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# THE IRON AND STEEL INDUSTRY IN AFRICA

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## INTRODUCTION

The following report consists of four chapters. The first deals with the past, present and prospective consumption of iron and steel in Africa and the extent to which it has been supplied so far from the domestic iron and steel industry. The second chapter is concerned with the availability of raw materials and fuel for the expansion of iron and steel production and the third chapter deals with the economics of the industry including economies of scale, transport costs and prices. The last chapter deals with the future development of the industry based on the analysis of the preceding three chapters and on the discussions which have been taking place during the last two years on industrial co-ordination in Africa.

# CHAPTER I

## CONSUMPTION OF IRON AND STEEL

1. The following table shows consumption of iron and steel products in the various sub-regions 1/ of Africa during the last 11 years.

Consumption of Iron and Steel 2/

'000 tons

| | North Africa | West Africa | Central Africa | East Africa | Southern Africa |
|---|---|---|---|---|---|
| 1953 | 450 | 220 | 180 | 170 | 1,300 |
| 1954 | 560 | 230 | 190 | 240 | 1,390 |
| 1955 | 670 | 250 | 230 | 350 | 1,510 |
| 1956 | 680 | 250 | 230 | 350 | 1,550 |
| 1957 | 620 | 320 | 240 | 370 | 1,760 |
| 1958 | 820 | 310 | 150 | 320 | 1,650 |
| 1959 | 920 | 370 | 130 | 290 | 1,300 |
| 1960 | 1,130 | 360 | 90 | 380 | 1,620 |
| 1961 | 1,100 | 450 | 110 | 420 | 1,810 |
| 1962 | 1,050 | 500 | 110 | 430 | 1,770 |
| 1963 | 1,070 | 530 | 140 | 430 | 1,980 |

Average annual consumption 1961/3 in the North African sub-region amounted to just over 1 million tons, of which the UAR accounted for 420,000 tons. Domestic supplies during this period averaged 300,000 tons

1/ North Africa: Algeria, Libya, Morocco, Sudan, Tunisia and the UAR.
West Africa: Dahomey, Gambia, Ghana, Guinea, Ivory Coast, Liberia, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone, Togo and Upper Volta.
Central Africa: Angola, Cameroon, Central African Republic, Chad, Congo (Brazzaville), Congo (Leopoldville) and Gabon.
East Africa: Burundi, Comoro, Ethiopia, French Somaliland, Kenya, Madagascar, Malawi, Mozambique, Reunion, Rhodesia, Seychelles, Somalia, Tanzania, Uganda and Zambia.

2/ Finished steel including a small quantity of iron products mainly cast iron pipes.

from plants in UAR and Algeria. In the West African sub-region, average annual consumption during the same period amounted to 500,000 tons of which only 10,000 tons came from domestic sources namely a scrap melting plant in Nigeria. Annual consumption in the East African sub-region averaged 440,000 tons of which Rhodesia accounted for 170,000 tons. Domestic supplies came from integrated works in Rhodesia (50,000 tons) and from scrap melting plants in Uganda and Ethiopia (15,000 tons). Average annual consumption in the Central African sub-region was 120,000 tons of which Congo (Leopoldville) accounted for about half. Domestic supplies amounting to about 10,000 tons came from a scrap melting plant in the Congo. Southern Africa is the largest steel consuming sub-region, consumption averaging in 1961/3 about 1,850,000 tons. Imports amounted to only 130,000 tons, the South African steel works producing 1,990,000 tons and exporting 270,000 tons.

2. Iron and steel consumption in Africa excluding South Africa increased from 1953 to 1963 at an average rate of 7 per cent p.a. in spite of the disturbances brought about by political events. In the Central African sub-region i.e. Congo where these disturbances were most acute, consumption declined while in West Africa where they were least evident it increased by 9 per cent p.a.

Under conditions of steady expansion[1] it may be expected that iron and steel consumption in any under-developed country will increase more rapidly than the gross domestic product because the subsistence sector which makes a substantial contribution to the economy of such a country uses little steel so that the increase in GDP coming from an expansion of the monetary sector will bring a more than proportional increase in steel consumption. Moreover, at the initial stages of expansion there is a tendency for highly steel intensive activities such as railway construction to be embarked upon. A regression line fitted to the figures of steel consumption per head and GDP per head in 1959/61 for

1/ For the general relation between steel consumption and GDP see Annex I.

all the African countries suggests in fact that for an increase of 1 per cent in GDP per head, steel consumption at the current stage of development increases by 1.7 per cent. Corresponding therefore to an increase of 5 per cent in GDP, i.e. 2 per cent increase in population and 3 per cent in income per head which is the minimum rate of growth in Africa suggested by the United Nations, the increase in steel consumption would be 7.1 per cent. Similarly an increase in GDP of 6 per cent p.a. would give an 8.8 per cent increase in steel consumption.

3. Detailed estimates of future demands for steel have been made for African countries in the document[1] (E/CN.14/INR/27), "The Development of the Iron and Steel Industry in Africa". In this document total steel demand including both direct and indirect is expected to increase by about 7 per cent p.a., and after allowing for the substitution of imports of engineering goods by domestic products direct steel demand is expected to increase by 8 per cent p.a. (and excluding rails by 9 per cent p.a.). Alternative estimates for East Africa (The Development of the Engineering Industries in East Africa - Mechanical Engineering (E/CN.14/INR/90)) using given projected increases in GDP suggest an increase in total steel consumption of 6.7 per cent p.a. i.e. slightly less than above. This lower rate of total growth is offset however as far as direct steel consumption is concerned by a higher rate of import substitution it being estimated that the domestic engineering industry can be expanded by 1980 to supply one-half domestic needs whereas in E/CN.14/INR/27 it is estimated that it will supply about one-third. This higher rate of import substitution results in a rate of increase of direct steel consumption of 8.9 per cent p.a. (E/CN.14/INR/87) Development of the Steel Industry in East and Central Africa).

4. As a working rule therefore it would appear that under condition of steady expansion consumption of iron and steel in African countries

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1/ In this document the subsistence sector is ignored throughout the calculations and the elasticity of steel demand in the monetary sector is taken as unity.

is likely to increase at an annual rate of between 8 and 9 per cent. Within this general framework consumption of certain products such as railways and galvanized sheet is expected to increase only slightly because of competition from other means of transport and other materials respectively while on the other hand that of cold reduced sheet is expected to increase by about half as much again as that of steel generally because of its use by the expanding engineering industries. The following table shows the consumption figures which have been projected for the various sub-regions.

**Projected steel consumption**

1000 tons

| | North Africa | | West Africa[a] | | Central Africa[b] | | E. Africa[c] |
|---|---|---|---|---|---|---|---|
| | 1970 | 1980 | 1970 | 80 | 1970 | 80 | 1980 |
| Rails | 100 | 150 | 140 | 180 | 30 | 40 | .. |
| Bar rod and sections | 1000 | 2250 | 390 | 990 | 130 | 310 | 820 |
| Plate and sheet | 600 | 1800 | 300 | 750 | 150 | 400 | 690 |
| Tubes | 300 | 670 | 100 | 230 | 30 | 80 | 20 + |
| Total | 2000 | 4520 | 930 | 2150 | 340 | 830 | 1530 |

including welded tube

\+ Seamless only.

a/ E/CN.14/IS/3.

b/ Report of the ECA mission for Economic Co-operation in Central Africa.

c/ E/CN.14/INR/87.

# CHAPTER II

## RAW MATERIALS AND FUEL

5. The main raw materials required for iron and steel making are iron ore, scrap, fuel, pure limestone (including dolomitic limestone) and water. Raw materials required in smaller quantities are manganese ore and ferro-alloys, and mention must also be made of the need for certain manufactured materials essential for the maintenance of production, notably furnace refractory blocks and bricks, casting pit refractories, and engineering spares. As a general rule, however, local availability of these secondary raw materials and materials needed for maintenance is not of prime importance in the first stages of a developing steel industry because they can be readily imported. Fresh water in large quantities is one of the essential requirements for an iron and steel works and it is difficult to visualize the construction of such a works in countries where water is scarce at present. This does not mean that such countries would never be able to operate a steel works, but merely that such developments must be delayed until water supplies can be developed.

6. The raw iron required will come from ore, scrap, or both. Although ore alone or scrap alone can sustain an iron and steel works, usually both are used. In a country in the early stages of industrial development little scrap will be available. This follows from the fact that there are few metal-using industries from which scrap can be collected and little equipment in the form of machines, buildings and vehicles available for scrapping. In Rhodesia, which is a relatively well developed African country, scrap arising from the metal-using industries including building and construction, i.e. process scrap, currently amounts to 2 kg. per head of the population compared with the current steel consumption of 10 kg. per head, but in East and West African countries 1 kg. per head is likely to be the maximum. Scrap (capital scrap) available from obsolete structures, machines and vehicles is calculated from their average life, i.e. about 50 years,

25 years and 10 years respectively and at this time distant it is obvious that there was little installed and therefore little becoming obsolete while in any case only a proportion of what becomes available is collected. In Rhodesia apart from the mines the main sources were from vehicles including the railways and from industries the total amounting to about 3 kg. per head of the population, but in less developed countries it is doubtful whether more than 1 kg. per head can be collected.1/ Not only is the quantity likely to be collected therefore very small in relation to current steel demand but moreover it is likely to be required in part by the existing iron and steel foundries. The iron foundries2/ are likely to be advantageously placed to collect the material, e.g. those making agricultural machinery equipment will collect scrap from local farms and they are very much less exacting than a steel works in regard to quality. Scrap availability will increase rapidly with economic development but will be subject to the time lag of about 20 years already described so that while small steel works depending on scrap will expand they will provide a steadily decreasing proportion of total steel consumption. On the other hand of course they use a local material which might otherwise not be collected at all or simply exported; they make a useful contribution to steel requirements and more important still do this at a low capital cost since none of the heavy capital expenditure involved in iron making is required and they give valuable training in steel technology. It is therefore important to encourage this activity.

7. As far as iron ore is concerned, new deposits are frequently revealed as prospecting proceeds. Numerous iron ore deposits are available in Africa but since an integrated works producing a minimum of half a million tons of iron a year and using therefore 1 million tons of ore is under consideration interest only attaches to those deposits

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1/ Estimates are for Cameroon 1 kg. per head and for Upper Volta 1/2 kg. per head.

2/ In Rhodesia iron and steel foundries took about 1/2 available scrap.

which individually or in close proximity can sustain such a works. Assuming that in view of the heavy social and industrial investment associated with a steel works a life of 30 to 50 years is required, this means a deposit of the order of 30 to 50 million tons or the equivalent in adjacent deposits. This assumes that the deposit is high grade which for practical purposes may be taken as containing over 50 per cent of iron. Lower grade deposits under 50 per cent can usually be beneficiated to raise their iron content but this is expensive and the naturally enriched deposits will almost invariably provide the basis for a steel industry. In most cases these higher grade deposits occur as pockets of enrichment in very much larger masses of lower grade iron bearing rock of perhaps 30 to 40 per cent iron content. It should also be recognized, however, that not only may new deposits be discovered since it is scarcely worth while to prospect in areas remote from transport facilities but also that in regard to existing deposits it has not been worth while in many cases to go to the considerable expense of proving the reserves by numerous borings. In many cases therefore the actual reserves may be very much greater than those stated for example in E/CN.14/INR/27. In particular the Sukulu deposits in Uganda are now estimated at about 45 millions tons, new deposits amounting to between 20-80 million tons have been estimated in the Eritrea province of Ethiopia and the deposits in Mali have been reassessed. Most African countries have in fact adequate iron ore resources to sustain an integrated iron and steel industry although their relative advantages for this purpose, depend also on the quality of the reserves, i.e. iron content and presence of impurities as well as on their accessibility. The major deposits in West and North Africa are connected by railway to the coast for export purposes, but others e.g. in Zambia, Gabon, Tanzania, and Lybia are not linked to transport facilities at present.

8. Fuel especially coal is much less generally available. Coking coal is required for the operation of the classical blast furnace system and is only available in large quantities in South Africa and Rhodesia, and in smaller quantities in the Sinai Peninsula. Non-coking coal is more

generally available - large quantities in Southern Africa and substantial deposits over 100 million tons in Morocco, Algeria, Tanzania, Nigeria and Katanga. Charcoal made from timber is a substitute for coking coal within limits in the blast furnace system and adequate supplies exist for example in East Africa where coal supplies are both limited and inaccessible. Oil and natural gas can be used to reduce coke requirements by injection into the blast furnace or by direct reduction of iron ore and are available in large quantities in North Africa, West Africa and Central Africa. Hydroelectric possibilities in Africa are probably unparalleled and could be used for electric smelting especially in the Central African and East African sub-regions.

# CHAPTER III

## ECONOMICS OF THE INDUSTRY

9. Two key economic issues arise in considering the establishment of an iron and steel industry in under-developed countries. The first is that of securing economies of scale which in metallurgical operations are very large and which in fact usually necessitate a market greater than that provided by any single country. At the same time the market area to be served cannot be spread too widely otherwise transport costs become prohibitive. The problem is therefore one of balancing increasing of economies of scale against rising transport costs. It is unlikely for example that an iron and steel plant established in one of the African sub-regions would be able to compete in other sub-regions with local plants and this is one of the main reasons for considering industrial development in Africa initially on a sub-regional basis. Without detailed analysis, however, is not possible to say whether one or two or even three plants could supply a particular sub-region most efficiently.

The second issue is that of choosing the lowest cost location for a plant having regard to the cost of assembling raw materials for the manufacture of steel and the cost of distributing the finished product. Once more it is only by detailed consideration of the location of markets that this issue can be decided.

Both these problems have been examined in some detail in the East African and West African sub-regions in the course of discussions on the development of the iron and steel industry, and the conclusions reached are discussed in the next chapter. The present chapter is concerned with the more general aspects of economies of scale and location.

10. As far as economies of scale are concerned it may be expected that metallurgical operations would broadly conform to what is sometimes called the 0.6 rule i.e. that increasing the capacity of a plant by

10 per cent will increase capital investment by only 6 per cent and therefore reduce capital costs per unit of output by 4 per cent (E/CN.14/INR/27). Doubling the capacity of works will accordingly reduce unit costs by about 1/4 and halving the capacity increase them by about 1/3. The different operations carried out in iron and steel manufacture vary, however, both in regard to the extent of economies of scale and also in regard to the level of output at which these economies become critical. Moreover, since total costs also include the cost of fuel, labour and raw materials, some of which are constant, economies of scale as far as total costs are concerned, are considerably less than those indicated by the above rule.

Fairly detailed investigations are included in E/CN.14/INR/87, and may be summarized as follows:-

Open cast mining of iron ore or coal can be efficiently conducted on a scale of about 1 million tons per annum with little further reduction of costs for increasing scale of operations but with costs increasing by about one-quarter if the scale of operations is halved.

Costs of iron production by the classical blast furnace method conform reasonably well to the 0.6 rule if raw material costs are excluded but the total cost of manufacturing iron per unit increases by about 17 per cent for a reduction in the scale of operations from 800,000 tons p.a. to 400,000 tons p.a. and would decline by 6 per cent for an increase of scale of operations from 800,000 to 1,600,000 tons p.a. Corresponding changes in unit costs in relation to scale for other iron making processes e.g. kiln processes are approximately 12 and 2 per cent respectively so that such processes tend to compete with the classical blast furnace at lower levels of output. These processes are used, however, mainly for other reasons, e.g. kiln processes where non-coking coal is available; and charcoal blast furnaces where only wood is available.

Similarly electric smelting processes can be efficiently carried out at a lower scale of output so that while from a thermal point of

view electricity must be very cheap to compete with coal, electricity at 0.2 cents per unit equals coal at $15.60 per ton, when capital costs are also taken into account the competitive price for coal is reduced to $5.4 per ton at low scales of output.

Steel making by the L.D. processes conforms fairly well to the 0.6 rule but electric steel making gives only small economies of scale and can be efficiently carried out on a small scale.

The rolling of sections and flat products also conforms to the 0.6 rule except that in regard to bar and rod it is possible by reducing the number of stands to secure efficient operations at an output below 200,000 tons p.a. There are of course several scrap melting and bar rolling mills in Africa operating at about 10,000 tons p.a. These mills are, however, high cost producers and are competitive mainly because they have the advantage of using cheap local scrap.

11. Total unit costs for an integrated works producing bar and rod would fall by about 14 dollars per ton if the scale of operation were increased from 400,000 to 800,000 tons p.a. and in the case of flat products by about 17 dollars per ton. Taking transport charges by rail as consisting of 4 dollars terminal charges and 2 cents per ton per mile running charges, such an increase in scale of operations would be justified if the additional market in the case of bar and rod were within 1,000 miles of the plant or 1,500 miles in the case of flat products. If only road transport is available then these figures would be reduced to about 800 to 1,100 miles respectively while the availability of sea transport would widen the market to about 1,600 and 2,600 miles. In general therefore and within the African sub-regions economies of scale are likely to outweigh transport costs and one large integrated plant is likely to be a cheaper means of supplying steel to a sub-region than two or more smaller plants.

12. Location analysis involves the evaluation at various possible sites of the total cost of assembling raw materials, of manufacturing steel and of distributing the finished product. The manufacturing cost will

vary with the process used, the quality of the available raw materials and with labour rates, etc., and must be evaluated in each case.

The cost of assembling raw materials relates essentially to transport costs on iron ore, fuel and limestone. Of these iron ore is easily the most important since even with high quality ore two tons are required for each ton of finished steel produced, whereas under certain circumstances, e.g. with careful preparation of the ore and the use of oil and natural gas injection coke requirements can be reduced to about 1/2 a ton per ton of finished steel. The quantity of limestone required depends on the quality of the iron ore but would not normally exceed 1/2 ton. An inland iron and steel plant is therefore normally located close to iron ore deposits and a coastal plant near a port which has a railway link with the iron ore deposits and at the same time has the advantage of cheap sea transport for importing other materials e.g. coke and limestone and distributing finished steel.

With improved bulk handling facilities the cost of transporting raw materials per ton mile has been reduced to about 1/3 of that for finished steel so that the total transport cost per ton mile on the raw materials required for steel manufacture is now about the same as that on the finished product. Nevertheless, iron and steel plants are located near the source of raw materials rather than the market, mainly because the market is not one particular location but consists of several centres so that in most cases moving nearer to one centre is moving away from another.

The precise calculation of the most suitable location requires an estimate of consumption at the various market centres and of the transport costs to each and as described in the following chapter these calculations have been made for the East and West African sub-regions. There are, however, certain general principles applicable to all location calculations. First of all it is reasonable to establish rerolling works in the main centres of consumption based on billets from the suitably located integrated works. This is because distribution costs are reduced to the extent that the cost of transporting billets to the centre

for rerolling is less than that of transporting finished steel and there is also less damage in transport. This saving is usually, however, insufficient to entirely offset the loss in economies of scale which results from dividing output even at the rolling stage and even of the simpler products such as bar and rod and the main justification for doing so is to spread employment and income and to widen experience in metallurgical operations. Secondly, it is possible to measure the extra cost involved in having two integrated plants instead of one, the loss in economies of scale being partly offset by the reduction in transport charges secured by each plant delivering within its own area. It should be noted, however, that while the extra unit cost of having two plants instead of one may be small, the total investment may be considerably greater e.g. if investment follows the 0.6 rule it would be nearly 1/3 higher.

13. As far as specialization on different types of finished steel is concerned, the economies of scale even on flat products are only about 6 dollars a ton when production is increased from 400,000 to 800,000 tons per annum, and it would only pay therefore to achieve this specialization if this gain were not lost in increasing transport charges, i.e., the extra transport involved were within 200 to 300 miles. With the low level of consumption in African countries, it is therefore doubtful whether the stage has yet been reached when specialization is an economic proposition and in general each integrated works will tend to make as many products as practicable so as to achieve economies of scale at the iron and steel making stages.

14. In all the cases so far examined in detail it has been shown that it is possible to produce iron and steel in Africa at costs well below than obtaining in Europe. In the case of West Africa the estimated cost of producing re-inforcing bar in an integrated works of 450,000 t.p.a. capacity at Buchanan after allowing 15 per cent on the investment is $98 per ton and at 800,000 tons capacity $81. The corresponding figure for a new plant installed in the UK is $116.

In East Africa it was estimated that an integrated works selling at prices equal to those of imported steel would make a gross return of 40 per cent on capital while two integrated works would make a return of 33 percent.

# CHAPTER IV

## FUTURE DEVELOPMENT

15. In discussing the future development of the iron and steel industry in Africa it is convenient to proceed by considering for each of the sub-regions in turn the present facilities available for iron and steel production, the extensions now in course of installation and lastly longer term possibilities. Finally some consideration may be given to the relation between development in the various sub-regions and the region as a whole.

### North region

Algeria has a small steel works in operation, rolling reinforcing bars and small sections and based on melting scrap in an open hearth furnace. The OH furnace has a capacity of 30,000 tons p.a. and the rolling mill 35-40,000 tons p.a. A major project for the erection of an integrated iron and steel works of 380,000 tons capacity at Bone and producing 300,000 tons p.a. of flat product is in course of execution and is expected to come into operation by the end of 1966. It is based on domestic ore and imported coke. The plant will have sintering facilities and oil injection resulting therefore in a low coke rate and the blast furnace will have a capacity of 400,000 tons p.a. Steel will be made by the L.D. process.

Tunisia has virtually completed the erection of a small integrated iron and steel works in the Menzel-Bourgiba region of 80,000 t.p.a. steel capacity and production is expected to begin by the end of 1965 or early 1966. It is based upon domestic ores and imported coke. The blast furnace has a capacity of 100,000 tons p.a. and the L.D. converter of 80,000 tons p.a. There is continuous casting of billets and the rolling mill (reinforcing bars and small sections) has a capacity of 70,000 tons p.a.

Morocco has no steel making facilities at present but a rerolling unit of 120,000 tons p.a. capacity is envisaged by 1967 at Casablanca. This may be based on billets from the Algerian works and from 1970 onwards on billets from an integrated plant of 300,000 tons per annum capacity

which may be established at Nador and based on domestic ore and coal. Alternatively, the Casablanca works may be based on scrap melting. No iron and steel facilities at present exist in Libya or in the Sudan.

Iron and steel making facilities in the UAR are relatively advanced. The main unit is the integrated works at Helwan with a finished steel capacity of 200,000 tons per annum producing flat products as well as light and medium sections. Other units include three semi-integrated plants with a capacity of 180,000 tons per annum in round bars. It is proposed to expand the capacity of the Helwan works to 1.5 million tons per annum ingot steel and to include a strip mill already under construction with an ultimate capacity of 700,000 tons per annum finished products. The plant will use oxygen steel making and continuous casting. The establishment of a second integrated plant is contemplated at Aswan with a capacity of 400,000 tons per annum in round bars and comprising electric reduction, oxygen steel making, continuous casting and a fully continuous bar mill. A wide plate mill of 200,000 tons per annum capacity and based on slabs from Helwan is under study and might form the nucleus of a third integrated works. The existing semi-integrated plant intend to double their capacity and one of them will specialize in special alloy steels.

16. West Africa

The only steel making facilities in West Africa at present are those of the scrap melting plants in Nigeria (near Enugu) and in Ghana (Tema) both with a current output of about 12,000 tons p.a. and a capacity in the case of the Tema works of about 30,000 tons p.a.

The future development of the steel industry in the sub-region on a co-ordinated basis has been considered at a number of conferences (E/CN.14/IS/3) starting from the stand point (subsequently modified to allow for an inland plant as well as a coastal one) that the market is only large enough to permit the operation of one integrated plant of an economical size and that this should accordingly be located at the site which gives the lowest over-all cost including cost of manufacture and cost of distribution. The calculations establishing this location in the case of a coastal plant were made by SETEC (E/CN.14/INR/72) and resulted in the choice of Lower Buchanan (Liberia) as compared with

alternative sites in Gabon, Ghana, and Nigeria. A subsequent investigation showed that the Buchanan site was also much lower cost than an alternative site in Mauritania. This report together with one prepared on the site of an inland steel works was submitted to the conference on Industrial Co-ordination in West Africa held in Bamako in October 1964. The conference which also took note of the intention of the Nigerian Government to proceed with a steel industry project on which they had already incurred considerable expense accepted the necessity of setting up an iron and steel works in the interior namely at Gouina together with the recommendations of the consultants in regard to the site for a coastal plant namely at lower Buchanan.

The initiative then passed to the Government of Liberia which in August 1965 called a consultative meeting on iron and steel in Monrovia (WAC/IRON/5) to consider a possible approach to co-operation in the establishment and development of an iron and steel industry in the sub-region, particularly with respect to the erection of an integrated plant at lower Buchanan. Documents were available showing the possible iron and steel units which could be established in a sub-region and stating the intentions of the Government of Liberia in regard to the proposed Buchanan plant. Discussions took place mainly on the need for establishing machinery to co-ordinate industrial development throughout the sub-region and on certain problems which the establishment of an integrated plant serving the whole sub-region would create. It was decided to appoint an interim committee of experts to pursue these matters further and to report as soon as possible to an appropriate inter-governmental body. The terms of reference of the Committee were laid down and included a request to report first of all on the constitution, functions and powers of an iron and steel authority to be established for the purpose of programming and harmonizing the development of the iron and steel industry in West Africa and secondly on various problems involved in the establishment and operation of the industry namely the type, size, and the location of re-rolling works which might be established in co-operation with the integrated works,

the price policy to be pursued, the possibility of removing tariffs, means of payment for the import of steel, and financial participation in the project by the various West African governments. The first meeting of the committee was held in Abidjan in October 1965 (WAC/IRON/10) and reviewed the various documents prepared on the above subjects. Resolutions were passed asking for detailed statements from the various governments on their immediate intentions in regard to iron and steel development in their respective countries and on their intentions in regard to the financing of sub-regionally based industries. It was agreed to postpone discussion on the document relating to the establishment of an iron and steel authority until the various governments had had an opportunity of examining it and stating their views in writing after which these matters would be further discussed at the next meeting of the committee early in March 1966.

17. Central Africa

The only steel making facilities at present operating in Central Africa are those of the electric scrap melting plant at Jadotville with a capacity of 8,000 tons p.a. and a current output of 7,000 tons p.a. Studies have been made on the possibility of manufacturing reinforcing bars and light sections for the UDEAC countries and for the Congo but neither scheme has been proceeded with. In the meantime, the ECA mission for economic co-operation in Central Africa July 1965 has advocated the desirability of setting up an iron and steel industry on a sub-regional basis which would require a detailed survey of the relative advantages of various possible sites for locating an integrated works on the lines of those already carried out in the East and West African sub-regions.

From the point of view of raw materials and manufacturing costs a coastal site in Gabon is likely to be favoured while from the point of view of the market the Congo which is expected to account for about two-thirds of the total steel consumption in the sub-region has a predominant interest. In the longer term the major iron and steel

development is likely to be based on the Mekambo iron ore deposits of Gabon or on the Sangha deposits of Congo (Brazzaville). The Mekambo deposits rank among the most important in the world and with the construction of the railway to the coast are likely to be exploited from 1973/74 onwards. The iron content is 64 per cent and the ore is low in phosphorus. As far as other materials for steel making are concerned, manganese ore can be obtained from the Franceville area and fuel oil from the Port-Gentil refinery or alternatively natural gas could be used. Ample limestone is available in the vicinity but as elsewhere in West or Central Africa metallurgical coke were to be imported. It has been shown (E/CN.14/INR/72) that there is a suitable site at Ovendo which taking into account port development plans has a good harbour and will be well connected to the rest of the sub-region. It is possible to envisage an integrated iron and steel works of 400,000 tons p.a., crude steel capacity based on conventional blast furnaces, L.D. steel, continuous casting and conventional rolling mills. It should be noted that production costs in Gabon were estimated in the ECA study to be not significantly greater than in Liberia (between 6 and 7 per cent) which seems likely to be the site of the first integrated iron and steel plant in West Africa.

Given the time required to construct the railway and develop the mine full scale production would hardly be possible at Ovendo before 1975. In the meantime, it is possible that the Inga hydroelectric scheme will have been initiated which would permit the development of an integrated iron and steel plant in the Congo based on electric smelting. To begin with this could be based on the high quality ore available from Mauritania, and later from Gabon. On a sub-regional view such works might have a capacity of 100,000 tons p.a. supplying bar and rod and sections for which the market by 1970 would be sufficient while the Gabon plant would produce flat steel products.

18. East Africa

The iron and steel making facilities available in the East African sub-region consist of the integrated works at Que Que in Rhodesia and the scrap melting works at Jinja in Uganda, and at Akaki near Addis Ababa, Ethiopia.

The Que Que works consists of blast furnaces with an annual capacity of about 250,000 tons p.a. and open hearth steel furnaces with a capacity of 150,000 tons p.a. The rolling mills have a capacity of about 160,000 tons p.a. including 45,000 tons of light sections as well as medium sections, rails, billets, etc. The immediate extension plans of the Rhodesian Iron and Steel Company include increased capacity in both iron and steel making. Ore preparation will be improved to increase the output of the existing blast furnaces and with a new 23 feet diameter furnace output will increase to 820,000 tons p.a. very largely for export. Steel making improvements will increase the output of the open hearth furnaces to about 200,000 tons p.a.

The Ethiopian iron and steel works at Akaki has an ingot steel capacity of 12,000 tons p.a. and a rolling capacity of 18,000 tons p.a. The bulk of the production is sold as reinforcing bar. Present production is about 6,000 tons p.a. and scrap availability within Ethiopia is sufficient for a production of 9,000 tons p.a.

The East African steel works at Jinja has a steel making capacity and a rolling capacity of 24,000 tons p.a. The main product is reinforcing bar although angles and flat bar are also produced. Current production is about 8,000 tons finished steel p.a. Scrap for the works is collected from Uganda, Kenya, and Tanzania and is ample for present rates of production, but could not sustain the maximum output. Expansion plans include the production of baling strip and tubing.

Other steel activities in the sub-region include the manufacture of tubes, drawing of wire and galvanizing of sheets. Steel pipes (present output about 3,000 tons p.a.) and conduit tubing are produced

in Zambia and seamless tubes (about 9,000 tons p.a.) in Rhodesia. Wire rod and wire are produced at Que Que where the steel plant has a capacity of about 25,000 tons p.a. Wire is also produced at Akaki. Galvanizing and corrugating plants with a capacity of about 50,000 tons p.a. are in operation in East Africa and new galvanizing lines are projected for Ethiopia and Uganda.

19. A plan for the co-ordinated development of the iron and steel industry in the sub-region was presented at the Conference on the Harmonization of Industrial Development Programmes in East Africa held in Lusaka from 26 October to 6 November 1965. As in the case of West Africa calculations were made to show, (E/CN.14/INR/87 and Add/2) the advantages of various sites for locating an integrated works but in this case it was not assumed a priori that a single plant serving the whole sub-region would necessarily be the best solution on purely economic grounds although in fact it turned out to be so. Calculations were made for a number of possibilities including a single integrated works, an integrated works, and rerolling works, two integrated works and three integrated works and rerolling works. The estimated surplus over and above that necessary to give a return of 25 per cent on capital (including depreciation) which would be earned under the various proposals at present prices of imported products is as follows:-

| | Annual surplus - US $' million |
|---|---|
| Single integrated works at Que Que | 71.5 |
| Semi-integrated works at Que Que and Mombasa | 62.0 |
| Integrated works at Que Que and Tororo | 50.8 |
| Integrated works at Que Que and Lusaka | 50.3 |
| Integrated works at Que Que, Tororo, Lusaka and rerolling at Dar-es-Salaam | 34.0 |

The proposal for three integrated works, although the least profitable, was recommended mainly to secure a balanced development of the sub-region. In detail this proposal suggested by 1980 the erection of three

integrated works each of about half a million tons annual capacity at Que Que (Rhodesia), Tororo (Uganda), and Lusaka or vicinity (Zambia), together with a large rerolling mill (1/4 million tons capacity) at Dar-es-Salaam and smaller rerolling works of about 50,000 tons annual capacity at Addis Ababa and in Madagascar. The profitable operation of the rerolling works would require them to be supplied with billets from the proposed integrated works at prices somewhat below market levels.

In view of the limited market until 1980 and the fact that the Zambia/Tanzania railway would have to be constructed it was proposed that the construction of the Lusaka works should be postponed until 1975, but that the expansion of the Que Que works and the erection of the Tororo works could begin immediately.

These proposals are to be submitted to the Council of Ministers which it was agreed should be established to co-ordinate industrial development in the sub-region.

20. Region

The policy for co-ordinating iron and steel development in Africa as adopted in the East and West African sub-regions is that of establishing one or a limited number of integrated plants supplying the whole of each sub-region so as to obtain economies of scale and supplementing these where desirable by rerolling mills located in particular countries and supplying normally national requirements. Since the integrated plant will be selling to a number of countries it has been found necessary to propose the establishment of a regulating authority to control prices, and to arrange for a removal of duties etc. as elaborated above in the case of West Africa, and to supervise any market sharing arrangement or specialization, etc. adopted to avoid wasteful duplication. From a regional point of view there is likely to be little potential competition between the various sub-regional plants since although certain operations in iron and steel manufacture, e.g. the blast furnace and the wide strip mill still have economies of scale at outputs over

million tons a year, these are not sufficient in general to offset transport charges and make such large units competitive throughout the continent. An exception might be where the transport of steel is possible by coastal shipping, but even then it would probably be uneconomic to admit similar products from other sub-regions except to relieve established shortages e.g. caused by lack of balance. The position is otherwise in regard to heavy sections, heavy plant, rails and special steel for which the sub-regional market is not sufficiently large to permit an economic scale output and it would appear reasonable to allow these products to flow freely between sub-regions just as other steel products are expected to flow freely between countries in the same sub-region. A regulating authority of some kind would then probably be required in due course to designate these products and to supervise the removal of duties and control of prices as in the case of sub-regional products. At the moment the only machinery for such inter-sub-regional discussions is that of working parties and the working party in industry will probably be meeting next in 1966 to consider industrial problems on a continental basis.

ANNEX

## General Relation between Steel Consumption and Economic Development

1. Since steel enters into every sector of Economic Development i.e. durable consumer goods, machinery, construction, transport equipment, it is appropriate to relate it to the gross domestic product.

Writing $O$ for the value at constant prices of the gross domestic product

$I$ for that of gross capital formation

$a_1$ for the weight of steel used directly and indirectly per unit of expenditure on consumption

$a_2$ for that per unit of expenditure or capital formation

$S$ for the weight of steel used in the economy both directly and indirectly

then $S = a_1 (O-I) + a_2 I$

$= a_1 O + (a_2 - a_1) I$

and if the proportion of GDP devoted to investment is p i.e. $I = p.O$

$= O(a_1 + p(a_2 - a_1))$

2. If $a_1$, $a_2$ and p are constant then

$$\frac{1dS}{Sdt} = \frac{1dO}{Odt} = g \text{ (growth)}$$

i.e. steel consumption increases at the same rate as GDP. In general however in under-developed countries $a_1$ and $a_2$ are increasing. This is largely because the non-monetary or subsistence sector in these countries makes a substantial contribution to GDP perhaps on the average about one-quarter and uses virtually no steel. It follows that if for example the contribution to GDP of the monetary sector increases by 10 per cent, the total domestic product will increase by 7 1/2 per cent and

steel consumption by 10 per cent. Such countries may also be at the stage where $a_1$ and $a_2$ are increasing because of expenditure on steel intensive activities such as railways but sooner or later as the economy develops $a_1$ and $a_2$ will decrease because of the disappearance of the subsistence sector and increasing expenditure on services etc. which have no steel content.

3. If p is constant then the rate of the expansion of the economy will also be constant and will depend on the output/capital ratio so that if

$$g = \text{rate of growth} = \frac{1}{O}\frac{dO}{dt}$$

r = output/capital ratio

s = rate of scrapping of assets

$$g = p.r. - s^*$$

For under-developed countries, r is usually about 0.4 so that if we take p equal to 0.14, i.e., investment at 14 per cent of the gross domestic product, the rate of growth of the economy will be 0.056 minus s equals about 5 per cent per annum, and both investment and steel consumption will increase at this same rate.

If, however, p is not constant, but is increasing for example by 0.7 per annum from an initial level of 0.14, then the rate of growth of the economy will steadily increase, i.e.,

$$\frac{dg}{dt} = r.\frac{dp}{dt} = 0.28 \text{ per cent.}$$

Then the rate of increase of investment will have to be twice as great as before.

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* Robson, R., Note on the Output/Capital Ratio and the Return on Capital in Developing Countries, Oxford Economic Paper, July 1965.

$$\frac{1}{I}\frac{dI}{dt} = \frac{1}{p}\frac{dp}{dt} + \frac{1}{O}\frac{dO}{dt}$$

$$= .05 + .05 = .10$$

And steel consumption will increase at a rate roughly halfway between the rate of growth of GDP and of investment. Taking $a_2$ as 6 times $a_1$, which is the usual condition in under-developed countries, then

$$\frac{1}{S}\frac{dS}{dt} = \frac{1}{O}\frac{dO}{dt} + \frac{a_2 - a_1}{a_1 + p_1 \ (a_2 - a_1)}\frac{dp}{dt} = .05 + .02 = .07$$

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