.

2. RELIABILITY OF THE INFORMATION AND CONCLUSIONS

The works of surveyal and investigation performed, and in particular the more ample one carried out by the soviet mission, present basic information, whose reliability should be considered as acceptable.

Of course, the only zone in which a survey at an exploitation level has been realized, is that of Balé, which in principle was the one which set the more promising indications concerning reserves and quality.

The remainder of the zones have been investigated in a superficial manner, because of which, in case of attempting to study its possible exploitation, a drilling campaign would be necessary and similar to the one carried out in Sector I and III of Balé.

In agreement with the information studied the following conclusions have been made:

a) The only zone which can be considered for a coming exploitation is the one mentioned as Sectors I and III of Balé, taking as reserves figure at a level of economical calculation, that of 97.7 million tons of ore with an average grade of iron of 57% on the mine run.

b) In order to commence the exploitation of the deposit it is necessary to begin with the realisation of a total sub-structure of the zone, given that it finds itself in a zone without any communication ties.

c) The most adequate transportation method would be the setting of a road with a length of 100 Km from the deposit to the Kita station, where it would join the Bamako-Dakar railroad.

d) At the present time, there does not exist in the zone a source of energy, and so a totally new electric line and its distribution network into the exploitation are necessary.

e) Given the high content of SiO_2 and Al_2O_3 of the ore, its previous concentration at mine entrance will be necessary before proceeding to its expedition.

f) The sale of the mineral could, in principle, occur in two markets, domestic and an exterior.

The market, at the present time non-existent, would be justifying in the case of the erection of an integrated steel plant in the country, which we will see in later sections is considered as totally non advisable.

Concerning the exterior market (basically the European market) the great transportation influence, first to Kita and later by railroad to Dakar, makes competition of this ore with those of other African sources (Mauritania, Liberia) impossible.

For example, during 1971, Spain imported 250,000 t. of iron ore from Mauritania, of a grade 66% Fe at a price of 10.50 \$/t. F.O.B. Nevadhibou port, and 35,000 t. of 50% grade at a F.O.B. price of 9.60 \$/t.

On the other hand, the total imported ore by Spain in 1971 (all origins) has been 2,372,000 t. with an average grade of 63% Fe and an average price C.I.F. Spanish port of 15.46 $/t.

With the above prices at the world market, the exports possibilities of the Balé ores are practically null, even with the introduction of substantital improvements in the transportation systems of Mali.

Using as transportation media the Senegal river, should put into practice the project of making the river navigable from Kayes up to the sea, the transportation price would be (assuming that the necessary improvements in the railroad are made), as shown:

- Transport Balé-Kita (100 Km)	1.50 $/t
- Transport Kita-Kayes (400 Km)	6.40 "
- River transport Kayes-Sea (1,000 Km)	3.50 "
- Total	11.40 $/t

- Total cost of ore put on sea: 22.70 $/t

The above price would be, almost twice as the offered by Mauritania.

And so, one can sum up by saying that due to the problems of different nature that present themselves -- (high cost of exploitation investment, lack of infrastructure, transportation costs, lack of domestic market, difficulties with an exterior market, etc.) it is adviseable to abandon totally the idea of exploitation of the known deposits in the - country.

3. STUDY OF THE MARKET OF STEEL PRODUCTS

3.1. Introduction

Some forecasts concerning the evolution of steel demand in the country have been made, in agreement with the evolution of importation of products in the past years, given that in a general manner, it can be estimated that the demand adjusts itself sensibly to said imports.

The use as a rate of the demand evolution of series of macroeconomic magnitudes, as is becoming usual in the forecasts of countries with a larger degree of development, results inevitable in a country such as Mali, whose steel consumption per capital was inferior to 2 kg in the period of 1964-1969.

And so we consider as an index of the increase in demand the population rise which is possible to foresee in the country.

3.2. Population

At the end of 1969 the population of Mali reached 4,929,000 inhabitants, which equals a density of 4.1 inhabitants per km^2. Approximately 550,000 persons (11.2% of the total population) lived in sites of more than 10,000 inhabitants that can be called cities, and urban population those living in such sites.

The principal nuclei of population are the following:

Bamako	189,200	habitants
Mopti	34,000	"
Segou	31,900	"
Kayes	29,900	"
Sikasso	23,400	"

The rate of annual population growth of Mali is 2.1% while that of its cities is 4.5% and that of Bamako being 6.5% because of migratory movements.

In the displacemente carried out through the country it was proved that practically all the consumption of steel in the country occurred in the cities and specially in Bamako.

In this manner, relating the steel consumption with the population increase, it was estimated that the minimum rise was a 3% yearly cumulative (correspondig to the population rise in Mali and a maximum of 7% (corresponding to the population rise in Bamako).

But in any way, important deviations from these figures can occur, given the small importance of the consumption. The carrying out of a more important construction may raise the figures to much higher limits.

3.3. Consumption

In order to realise the future demand forecaste, besidee considering the population rise, the available statistical sources were analised, with the belief that the most beneficial data for this study would be those of exterior commerce.

The importation of products between 1964 and 1969 were the following:

1964	8,699 t
1965	10,987 t
1966	7,297 t
1967	5,810 t
1968	13,299 t
1969	5,677 t
Total	51,769 t

The lack of information concerning stocks makes compulsory to consider that the importation corresponds to the consumption, obtaining an average yearly consumption of 8,628 t, equivalent to something less than 2 kg. per capita (1).

Given the low figure of consumption, the considerations concerning the irregular behaviour of it during various years are out of picture, lacking logic the habitual and sometimes complicated economical analysis. The only valid conclusion is that the steel is a product which is not utilised in Mali except for occasional projects, small and unequal in importance, but always being these reduced. One project only, for example the construction of a bridge or a

(1) Without including the steel contained in complete goods of investment or consumption, imported by Mali, such as equipment, automobiles, etc., but including loose parts, which in many cases are gathered together in the Tariff Chapter number 73 "Fer, fonte, acier et ouvrages" (Iron, Castings, Steel and Transformed products).

large building such as the Hotel de L'Amitié in Bamako, signifies at the moment of starting off a relative increase of great magnitude in steel consumption while the termination implies a relative decline equally remarkable.

In respect to the spatial distribution of steel consumption, in almost its totality takes place in Bamako or in the region of this name, being almost nil in the remaining zones of the country.

In order to establish the structure of steel consumption, the accounting of customs fees was resorted to, since the statistic of exterior commerce were not sufficiently detailed. According to customs fees only, the consumption of bars and sections of common steel could be learned, but not of flat products or special steels. However, it is estimated that this circumstance does not constitute any inconvenience for the objet of this study, since the production of flat rolled products and special steels should be considered as unattainable to the realistic possibilities of the country at the present time and during a long period of time.

The available data of the importation of bars and sections were only the following:

1/7/64 - 30/6/65	9,100 t
1968	8,140 t
1969	2,103 t
1970	2,202 t

From the comparison between these figures and those of total importation of steel products, one arrives at the conclusion that approximately 65-70% of the imported steel is made up of bars and sections, and that, subsequently, the average consumption of these products would be between 5,600 and 6,000 tons/year.

In order to obtain the distribution according to types and dimensions of these products, the only available information has been used, being from the data of the Société Malienne d'Importation et Exportation (SOMIEX), that carries out a great part of the importacion of steel products. In expressing concretely with respect to bars and sections, it could be estimated that the importations carried out by said company were the following:

1966	1,425 t
1967	4,000 t
1968	4,101 t
1969	450 t
1970	2,412 t
1971	3,680 t

As for types and dimensions, the corresponding detail is to be found in the following Table I.

Given the relative importance of this importations, it was considered that the structure of the imported steel products by SOMIEX was a valid indication of the total consumption structure of bars and sections in Mali, establishing the following average distribution.

1.- Bars up to 16 mm	55%
2.- Angles up to 36x36x4 mm	8%
3.- Flat stock up to 60x10 mm	5%
4.- Bars, angles and flat stock of larger dimensions than those indicated	14%
5.- Other sections (T, UPN, IPN.)	18%
	100%

TABLE Nº 1

IMPORTS OF STEEL PRODUCTS FROM 1.966 TO 1.971

Type of products		1.966	1.967	1.968	1.969	1.970	1.971	Units
Concrete Bars	6 mm	250	225	250	100	625	950	Ton
	8 mm	100	100	100	100	620	250	Ton
	10 mm	200	250	250	50	499	525	Ton
	12 mm	300	350	250	50	200	900	Ton
	14 mm	150	250	150			350	Ton
	16 mm		200	150			70	Ton
	18 mm		100					Ton
	20 mm		25			50	60	Ton
	22 mm		25					Ton
Angles		200	1.400	1.283		50	350	Ton
Flat Stock	25 x 5			300	50	50	50	Ton
	30 x 5				50	25	50	Ton
	36 x 5				25	25		Ton
	40 x 5				25	25		Ton
	50 x 5					25		Ton
	50 x 10					25		Ton
	60 x 10					25		Ton
	60 x 5					25		Ton
Black plate				75		354	350	Ton
Corrugated galvanized sheets and selfsupporting structures		32.142	164 200	170.285	49.142	1.285	9.000	Piece
UPN and IPN		225	1.075	1.180		88	125	Ton
Galvanized flat stock				7.000		39.800		Meter
Squares						55		Ton
T sections 35 x 35 x 5				75				Ton
T sections 40 x 40 x 5				75				Ton
Pipe				38				Ton

Source = Semiex

As can be noted, the light sections and bars (parts 1, 2 and 3 of the preceding table) make up 68% of the total consumption of rounds and sections, which is equivalent to an average annual consumption of 3,800 to 4,100 t.

The available information permitted fathoming only a little more with respect to the steel consumption in Mali; all that is left to point out its small quantity and its total dependence on a very few number of construction projects, in general modest, being practically non-existent an industry using steel in a more or less regular manner, as would normally occur in other countries.

3.4. Other economical and commercial factors

3.4.1. Commercial Channels

SOMIEX is a state firm responsible for performing, sometimes exclusively, the exterior commerce of Mali. As for the steel products, the greatest part of the importations are performed by SOMIEX. In the case that SOMIEX has not available the needed product and that its acquisition in the exterior market would consume much time, it is possible to perform direct importations if time and prices were bettered.

3.4.2. Transportation

In the corresponding chapter, the infrastructure of communications in Mali was considered, while here it is indicated that the transportation cost make up a significant incidence on the CIF price in Dakar of the imported products in Mali. In table 2 is gathered the CIF price in Dakar and Bamako of different types of steel products, the

TABLE 2

PRICE OF STEEL PRODUCTS

DESIGNATION	Dimensions	Unit	CIF DAKAR	CIF BAMAKO	WITH TAXES	GROSS	RETAIL
Concrete bars	6 mm	kg.	89	127	160	210	225
	8 mm	kg.	88	126	159	206	221
	10 mm	kg.	86	124	157	201	216
	12 mm	kg.	84	122	153	205	210
	14 mm	kg.	82	120	150	200	205
	16 mm	kg.	81	119	149	200	205
	20 mm	kg.	80	119	149	188	200
Flat stock	20x4	kg.	93	132	166	215	220
	25x5	kg.	92	131	165	210	220
	30x5	kg.	91	129	163	200	215
	30x8	kg.	90	128	162	200	215
	30x10	kg.	90	128	162	200	215
	40x5	kg.	90	128	162	200	215
	60x5	kg.	88	124	156	190	200
	60x10	kg.	85	123	154	185	190
Galvanised corrugated sheets	5,600	Sheet	1.000	1.129	1.380	1.605	1.685
	6,400	"	1.050	1.197	1.460	1.685	1.775
	7,200	"	1.152	1.317	1.603	1.850	1.945
	8,000	"	1.380	1.564	1.921	2.215	2.330
	10	"	1.700	1.930	2.366	2.730	2.870
Black plates	0,8	"	1.250	1.744	2.200	2.910	3.060
	1,0	"	1.480	2.088	2.900	3.400	3.655

Unit: FM
Source: Somiex

difference between the two being due to the transportation charges and the port expenses.

Concerning transportation costs, it should be taken into account that the indicated tariffs in the infrastructure section are applied to the distance from the border to Mopti, theoretical center of Mali. In this way, the sale price of steels products in the country is unified although, actually, the major portion of consumption takes place in Bamako, in which one sees the steel products are heavely burdened by unreal transportation costs.

The repercussion of port and transportation costs over the CIF price in Dakar waivers between 41% and 49% for the construction bars and section, according to products. In the case of flat rolled products and special steels, its incidence is inferior because of their greater prices, waivering between 13% and 39%, according to products.

3.4.3. Tariffs and Taxes

Table 3 gathers the rights and taxes applied to the steel products imported by Mali. Said products are included in Section X, Chapter 73 of the standing tariffs. In respect to the rebates according to origin and mechanics of the working of the tariff, we refer to paragraphs 5.4 and 5.5.

For its part, the already quoted Table 2 presents the prices of steel products once the customs duties and taxes have been paid, represeenting between 30,000 and 34,000 FM/t., for the construction bars and sections, and between 40,000 and 45,000 FM/t. for the flat rolled producte.

TABLE Nº 3

ENTRY TARIFFS. COMMON METALS AND TRANSFORMED PRODUCTS

Tariff Number	Type of Products	Number of the statistical nomenclature	D.D. %	T.I. %	T.V.A.
73.02	Ferroalloys	73.02.00	5	20	T.O.
72.03	Iron casting, iron and steel scraps, as well as rejects of the same materials	73.03.00	5	20	T.O.
73.06	Iron and steel ingots, masses and conglomerates	73.06.00	5	15	T.R.
73.07	Iron and steel bloms, billets, slabs and flat stock; iron and steel forging or hammering blanks.	73.07.00	5	10	T.R.
73.10	Iron and steel bars, hot rolled or drawn or forged (including wire rod), iron or steel bars, cold rolled or cold finished, hollow steel bars for mine drilling				
	B-Other				
	1) Concrete reinforcing bars, including "Tor" with a weight per linear meter equal or higher than 2,460 kgs.	73.10.99	10	Ex	T.R.
	II) Other	73.10.99	10	20	T.R.
73.11	Iron or steel section, hot rolled or drawn, forged, as well as cold produced or finished, iron and steel sheetpiles, even bored or assembled.	73.11.00			
	A) Broad flange I guiders, for electric power transmission lines	73.11.00	10	Ex	T.R.
	B) Other	73.11.00	10	20	T.R.

D.D.: Customs Duties
T.I.: Import Duties

T.V.A.: Added Value Tax
T.O.; Common Rate, 25%
T.R.: Reduced Rate, 11.1%

The repercuesion concerning the CIF price in Dakar of the imported steel products for conetruction bars and sections is in the order of 36-37% and for the flat products from 25-26%.

3.4.4. Prices

Table 2, already quoted, gathers the present gross and retail prices of the different steel products, at the same time permitting the knowledge of which are the components of the final prices. Anyway, in order to explain how the prices in Mali are composed, following, is included the liquidation of a Russian shipment of construction bars.

Date of liquidation: 14 November 1970.

Weight of shipment: 1,129,715 kgs.

	Components (FM)	Accumulated Value (FM)
1. CIF Dakar Value	98,284,502	98,248,502
2. Forfaits 1%	982,845	99,267,347
3. Transport Coste to the border with Mali	10,810,682	110,078,029
4. Custom rights	Exempt	110,078,029
5. Importation Rate (20% value at border)	22,015,606	132,093,635
6. TVA (11.1% on/value after customs rights and import rate)	14,662,393	146,756,028
7. Charges for Interior Transportation (applicable route: Border-Mopti at 20,425 FM/t).	23,074,429	169,830,457
8. Wholesale margin	23,314,526	193,144,983
9. Retail margin	9,737,249	202,882,232

The indicated Table 2 permits the observation of the increases that over the CIF-Dakar price, entail the wholesale and retail prices of the different steel products in Mali.

The increases are the following:

	Wholesale	Retail
Construction bars and sections	118-136%	124-153%
Flat rolled products	61-135%	69-247%

The conclusions taken from the preceding are clear. The prices are very high and made higher because of transportation, tariffs and wholesale margins.

Nevertheless, because of the present circumstances in Mali, it is difficult to speak out concerning the effects that high prices may have on steel consumption. Given the small importance of consumption there is nothing left to conclude about the price-demand elasticity of steel in Mali. Probably other factors, industrial development, scarcity of foreign currency, etc., have more influence over steel consumption than the price of steel products.

3.4.5. Market in neighboring countries

Those countries being considered neighboring and with which the possibility of commerce of steel products exists, are those which compose the Union Douanière des Etats de l'Afrique de l'Ouest (UDEAO).

The group of countries of the UDEAO cover their needs of steel products by way of impertations. As for the flat rolled sections and special steels that will continue in its present state for a long period of time, in contrast, as for the construction bars the importers believe that 80% of these products could be produced in the area. This percentage would drop to 65-70% for the sections.

The bars and sections market was evaluated in 1.964 (1) on the following figures:

Country	Bars	Sections
Mauritania	391	321
Senegal	10.258	5.925
Mali	2.404	1.471
Subregion Total	13.053	7.717
Ivory Coast	13.108	7.195
High-Volta	1.728	1.023
Subregion Total	14.836	8.228
Niger	1.351	1.325
Dahomey	1.355	3.160
Togo	2.162	487
Subregion Total	4.868	4.972
UDEAO TOTAL	32.757	20.907

Unit: Metric tons.

The importations had increased at an annual rate of 7-8% between 1957 and 1964, a rate which has never afterwards been maintained for the joint area. In 1970 it seemed probable that the importation of bars did not surpass 40,000 t, and that of sections 25,000 t. In fact, in some countries, the steel products market has been

(1) ONUDI: "Conjectures sur l'industrialisation et l'économie industrielle du Mali, 1969-1975" BAMAKO 1969.

restricted. In Senegal, especially, the present average consumption of construction bars was estimated at 9,034 t. for the three-year period of 1967-1969, while in the three-year period of 1961-1963 it already was of 8,877 t. and in 1969 it was evaluated that the consumption of section had fallen 30% in comparison to 1964.

Within the UDEAO has been attempted an interstate plan for the steel sector and various projects have been studied, especially on the part of Senegal, without the materialization of any project up to now.

3.4.6. Demand forecasts

Formulating forecasts with the complex methods used in Western countries lacks logic in the case of Mali. Neither the complicated correlations among nations with different levels of income and consumption of steel are utilizable, nor those which exclusively center on the historical evolution of the consumption of a single country. In Mali, it waivers notably from one year to another and on the other hand, the annual consumption per capita, less than 2 kg during the period of 1964-1969, is found much below the methodological limits permitting the carrying out of correlations between the income and consumption of steel.

As was previously indicated, steel consumption figures an annual average of 8,628 t. for the period of 1964-1969, considering that it corresponds with the importation of the steel products. Making abstractions of the conjuncture annual variations, that will be very large, it is estimated that steel consumption can grow between 3 and 7% annually.

Under these hypothesis the following average annual consumption for the period 1972-1975 would be obtained.

	3% Annual growth	7% Annual growth
Bars and light sections (1)	4,900	6,400
Other bars and sections	2,200	2,900
Total bars and sections	7,100	9,300
Flat rolled products, special steels and other steel products	3,500	4,600
General Total	10,600	13,900

In the remaining countries of the UDEAO a future evolution of demand could follow similar lines. In accordance, the joint area demand, concerning construction bars and sections, would amount for the period 1972-1975 to an average annual figure of 72,000-81,000 t., of which 44,500 to 50,000 t. would correspond to construction bars and the remaining 27,500 to 31,000 to sections.

The UDEAO, overall, would constitute a market of certain importance, but it is thought very difficult to base on it at the present time, nor before 1980, the steel production of some of the member countries. On one hand, in all the countries there exists a great scarcity of one

(1) Bars up to 16 mm, angles up to 36 x 36 x 4 mm and flat stock up to 60 x 10 mm.

of the necessary inputs for steel production, that of electric energy (very expensive, furthermore) and on the other, above all, the infrastructure of communications and transportation costs hinder, within such an extensive area as that formed by the member countries of the UDEAO, that the steel products obtained in any of said countries can find themselves in advantageous economical conditions in the markets of the remaining states, in spite of the special treatment given to their products.

Particularly for Mali, its export possibilities are null because of the following reasons:

- The manufacturing of steel products with sales possibilities in external markets would make necessary the obtention of sales prices in competitive position with respect to the same products of other origins.
- The possibility of obtaining such products from local raw materials is estimated as impossible by the reasons below:
  - Lack of coal
  - Lack of electric power
  - Existence of iron ore, but in orebodies only in exploration status, but without exploitation.
- Starting from imported materials (semiproducts), the cost involving the transportation from the origin country (normally Europe) to Mali should be considered, and later the delivery of the finished product to destination point.

The competition of this product with that one coming from Europe appears to be impossible in all the coast located points, by the following reasons:

- Price Dakar of European bars: 89 FM/kg.

- Transport Dakar-Bamako (the only point with power). Point of the coast: 76 FM/kg. (See table nº 2).

As it may be appreciated, the transportation price only to and from Mali is 85% of the total price of the product coming from Europe. Such is the case that would take place with Mauritania if Mali intended to export to that country.

On the other hand, these countries whose demand is higher (Senegal and the Ivory Coast) have their own plans of commissioning small steel plants destined to cover the internal demand of those products of greatest consumption (concrete reinforcing bars).

Concretely, in the Ivory Coast, it appears to be in a commissioning stage a rolling mill, and in Senegal another one is in advanced stage of project.

Therefore, those countries would not be potential buyers, but may be competitors.

Finally, the interior countries without steel production could be possible clients. Those countries, and their bars demand, were the following in 1970

Niger	2,100 t
High-Volta	2,500 t

From Mali to these countries, the difficulties of access are substantial, but much smaller from Ivory Coast.

At the present time, the most that each country can aspire to, is to satisfy, in part, its own domestic demand of construction bars and sections, leaving for a later date the solution of the steel production problems and the planification of the sector in the interstate context of the UDEAO. All the preceding does not mean that steel production development on an interstate scale is not desirable; it simply means that it is not an attainable objective at the moment.

Certainly, conclusions from the exposed foresights are not very optimist. No doubt, an strong increase in demand may take place, the consumption of Mali growing up to approximately 10 kg/yr. per capita, a figure that, even very small, would suppose a spectacular increase for the country.

Evidently, such increase may take place at any moment, but in the opinion of the Tecniberia's experts, at the present time no signs are appreciable to allow to predict when the demand increase may start, that being before of after 1980.

The most significant reasons are the following:

a) Between 1964-1969 the steel consumption has maintained itself practically constant, the conjunctural increases being originated by some important construction works in the country, but in the ensemble the consumption is stabilised.

b) The sectors that could influence the most the demand increase are housing development, public works and new industries.

In the housing sector the Three-Years Plan 1970-1972, yet in force, foresees the construction of 400 housing units in total, a very small figure.

With respect to public works, the project of the Manantali hydropower plant is ready, but no idea is known about construction dates and financing possibilities.

Also, a railroad renewal programme exists, but in a similar status as the above one.

Finally, the new industries plan included in the Three-Year Plan is very restricted, and even so it appears as its goals might not been achieved.

In short, it may be stated that the industrial development of the country, that in the moment it will start would give place to an important increase in the steel consumption of the country, has no starting possibilities for the time being, as:

- The country has no appreciable internal source of wealth and the reserves during the last 5 years have been always null.
- Foreign aid has a very restricted character and is considered as insufficient for a true development.

Therefore, the precisions included in this report are estimated as very realistic, although they might be largely surpassed, in case that the present situation of the country changes. That is very difficult to predict at the moment.

On the other hand, the much more ambitious estimations made previously in a study by UNIDO(1) which

(1) See page 45, foot note.

was examined in Mali, have not been backed up by the reality.

Moreover, accepting that the development levels of the different countries may be stated following modern terminology, (from start to completion), as:

I. Pre-industrial

II. Underdevelopment

III. Semi-industrial

IV. Industrial

V. Post-industrial

At level III, for every 5-7$ (according to countries) of Gross National Product corresponds an steel consumption of 1 kg.

At level II, ratio may reach 10$ of produced GNP/1 kg of steel consumption.

But at level I, the ratio only by exception surpasses the level of 30$/1 kg of steel, and in many instances it falls down to 50/1.

Mali is placed in the preindustrial stage and it is possible to state that historically, taking into account the value of its Gross National Product, the steel consumption in the country is not out of proportion.

Evidently, its consumption does not correspond to its actual steel needs. Nevertheless, the point is that the filling of this need can only be considered within the global frame of the total needs of the country, which if always are alternative, in the case of a country like Mali, to emphasize one of the needs (such of steel) may unbalance for a long period the economy already bad balanced and to jeopardise its development possibilities for an even longer period.

At all events, as the shift to an autosustained development may take place in a delay of time difficult to be fixed, but which could be placed between 1980 and 1985, the Tecniberia's experts estimate that, once such change in the "statu-quo" takes place, their estimations could be greatly modified. In such moment, 1983 for instance, the demand could reach the following figures:

Bars and light sections	18,000 tons
Other bars and sections	8,000 "
Rolled sections, sheets, special steels and other steel producte	9,000 "
Total	35,000 tons

To accomplish the above figures is only a possibility, conditioned to the above consideratione, but evidently should be taken in account by all means.

4. STUDY OF OTHER NECESSARY ELEMENTS FOR THE INSTALLATION OF A STEEL PLANT

4.1. Introduction

As important as the existence of raw materials for an stesl plant, is the supplying in a regular and economic manner of a series of necssary consumptions for a normal manufacture within the same.

In the present chapter, we will analyse the existence of these elemsnts in ths country, their prices, and the possibility of adequately fseding the possibls steel plant whose installation we study.

4.2. Electric snergy

This point is studied from its double aspect of present production capacity and future installat ion projects, and production prices and sale of the energy (incidsnce in the operating cost of the steel plant).

The power installed in Mali in 1968 was in practics of 29, 890 KVA distributed aproximately in the following theoretical form:

Thermoslectric plants	2 groups of 1, 500 KVA sach
	2 groups of 4, 000 KVA each
	1 group of 1, 000 KVA
Hydropowsr plants	2 groups of 5, 000 KVA total

In practice, the actual production capacity is higher to that which figures in theoretical form in the groups, and it could be said that of the total installed capacity, 22, 465 KVA wers in thermoslectric plants that used fuel-oil as fuels, and the remaining 7,425 KVA in hydro-power plants.

The possibilities of the country for the installation of new power plants are null from the point of view of the availability of fuel for thermoelectric plants (the existence of oil and coal in the country is not known), and in contrast, the hydraulic reserves are very high.

However, the importance of the initial investments in the hydropower plants in relation with the termoelectric ones have made that, up to the present time, these resources have not been exploited.

The future projects of installation of new power plants are the following:

- Thermoelectric plant of 6,000 KVA with a commissioning date about 1973 (in reality, it deals with the expansion of the existing ones).
- Hydropower plant of Selingue, about 150 km from Bamako, with an installed power of 25,000 KVA. The project is in an advanced stage but its construction has not begun, nor can the date of its commissioning be known, although it is estimated that it can not be before 1.975.
- Hydropower plant of Manantali in the Kayes zone, a project over which, at the present time, there does not exist a single concrete date concerning project, power to install and commissioning date. And so we consider impossible thinking of a date before 1980, given the state in which it is found at the moment.

Approximately 80% of the consumption of electric energy occurs in Bamako whose demand in the peak hours reaches 6,000 Kwh.

The direct sale price of electric energy is the following, according to the time period in which it occurs.

Peak hours (19,30 - 22,00)	51 FM/Kwh
Flat hours (6,00-12,00; 15,00-19,30; 22,00-24,00)	38 FM/Kwh
Valley hours (0,00-6,00; 12,00-15,00)	29 FM/Kwh

In the preceding costs the taxes are not included. These burden the Kwh in approximately 2 FM. The custom rights and importation tariffs corresponding to the fuel oil used in the thermoelectric plants have not been included.

The average direct sale price is estimated at 49,33 FM/Kwh and the average total sale price, slightly higher, reaches 52,12 FM/Kwh. In Mali there doesn't exist the industrial tariff and the billing to the big consumers is done depending on the period (peak, flat, valley) in which the consumption occurs, but without the existence of reduced tariffs for industry.

The incidence of cos φ is the following: The normal is established at 0,857, and the consumer who adapts himself to it suffers no overcharge, nor discount, which are the following in other cases:

- Cos φ greater than 0.857: Up to 10% discount
- Cos φ lower than 0.857: Up to 20% overcharge

The annual per capita consumption in Mali is placed at 22 kgs of equivalent coal, and that of electric energy has grown from 4 Kwh per capita in 1961 to 8 Kwh in 1969, estimating that in 1971 it reached 9 Kwh per capita for an overall consumption in the country of 44 million Kwh.

In concluding, it can be said that the average price of electric energy is very high and that the marginal costs are increasing in a very accentuated way, as can be gathered from the differences between average costs of production depending on the hours of the day. In its case the demand grows at an annual rate of 10-11%, although there are great annual differences, taking into account that the commissioning of one or several industries strongly reflects on the demanded quantity of electric energy, the demand being in any case modest. For example, in 1972 it is to be tried that the ITEMA (a textile industry) and the Hotel de l'Amitié begin to operate. This by itself would requires the installation of an additional power of 1,000 KVA and ITEMA, on its part, 2,000 KVA.

Therefore, given the insufficiency of production on one hand, the notable increase in demand, which we estimated surpasses production, and above all, the very high cost of Kwh, the installation of an industry using electric energy as raw material results, evidently, impossible.

4.3. Water

Mali has at its disposal a great potential source of wealth: water. Two rivers, the Senegal and the Niger irrigate its plains, owing most of all to the Niger, with its interior delta, that the country is not a desert. However, its harnessing is minimum, and on the other hand, the Niger has become an important source and route of contagious diseases, bacterial and microbian.

The cities and towns of Mali lack, almost completely, systems of water supply for industrial and domestic use. Following is gathered the evolution of the water supplying in the period of 1961-1969, for the cities that have available to them supply systems.

	Bamako	Kayes	Gao	Bougouni	TOTAL
1961	2,931	568	271	54	3,824
1962	3,378	604	237	54	4,273
1963	3,921	583	179	52	4,735
1964	4,144	538	280	49	5,011
1965	3,865	554	407	52	4,878
1966	4,897	585	150	46	5,678
1967	4,500	572	166	54	5,292
1968	4,800	1,102	195	57	6,154
1969	5,170	701	187	64	6,122

Unit: Millions of m^3

Even in the most favorable case, which is that of Bamako, the consumption per inhabitant and day is 75 liters, including the water for industrial use, besides that destined for domestic use.

In short, water is a limitative factor of production, not for its scarcity, but for its lack of supplying systems, reaching a cost of 75 FM/m^3 except that destined for industrial uses, that taking advantage of fiscal tariffs reduces its prices to 55 FM/m^3, a still elevated tariff.

This limits the possibilities of a plant installation because it is unthinkable an intake of water from the general supplying system.

However, no difficulty exists in installing the plant in a zone close to the river making a private intake and outlet for the plant, totally independent of the rest of the general supply.

In summary, the supplying of water to the plant does not present any difficulty in the case of it being installed in a zone close to the river, and with an exclusive circuit of water adapted for the plant, and independent of the general one.

4.4. Transportation

The possible transportation methods for use in the country are of three types: road, railroad and waterway. In the following, each is studied in detail.

4.4.1. Road Transportation

Mali had available to it in 1/1/1970, 12,091 km of roads, of which 7,500 km were practicable at all times.

According to category, the roads are divided into 3 classes:

	Longitude (km)	Practicable at all times
National Roads	5,489	4,500
Roads of local interest	4,787	2,000
Roads of regional interest	1,815	1,000

In 1/1/1970 the paved roads had a longitude of 1,477 km and in other 173 km the corresponding work was being carried out. Between 1/1/1969 and 31/12/1969, 148 km had been paved.

Bamako is the most important communication center by road. Other important centers are: Kayes, Segou, Bougouni, Sikasso, Mopti and Gao.

The licensing of industrial vehicles has experienced the following evolution:

	Light vehicles	Heavy vehicles	TOTAL
1965	1,315	313	1,628
1966	1,303	337	1,640
1967	1,355	259	1,614
1968	1,351	208	1,559
1969	1,887	172	2,059
Annual Average	1,442	258	1,700

The pronounced decrease in the licensing of heavy vehicles is attributed to the discontinuance of shipments by China, that in 1966 reached a maximum of 176 units, and disappeared completely in 1969.

The transportation costs are high, the average tariff being 18.20 FM/ton/km.

The conditions of feasibility of the roads, like that of the important transportation cost, make it be considered as not a fundamental procedure of transportation, and only as secondary distributor of finished products.

4.4.2. Railroad Transportation

Forming part of the projected Dakar-Niger railroad, is found the only route available to Mali. The Dakar--Koulikoro segment has a length of 1,288 km of which 645 km correspond to Malian territory. From the Senegalese border, close to Kayes, the railroad is directed to Bamako passing by Kita. Between Bamako and Koulikoro, final point, measures only 30 km.

The railroad park of Mali is made up of:

- 15 Diesel locomotives of 300-1.050 CV
- 3 Automotors of 500 CV
- 7 Steam locomotives of 150-400 CV
- 54 Passenger cars
- 229 Covered cars of 18-35 t
- 46 Tip cart cars of 18-35 t
- 8 Tank cars of 25 m^3
- 1 Refrigerator car
- 24 Service cars.

In the fiscal year 1964-1965, the railroad of Mali transported 504,600 passengers, and in 1968-1969, 624,300. The respective figures of passengers/km were 51.9 and 78.7 million.

For its part, the goods traffic increased from 214,200 t. in the fiscal year 1964-1965, to 291,400 in that of 1968-1969, equivalent to 106.6 and 140 millions of tons/km, respectively.

The distribution according to type of traffic was the following:

	Fiscal year 1964-65		Fiscal year 1968-69	
	1000 t.	millions TK	1000 t.	millions TK
Importation Traffic	148,0	81,2	181,4	92,1
Exportation Traffic	39,7	19,5	55,5	30,2
Total. Exterior Traffic	187,7	100,7	236,9	122,3
Interior Traffic	26,5	5,9	54,5	17,8
General Total	214,2	106,6	291,4	140,1

As it is observable, there exists a great unbalance between importation and exportation traffic, which in many cases causes the retention in Mali of locomotives and cars of Senegal, waiting to find freight for the return, which causes tensions.

Equally important are those caused by the lack of freight payment. These reasons frecuently force Senegal to block the railroad, originating serious problems in Mali. In fact, since the first interruption was produced, in August of 1960, Mali is detouring by way of Abidjan, a growing part of its exterior traffic, a more costly alternative when part of the distance is realised by road, and which on the other hand, is transforming the traditional commercial circuits, Bamako not being in this route the obliged - center of distribution.

At present, the capacity of freight transportation on the line is 2,500 tons per week, equivalent to 7 trains weekly, an average being obtained.

At the present time, a program of betterment and modernisation is foreseen for the railroad, that could lead the transportation capacity, in a first stage, to a maximum of 4,000 tons per week, which is equal to an average of 10 trains weekly between Dakar and Bamako.

However, to be able to surpass these figures a more important inprovement program will be necessary, including:

- a public works project, reinforcing the structure of various bridges.
- a charge of track, for at present it is of 30.5 kg/m and 1 m gauge, to a track of 45 kg/m.
- acquisition of new equipment and materials as much in locomotives as in cars.

This program, which in principle is foreseen for 1975, requires an ample plan of investments; therefore, as a base datum, a transportation capacity superior to 4,000 tons per week should not be considered.

The cost of railroad transportation amounts to 12.10 FM tons/kilometer, which represents a total price of about 9,000 FM, from the frontier of Senegal to Bamako.

4.4.3. River transportation

Approximately 1,750 km of the Niger River and 100 km of the Senegal River are navigable within Mali, while the navigable length in all seasons is inferior.

The river traffic of passengers and freight has changed in the following manner:

Freight

Fiscal Year	1,000 t	Millions TK	Passengers (1,000)
1964-1965	71.48	23.82	69.34
1968-1969	56.87	25.85	70.09

The cargo port is Koulikoro, from where the river is navigable up to its mouth.

Therefore, this transportation element could be used solely as complementary for the distribution of finished products up to the eastern zone of the country.

4.4.4. Summary

Of the possible transportation means to be used in the country, the conclusion is reached that only the railroad with Dakar can be considered as a primary route of introduction.

It presents the following advantages:

a) Connects with the natural port of arrival of raw materials, which is Dakar.
b) Permits the use throughout the year.
c) Permits the transportation of large quantities of materials.
d) The cost of ton/km is the lowest.

The remainder of the existing means (truck or ship) can be used as a complement for the distribution of finished products from the plant to consumption points.

5. COMPLEMENTARY FACTORS THAT CAN INFLUENCE IN THE INSTALLATION OF THE STEEL PLANT

5.1. Introduction

In the present chapter are gathered a series of complementary aspects, that according to zones or countries may have a secondary influence, or be of a primary importance.

These factors have, on one hand, a direct influence in the manufacturing (special hand labor), in use (the transforming industries), and last in the competition with other products of the exterior (interior tariffs and taxes).

Following, we will analise these concepts.

5.2. Labor

In this section, the evolution of the overall population of the country, is studied in the first place, later being analised the teaching and the evolution of the active population that makes up the possibility of the existence of labor for the steel plant.

5.2.1. Population (1)

At the end of 1.969 the population of Mali reached 4,929,000 inhabitants/km^2, which is equivalent to a density of 4,1 inhabitants/km^2. Approximately 550,000 people (11,2%

(1) Partial transcription of chapter C.3.2.

of the total population) lived in nuclei superior to 10,000 inhabitants, that, forcing the issue, could be called cities, and urban population that living in the same.

The principal nuclei of population are the following:

Bamako	189.200	inhabitants
Mopti	34.000	"
Segou	31.900	"
Kayes	29.900	"
Sikasso	23.400	"

The annual rate of increase of the population of Mali is 2.1%, while that of its cities reaches 4.5%, and that of Bamako 6.5% because of migratory movements.

The population distribution by ages is the following:

0 - 4	years	19.5%
5 - 9	"	15.3%
10 - 14	"	14.0%
15 - 19	"	8.0%
20 - 24	"	6.5%
25 - 29	"	5.0%
30 - 34	"	6.4%
35 - 39	"	5.7%
40 - 44	"	4.9%
45 - 49	"	4.0%
50 - 54	"	2.9%
55 - 59	"	2.2%

60 - 64 years	1.5%
65 - 69 "	1.1%
70 and more years	0.6%

The age structure corresponds to that of a country with high birth and death rates.

In all, the average age in Mali does not reach 20.7 years, and almost half of the population is less than 14 years old.

5.2.2. Education

Education is one of the gravest problems that exist in Mali, firstly for its quantitive and qualitive insufficiency, and secondly, because given the low life average of the population, the investments in human capital have a too low period of profitability.

Primary education is called basic and is made up of two cycles. In a population of those people being 5 to 14 years old were 1.400.000, those found in the first cycle (the first five years) of study reached 179,000 in the beginning of the 1.969-1.970 course. Those of the second cycle were limited to 37,000.

The rate of scholarization of the first cycle only reached 24.1%. Said rate has suffered the following change.

Course	1.963/64	19.6%
"	1.964/65	21.1%
"	1.965/66	28.0%
"	1.966/67	20.3%
"	1.967/68	22.4%

Course 1.968/69	21.6%
" 1.969/70	24.1%

The demographic increase and the budget reductions produced a decline in the rate of scholarisation, that the standing Development Plan foresees reaching 29.7% in the course 1.973/1.974.

At the beginning of the school year 1.969/1.970, the number of students of secondary education rose to 2.900, the demand of student openings being superior to the offer. In that way, of 952 new petitions only 415 (43%) could be complied with, for the first part of the "baccalaureate", while in the second part, of 437 petitions, 259 were accepted (59%).

The normal schools reckoned with 1,700 students, at the beginning of the 1.969/1.970 shool year, the technical-professional centers with 3,200, and those of superior education with 500.

The ratios habitually used to characterise the education, reach the following figures in Mali at present:

	Students/ teacher	Students/ class	Teacher/ class
Basic education, first cycle	40.7	45	1.10
Basic education, second cycle	24	36	1.67
Secondary education	13.8	33	2.40
Normal education	16.4	32.8	2.15
Technical-professional education	8	30	3.50
Superior education	6.4	-	-

Lastly, it should be indicated that so much the preceding ratios, as the scholarisation figures transcribed, can not in any case be the instrument of comparison between the education situation in Mali and the Western countries, given that the educative realities concerning quality and means are very different.

5.2.3. Active population

In contrast to the developed countries where the potentially active population is understood to be that of the 14 to 65 age group, in Mali the superior limit is 45 years, the age at which, except for a few cases, the people are considered to be dependent for their subsistence.

Consequently, the potencially active population only represents 38.1% of the total population, a similar and even inferior percentage to that of the really active population in developed countries.

Practically all the population works within the traditional sector, and only a minimum within the modern sector. Within the traditional sector are included the agricultural, cattles and artisan activities, etc., and within the modern one, the few activities that operate in relatively up to date productive conditions.

It makes little sense in Mali to distinguish among the classic sectors in which the Western economies are usually divided. In fact, the majority of the population participates in everything, the division of labor still not taking place, and the economy is a barter economy, without money having become a change instrument.

The number of salaried people, as it corresponds to a pre-capitalist situation, is very small. According to the 1.966 census, the number of salaried workers was 51.254, but other estimations limit said number to 18,000-20.000 - persons. Whatever the real number, the conclusion is identical; the production relations correspond to a pre-capitalist state of the economy, that is to say, characterised by the - non-accumulation of capital

The total of the salaried workers is distributed in the following manner:

Public sector	32%
Commerce & Banking	19%
Construction Industry	15%
Agriculture	11%
Transportation	10%
Industry (Without Construction)	9%
Non-Classified	4%
Total	100%

In the 1965-1969 period, 10,800 offers of employment subject to salary were registered, which equals an annual average of 2,160 offers. For its part, the demands surpassed the figure of 25,000 for the period already mentioned. Last of all, the number of employments covered was 8,900, that is to say, 82% of the offers, and only 35% of those demanded

The paid salaries in Mali rise to the following monthly figures:

Unqualified worker	15 $
Specialized worker	30-50 $
Shop foreman	50-100 $
Native engineer	130-200 $
Foreign engineer (1)	1.600-1.800 $
Administrative official	60-100 $
Accountant	100-120 $
Personnel chief	120-160 $

In Mali, one can not speak about employment and unemployment levels according to the theoretical concepts elaborated in the West, which meaning is very different in that country. Unemployment in capitalistic countries means that there exists an ensemble of people wanting to work and looking for it, but who can not find employment within their professional category. Unemployment in Mali does not mean lack of work, because it is difficult to determine if those that find themselves carrying-out activities such as ambulatory sale of goods of small value, or services of automobile guarding, are or not occupied. On other hand, it is difficult to classify them in any professional category. In short, the only thing that can be said is that, in any case, their work is not very productive, due to climatological reasons, because of the

(1) Including travelling expenses, lodging, etc.

model culture demands it, and most of all, because of the lack of a modern work offer, and the excess of traditional labor.

5.2.4. Skilled labor in steel manufacturing

It can be said that there practically exists no experience in the steel field. In fact, up to the present time, the totality of the steel products used in the country originates from outside, and the scrap produced is stored or sold to other countries (fundamentally Ivory Coast).

However, important expertise can be found in machine reparation shops. There exists in Bamako two shops that can be used and cover a good part of the necessities of an steel plant. These shops are:

- A shop of railroad repairs, belonging to the railroad Company.
- A vehicle reparation shop, belonging to a private firm.

In both shops, considerable skill and equipment were observed, that permit to foresee a normal maintenance of the steel plant, its greatest inconvenience being the lack of the regular supplying of spare parts.

All the same, the total lack of labor with a minimum of experience within the steel production field, makes necessary the previous assistance of a team of advisers that must remain in the country for a long time.

This reason is one more which advise the installation, in a first stage, of a production plant of restricted capacity for the country's own necessities, although aimed to a greater future development.

5.3. Transforming industries

The existing industry in the country was formed at the end of 1968 by the following plants:

a) State industries

- SNEHM. S.M. of Exp. of Oil Products of Mali
- SONFA. S.N. of Exp. of Slaughter-houses and annexes.
- SOCOMA. S.N. of Exp. of Canning of Mali
- SONATAM. S.N. of Exp. of Tobacco and Matches of Mali
- COMATEX. Malian Textile Company
- A.C.M. General Shops of Mali .
- SOMACO. S.N. of Construction Materials
- SONETRA. S.N. of Construction Enterprises
- IN. National Printing Office

b) Mixed

- SOCORAM. Radioelectric Constructions Company of Mali
- E.D.M. Power of Mali.

c) Private	Company
Upholstery Shop	(UNICCOP) Bamako, 800 sq. m. of upholstery
Metal Shop	(ACM), Markale. 250 l FM.
Metal Shop	(ACM), Koulikoro, 30 l FM
Wood Shop	(ACM), Bamako. 120 l FM.
Ceramics Shop	SOMACO. Djikoroni. 410-550 T
Brick Plant	SOMACO. Moguambougou. 3.300 T hiq. 15.000 sq. m.

Marble Quarry	SONETRA. Sekinkeguy. 1200 T marble plates.
Marble and Granite Plant	SONETRA. Bamako 10.000 m^2 marble plates. 17.000 sq. m.
Radioelectric Shop	SOCORAM. Bamako. 12.000 units
Insecticides Shop	D. of Industries. Bamako. 6 millions de b. 2 millions de p.
National Printing Office	Bamako. 108_1 FM
Hydropower Plant	EDM. Sotuba. 6800 KVA

After that date the following plants have been commissioned:

- Ciment	Diamou 50.000 T of ciment
- Milk	Bamako. 5.000 l./day
- Wood	ACM. Bamako
- Tanning and shoes	Bamako. 20.000 pieces 35.000 pieces

Finally the installation projects of new plants refer to the following products:

1) Canning plant for tomato and fruit juices of Baquineda
2) Oil and soap products of Koulikoro
3) Brick plant of Magnambougou
4) Assembly shop of radioelectric material (SOCORAM)
5) Textile combine of Séjou
6) Upholstery and Craftmanship School shop of textiles
7) Formulation and conditionning plant for insecticides
8) Frigorific packing plant of Bamako (with annexed industry of tanning and shoe products).

As it can be observed from all the running installations, only the metallic shops use steel products as raw material in their production programs.

Therefore, it can be stated the inexistence in the country of an steel products transforming industry.

Starting from the this fact, if may be concluded that the erection of a steel plant in the country should be aimed to obtain the products with a most direct consumption, as construction bars and sections.

5.4. Customs Duties and Taxes

5.4.1. Entry Tariffs

General Regulations

By entry tariffs are known all indirect taxes encumbering incoming goods to the territory of Mali and declared for consumption.

Among entry taxes the following ones can be distinguished:

a) Custom Duties (D.D.)

It has an essentially protective character. It is only applicable to certain products according to their origin and provenance.

The inscrived quotas to the tariff are those of the minimum tariff.

b) Import Duties (T.I.)

It is applied to the goods of any origin and provenance. It has essentially a fiscal character.

c) Added Value Tax. (T.V.A.)

It is applied to all imported goods whatever their origin or provenance.

d) Local Tax (T.L.)

It is only applied to imports of alcoholic beverages, oil products and tobacco goods.

The general regulations for the collection of the above entry tariffs are as follows:

1. D.D.

It is liquidated on the taxable value as defined in articles 2 et 27 of the Customs Code.

2. T.I.

It is liquidated on the taxable value, augmented by the D.D. amount.

3. T.V.A.

It is liquidated on the taxable value, augmented by the D.D. and the T.I. amounts.

4. T.L.

It is liquidated on the taxable value, augmented by the D.D., T.I. and T.V.A. amounts.

The T.V.A., has a legal rate and an usage rate.

Furthermore, the T.V.A. has a common rate, an increased rate and a reduced rate.

	Legal rate	Usage rate
Common rate (T.O.)	20%	22%
Increased rate (T.M.)	40%	66,6%
Reduced rate (T.R.)	10%	11,1%

The T.V.A. is liquidated by applying the usage rate.

Table nº 3 (see C.3.4.3.) shows the entry tariffs applicables to common metals and transformed products of these metals, imported by Mali. The annexed table shows the applicable tariffs to the materials and equipment used in the presently studied plants.

5.4.2. Customs Union of West Africa States (UDEAO)

The UDEAO includes the following countries:

- Mauritania
- Senegal
- Mali
- Ivory Coast
- High-Volta
- Niger
- Dahomey
- Togo

Following the Agreement signed in Abidjan the 3rd. June 1966, the products with origin in the UDEAO, introduced in a member State are submitted to a fiscal taxation, whatever their form, and which total amount will be equal to the 50% of the most favorable global fiscal rats, applied to the similar imported product.

Act nº 1/UD/1967 sets that the most favorable global fiscal rate should be understood of the ensemble of the applicable fees to the similar products imported from

MATERIALS AND MACHINES FOR THE STUDIED PLANTS

ENTRY TARIFFS

Tariff nº	Product Type	Statistical nomenclature Nº	D.D. %	T.I. %	T.V.A.
69.02	Refractory construction bricks, slabs, tiles and other similar pieces	69.02.00-1	5	10	T.O.
84.13	Burners for liquid fuels, automatic hearths and their forehearths, mechanical grates and their mechanical equipment for ashes removal and similar equipment if forming an independent unit.				
	A. Burners				
	I) For liquid fuels	84.13.01-55	5	25	T.O.
	B. Automatic hearths, forehearths, mechanical grates for ashes removal and similar equipment, if forming an independent unit.				
	C. Other furnaces.				
	I) Industrial and carbonizing furnaces	84.13.10-57	5	25	T.O.
84.14	Industrial and laboratory furnaces excluding the electric furnaces of nº 85-10				
	C. Other furnaces				
	I) Industrial and carbonizing furnaces	84.14.12-60	5	20	T.R.
	D. Spare parts	84.14.30-62			
	Furnace duties according to their class				
84.20	Weighing instruments and equipment				
	B.I.) Weighing bridges and fixed scales	84.20.13-104	5	Ex.	T.R.
84.22	Hoisting equipment, travelling cranes				
	F. Travelling cranes	84.22.34-123	5	10	T.O.

84.44	Rolling mills, mill stands and rolls	84.44.00-209	5	10	T.O.
84.45	Machine tools for the working of metals and metallic carbides, other than those listed at n^{os} 84-49 and 84-50.				
	B. For the working of materials other than those of paragraph A:				
	I) Surfacing, turning off, turning off and filleting fathes with a weight,				
	- a) over 5.000 kg	84.45.11	5	10	T.O.
	- b) below 5.000 kg	84.45.12	5	20	T.O.
	IX Shaping machines with an unit weight:				
	- b) 3.000 kg or below	84.45.34	5	20	T.O.
	XI Milling machines:				
	- b) other with an unit weight:				
	2º. 2.000 kg or below	84.45.37	5	10	T.O.
	XII Drilling machines:				
	- other with an unit weight:				
	1º. over 500 kg	84.45.43	5	10	T.O.
	2º. 500 kg or below	84.45.44	5	20	T.O.
	XVII Shears or cutting machines:	84.45.54	5	20	T.O.
	C. Other				
	b) Cutting, punching, and chamfering machines, with a weight:				
	1º. over 2.000 kg	84.45.75	5	10	T.O.
	2º. 2.000 kg or below	84.45.76	5	20	T.O.

84.48	Accessories and spare parts for the machine tools from nº 84.45 to 84.47 included.				
	A.	84.48.08-282	5	20	T.O.
	B.	84.48.10-283	5	20	T.O.
	C.	84.48.21-284	5	20	T.O.
85.11	Electrical industrial furnaces.				
	A. Industrial furnaces including equipment for induction or electric losses heat treating.	85.11.08-34	5	10	T.O.
	B. Gauging, cutting or welding equipment:				
	I) Arc				
	- b) other (rotating or static equipment, with transformer, rectifier or other).	85.11.19-37	7	25	T.O.
85.01	A. II. Electric motors and motor reducers over 20 CV	85.01.09-3	7	25	T.O.
	B. Transformers				
	I) Measuring transformers	85.01.21-5	7	25	T.O.
	II) Other transformer with a power:				
	b) equal or over 40 KVA	85.01.21-6	7	5	T.O.
	E. Spare parts and accesories for the equipment of paragraphs C and D.	85.01.61-12	7	25	T.O.
85.24	Carbon and graphite pieces and parts, electrodes for furnaces				
	B. Electrodes for electric furnaces	85.24.10-70	5	10	T.O.
90.12	Optical microscopes	90.12.00-23	5	30	T.O.
90.13	Pyrometers	90.23.00-38	5	30	T.O.
90.25	Instruments and equipment for physical or chemical analysis (spectrometers)	90.25.00.40	5	30	T.O.

D.D.: Custom duties; T.I.; Import duties; T.V.A.: Added value tax; T.O.: Common rate, 25%.

T.R.: Reduced dat. 11,1%

the EEC, with a minimum of payment equal to the domestic taxes.

a) Applicable fiscality to origin products manufactured in a member State of UDEAO, exclusively or incorporating raw materials foreign to such State.

- Exemption of D.D.
- 50% of T.I.
- 50% of T.V.A.
- 50% of T.L.
- Minimum payment equal to the amount of domestic taxes (T.V.A. and T.L.).

b) Applicable fiscality to raw products in provenance of a member State of UDEAO and to the obtained products only from the above, as soon as their packing (whatever their origin).

- Exemption of D.D.
- Exemption of T.I.
- Payment of T.V.A.
- Payment of T.L.

5.4.3. The European Economic Community (EEC)

All goods and products coming from EEC member States, take profit of the D.D. exemption, intending to their origin and transport by the most direct road production of evidence.

5.5. Preferences granted to industrial investments

Regulation nº 29/CMLN of 23 Mai 1969 established the different clases of industrial projets having a priority, among which are the metallurgical ones.

Following such Regulation, the Republic of Mali may grant to the Companies having a priority the benefits of an special system taking the two following forms:

- The common system
- The particular system

5.5.1. Preferences granted to the common system qualification

The most important related to metallurgical Companies are the following:

1. Exoneration from payment of import duties during ten years.

   a) On materials, equipment and tools directly needed for the production and transforming of products.

   b) On raw materials and products taking part integrally or by part of their elements in the composition of the manufactured or transformed products.

   c) On raw materials and products aimed to the non reusable conditionning and packing of manufactured or transformed products.

2. Exoneration from industrial and commercial profit taxes during the first five exploitation trading years.

3. Exoneration from patent's taxation during five years.

4. Exoneration during five years of land taxes on buildings.

5. Exonaration during five yars of taxes on unalienable properties.

5.5.2. Preferences granted to the particular system qualification

In the case of metallurgical investments, the particular system will be granted to the Companies that will have a paramount importance for the econimic development of Mali and with an investment program not below 500 millions F.M.

The most important preferences for metallurgical companies are the following:

1. The preferences granted to the common system.
2. Agreement with the State including:
   a) A maximum duration period of twenty years, eventually extendable for a new five years period.
   b) Fiscal and import duties system stabilisation during the validity of the agreement. Such stabilisation includes taxes, taxations, fiscal fees and Government dues of any kind existing at the signature date of the Agrement decree, both in its position and in its percentage.
3. Guarantees on banker's credit matters.
4. Eventually, guarantees about the usage modalities of water resources and other needed in the exploitation.

D. PREFEASIBILITY STUDY

D. PREFEASIBILITY STUDY

1. GENERAL REMARKS

In the first phase of the study, they were described the conditions in which the country finds itself and which permit to recommend the most adequate solutions for the installation of an steel plant in Mali.

The difficulties found are motivated basically by the following factors:

- Distance from the sea, which represents lack of raw materials at acceptable prices.
- Small capacity of internal transportation.
- Scarcity of electrical energy.
- Small market.
- Lack of capital.
- High taxes.

In this way, the following points have been determined.

1.1. Technical solution

Among the different processes known about the production of steel, the only one which is considered feasible at some extent, at the present time, is the electric furnace for the melting of scrap.

In any case, even this process which in principle is the only one to be considered feasible, finds a grave difficulty in the scarcity of electric power in the country.

To this point must be added that the power price is so high that it makes impossible to use the electric furnace as a process of steel production.

In sections 2.5 and 2.6 the resulting cost of the steel which would be obtained in the country has been calculated, from which is concluded its lack of competition with the imported product, which would always be offered at a much lower price. However, throughout the length of the study is repeated the convenience of foreseeing the installation of an electric furnace, at the moment when the giant hydropower plant at Matali is underway.

The steel plant would be installed in the Kayes region (next to the power plant), and would consist of its own rolling mill, although it should also be anticipated the possibility of sending billets to the first rolling mill installation in Bamako which by that period will have a production capacity of 14.000 t/a year, working at two shifts.

Finally, the idea of another different method of manufacturing, starting off iron ore as raw material at the present time, and even counting with the hydropower plant at Mantali, is considered unfeasible from every possible point of view.

1.2. Relations with other countries

The steel market in countries which we could say lie in the possible zone of influence of the steel plant to be installed in Mali, is extremely reduced. Only in two countries can it be said that there is a consumption, in a certain way, important. These two countries are Senegal and Ivory Coast.

Ivory Coast, at the present time, has a bar rolling mill plant using scrap as raw material. Therefore it is not feasible to think of selling to this country.

For its part, Senegal has no steel plant, but it is trying to carry through a 20.000 t/yr one, and its proyect is in a advanced stage. Because of this, we estimate that this country can not be considered as an importer, but shortly as an exporting country.

The other countries of the zone, of which no plant project is known, have a very low consumption, although they can be considered as potential markets of the producing countries of the zone. However, given the great influence of transportation and the necessity of importing a great part of the raw materiale, the resulting prices would be higher than those of the products directly imported from Europe.

A common policy of trade protection could be established by these countries, to fight back against third countries, but at the present time not only do differences exist, but there seems they are becoming even more important.

Because of this, and although in some cases there might be realized some type of exportations, it must be considered realistically that they will not exist and that the study of the installation of a plant should be done on the basis of the forecast of the country's interior demand.

1.3. Present and future consumption in Mali and other countries

In Section C.3.4.6., some forecasts concerning the future demand of Mali and neighbouring countries have been done. Those forecasts are very difficult to precise, given that in countries with so low consumptione, the realisation of an important work conduces to duplicate the steel consumption.

On the other hand, a program of exterior help may give rise to a strong increase of the country's industrialisation with a corresponding rise in the demand of steel products. However, because there exists no indication of this type actions, it has been realistically (1) estimated that the consumption figures will be of the following order.

	Mali		UDEAO countries	
	1.975	1.980	1.975	1.980
Bars and light sections.............	6.400	9.000	32.500	43.070
Other bars and sections	2.900	4.000	14.750	23.200
Total bars and sections	9.300	13.000	47.250	66.270
Rolled products, plats, special steels and other steel products	4.600	6.500	29.250	41.030
TOTAL	13.900	19.500	76.500	107.300

The demand has been separated in these three sections for the following reasons:

a) Bars and light sections are the simplest products to ma-

(1) However, it must be taken into account what is indicated in paragraph C.3.4.6., final lines.

nufacture, and from which starts the steel production of a country. On the other hand, this type of product permits to obtain profitability from plants of a very reduced production capacity.

At the present time, there exist a plant of this type on Ivory Coast and a project which seems to be in an advanced stage in Senegal. In the present study, a plant of this same type is also proposed for Mali. In the rest of the countries the existence of any installation projects are not known.

b) The medium and heavy bars and sections make necessary a much higher investment and make obligatory a far higher production in order to obtain profitability from the plant. With the considered consumption figures, the installation of a plant of this type does not seem profitable in any of the countries for their own use, and only the installation of a plant for collective consumption seems feasible but at a date after 1.980.

c) For the special steels and plates, the necessary capacities are even superior, for which any prevision in that respect is impossible.

1.4. Use of Natural Resources

From a steel production point view, the known resources of the country do not carry a great importance concerning the installations which are foreseen, i.e.:

- Iron Ore

All the steel production systems, that could be installed beginning with iron ore, have been rejected for various reasons, therefore that raw material could not be used in the country.

- **Scrap**

The domestic scrap production, although being small, could be used altogether with that of importing for the electric furnace charge. However, and as it is economically justified at the end of the study, the installation of an electric furnace is not considered advisable at the present time.

- **Electric Energy**

The present needs of electric energy in the country are equivalent to the present production. On the other hand, the increase arising in the consumption surpass the installation schedule of new power plants, which makes unfeasible the installations of new plants of great energy consumption.

This, plus the enormous prices of Kwh, makes impossible the installation of an electric furnace to melt scrap, even for small production capacity.

- **Water**

The quantity of water in the country is extensive, but practically it is only available from two great rivers, the Niger and the Senegal. Outside of these river beds the distribution is practically nil, and the m^3 price is very high.

Being so, any type of industry with an important consumption of water (such is the case for an steel plant) must be located on the river banks.

In this way, it has been determined as the most convenient installations sites of the later presented plants, that of Bamako (environs) for the rolling plant, and Kayes for the electric steel plant, although this at a much later date.

In summing up, it should be stated that the country's own resources do not permit, in any way, to affirm the convenience of erecting an steel plant, which is conditioned, from technical as well as from economical points of view, by the development of the demand of steel products.

1.5. Capacity of the installation

Taking into account all aforementioned considerations and the contents of the preceding points of the study, the following installations are considered as most convenient for the steel production development of Mali, in agreement with the time program which is indicated below.

a) Installation of a rolling mill for bars 6 to 20 mm of ∅ and sections up to 50 mm, with a production capacity of 7.000 t/yr. working at an 8 hours shift a day.

   The mill will be fed with billets imported from Europe, being convenient to obtain a long range contract with some steel industry in order to procure a price as good as possible.

The installation will be located in the Bamako environs, having to begin inmediately the project studies, so that the plant will operate by 1.976.

During a first phase, said plant will be operated at one shift, being estimated that by 1.980, and perhaps even before this date, it will be operated at two shifts. That is to say, the plant would have a total production capacity of 14.000 t/yr.

This plant will be endowed with a low degree of mechanisation, which results convenient at the present time, due to:

- Low cost of labor
- Creation of a larger number of work positions since the present labor supply is great.
- A smaller initial investment in the plant
- Lower risks and importance of break-downs
- Lower need of labor specialisation
- Lower term in the providing of equipment, installation, and commissioning.

b) Installation of an electrical steel plant for the production of billets. The production capacity of said plant will be 25.000 tons/yr., and will be located at Kayes, that is to say, next to the only great power plant planned for the country, that of Manantali.

In principle, it is not only foreseen the installation of the steel mill, but also the corresponding rolling plant, although eventually work would be started exclusively with the steel mill. Rolling operations would be performed in the plant of point a), which, as was previously stated would have a capacity of 14.000 t/yr. working at 2 shifts (with mechanisation, this rolling mill can get a capacity similar to that of the steel mill).

The raw material will naturally be scrap, which in part will originate from the country, and the rest to be imported.

Concerning the date of the commissioning of this plant, it is impossible to fix it, since as has been repeatedly stated, it depends on the Manantali power plant which finds itself in a very preliminary stage.

In the present chapter and in point 2 the following projects are studied in a detailed manner.

1) A rolling plant of 4.000 t/yr. of bars and light sections at one shift, processing imported billets.

2) A rolling plant, which is the recommended one, for 7.000 t/yr. at one shift.

   The same plant at two shifts for 14.000 t/yr

3) A steel mill and rolling plant for 7.000 t/yr.

4) A steel mill and rolling plant for 25.000 t/yr.

5) A steel mill, continuous casting and rolling mill for 25.000 t/yr.

All these projects are studied both from a technical and an economical point of view.

1.6. **Recommendations**

Concerning the plan of action to be realised for the proper development of the steel industry of the country, these set forth are the main recommendations:

1) The installation of a great capacity plant should be posterior to the installation of Manantali power plant, which is a project of great importance for the country.

2) At the present time, and in agreement with the existing and foreseen demand, an installation for great capacity would result unprofitable.

3) However, the installation of a small rolling plant (7.000 t/yr.) is justified and would produce the following advantages for the country:

   a) Elimination of the foreign currency expenses to purchase the steel products manufactured in that plant, being the cost of the billets inferior to that of the finished product.

   b) To obtain a larger profit for the exploiting firm or to lower the sale prices.

   c) Creation of jobs positions, which are urgently needed by the country.

   d) Training of labor with steel production experience, which at the present time is non-existent and will be very necessary in case of future installation of a greater capacity plant.

In this way, it is recommended to the country's authorities, the following plan of action at short term, from the steel production point of view.

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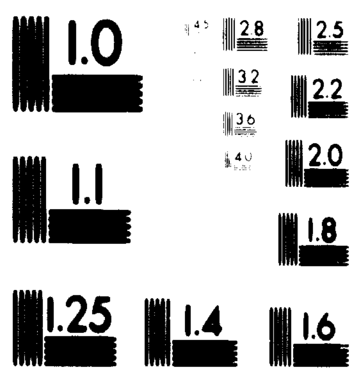
2 OF 2



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

24x
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- Immediate commencement of the realisation of the project to erect a 7.000 t/yr. plant in Bamako, the production starting date being set for 1.976.
- Simultaneous search for equipment suppliers and their financing within the country or outside.
- To determine the most adequate location for the plant with a study of the civil and necessary foundation works.

2. STUDY OF THE PROPOSED SOLUTIONS

2.1. Rolling mill plant starting from billets, for 4.000 t/yr.

This rolling mill is capable of rolling 4.000 t per shift, working 8 hours per day.

The number of working days will be 280 per year, equivalent to 2.240 hours/year. Therefore, the average production unts to 1.785 Kg./hour.

The working program, adapted to the present needs, includes the rolling of 6 to 20 mm concrete reinforcing bars.

Also, angle bars up to 50 mm flange can be rolled.

The installation includes a main building, 16 m wide and 64 m long, provided with a 5 ton travelling crane, to discharge the billets from the trucks coming from the Bamako railroad station, on the Dakar-Bamako line.

The installation foresees the minimum possible investment, in order to offer the highest possibilities of employment of local labor, as this is advisable taking into account the present circumstances at Mali.

2.1.1. Description of the installation

Operating process

The billets, purchased abroad, have a section of 100x100 mm and are cut to length by a shear, according to the necessary weight suitable to the section to be rolled.

The billets are fed to a pushing reheating furnace with side discharge of the hot billets.

The installation includes:

- 1 rolling mill, 350 mm, with 3 three-high stands, 1,000 mm barrel, and a finishing two-high stand, 600 mm barrel.

- 1 500 CV motor, flywheel, speed reducer to 120 r.p.m., and gearbox.

- The first is a roughing stand.

- When only 16, 18 and 20 mm bars are rolled, only the 4 stands of this mill are used.

- The fourth is a finishing stand, two-high.

The rolled bars are cut to 12 m lengths, and therefore the charge will be calculated in a suitable multiple amount to avoid losses.

In any case, we estimate that no problems will arise at Mali for the selling of not standard lengths, as the product has a much higher price than the usual one at the world market, as it will be shown in the cost analysis. Therefore, it is advisable to avoid losses originated by cutting to standard lengths.

- 1 mill, 300 mm, with 4 three-high stands, 800 mm barrel, and with a two-high finishing stand, 500 mms barrel.

- 1 [illegible] CV motor, fhywheel, speed reducer to 200 r.p.m. and gearbox.

- This mill is used for the finishing operations of the' 6, 8, 10, 12 and 14 mm bars.

In this instance, the billet is roughed at the 1st. stand of the 350 mm mill, using the 2nd. and 3rd. stands of this mill as intermediate, being finally rolled at the 300 mm mill.

The 6, 8, and 10 mm bars will be coiled.

The 12 and 14 mm bars will be cut at 12 m length, by shears placed at the exit of the finishing stand.

The end part of the bay will be used as warehouse for finished products.

For small repairs a lathe, a planer, a saw and a welding machine will be available.

The plant will be fed by a 1,200 KVA substation, capable of standing the overloads produced by load peaks at the rolling mills.

A fuel-oil tank for the reheating furnace and a water cooling plant for the rolling mill will be also included.

It is very important to provide a suitable stock of rolls in order to change those broken or worn away, taking into account the long distances from the roll suppliers.

Also, the sufficient amounts of spare parts to allow a good maintenance service should be foreseen.

To avoid difficulties, the rolling stands will be provided with ball-bearings; this will eliminate the spare parts corresponding to other bearing systems.

2.1.2. Economical study

Consumptions

To obtain 1,000 kg of rolled products the average consumptions will be:

	Units	FM/Unit	Total FM
Fuel-oil	80 Kgs	45	3.600
Electric Power	120 Kwh	38	4.560
Water	8 m^3	8	64
Rolls	1,5 Kgs	1.150	1.725
Refractories	6 Kgs	92	552
Miscellaneous			400
			10.901

Labor	FM/man-year	Total FM
1 Lathe-operator	864.000	864.000
2 Mechanics	864.000	1.728.000
2 Electricians	864.000	1.728.000
2 Furnace-men	216.000	432.000
12 Rollers	216.000	2.592.000
4 Storekeepers	216.000	864.000
1 Crane operator	216.000	216.000
6 Reserves	216.000	1.296.000
30		8.500.000

Qualified personnel		
1 Mill superintendent	7.000.000	7.000.000
1 Mill foreman	1.500.000	1.500.000
		8.500.000

Management and staff personnel

	FM/man-year	Total FM
1 Manager	10.000.000	10.000.000
1 Accountant	1.100.000	1.100.000
1 Purchasing and store clerk	1.100.000	1.100.000
1 Sales clerk	1.100.000	1.100.000
1 Cost accounting clerk	1.100.000	1.100.000
2 Administrative assistants	576.000	1.152.000
2 Storeroom assistants	432.000	864.000
3 Watchmen	120.000	360.000
12		16.776.000
Total 44 persons		34.996.000

Investments

2 Rolling mills (500 CV and 400 CV), including electrical equipment	92.000.000
1 Billets shear	10.000.000
2 Roller conveyors and shears	7.500.000
1 5 ton travelling crane, 16 m span	11.500.000
1 Roll lathe	10.000.000
1 Reheating furnace	16.000.000
Fuel-oil, water, power, scales and ancilllary installations	25.000.000
	172.000.000
Transportation	4.500.000
Erection and commissioning	50.000.000
Taxes	43.000.000
	269.500.000

Buildings	100.000.000
	369.500.000
Contingencies, 10%	36.950.000
	406.450.000
Offices and ancillary workshop	20.000.000
Total Investments	426.450.000

Consumption materials such as rolls and spare parts are not included, as these items are integrated in the product cost, and should be included in the necessary capital for the business development.

Price of imported billets

This item swings in price following the international market situation.

The billets prices, discharged on Dakar port, can be estimated between 100 and 110 $/Tm, or 51,000 and 56,100 FM respectively.

In both cases the F.O.B. plant price is calculated as follows:

Railroad charges have been calculated with the data made available by the Dakar-Bamako Railroad Co. for billets.

The import taxes are not chargeable for the first 10 years of operation.

The TVA is deductible from the IAS applied to the finished product sold in the country.

	FM	FM
Price at Dakar	51.000	56.100
Railroad to border	7.066	7.066
Price CIF border	58.066	63.166
T.I. (Exempt)		
T.V.A. (deductible)		
	58.066	63.166
Railroad border to Bamako	7.792	7.792
	65.858	70.958
Transportation to plant	1.000	1.000
Total	66.858	71.958

Cost of the finished products

a) Billets at 66.858 FM/ton, F.O.B. plant

		Cost per ton of finished product
1º) Billets: 1.080 kg x 66.858 FM/ton		72.206 FM
Recovery: 50kg x 3.000 FM/ton		-150 FM
		72.056 FM
2º) Rolling consumptions		10.901 FM
3º) Other costs		
Mill Labor	9.720.000 FM	
Qualified personnel	8.500.000 FM	
Repairs	3.000.000 FM	
Amortization	35.145.000 FM	
	56.365.000 FM	
Applied to 4.000 t/year		14.091 FM

			Cost per ton of finished product
4º) Administration, management and other costs			
	Personnel	16.776.000 FM	
	General expenses	10.000.000 FM	
	Amortisation of offices and ancillary workshop	1.000.000 FM	
		27.760.000 FM	
	Applied to 4.000 t/year		6.944 FM
	Average cost per ton of rolled product		103.992 FM

		Cost per ton of finished product
b) Billets at 71.958 FM/t, F.O.B. plant:		
1º) Billets: 1.080 kg x 71.958 FM/t		77.714 FM
	Recovery: 50 kg x 3.000 FM/t	-150 FM
		77.564 FM
2º) Rolling consumptions		10.901 FM
3º) Other costs		14.091 FM
4º) Administration, management and other		6.944 FM
	Average cost per ton of rolled product	109.500 FM

This figure does not include either the commercial costs, nor the financial expenses.

2.2. Rolling mill plant of 7.000 t/yr. per shift

2.2.1. Production of 7.000 t/yr. working at one shift

Drawing nº 1 shows the general layout of a rolling mill capable of rolling 7.000 t per shift, working 8 hours per day.

This installation can also work at two shifts, and then the production would be 14.000 t/year.

Should the needs of the country advise the increaee in production, it may possible to work partially a third shift. Nevertheless, a third ehift would not increaee much the production, as some time is necessary for roll changes, repairs and setting. Above all, and takinginto account the lack of industrial experience at Mali, the installation would not be utilised at full capacity, and therefore it is not recommended to work more than two shifts.

Therefore, if the needs of the country were higher than 14.000 t/yr., it would we advisable to mechanise the installation to get higher production, a solution always possible.

The number of working days will be 280 per year, equivalent to 2.240 hours/year. Therefore, the average production amounts to 3.125 kg/hour.

The working program, adapted to the present neede, includes the rolling of 6 to 20 mm concrete reinforcing bars.

Also, angle bars up to 50 mm flange can be rolled.

The installation includes a main building, 18 m wide and 70 m long, provided with a 5 ton travelling crane, to discharge the billets from the trucks coming from the Bamako railroad station on the Dakar-Bamako line.

As alternate solution the plant could be located on the railroad with side track, avoiding an intermediate transportation. Nevertheless, the transportation cost would not change, as it would be necessary to lay the correspondigg track, and a locomotive would be necessary.

The building is of reinforced concrete construction, with a simple asbestos roof.

Along the building, warehousee, mechanical shop and office buildings are disposed.

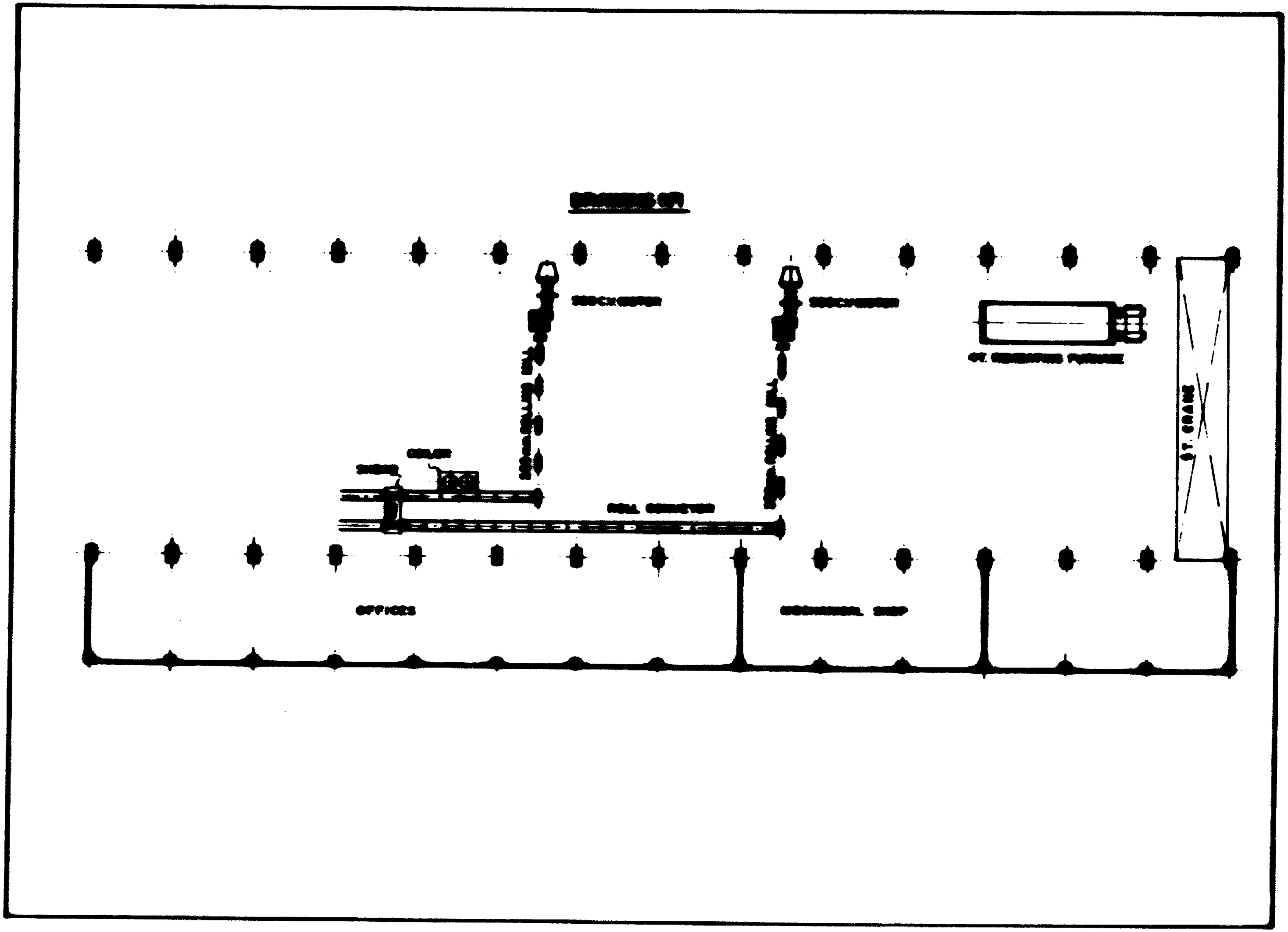
This installation foresees the minimum possible investment, in order to offer the higheet possibilities of employment of local labor, as this is advisable taking into account the present circumstances at Mali.

The planned building is reduced to a minimum and if necessary, it could be expanded at both ends, to increase the billets and finished products warehouses.

1. <u>Description of the installation</u>

<u>Operating process</u>

The billets, purchased abroad, have a section of 100 x 100 mm and are cut to length by a shear, according to the necessary weight suitable to the section to be rolled.



ROLL CONVEYOR
8T CRANE
OFFICES
MECHANICAL SHOP

The billets are fed to a pushing reheating furnace with side discharge of the hot billets.

The installation includes:

- 1 rolling mill 350 mm, with 1 three-high stand, 1.000 mm barrel, 3 three-high stand, 800 mm barrel, and a finishing two-high stand, 600 mm barrel.
- 500 CV motor, flywheel, speed reducer to 120 r.p.m. and gearbox.
- The first is a roughing stand.
- When only 16, 18 and 20 mm bars are rolled, only the 5 stands of this mill are used.
- The fifth is a two-high finishing.

The rolled bars are cut to 12 m lengths, and therefore the charge will be calculated in a suitable multiple amount to avoid losses.

In any case, we estimate that no problems will arise at Mali for the selling of not standard lengths, as the product has a much higher price tan the usual one at the world market, as it will be shown in the cost analysis. Therefore, it is advisable to avoid losses originated by cutting to standard lengths.

- 1 mill, 250 mm, with 4 three-high stands, 800 mm barrel, and with a two-high finishing stand, 500 mm barrel.
- 500 CV motor, flywheel, speed reducer to 300 r.p.m., and gearbox.
- This mill is used for the finishing operations of the

6, 8, 10, 12 and 14 mm bars.

In this instance the billet is roughed at the 1st. stand of the 350 mm mill, using the 2nd, 3rd and 4th. stands of this mill as intermediate, being finally rolled at the 250 mm mill.

The 6, 8, and 10 mm bars will be coiled.

The 12 and 14 mm bars will be cut at lengths, of 12 m by shears placed at the exit of the finishing stand.

The end part of the bay will be used as warehouse for finished products.

In a side bay, the roll grinding shop will be placed, including a special lathe.

For small repairs, a lathe, a planer, a saw and a welding machine will be available.

The plant will be fed by a 1.200 KVA substation, capable of standing the overloads produced by load peaks at the rolling mills.

A fuel-oil tank for the reheating furnace and a water cooling plant for the rolling mill will be also included.

It is very important to provide a suitable stock of rolls in order to change those broken or worn away, taking into account the long distances to the roll suppliers.

Also, the sufficient amounts of spare parts to allow a good maintenance service should be foreseen.

To avoid difficulties, the rolling stands will be provided with ball-bearings; this will eliminate the spare parts corresponding to other bearing systems.

2. Economical study

Consumptions

To obtain 1.000 kg of rolled products the average consumptions will be:

	Units	FM/Unit	Total FM
Fuel-Oil	70 kgs	45	3.150
Electric Power	120 Kwh	38	4.560
Water	8 m^3	8	64
Rolls	1,6 kgs	1.150	1.840
Refractories	5,5 kgs	92	506
Miscellaneous			350
			10.470

Labor	FM/man-year	Total FM
1 Lathe-operator	864.000	864.000
2 Mechanics	864.000	1.728.000
2 Electricians	864.000	1.728.000
3 Furnace-men	216.000	648.000
14 Rollers	216.000	3.024.000
6 Storekeepers	216.000	1.296.000
1 Crane operator	216.000	216.000
7 Reserves	216.000	1.512.000
36 (1)		11.016.000

(1) The above figure is the necessary one, but it is possible that at Mali more people will be necessary. Never theless, this fact does not alter substantially the cost, taking into account the cheap local labor.

Qualified personnel	FM/man-year	Total FM
1 Mill superintendent	7.000.000	7.000.000
1 Mill foreman	1.500.000	1.500.000
2		8.500.000

Management and staff personnel

1 Manager	10.000.000	10.000.000
1 Accountant	1.100.000	1.100.000
1 Purchasing and store clerk	1.100.000	1.100.000
1 Sales clerk	1.100.000	1.100.000
1 Cost accounting clerk	1.100.000	1.100.000
3 Administrative assistants	576.000	1.728.000
3 Storeroom assistants	432.000	1.296.000
3 Watchmen	120.000	360.000
14		17.784.000
Total 52 persons		37.300.000

Investments

2 Rolling mills, 500 CV each, including electrical equipment	140.000.000 FM
1 Billets shear	10.000.000 "
2 Roller conveyors and shears	7.500.000 "
1 5 ton travelling crane 18 m span	11.500.000 "
1 Roll lathe	10.000.000 "
1 Pushing reheating furnace, 4 t/hour	23.000.000 "
1 Coiler	10.000.000 "
1 Flying shear	20.000.000 "

Fuel-oil, water, power, scales and ancillary installations	25.000.000 FM
	257.000.000 "
Transportation	5.000.000 "
Erection and commissioning	78.000.000 "
Taxes	64.000.000 "
	404.000.000 "
Buildings	120.000.000 "
	524.000.000 "
Contingencies, 10%	52.400.000 "
	576.400.000 "
Offices and ancillary workshop	20.000.000 "
Total Investments	596.400.000 "

Consumption materials, such as rolls and spare parts, are not included in the investments, as these items are integrated in the product cost, and should be included in the necessary capital for the business development.

Price of imported billets

See point D.2.1.2.

Cost of the finished products	Cost per ton of **finished product**
a) Billets at 66.858 FM/ton, F.O.B. plant	
1º) Billets: 1.080 kg x 66.858 FM/ton	72.206 FM
Recovery: 50 kg x 3.000 FM/ton	-150 FM
	72.056 FM

		Cost per ton of finished product
2º) Rolling consumptions		10.470 FM
3º) Other costs		
Mill labor	11.016.000 FM	
Qualified personnel	8.500.000 "	
Repairs	3.500.000 "	
Amortization	51.040.000 "	
	74.056.000 "	
Applied to 7.000 t/year		10.579 FM
4º) Administration, management and other costs		
Personnel	17.784.000 FM	
General expenses	11.000.000 "	
Amortization of offices and ancillary workshop	1.000.000 "	
	29.784.000 "	
Applied to 7.000 t/year		4.254 FM
Average cost per ton of rolled product		97.359 FM

b) Billets at 71.958 FM/ton, F.O.B. plant:	Cost per ton of finished product
1º) Billets: 1.080 kg x 71.958 FM/ton	77.714 FM
Recovery: 50 kg x 3000 FM/ton	-150 FM
	77.564 FM
2º) Rolling consumptions	10.470 FM
3º) Other costs	10.579 FM
4º) Administration, management and other	4.254 FM
	102.867 FM

2.2.2. Production of 14.000 t/yr. working at two shifts

The installations are the same as in the previous case, except that the work is done in two shifts.

Economical Study

Consumptions

To obtain 1,000 kg of rolled products the average consumptions will be:

	Units	FM/Unit	Total FM
Fuel-oil	55 kgs	45	2.475
Energy	120 kwh	40	4.800
Water	8 m^3	8	64
Rolls	1,5 kgs	1.150	1.725
Refractories	4,8 kgs	92	441
Miscellaneous			300
			9.805

Labor	FM/man-year	Total FM
1 Lathe operator	864.000	864.000
4 Mechanics	864.000	3.456.000
4 Electricians	864.000	3.456.000
6 Furnace-men	216.000	1.296.000
28 Rollers	216.000	6.048.000
12 Store keepers	216.000	2.592.000
2 Crane operators	216.000	432.000
12 Reserves	216.000	2.592.000
69		20.736.000

Qualified personnel	FM/man-year	Total FM
1 Mill superitendent	7.000.000	7.000.000
2 Mill foremen	1.500.000	3.000.000
3		10.000.000

Management and staff personnel		
1 Manager	10.000.000	10.000.000
1 Accountant	1.100.000	1.100.000
1 Purchasing and store clerk	1.100.000	1.100.000
1 Sales clerk	1.100.000	1.100.000
1 Cost accounting clerk	1.100.000	1.100.000
5 Administrative assistants	576.000	2.880.000
5 Storeroom assistants	432.000	2.160.000
3 Watchmen	120.000	360.000
18		19.800.000
Total 90 persons		50.536.000

Investments

They are the same that for the production of 7.000 tons per year, that is to say 596.400.000 FM.

This figure does not include the consumption materials, nor the business development costs.

Cost of the finished products

Taking into account the two alternative values in the price of the billets, the average cost of the rolled product will be:

a)	Billets at 66.858 FM/t, F.O.B. plant		Cost per ton of finished product
	1º) Billets		72.056 FM
	2º) Rolling consumptions		9.805 FM
	3º) Mill labor	20.736.000 FM	
	Qualified personnel	10.000.000 "	
	Repairs	6.000.000 "	
	Amortisation	51.040.000 "	
		87.776.000 FM	
	Applied to 14.000 t/yr.		6.269 FM
	4º) Management, administration and other		
	Personnel	19.800.000 FM	
	General expenses	12.000.000 "	
	Amortisation (offices and ancillary workshop)	1.000.000 "	
		32.800.000 FM	
	Applied to 14.000 t/yr		2.342 FM
	Average cost per ton of rolled product:		90.472 FM

b)	Billets at 71.958 FM/t F.O.B. plant	Cost per ton of finished product
	1º) Billets	77.564 FM
	2º) Rolling consumptions	9.805 FM
	3º) Other costs	6.269 FM
	4º) Management, administration and other	2.342 FM
		95.980 FM

2.2.3. Comparison with the imported products

The table nº 2 shows the prices of the imported rolled bars from 6 to 20 mm. Those prices are the following:

Without taxes:

	FM/kg
6 mm	127
8 "	126
10 "	124
12 "	122
14 "	120
16 "	119
20 "	119

With taxes:

	FM/kg	Taxes FM
6 mm	160	33
8 "	159	33
10 "	157	33
12 "	153	31
14 "	150	30
16 "	149	30
20 "	149	30

According to the different production hypothesis and prices of the imported billets, the following production costs per metric ton will result:

Production costs of the finished product (FM/t)		
Production t/year	Billets at 66.858 FM/t	Billets at 71.958 FM/t
7.000	97.359	102.867
14.000	90.472	95.980

The billets will be derated of the import duties during 10 years, and only the TVA would be applicable, which represents 11,1% on the CIF border value.

According to the different hypothesis of costs of the billets, the TVA will amount to:

CIF border price of the billets	TVA
58.066 FM/t	6.445 FM/t
63.166 "	7.011 "

2.2.4. Profitability

Below, for a period of 11 years, it has been done a short analysis of the plant profitability, which aim is to study the distinct tax situations. In order to carry out this analysis, the following assumptions are set forth:

1. In the first year, the plant will produce 7.000 t. of rolled products.

2. The market of Mali will allow to increase production in the following years at a rate of 7%.

Production, thus, will develop in the following manner:

Year	Production (t)
1	7.000
2	7.490
3	8.014
4	8.573
5	9.176
6	9.818
7	10.505

Year	Production (t)
8	11.240
9	12.027
10	12.869
11	13.770

It has been already noted that 7.000 tons are produced at one shift and 14.000 tons at two, being possible to mechanicise the rolling mill henceforth or to work 20 hours a day.

On the other hand, it is logical that productivity will increase year after year, and therefore with the studied installation it will be possible to fulfill the former program.

The current selling prices made available by SOMIEX (1) and taken from the table nº 2 are:

- Concrete bars

	FM/Kg	
	Gross	Retail
6 mm	210	215
8 "	206	221
10 "	201	216
12 "	205	210
14 "	200	205
16 "	200	205
20 "	188	200

(1) As it can be observed, the prices present differences attributable not only to the distinct sizes of the product. SOMIEX, nevertheless, states that these prices are those in force in Mali.

Establishing an average wholesale price, without taxes of 150 FM, a final price of 180 FM is obtained after including 20% IAS.

The IAS tax is equivalent to 30 FM, which amply covers the TVA of the billets.

If this plant, being a new one, was charged with only 10% IAS and only acting on the added value, the following result will be attained:

- Sale price	150 FM/kg	150 FM/kg
- Border billets value	58 "	63 "
- Added value	92 "	87 "
- IAS	9,2 "	8,7 "
- Sale price	159,2 "	158,7 "

In both cases, the IAS covers the TVA of the imported billets. Therefore it would result an important decrease in the amount of the selling price in the country, what would repercuss advantageously in the consumption of rolled products.

<u>Cost of the rolled product</u>

According to the different production levels, different costs of the rolled product will result:

The cost has been divided into:

1º) Cost of the billets: Fixed

2º) Rolling consumption:	For 7.000 t/yr	10.470 FM/t
	" 14.000 "	9.805 "
3º) Other costs:	" 7.000 "	10.579 "
	" 14.000 "	6.269 "

4º) Administration, management and other: For 7.000 t/yr 4.254 FM/t
" 14.000 " 2.342 "

As the costs of the intermediate stages in the production, that is to say between 7.000 t and 14.000 t, are difficult to establish since this depends on how all the component parts of the cost may change and since the detailed analysis of this is not the aim of this study, it has to be assumed that a linear variation occurs, a sufficiently accurate method that in no way affects the solution of the problem.

The following cost will result:

Cost = Price of the billets + sum of the other costs.

The cost at FM/t, of the finished product is obtained in the way that the table nº 4 shows forth.

It is necessary to add the following in order to arrive at the total cost:

1º) Domestic transportation costs which entail an average of 2.500 FM/t to establish the same price for all the merchandise within the country.

2º) Wholesale costs estimated at 1.000 FM/t.

3º) The financial expenses of the immobilization of the raw materials and of the equipment normally used in the plant (rolls, spares, etc.).

It is assumed that both billets and equipment must be kept in stock to cover a six month period of production. This period can be reduced to three months if long term contracts are made, but it is absolutely necessa-

TABLE Nº 4

COST OF THE FINISHED PRODUCT (FM/T)

Year	Production t/year	Cost of the billets: 72.056 FM/t			Cost of the billets: 77.564 FM/t		
		Cost of the billets	Other costs	Total Cost	Cost of the billets	Other costs	Total Cost
1	7.000	72.056	25.303	97.359	77.564	25.303	102.867
2	7.490	72.056	24.820	96.876	77.564	24.820	102.384
3	8.014	72.056	24.305	96.361	77.564	24.305	101.869
4	8.573	72.056	23.755	95.811	77.564	23.755	101.319
5	9.176	72.056	23.162	95.218	77.564	23.162	100.726
6	9.818	72.056	22.530	94.586	77.564	22.530	100.094
7	10.505	72.056	21.854	93.910	77.564	21.854	99.418
8	11.240	72.056	21.131	93.187	77.564	21.131	98.695
9	12.027	72.056	20.356	92.412	77.564	20.356	97.920
10	12.869	72.056	19.528	91.584	77.564	19.528	97.092
11	13.770	72.056	18.641	90.697	77.564	18.641	96.205

ry to take into account transportation problems and the limited capacity of the Bamako-Dakar railway.

It has been calculated that the capital immobilised for the preceding reasons will amount to 262.500.000 FM, which would represent an annual cost, at the conditions in Mali, of 26.250.000 FM to be divided amongst 7.000 t/yr of finished products, in other words, at 3.750 FM/t.

If a greater tonnage is produced, the cost per ton of the finished product would not change, being the global cost proportional to the tonnage.

Therefore, a sum of 7.250 FM/t must be added to get the new total costs in the different production hypothesis and prices of the billets.

<u>Total cost of the finished product</u>

Production t/year	Billets at 66.858 FM/t	Billets at 71.958 FM/t
7.000	104.609 FM/t	110.117 FM/t
14.000	97.722 "	103.230 "

<u>Results of the fiscal years</u>

For the first five years the tax on industrial profit, which is 50% of the actual profit, is not paid.

Therefore, the results of the sixth year are taxable.

For the first ten years, imported raw materials are exempt from import taxes (T.I.).

The eleventh year, therefore, is the first year that this duty is applicable.

Below, the tables nº 5 and nº 6 explain the forming of the net profit, after the IAS, for the first eleven years of the plant, having being assumed that the annual increase rate of the production will be 7%, and the following hypothesis on billets cost.

1. CIF border price of the billets: 58.066 FM/t, and hereunder, 72.056 FM as billets cost per ton of finished product (without import taxes).

2. CIF border price of the billets: 63.166 FM/t, and, hereunder, 77.564 FM as billets cost per ton of finished product (without import taxes).

In both cases the same sale price (150.000 FM/ /t) of the finished product has been adopted. This price does not include the IAS, a tax that is repercussed on the consumer, not altering, therefore, the results of the tables which follow.

The calculations included in the above tables and the profits derived from them, make the implicit assumption that the plant works at full capacity in normal conditions and with a market which absorbs the total production. On the other hand, between the 1 shift operation and the 2 shifts operation, it is assumed that the labor will extend its working hours, or by slow increases will adapt itself to the requirements of the different production levels.

In the assumption that the plant has available all the necessary production media to attain 7.000 t/year, working at 1 shift, the minimum levels of production, below which the plant would work at a loss, are the follow-

TABLE Nº 5

RESULTS: CASE OF MAXIMUM PROFIT

HYPOTHESIS: -ANNUAL RATE OF INCREASE IN PRODUCTION: 7%

-CIF BORDER PRICE OF THE BILLETS: 58.066 FM/T

Year	Production (t)	Cost without import taxes (FM/t)	Import taxes (FM/ /t) (1)	Total cost (FM/t)	Sale price (FM/t)	Profit before taxes		Profit after taxes (FM)
						Average (FM/t)	Total (FM)	
1	7.000	104.609	-	104.609	150.000	45.391	317.737.000	317.737.000
2	7.490	104.126	-	104.126	150.000	45.874	343.596.260	343.596.260
3	8.014	103.611	-	103.611	150.000	46.389	371.761.446	371.761.446
4	8.573	103.061	-	103.061	150.000	46.939	402.408.047	402.408.047
5	9.176	102.468	-	102.468	150.000	47.532	436.153.632	436.153.632
6	9.818	101.836	-	101.836	150.000	48.164	472.874.152	236.437.076
7	10.505	101.160	-	101.160	150.000	48.840	513.064.200	256.532.100
8	11.240	100.437	-	100.437	150.000	49.563	557.088.120	278.544.060
9	12.027	99.662	-	99.662	150.000	50.338	605.415.126	302.707.563
10	12.869	98.834	-	98.834	150.000	51.166	658.455.254	329.227.627
11	13.770	97.947	6.271	104.218	150.000	45.782	630.418.140	315.209.070

(1) Import taxes per ton of finished product = 10% x CIF border price of the billets x 1,08

10% x 58.066 FM x 1,08 = 6.271

1,08 = Conversion coefficient of the billets into finished product

TABLE Nº 6

RESULTS: CASE OF MINIMUM PROFIT

HYPOTHESIS: -ANNUAL RATE OF INCREASE IN PRODUCTION: 7%

-CIF BORDER PRICE OF THE BILLETS: 63.166 FM/T

Year	Production (t)	Cost without import taxes (FM/t)	Import taxes (FM/t) (1)	Total cost (FM/t)	Sale price (FM/t)	Profit before taxes		Profit after taxes (FM)
						Average (FM/t)	Total FM	
1	7.000	110.117	-	110.117	150.000	39.883	279.181.000	279.181.000
2	7.490	109.634	-	109.634	150.000	40.366	302.341.340	302.341.340
3	8.014	109.119	-	109.119	150.000	40.881	327.620.334	327.620.334
4	8.573	108.569	-	108.569	150.000	41.431	355.187.963	355.187.963
5	9.176	107.976	-	107.976	150.000	42.024	385.612.224	385.612.224
6	9.818	107.344	-	107.344	150.000	42.656	418.796.608	209.398.304
7	10.505	106.668	-	106.668	150.000	43.332	455.202.660	227.601.330
8	11.240	105.945	-	105.945	150.000	44.055	495.178.200	247.589.100
9	12.027	105.170	-	105.170	150.000	44.830	539.170.410	269.585.205
10	12.869	104.342	-	104.342	150.000	45.658	587.572.802	293.786.401
11	13.770	103.455	6.821	110.276	150.000	39.724	546.999.480	273.499.740

(1) Import taxes per ton of finished product = 10% x CIF border price of the billets x 1,08

10% x 63.166 FM x 1,08 = 6.821

1,08 = Conversion coefficient of the billets into finished product ing, taking into consideration a sales price for the final product of 150.000 FM/t.

1. Billets at 58.066 FM (border), without T.I. 1.680 t/year
2. Billets at 58.066 FM (border), with T.I. 1.900 "
3. Billets at 63.166 FM (border), without T.I. 1.850 "
4. Billets at 63.166 FM (border), with T.I. 2.100 "

Such low minimum production levels are originated because in the costs estructure, the variable costs are the most important part, specially that one of the imported billets, that just alone amounts from 69% to 72% of the cost, according to the purchasing prices, and provided T.I. is applied or not.

Nevertheless, it is necessaty to take into consideration, that for a production up to 5.300 t/year, a plant of only 4.000 t at 1 shift as such one proposed in paragraph D.2.1., would be more profitable.

On the other hand, the sales price may change. For instance, for a price of 120.000 FM/t, the 7.000 t plant, here described, would need a minimum production level of 3.400 t/year in the most favorable case, and of 5.650 FM/t in the less favorable one.

All the above considerations are given from an enterprise's profitability point. From another point of view, that one of social profitability, there is no doubt that even with enterprise's losses, this plant should be erected in Mali, by the reasons stated below, among other:

- Multiplying effect on the economy of Mali.
- Building up of human capital
- Savings in foreign currency
- Creation of modern jop openings.

Incidence on the payment balance of Mali

The plant will have the following effects:

a) Lower payments in foreign currency
   - Substitution of bars and sections imports.

b) Higher payments in foreign currency
   - Equipments to be imported
   - Billets to be imported
   - 1 Manager

Under the assumption that all payments for expenses made abroad are and will be made in foreign currency, the annual savings to be obtained are as follows:

Production	Billets at 58.066 FM/t	Billets at 63.166 FM/t
7.000 t/year	192.000.000 FM	153.000.000 FM
14.000 t/year	439.000.000 FM	361.000.000 FM

2.3. **Previous reflections to the study of steel plants with steel melting shop.**

Raw materials

Scrap will be used in all cases having been estimated that Mali can supply 1,200 t/yr and obtain another - 1,500 t/yr. from adjacent countries and the remaining scrap needed from other countries.

Below, two explonatory tables are presented, concerning necessities, possible sources, and prices of the scrap in each one of the hypothesis of manufacturing of the finished products.

Electrical energy

The price applied to electrical energy differs slightly from the one utilised in section D.2.2., which precedes - this one. This is due to the differences in the rated power and in the regularity of the consumption during the 24 hours of the day.

The adjoining diagram shows in the upper part the hours considered in Mali as peak, flat and valley hours, with their corresponding tariffs.

In the lower part, the diagram shows the prices resulting from each one of the hypothesis of work shifts in the - steel plants analysed. In the economical studies which follow, the prices are slightly higher than those indicated in the diagram. The differences must be attributed to the taxes on the electrical energy consumption.

TABLE Nº 7

NEEDS AND ORIGIN OF SCRAP

Finished products (tons)	7.000	25.000	25.000 C.C.
Needs of scrap per 1000 tons	1.276,50	1.220,80	1.187,20
Total (tons)	8.936	30 520	29.600
Sources of scrap			
Mali (tons)	1.200	1.200	1.200
Plant recovery (tons)	1.174	2.840	2.060
Neighbouring countries (tons)	1.500	1.500	1.500
Other countries (tons)	5.062	24.900	24.920
Total (tons)	8.936	30.520	29.600

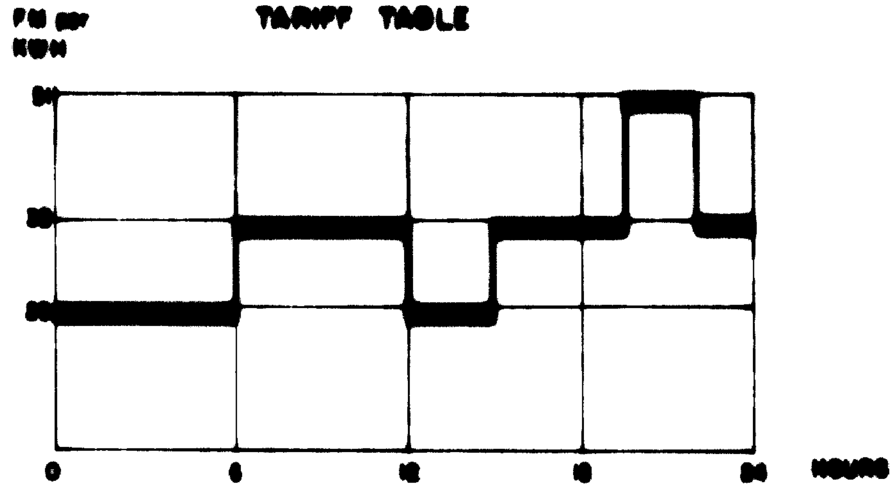
TABLE Nº 8

RESULTING PRICE OF SCRAP

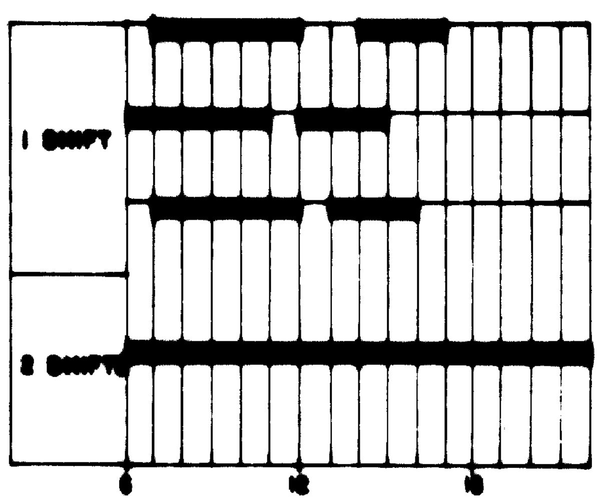
Origin	Finished products: 7.000 t.			Finished products (without continuous casting): 25.000 t.			Finished products (with continuous casting): 25.000 t.		
	Scrap t.	Price FM/t	Total FM x 10^3	Scrap t.	Price FM/t.	Total FM x 10^3	Scrap t.	Price FM/t.	Total FM x 10^3
Mali	1.200	5.100	6.120	1.200	5.100	6.120	1.200	5.100	6.120
Plant recovery	1.174	36.271	42.583	2.840	43.991	124.935	2.060	43.984	90.607
Neighbouring countries	1.500	25.000	37.500	1.500	25.000	37.500	1.500	25.000	37.500
Other countries	5.062	47.000	237.914	24.980	47.000	1.174.060	24.920	47.000	1.174.240
Total	8.936	36.271	324.117	30.520	43.991	1.324.615	29.680	43.984	1.305.467

ELECTRIC POWER

TARIFF TABLE



WORKING HOURS



AVERAGE PRICE	
SHIFTS	FM / KWH
1	[illegible],875
1	34,025
1	[illegible],750
2	[illegible],540
3	[illegible]

Water

In that which has to do with water, the price applied is the same to the one in section D.2.2., and is lower than that which prevails in Mali, on assuming that the mills could set up their own supply systems at a much less cost.

Criteria for amotisation

The two following criteria have been adopted:

1.- The buildings must be amortised in 20 years

2.- The equipment mus be amortized in 10 years

Scope of the economic studies

The economic studies arrive exclusively up to the obtaining of the production cost. Commercial and financial expenses, profitability of the firm, etc, are omitted because every plant studied (with melting shop) must be discarded, in view of the production costs which are obtained in each case.

On the other hand, in the less unfavorable cases -the manufacture of finished products (25.000 t/yr.) with or - without continuous casting- a market for the production would be lacking.

2.4. Study of a melting shop and a rolling mill plant for 7.000 t/yr. of finished products.

The rolling mill installation is the same one already studied, and a melting shop is installed to produce the necessary steel for the rolling operations. The necessary - liquid steel is 8.312,5 tons, which after the process wil give 7.000 t net of finished products.

A 6 ton electric arc furnace will be used.

The transformer's power rating will be 2.000 KVA.

This low power in relation to the furnace's capacity is chosen taking into account the power's availability in the country.

The number of heats per year will be: 8.312,5/6 = 1.385, which, divided among 250 days per year, gives an average of 5,54 heats/day.

Melting facilities

The plant has a bay of 18 m width and 6 m height up to the rail of the 12 ton travelling crane.

The columns are 5 m away, and at the start, an area of 18 x 35 = 630 sq. m. is covered.

Here, the scrap's storage will take place, with a capacity of 4.500 ton for 6 months' work of the plant.

Electric furnace

In the last span of the building the scrap basket is loaded on a scale, and the crane takes it on to the furnace for roof charging.

The liquid steel is poured into ladles, which are transported by the crane to the casting pit, pouring into - ingots of 100 ⌀ x 1.200 mm on 3 stools of 24 ingots each.

To reduce the ingot pipe, a covering of exothermic products is used.

The ingot moulds will last at least 100 heats and can be cast with the same facilities, but in a specific casting area. 4 ingots moulds per day are necessary, i.e. 1.000 per year. They can be cast in groups of 10, twice a week. This would make unnecessay its import, that is not advisable.

A team of 4 men can perform this work, including all necessay operations. Once the steel is solid, its stripping is made, and the ingots are grouped by heats and transferred to the end of the bay for the storage previous to the rolling operations.

The rolling mill facilities have already been described, ant it is necessay to point out that when the starting material are billets, endcropping is not necessary.

In the present case, a cropping of 5% for pipe cleaning is foreseen.

2.4.1. **Personnel**

Labor

Melting shop	**FM/man-year**	**Total FM**
2 Mechanics	864.000	1.728.000
2 Electricians	864.000	1.728.000
4 Molders	400.000	1.600.000

	FM/man-year	Total FM
6 Scrap bay men	216.000	1.296.000
6 Melters	216.000	1.296.000
3 Ladle operators	216.000	648.000
10 Casting pit workers	216.000	2.160.000
6 Ingot handlers	216.000	1.296.000
3 Crane operators	216.000	648.000
6 Reserves	216.000	1.296.000
40		13.696.000

Rolling mill

1 Lathe operator	864.000	864.000
2 Mechanics	864.000	1.728.000
2 Electricians	864.000	1.728.000
3 Furnace men	216.000	648.000
14 Rollers	216.000	3.024.000
6 Storekeepers	216.000	1.296.000
1 Crane operator	216.000	216.000
7 Reserves	216.000	1.512.000
36		11.016.000

The mechanics and electricians are assigned to each one of the installation from a costs' point of view, -- although they actually may attend both installations.

Qualified personnel

Melting shop	FM/man-year	Total FM
1 Superintendent	7.000.000	7.000.000
3 Furnace foremen	1.500.000	4.500.000
3 Analysts	1.000.000	3.000.000
7		14.500.000

Rolling mill	FM/man-year	Total FM
1 Superintendent	7.000.000	7.000.000
1 Foreman	1.500.000	1.500.000
2		8.500.000

General

1 Manager	10.000.000	10.000.000
1 Accountant	1.100.000	1.100.000
1 Purchasing and store clerk	1.100.000	1.100.000
1 Sales clerk	1.100.000	1.100.000
1 Personnel manager	1.100.000	1.100.000
1 Cost accounting clerk	1.100.000	1.100.000
5 Administrative assitants	576.000	2.880.000
4 Storeroom assistants	432.000	1.728.000
3 Watchmen	120.000	360.000
18		20.468.000
Total employees: 111		68.180.000

2.4.2. Investments

Melting shop

1 Electric furnace, 6 ton, 2.000 KVA and ancillary installations	85.000.000 FM
1 Travelling crane, 12 ton, 18 m. span, with electrical installation and rails	40.000.000 FM
1 Laboratory (Spectrometer)	40.000.000 FM
Ancillary installations for water, compressed air, power line, switchboards, silos, scrap baskets, scales, stools, fuel-oil heaters, fuel-oil storage, etc.	30.000.000 FM
	195.000.000 FM

Transportation	2.200.000 FM
Erection and commissioning	58.500.000 FM
	255.700.000 FM
Duties and taxes	63.925.000 FM
	319.625.000 FM
Buildings	75.000.000 FM
	394.625.000 FM
Contingencies, 10%	39.462.500 FM
	434.087.500 FM

<u>Rolling mill</u>

2 Rolling mills 500 CV	140.000.000 FM
1 Crop-shear	10.000.000 FM
Exits and shears	7.500.000 FM
5 ton crane, 18 m span crane	11.500.000 FM
Roller conveyor	10.000.000 FM
Reheating furnace, 4 ton/hour	23.000.000 FM
1 Flying shear	20.000.000 FM
1 Coiler	10.000.000 FM
Power installatiom, water, lighting, scales, and miscellaneous	25.000.000 FM
	257.000.000 FM
Transportation	5.000.000 FM
Erection and commissioning	78.000.000 FM
Customs' duties	64.000.000 FM
	404.000.000 FM
Buildings	120.000.000 FM
	524.000.000 FM
Contingencies, 10%	52.400.000 FM
	576.400.000 FM

Consequently, the investment will be:

- Melting shop	434.087.500 FM
- Rolling installations	576.400.000 FM
- Offices and ancillary workshop	20.000.000 FM
TOTAL	1.030.487.500 FM

2.4.3. **Production costs**

These costs are calculated below for the two plants: melting and rolling mill plants.

The basic raw material is scrap, which was already considered in D.2.3., and where it was obtained an average - purchasing price, which can also be applied to the produced scrap which is recuperated to be reintroduced into the working cycle.

The cost of 1.000 kg of net ingot for rolling vill be calculated, taking into account that the necessary scrap weight be 15% higher.

From this percentage, 8% are melting losses, and 7% can be recuperated, with an estimated 5% in runners and - 2% in rejected heats.

To produce 7.000 tons/year of rolled products, the following balance can be estimated:

Charge	8.935,50 t	
Melting losses	-621,60 t	
Runners	-388,50 t	
Rejected heats	-155,40 t	
Ingots	7.770,00 t	in melting shop
Rolling losses	-140,00 t	
Crop ends	-280,00 t	
Rejects	-350,00 t	
Rolled product	7.000,00 t	in rolling mill plant

The produced scrap will be:

Runners	388,50 ton
Rejects	155,40 "
Crop ends	200,00 "
Rejects	330,00 "
	1.173,90 ton

2.4.3.1. Cost per 1.000 kg of ingots

1º) Charge

Scrap. 1.150 kg at 36.271 FM/t	41.711 FM
Recuperation. 70 kg at 36.271 FM/t	-2.538 FM
	39.173 FM

2º) Melting consumptions

	Units	Price FM	Cost FM
Ferrosilicon 75%	2,50 kgs	260	650
Ferromanganese 80%	5,00 "	220	1.100
Lime	55,00 "	20	1.100
Fuel-oil	8,00 "	45	360
Electric power in melting	750,00 kwh	37	27.750
Auxiliary electric power	40,00 kwh	37	1.480
Water	4,00 m^3	8	32
Electrodes	7,00 kgs	700	4.900
Dolomite	20,00 "	50	1.000
Refractories	50,00 "	130	6.500
Aluminium	0,20 "	700	140
Ladle and casting refractories	18,00 "	70	1.260

	Units	Price FM	Cost FM
Ingot moulds	25,00 kgs	160	4.000
Exothermics	6,00 "	400	2.400
Miscellaneous			3.000
			55.672

3º) Other melting costs

Labor	13.696.000
Qualified personnel	14.500.000
Repairs	3.500.000
Laboratory and other	3.000.000
Amortisation	39.283.750
	73.979.750

This cost is divided among the 7.770 tons of yearly produced ingots, therefore: 9.521 FM per ton.

Summary of costs for 1.000 kgs of ingots

1º) Scrap	39.173 FM
2º) Consumptions	55.672 FM
3º) Other costs	9.521 FM
	104.366 FM

2.4.3.2. Cost per 1.000 kgs of rolled bars

1º) Ingot

1.110 kg of ingots at 104.366 FM/t	115.846 FM
Recuperation: 90 kg of scrap at 36.271 FM/t	-3.264 FM
	112.582 FM

2º) Rolling consumptions

To obtain 1.000 kg of rolled products, starting from ingots, and working at 1 shift, the consumptions will be:

	Units	Unit price FM	Cost FM
Fuel-oil	75 kgs	45	3.375
Electric power	130 kwh	37	4.810
Water	8 m^3	8	64
Rolls	1,8 kgs	1.150	2.070
Refractories	6 kgs	92	552
Miscellaneous			400
			11.271

3º) Other rolling costs

Labor	11.016.000 FM
Qualified personnel	8.500.000 FM
Repairs	3.500.000 FM
Amortization	51.040.000 FM
	74.056.000 FM

Applying this cost to the 7.000 tons of yearly production, we have 10.579 FM per ton.

Summary. Cost of 1.000 kg of bars at the rolling mill exit.

1º) Ingots	112.582 FM
2º) Consumptions	11.271 FM
3º) Other costs	10.579 FM
	134.432 FM

To obtain the total cost, general expenses applicable to the steel plant and rolling mill should be added:

Common costs

1º) Personnel	10.468.000 FM
2º) General expenses	13.000.000 FM
3º) Amortisation of the offices and the ancillary workshops	1.000.000 FM
	34.468.000 FM

Applying these costs to the 7.000 tons of finished products, we obtain 4.924 FM per ton, therefore.

Total cost per 1.000 kg of finished product

Cost at rolling mill exit	134.432 FM
Common costs	4.924 FM
	139.356 FM

The commercial and financial expenses are not included in the above figures.

2.5. **Study of a melting shop and rolling mill plant for 25.000 t/year of finished products**

The technical description has been omitted. See section D.2.6. which follows this one since the facilities are similar with the exception of the continuous casting which in the steel plant presently studied has in its place a casting pit.

2.5.1. **Personnel**

Labor

Melting shop	FM/man-year	Total FM
4 Mechanics	864.000	3.456.000
4 Electricians	864.000	3.456.000
4 Molders	400.000	1.600.000
9 Scrap bay men	216.000	1.944.000
9 Melters	216.000	1.944.000
6 Ladle operators	216.000	1.296.000
10 Casting pit workers	216.000	2.160.000
6 Ingot handlers	216.000	1.296.000
6 Crane operators	216.000	1.296.000
9 Reserves	216.000	1.944.000
67		20.392.000

Rolling mill	FM/man-year	Total FM
2 Lathe operators	864.000	1.728.000
4 Mechanics	864.000	3.456.000
4 Electricians	864.000	3.456.000
4 Melters	216.000	864.000
24 Rolling mill operators	216.000	5.184.000

	FM/man-year	Total FM
8 Storekeepers	216.000	1.728.000
2 Crane operators	216.000	432.000
9 Reserves	216.000	1.944.000
57		18.792.000

Qualified personnel

Melting shop

1 Superintendent	7.000.000	7.000.000
3 Furnace foremen	1.500.000	4.500.000
3 Analysts	1.000.000	3.000.000
7		14.500.000

Rolling mill

1 Superintendent	7.000.000	7.000.000
2 Foremen	1.500.000	3.000.000
3		10.000.000

General

1 Manager	10.000.000	10.000.000
1 Administrator	8.000.000	8.000.000
1 Accountant	1.100.000	1.100.000
1 Purchasing and store clerk	1.100.000	1.100.000
1 Sales clerk	1.100.000	1.100.000
1 Personnel manager	1.100.000	1.100.000
1 Cost accountant	1.100.000	1.100.000
8 Administrative	576.000	4.608.000
5 Storeroom assistants	432.000	2.160.000
3 Watchmen	120.000	360.000
23		30.628.000
Total 157 people		94.312.000

2.5.2. Investments

Melting shop

1 Electric arc furnace 20 ton, 10.000 KVA with complementary facilities	195.000.000 FM
1 Scrap crane 30/5 ton	60.000.000 FM
1 Casting crane 35/10 ton	66.000.000 FM
1 Crane of 6 ton in store room	18.000.000 FM
Laboratory	40.000.000 FM
Auxiliary equipment	50.000.000 FM
	429.000.000 FM
Transportation	4.000.000 FM
Erection and commissioning	128.700.000 FM
	561.700.000 FM
Taxes	140.420.000 FM
	702.120.000 FM
Buildings	220.000.000 FM
Total	922.120.000 FM
Contingencies 10%	92.212.000 FM
	1.014.332.000 FM

Rolling mill

5 ton crane	15.000.000 FM
Reheating furnace, 8 t/hour	40.000.000 FM
Roughing mill with swinging tables	120.000.000 FM
Roller conveyor and tables	20.000.000 FM
350 ∅ and 250 ∅ mills with repeaters	130.000.000 FM
Cooler	50.000.000 FM
Shears	25.000.000 FM
Roll lathe	20.000.000 FM

Power installation, water, light facilities, coilers, scales, and complementary installations	70.000.000 FM
	490.000.000 FM
Transportation	9.000.000 FM
Erection and commissioning	147.000.000 FM
	646.000.000 FM
Taxes	161.500.000 FM
	807.500.000 FM
Buildings	272.000.000 FM
	1.079.500.000 FM
Contingencies 10%	107.950.000 FM
	1.187.450.000 FM
Offices and auxiliary workshops	40.000.000 FM
	1.227.450.000 FM
Total investment	2.241.782.000 FM

2.3.5. Production costs

To obtain 25.000 t/yr. of rolled products, the following balance can be estimated.

- Scrap charge	30.520 t
- Melting losses	-2.180 t
- Runners	-545 t
- Rejects	-545 t
- Ingot	27.250 t in steel plant
- Rolling losses	-500 t
- Crop ends	-1.000 t
- Rejects	-750 t
- Rolled product	25.000 t

The production of scrap will be:

- Runners 545 t
- Rejects 545 t
- Crop ends 1.000 t
- Rejects 750 t

2.840 t

2.5.3.1. Cost per 1.000 kg of ingots

1. Charge

Scrap: 1.120 kg at 43.991 FM/t	49.269 FM
Recuperation: 40 kg at 43.991 FM/t	-1.759 FM
	47.510 FM

2. Melting consumptions

	Units	Price FM	Cost FM
Ferrosilicon 75%	2,5 kgs	260	650
Ferromanganese 80%	5 kgs	220	1.100
Lime	50 kgs	20	1.000
Fuel-oil	6 kgs	45	270
Electric power in melting	680 kwh	37	25.160
Auxiliary electric power	30 kwh	37	1.110
Water	3 m^3	8	24
Electrodes	6 kgs	700	4.200
Dolomite	12 kgs	50	600
Refractories	40 kgs	130	5.200
Aluminium	0,2 kgs	700	140
Ladle and casting refractories	12 kgs	70	840
Ingot moulds	18 kgs	160	2.880
Exothermics	6 kgs	400	2.400
Miscellaneous			3.000
			48.574

3. Other melting shop's costs

Labor	20.392.000 FM
Qualified personnel	14.500.000 FM
Repairs	6.000.000 FM
Laboratory and others	3.000.000 FM
Amortization	89.333.200 FM
	133.225.200 FM

This cost is applied to 27.250 t of yearly produced ingots, that is to say, at 4.888 FM per ton.

Summary of costs per ton of ingots

1. Scrap	47.510 FM
2. Melting shop's consumptions	48.574 FM
3. Other costs	4.888 FM
	100.972 FM

2.5.3.2. Cost of the rolled product (1.000 kgs)

1. Ingot

1.090 kg of ingots at 100.972 FM/t	110.059 FM
Recuperation. 70 kg of scrap at 43.991 FM/t	-3.079 FM
	106.980 FM

2. Rolling consumptions

To obtain 1.000 kgs of rolled products starting from ingots and working at 2 shifts, the consumptions will be:

	Units	Price FM	Cost FM
Fuel-oil	55 kgs	45	2.475
Electric power	130 kgs	37	4.810
Water	6 m^3	8	48
Rolls	1,55 kgs	1.150	1.782
Refractories	4,50 kgs	92	414
Miscellaneous			350
			9.879

3. Other rolling mill costs

Labor	18.792.000 FM
Qualified personnel	10.000.000 FM
Repairs	8.000.000 FM
Amortisations	103.785.000 FM
	140.577.000 FM

This cost is applicable to the 25.000 ton of yearly production, resulting in 5.623 FM per ton.

Summary.Cost at the rolling mill exit of 1.000 kgs of finished products

1. Ingots	106.980 FM
2. Consumptions	9.879 FM
3. Other costs	5.623 FM
	122.482 FM

To obtain the total cost the following expenses must be added:

Common costs

1. Personnel	30.628.000 FM
2. General expenses	20.000.000 FM
3. Amortisation of the offices and the auxiliary workshops	2.000.000 FM
	52.628.000 FM

Applying this cost to 25.000 tons of finished products, it results in 2.105 FM per ton.

<u>Total cost per 1.000 kgs of finished products</u>

Cost at the rolling mill exit	122.482 FM
Common costs	2.105 FM
	124.587 FM

The commercial and financial expenses are not included in the above figures.

2.6. Melting shop with continuous casting and rolling mill plant for 25.000 t/yr. of finished products

2.6.1. Technical description (1)

1. Main equipment

1 20 t. electric furnace, with 10.000 KVA transformer

1 Continuous casting machine, two strands, for the production of billets, 80x80 to 120x120 mm, and 4 m length

1 Reheating beam furnace, fuel-oil operated, with a production from 8 t/hour to 12 t/hour (maximum)

1 Rolling mill including the 3 following sections:

- 1 Roughing section, 3 three-high stands, with a 600 CV motor. Rolls diameter, 450 mm

  This section can work as roughing mill for the second section or as finishing mill for the following products:

  - bars, 30 to 70 mm ø
  - hexagons, 30 to 60 mm ø
  - sections, 40 to 100 mm ø

- 1 Intermediate section, 5 two-high stands, with a 400 CV motor. Rolls diameter, 350 mm

  It can operate as roughing mill for the third section, or as finishing mill for the following products:

  - bars, 14 to 30 mm ø
  - sections, 15 to 40 mm ø

- 1 Finishing section, 5 two-high stands, with a 400 CV motor. Rolls diameter 350 mm

Here, the 6 to 14 mm ø bars will be rolled

(1) See drawing nº 2, attached.

2. Auxiliary material

Travelling cranes

1 30/5 t crane for the electric furnace charging, with a 35 CV motor

1 30/10 t for the furnace tapping, with a 50 CV motor

2 cranes, 5 t (one for the finished products handling and the other one for the billets handling and rolling mill operation) with 25 CV motors.

Electric furnace

- 4 bins for the storage of coke, lime, dolomite and limestone.
- Equipment for furnace roof repairs
- Ladle heating equipment
- Stopper reheating furnace
- Electrodes preparation equipment
- 2 baskets for scrap and raw materials charging
- 1 Transfer car

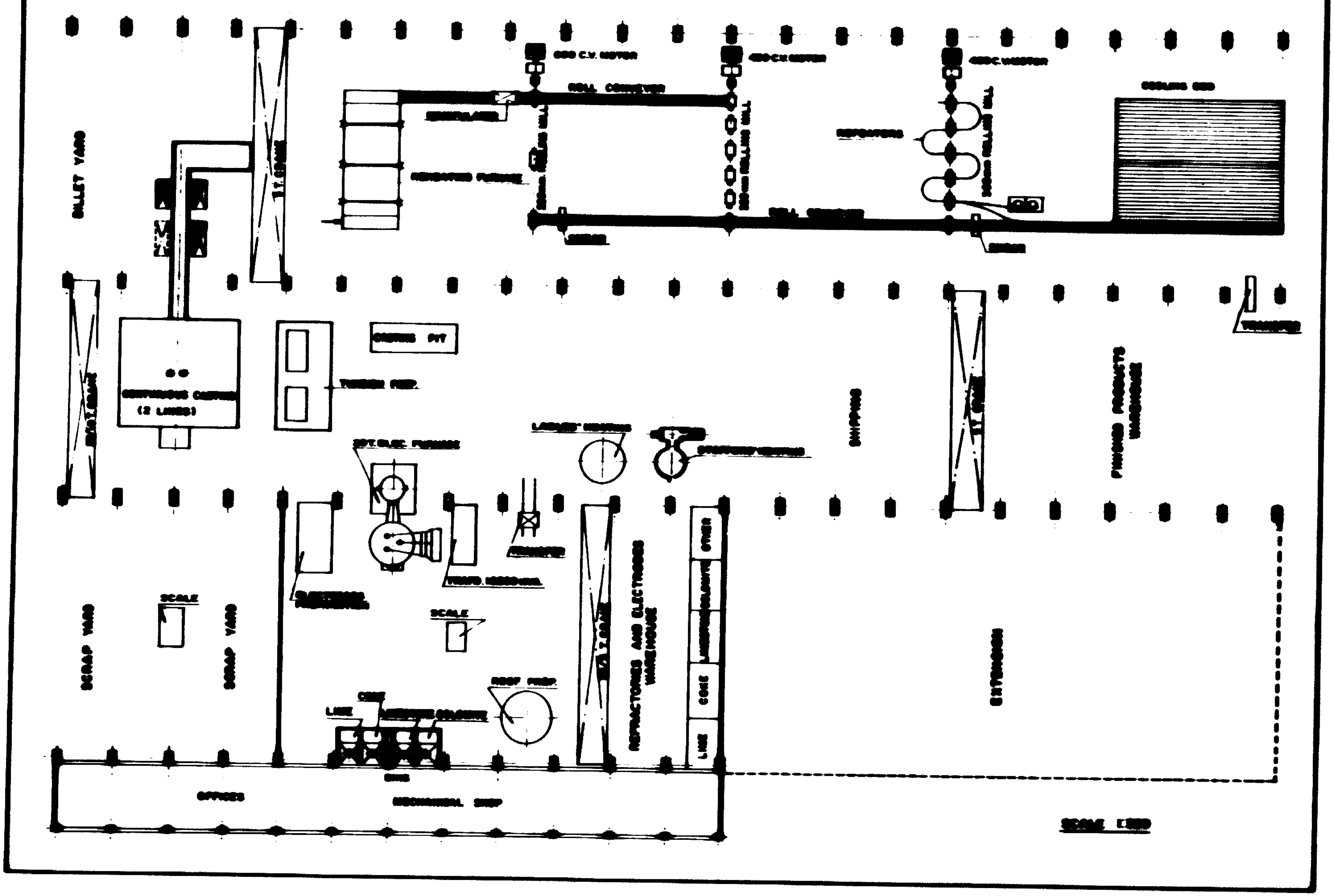
Continuous casting

- Tundish preparation equipment
- Billets removal equipment
- Billets handling equipment

Rolling mills

- Charging table
- 3 Rolls conveyors
- 2 Shears
- 1 Cooling table for finished products
- 4 Repeaters
- 1 Transfer for finished products

DRAWING Nº2



BILLET YARD
ROLL CONVEYOR
REPEATERS
COOLING BED
CASTING PIT
CONTINUOUS CASTING
(2 LINES)
SHIPPING
FINISHED PRODUCTS
WAREHOUSE
REFRACTORIES AND ELECTRODES
WAREHOUSE
EXTENSION
SCRAP YARD
SCRAP YARD
SCALE
SCALE
LIME
COKE
OTHER
OFFICES
MECHANICAL SHOP

3. Buildings

The plant will consist of 3 bays, with different dimensions according to their use.

a) Furnace bay

24 m x 60 m and 16 m high up to the travelling crane girder.

In this bay will be located:

- Scrap stockage
- Refractories and electrodes stockage
- Basket for furnace charge

b) Casting bay

20 m x 110 m and 16 m high up to the travelling crane girder.

In this bay will be located:

- The casting equipment preparation (ladles and stoppers)
- Casting operation (20 t/taps).
- Tundish preparation for continuous casting
- Finished products stockage and preparation of sold products.

c) Rolling mills bay

24 m x 110 m and 12 m high up to the travelling crane girder.

In this bay will be located:

- Handling and stockage of billets at the exit of the continuous casting machine
- Beam furnace to reheat the billets.
- Rolling mill, divided into three different sections, according to the sizes of the products to be rolled.
- Shear equipment

  Transportation between stands by roller tables and repeaters.

- Cooling of finished products
- Transportation of finished products to the warehouse

4. Power

Furnace. 10.000 KVA transformer	10.000 KW
Continuous casting. 120 CV motors	90 "
Rolling mill. 1.400 CV motors	1.030 "
Cranes. 110 CV motors	80 "
Pumping equipment. 200 CV motors	150 "
Lighting	60 "
Auxiliary equipment	100 "
Total	11.510 KW

The working time for each section will be evaluated in a general manner at:

Furnace: 240 days/yr. x 24 h/day
Rolling mill: 280 days/yr. x 16 h/day

The total consumption of power in the plant will be:

Furnace 700 Kwh/t x 30.000 t/year =	21.000.000 Kwh/yr.
Rest of the plant: 200 Kwh/t x 25.000 t/year =	5.000.000 Kwh/yr.
Total consumption	26.000.000 Kwh/yr.

5. Productions

Furnace:

250 days/year
6 heats/day

20 tons/heat

Total : 250 x 6 x 20 = 30.000 t/yr.

<u>Continuous casting</u>

All the furnace's production can be processed. In case of breakdown, the casting will be done directly at the casting pit.

<u>Reheating furnace</u>

280 days/year

16 hours/day

8 t/hour (average); 12 t/h (maximum)

Total: 280 x 16 x 8 = 26.240 t/yr.

<u>Rolling mill</u>

280 days/year

2 shifts/yr.

Total 560 shifts/yr.

<u>Production</u>

- Roughing section	8.000 t/yr. (30 to 100 mm)
- Intermediate section	13.000 t/yr. (14 to 30 mm)
- Finishing section	4.000 t/yr. (6 to 14 mm)
Total	25.000 t/yr.

The production capacity per shift will be:

- Roughing section 100t/shift x 80 shifts = 8.000t/yr.

- Intermediate section	60 t/shift x 220	shifts	= 13.000 t/yr.
- Finishing section	30 t/shift x 140	"	= 4.000 "
Total	440		25.000 t/yr.

The capacity of the plant has been balanced, in order to adopt the following working procedure

6. Operating procedure at the rolling mill

a) Large sections

The starting products will be 120 x 120 mm billets, - and only the 3 stands of the 450 mm mill will work.

The products rolled at the 3rd. stand will be conveyed - through the roller conveyor to the cooling table, after - being cut to predetermined lengths by the shear.

b) Medium sections

The 100 x 100 mm. billets will be rough rolled at the 1st. stand of the 450 mm mill. Later, and through the roller conveyor they will pass to the 5 stands of the first 350 mm mill, in order to obtain the corresponding sections, which will pass to the cooling table after being cut by the shears.

c) Light sections

Starting from 80 x 80 mm. billets, these will be rolled first at the five stands of the first 350 mm mill. From the last stand, the products will be conveyed by the elevator to the first stand of the second 350 mm mill, which, through repeaters will roll the final product for sale. The sections will be sheared and then cooled or eventually - coiled.

2.6.2. Economical study

1. Personnel

Labor

Melting shop	FM/man/year	Total FM
4 mechanics	864.000	3.456.000
4 electricians	864.000	3.456.000
9 scrap bay men	216.000	1.944.000
9 melters	216.000	1.944.000
6 ladle operators	216.000	1.296.000
6 crane operators	216.000	1.296.000
6 reserves	216.000	1.296.000
44		14.688.000

Continuous casting		
3 mechanics	864.000	2.592.000
3 electricians	864.000	2.592.000
9 melters	216.000	1.944.000
6 relief men	216.000	1.296.000
3 shear operators	216.000	648.000
12 relining men	216.000	2.592.000
6 reserves	216.000	1.296.000
42		12.960.000

Rolling mill		
2 lathe operator	864.000	1.728.000
4 mechanics	864.000	3.456.000
4 electricians	864.000	3.456.000

	FM/man/year	Total FM
4 melters	216.000	864.000
24 rolling mill operators	216.000	5.184.000
8 storekeepers	216.000	1.728.000
2 cranemen	216.000	432.000
9 reserves	216.000	1.944.000
57		18.792.000

Qualified personnel

Melting shop

1 superintendent	7.000.000	7.000.000
3 furnace foremen	1.500.000	4.500.000
3 analysts	1.000.000	3.000.000
7		14.500.000

Continuous casting

1 superintendent	7.000.000	7.000.000
3 foremen	1.500.000	4.500.000
4		11.500.000

Rolling mill

1 superintendent	7.000.000	7.000.000
2 foremen	1.500.000	3.000.000
3		10.000.000

General

1 manager	10.000.000	10.000.000
1 administrator	8.000.000	8.000.000

	FM/man/year	Total FM
1 accountant	1.100.000	1.100.000
1 purchansing and sto re clerk	1.100.000	1.100.000
1 sales clerk	1.100 000	1.100.000
1 personnel manager	1.100.000	1.100.000
1 cost accountant	1.100.000	1.100.000
8 administrative assis- tants	576.000	4.608.000
5 storeroom assistants	432.000	2.160.000
3 watchmen	120.000	360.000
23		30.628.000
Total 180 persons		113.068.000

2. Investments

Melting shop

The investments are the same as in the case of a plant without continuous casting (the ingot moulds needed are considered as consumption products), with the exception of the buildings which are reduced by 110.000.000 FM (100.000.000 + 10% contingencies)

Therefore, the investments are:

1.014.332.000 FM
- 110 000.000 FM

904.332.000 FM

Continuous casting

- Continuous casting, 2 strands	360.000.000 FM
- Ancillary equipment	98.000.000 FM
- Civil works	80.000.000 FM
	538.000.000 FM
- Transportation	36.000.000 FM
	574.000.000 FM
- Erection and commissioning	170.000.000 FM
	744.000.000 FM
- Taxes	180.000.000 FM
	924.000.000 FM
- Buildings	180.000.000 FM
	1.104.000.000 FM
- Contingencies 10%	110.400.000 FM
Total continuous casting	1.214.400.000 FM
Rolling mill	1.187.450.000 FM
Offices and ancillary workshops	40.000.000 FM
TOTAL INVESTMENT	3.346.182.000 FM

3. Production cost

To obtain 25.000 t/yr. of rolled products, the following balance can be estimated:

- Charge of scrap	29.680 t
- Melting losses	-2 120 t
- Rejects	-1.060 t
Ingots	26 500 t in steel plant

- Rolling losses	-500 t	
- Rejects	-1. 000 t	
Rolled product	25. 000 t	in rolling mill plant

The production of scrap will be:

- Rejects	1. 060 t
- Rejects	1. 000 t
	2. 060 t

3. 1. <u>Ingots cost, 1. 000 kg</u>

1º <u>Charge</u>

Scrap, 1. 120 kg. at 43. 984 FM/t	49. 262
Recuperation, 40 kg. at 43. 984 FM/t	-1. 759
	47. 503

2º <u>Melting consumptions</u>

	Units	Price FM	Cost FM
Ferrosilicon 75%	2, 5 kgs	260	650
Ferromanganese 80%	5 "	220	1. 100
Lime	50 "	20	1. 000
Fuel-oil	6 "	45	270
Electric power in melting	710 kwh	37	26. 270
Auxiliary electric power	30 "	37	1. 110
Water	3 m^3	8	24
Electrodes	6 kgs	700	4. 200
Dolomite	12 "	50	600

Refractories	40 kgs	130	5.200
Aluminium	0,2 "	700	140
Miscellaneous			3.000
			43.564

3º Consumptions in continuous casting

	Units	Price FM	Cost FM
Power	12 kwh	37	444
Mould cooling water	6 m^3	30	180
Cooling water	2 "	8	16
Machine water	3 "	8	24
Compressed air	2 "	1,5	3
Oxygen	0,5 "	120	60
Colza oil	0,2 "	500	100
Fuel-oil	4 kgs	45	180
Tundish refractories	6 "	100	600
Stoppers, etc			400
Ingot fixing			100
Copper moulds	0,2 "	800	160
Miscellaneous			500
			2.767

4º Other melting costs

Labor	14.688.000 FM
Qualified personnel	14.500.000 FM
Repairs	6.000 000 FM
Laboratory and others	3.000.000 FM
Amortisation	83.833 200 FM
	122 021.200 FM

This cost is applied to 26.500 t of ingots, that is to say at 4.604 FM/t.

5º Other costs in continuous casting

Labor	12.960.000 FM
Qualified personnel	11.500.000 FM
Repairs	12.000.000 FM
Amortization	111.540.000 FM
	148.000.000 FM

This cost is applicable to 26.500 of ingots resulting in 5.584 FM per ton

Summary of the costs per 1.000 kg of ingots

1.- Scrap	47.503 FM
2.- Melting consumptions	43.564 FM
3.- Consumptions in continuous casting	2 767 FM
4.- Other melting costs	4 604 FM
5.- Other costs in continuous casting	5.584 FM
	104.022 FM

3.2. Rolled product. Cost per 1.000 kgs

1º Ingots. 1.060 kg at 104.022 FM/t	110.263 FM
Recuperation. 40 kg of scrap at 43.984 FM/t	-1.759 FM
	108.504 FM

2º Rolling consumptions

To obtain 1.000 kg of rolled product, starting from ingots from the continuous casting, and working at 2 shifts, the consumptions will be:

	Units	Price FM	Cost FM
Fuel-oil	45 kgs	45	2.025
Electric power	110 kwh	37	4.070
Water	6 m^3	8	48
Mill Rolls	1,4 kgs	1.150	1.610
Refractories	4 kgs	92	368
Miscellaneous			250
			8.371

3º Other rolling costs

Labor	18.792.000 FM
Qualified personnel	10 000.000 FM
Repairs	6.500.000 FM
Amortizations	103.785.000 FM
	139.077 000 FM

This figure is applicable to 25 000 t, resulting 5.563 FM per ton.

Summary. Cost of 1.000 kg of rolled product

At the rolling mill exit the cost will be:

1. Ingots	108.504 FM
2. Rolling consumptions	8.371 FM
3. Other costs	5.563 FM
	122.438 FM

To obtain the total cost, the following expenses must be added:

1º Personnel	30.628.000 FM
2º General expenses	20.000.000 FM
3º Amortisation of offices and ancillary workshops	2.000.000 FM
	52.628.000 FM

Figure to be applied to 25.000 t. of rolled products, at 2.105 FM per ton

TOTAL COST, 1.000 kg of rolled products

- Cost at the rolling mill exit	122.438 FM
- Common costs	2.105 FM
	124.543 FM

The commercial and financial expenses are not included in the above figures.

2.7. Comparison among the different steel producing plants

The two following tables show the differences among the above studied plants.

The first table shows personnel and investments figures. The second one the different production costs. From these tables it can be concluded:

1) The minimum production cost is obtained with imported billets. Similarly, cases 1, 2 and 3, where only rolling exists, are those with minimum investments.

2) For the steel mill of 7.000 t capacity (case nº 4) the production costs are very high. Actually, what is considered as production cost only in case 4, i.e. 139.356 FM/t, taken as sales price for the plants having only rolling mills, would allow them to be very profitable.

3) In cases 5 and 6, similar productions costs are obtained. These costs are intermediate among the above ones.

4) The necessary investments for cases 5 and 6, specially in the case of the continuous casting, are substantial for Mali, a country with short capital availability. Therefore, to select such solutions would be a bad resource's attribution policy as better results can be obtained with lower investments.

5) In the cases 4 to 6 the ingot's cost is very high, because of two factors: scrap's transport prices and electric power cost. The last one billed at 3 FM/kwh is a rather costly input for steel production in electric furnaces, which are rather strong power consumers.

TABLE Nº 9

COMPARISON OF THE NECESSARY PERSONNEL AND INVESTMENTS AMONG THE STUDIED STEEL PLANTS

Production t/year	Rolling mill			Melting shop and rolling mill		Melting shop, continuous casting and rolling mill
	1	2	3	4	5	6
	4.000	7.000	14.000	7.000	25.000	25.000
1. Employed personnel						
Labor force						
- Melting shop				48	67	44
- Continuous casting						42
- Rolling mill	30	36	69	36	57	57
- Total	30	36	69	84	124	143
Qualified Personnel						
- Melting shop				7	7	7
- Continuous casting						4
- Rolling mill	2	2	3	2	3	3
- Management and services	12	14	18	18	23	23
- Total	14	16	21	27	33	37
- GRAND TOTAL	44	52	90	111	157	180
2. Investments						
- Melting shop				434.087.500	1.014.332.000	904.332.000
- Continuous casting						1.214.400.000
- Rolling mill	406.450.000	576.400.000	576.400.000	576.400.000	1.187.450.000	1.187.450.000
- Offices and auxiliary workshops	20.000.000	20.000.000	20.000.000	20.000.000	40.000.000	40.000.000
- TOTAL	426.450.000	596.400.000	596.400.000	1.030.487.500	2.241.782.000	3.346.182.000

TABLE Nº 10

COST COMPARISON AMONG THE STUDIED STEEL PLANTS

Production t/year	Rolling mill			Melting shop and rolling mill		Melting shop, continuous casting and rolling mill
	1	2	3	4	5	6
	4.000	7.000	14.000	7.000	25.000	25.000
Melting shop, 1.000 kg of ingots						
- Scrap charge cost, FM				39.173	47.510	47.503
- Melting consumptions, FM				55.672	48.574	43.564
- Other melting costs, FM				9.521	4.888	4.604
- Continuous casting consumptions, FM						2.767
- Other costs in continuous casting, FM						5.584
- Cost of 1.000 kg of ingots, FM				104.366	100.972	104.022
Rolling mill, 1.000 kg of finished products						
- Ingot or billets cost, FM	72.056	72.056	72.056	112.582	106.980	108.504
- Rolling consumptions, FM	10.901	10.470	9.805	11.271	9.879	8.371
- Other rolling mill costs, FM	14.091	10.579	6.269	10.579	5.623	5.563
- Cost of 1.000 kg at rolling exit, FM	97.048	93.105	88.130	134.432	122.482	122.438
- Common costs, FM	6.944	4.254	2.342	4.924	2.105	2.105
- Total cost of 1.000 kg of finished products	103.992	97.359	90.472	139.356	124.587	124.543

6) On the other hand, electric power is one of the most scarce production factors at Mali. To assign it in large amounts to the production of steel, would be a bad resource's attribution policy.

7) The Malian market does not justify an steel production of 25.000 t/year. Steel exports would only be possible, taking into account the high production cost, by means of strong export bourses, a policy not to be recommended.

8) In cases 4 to 6, many more job openings will be available than in cases 1 to 3. Nevertheless, this is a more theoretical than actual benefit. On the one hand, the capital investment by job position is much higher. On the other hand, if these resources (mainly capital and electric power) were applied to other more feasibles industries in Mali, the number of job openings would be greater.

9) The present levels of technology and know-how make preferable to adopt as best solution for the steel production the construction of a rolling mill plant without steel melting furnace.

10) Using imported billets, production costs obtained in cases 1 to 3 are very similar to the international ones.

On the other hand, with such costs, the steel industry of Mali could compete with the presently imported products in a very favorable manner. Such would not be the case in options 4 to 6.

11) In cases 1 to 3, sales prices could be substantially reduced, with the consequent stimulus in consumption.

This would expedite the installation of other industries.

12) If objetive and positive solutions to the economic policy of Mali are to be recommended, it is then necessary not to take into account, but to discard, the solution of a steel plant of disproportionate size, with low export possibilities owing to its production costs, and located in a country scarcely industrialised, which, besides, would have ite industrial development jeopardized, as such plant would absorb a non justified amount of resources.

13) Nevertheless, when Mali has available a big capacity hidropower plant, the power costs will come down sharply and then, probably, the installation of a melting shop and a rolling plant for 25.000 t/yr will be feasible, as a great part of the present inconvenients will be eliminated and, in return, the present advantages for job openinge, macroeconomics effecte, and son on, will be greater.

14) Accordingly, it is recommended to perform as soon as possible a detailed techno-economical survey on the feasibility of the rolling mill plant for 7.000 t/yr., working at 1 shift. This plant will operate at a later stage at 2 shifte. The conetruction of a melting shop will be postponed until favorable conditions arise.

In the opinion of the Tecniberia's experts, the above considerated steps should be successively implemented in order to develop the Mali's steel industry.

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