PRE-INVESTMENT STUDY OF THE COPPER FABRICATING INDUSTRY IN THE EAST AND CENTRAL AFRICAN SUB-REGIONS

prepared for the

United Nations Economic
Commission for Africa

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Maxwell Stamp Associates Limited

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NOTE: (i) Throughout this report decimal units have been used unless otherwise stated. 'Tons' therefore refers to metric tons.

(ii) The currency used throughout is the United States Dollar unless otherwise stated.

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CHAPTER 1

INTRODUCTION

1.1 Background to the Study

This study is one of a series initiated by the Economic Commission for Africa of the United Nations (UNECA) to investigate the potential for industrial development opened up by closer regional economic co-operation. The study was commissioned by the Ministry of Overseas Development as part of its technical assistance programme. It was carried out by Maxwell Stamp Associates Ltd. working in close co-operation with the UNECA and with the assistance of the Governments concerned.

The industry covered in this study is copper fabrication in the Eastern and Central sub-regions of Africa. These two regions contain the main copper producing countries in Africa - Zambia and the Democratic Republic of the Congo. In both countries copper is at present mined and refined almost entirely for export (though there are a few firms in the region engaged in the fabrication of copper on a small scale by European standards. However, there is a substantial local demand for products made from copper such as wire and cable, tubes and shapes etc., and this demand would seem likely to expand as the process of industrialisation gathers pace.

Consequently there were sound 'a priori' reasons for investigating the copper fabrication industry with a view to determining the feasibility of establishing further copper fabrication plants to serve the two sub-regions. The principal raw material is readily available and indigénously produced; the local industry would have the competitive advantage of not paying transport costs to and from Europe; and the local production of intermediate goods such as wire, cables, sheets, shapes, profiles etc. would tend to alleviate the strain on national balance of payments caused by investment in such vital industries as electricity, communications, construction, engineering and transport. In addition, there is a possible market for copper products in the North and West African sub-regions which do not produce copper in significant quantities.

1.2 Aims and Methodology of the Study

The aim of the study is to consider the present and future opportunities for the fabrication of copper into semi-manufactured and manufactured products in the Central and East African sub-regions within a framework of regional economic co-operation. The findings of this study are to be integrated with those of other industries in the sub-regions and will be used in drawing up the UNECA sub-regional development plans.

The philosophy behind these studies is based on the realisation that:-

(a) individual countries rarely possess large enough markets to support industries of sufficient size to benefit from economies of scale. Consequently it is possible to accelerate the process of industrialisation only by developing industries which serve a whole region. Consultants have therefore been requested to estimate the potential development of the industry in a regional market not fragmented by tariffs, duties, administrative controls and other artificial limitations to trade;*

(b) for an industry effectively to meet the demands of an entire region there must be a comprehensive and economic transport system. However, the current level and pattern of industrial activity does not generate sufficient traffic to support a comprehensive and economic transport system. To

* J. L. Lacroix - Reference Framework for Sectoral Studies in Central Africa. (Inter-Office Memorandum dated 14th February, 1967.

break out of this vicious circle the UNECA asked consultants to estimate the amount of traffic that would be generated by the industry given certain hypotheses about the transport network. These hypotheses relate to the cost of various modes of transport and the likely extent of the transport network in 1980 and are set out in the UNECA document 1967-826+; and

(c) the demand for products of industries such as the copper fabrication industry producing intermediate goods is dependent on the growth of other industrial sectors. Equally the growth of each industrial sector is dependent on the supply of intermediate goods. Consequently to encourage the development of each sector in harmony consultants have been asked to predict future growth on the basis of common assumptions as to the growth of each major industrial sector in each country. The assumptions as to growth rates were provided by the UNECA and are based on estimates in national plans and regional development surveys.*

Within this basic methodological framework the terms of reference were as laid out in a letter dated 24th June 1968 from the Ministry of Overseas Development to Maxwell Stamp Associates Ltd. These were subsequently elaborated in discussion with the UNECA.

The principal objectives of the survey are summarised as follows:-

(1) to analyse the current consumption of copper and copper alloy products in East and Central Africa with particular reference to the following countries:-

East African Sub-region		Central African Sub-region
Burundi	Kenya	Congo (Kinshasa)
Ruanda	Uganda	Congo (Brazzaville)
Malawi	Somalia	Central African Republic
Madagascar	Zambia	Chad
Mauritius	Tanzania	Cameroon
Ethiopia		

(Throughout the report the area comprising these 16 countries is referred to as 'the Region')

(2) to establish the current sources of supply of copper products consumed in these markets and to describe the present level of development and future plans of the regional copper fabrication industry;

(3) to project the demand for copper and copper alloy products over the next 15 years in the Region;

(4) to evaluate the future market for copper products in the North and West African Sub-regions;

(5) to establish the extent to which aluminium and plastics are likely to be substituted for copper and copper alloy products in the area under study;

(6) to determine the extent to which the copper fabrication plants in operation or about to be established can meet the present and future demand for copper and copper alloy products in the Region;

\+ L. Gelineau - 'Working Hypotheses for the Transport Sector'.

* Estimates of future output based on these assumptions are given in Table 5.III.

(7) to determine whether future demand can be satisfied by the development of existing plants and examine the feasibility of establishing new copper fabricating plants to serve regional markets;

(8) to indicate:-

(i) the optimum location of any new plants in the light of the present and proposed transport system and the economics of location;

(ii) the magnitude of the investment which would be required;

(iii) the skilled and unskilled labour force needed; and

(9) to qualify the links between the copper fabrication industry and other sectors of the economy.

1.3. Method of Study

The information necessary to meet the objectives of the survey was obtained by three means.

(i) A study was made of published information, particularly the import statistics of the countries being studied; the export statistics of industrial countries supplying copper products; the national income statistics of the countries being studied and projections prepared by the local planning authorities or the UN; and studies prepared by the UNECA. A list of references to the documents consulted is appended to this report.

(ii) A team of three economists visited all the major copper user and producer countries in the East and Central regions (Cameroon, Congo (K), Congo (B), Ethiopia, Kenya, Madagascar, Malawi, Mauritius, Tanzania, Uganda, Zambia) during July and August 1968. In each country visits were made to local producers of copper ore and metal, to fabricators of copper and to the main users of copper products. The main users of copper products in each country were usually the electricity authorities, the telephone authorities, the railways, the mining industry and the construction industry. Further information about prospective developments in producer and user industries and the industrial infrastructure was obtained from Ministries concerned with planning, trade and industry, construction and transport. A list of organisations contacted is appended to this report.

(iii) A considerable amount of information on the technology and economics of copper fabrication was available to Maxwell Stamp Associates as a result of previous studies carried out in this field. However, this was supplemented by consultation with major copper fabricators and plant manufacturers in the U.K. and other European countries. In addition, the fabricators of copper already established in East and Central Africa were able to provide information on their own activities which was essential in considering the application of this technology to African conditions.

(iv) Information on the current and future market for copper products in the West and North African sub-regions was obtained solely from published sources, in accordance with the terms of reference.

1.4. Scope of the Study

Copper can pass through a very large number of stages and processes between its extraction from the ore and its incorporation into a range of end products. Figure 1.I shows in schematic form the different processes and products involved. This figure and the following brief description of the copper industry serve as an introduction to this report and the technical terms used throughout.

The extraction and metallurgical processes are not the direct concern of this study except in as much as they determine the form in which raw copper is produced. The copper ore is usually a sulphide ore containing between 1 per cent and 6 per cent of copper, though oxide ores are also mined in both Zambia and the Congo (K). Most of the mines are underground but opencast mining being much cheaper, enables a lower grade of ore to be exploited.

The ore is concentrated as near to the mine as possible to remove a large proportion of the waste minerals. Concentrates generally contain between 25 and 45 per cent copper. The concentration process may be carried out by flotation, in which case the concentrate normally passes to the smelter, or by leaching, in which case it may be possible to electro-deposit the copper directly.

If the concentrate is to be smelted it is treated first in a smelter and then a converter to produce blister copper. This is an impure form of copper containing about 1 per cent of impurities. These impurities render it unsuitable for most purposes and it must be further refined. Usually it is fire refined then cast as an anode and refined by electrolysis to produce a very pure copper of consistent composition. Sometimes, however, a fire refined copper is sufficiently pure and it may be cast directly into a form suitable for fabrication. If the concentrate is produced by leaching and is then treated by electro-deposition, pure electrolytic copper is produced direct. Sometimes the copper so produced requires a further stage of fire-refining.

Both processes of electrolytic refining produce copper in the form of cathodes. These are large plates which may be sold as such but are usually recast into wire bars. Fire refined copper is also usually cast into wire bars which is the main form in which copper is traded. Wire bars are rectangular blocks tapered at each end weighing between 70 and 200 kilos.

The wire bar occupies a central place in the diagram since it is the form in which copper is principally traded. This is because it is the most suitable form of input for the major fabrication process i.e. rolling wire rod (for drawing into wire). Other fabrication processes, however, require a different shape of input: billets for extrusion and tube pier slabs for sheet and strip rolling, and cathodes for continuous casting and foundry work. Copper can be cast directly into billets or slabs from the cathode melting furnace or from fire refined blister copper. Because the wire bar is the standard shape, however, there is less trade in billets or slabs and the latter usually have to be recast from wire bars by the fabricator.

The main end use of copper is as an electrical conductor, usually in the form of wire or cable. Consequently the most important fabrication processes are those associated with the production of bare insulated conductors, namely

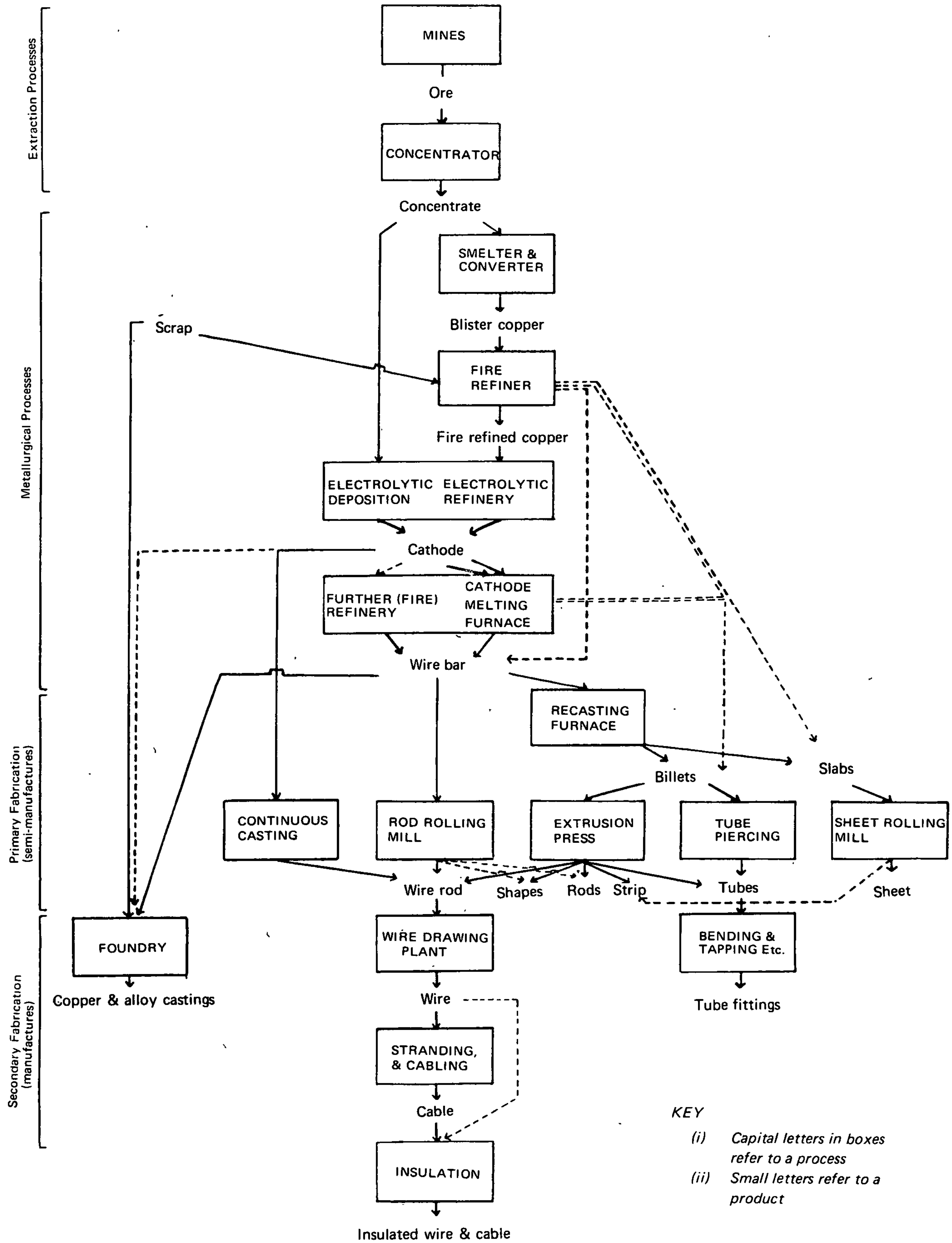
(i) the conversion of primary copper to rod;

(ii) the drawing of rod to wire;

(iii) the stranding, bunching and cabling of wire;

(iv) the insulation of wire.

Fig. 1. I - Flow Chart of the Copper Mining and Fabrication Industry.



Wire rod may be produced by rolling, by extrusion or by continuous casting of rod which involves some subsequent rolling down to wire rod dimension. Wire rod rolling is the process most widely used, particularly for large-scale production of wire rod. Extrusion is also a common process but is principally used firstly because the same press can extrude shapes, tubes, strip and ordinary rod as well as wire rod and secondly because most brasses are not amenable to rolling. Continuous casting is the newest method of producing wire rod and has only recently become commercially viable. It does, however, seem to have a promising future since it enables rod to be cast direct from cathode, thereby removing the need to recast into wire bars or billets and slabs. It also produces rod up to almost any length that might be required.

Wire drawing plant takes as its input 6mm or 8mm rod and by drawing through successively smaller dies produces wire of the required diameter.

Some wire is immediately passed to the insulation plant, but most is first stranded or cabled. Stranding involves simply twisting or grouping the wires together whereas cabling machines wind the wire in successive layers round a central core.

The insulation plant covers wire, stranded wire or cable with insulant. A number of other operations such as armouring and bunching may also be carried out. The function of the insulant is firstly to prevent electric current leaving the wire, secondly to provide protection from mechanical abrasion and thirdly to group together a number of wires. The method of insulation used depends partly on the importance of each function. In general, wires or stranded wires are insulated, then several may be bunched together, and a sheath of insulant is applied overall to bind the bunched wires together and provide additional mechanical protection. The principal insulants used in modern plant are synthetic plastics such as PVC or polyethylene but rubber, synthetic rubber, linen, paper and enamel are also used. Armouring is generally effected by winding with steel wire before applying the outer sheath of insulant, though extruded lead and aluminium coatings are also used.

As mentioned above, extrusion presses produce not only wire rod but strip, shapes, tubes and rods for other purposes than wire drawing. As Figure 1.I shows, each of these products can be made by at least one other process: strip by rolling in rod or sheet mills, tubes by piercing and certain shapes by rolling on a rod mill. Most types of brass can only be handled by an extrusion press.

Tube piercing involves the rolling of a billet against a spike to produce a large pipe. This is drawn down to the appropriate size of tube. A proportion of tube output, from both extrusion and piercing plants, is converted into tube fittings, e.g., elbows, T-joints, bends, etc .

A sheet rolling mill can produce either sheet or strip and usually takes slabs or cakes as its input.

Foundries produce castings of copper and alloy. The alloys principally used are brasses and bronzes. Brasses are alloys of copper and zinc and bronzes are alloys of copper and tin.

The products of the copper fabrication industry are divided into two groups, semi-manufactures and manufactures. Semi-manufactures include sheet, strip and plate; tubes; shapes; and rod and wire rod. Of these products wire rod is the only one which is always further converted by the copper fabrication industry. It is used for wire drawing. A small proportion of tubes is converted into tube fittings. The principal manufactures are wire, stranded wire, castings and tube fittings. A variety of products made entirely of copper and copper alloys is included as manufactures in the import classification. These include nails, screws, washers etc.; containers; domestic

cooking and heating apparatus, builders' and sanitary articles; and other minor categories.

Insulated conductors and the process of insulation have been included within the scope of the survey even though they are not normally classified as part of the copper fabrication industry or its products. This is because a large proportion of copper output is incorporated into insulated conductors and insulation is often carried out in wire drawing and stranding plants.

To summarise, the scope of this survey is defined:

(i) to exclude the casting and shaping of raw copper into wire bars, billets, slabs etc. carried out by the mining companies;

(ii) to include casting, continuous casting, rod rolling, extrusion, tube piercing, sheet rolling, wire drawing, stranding, insulation and the production of manufactures made wholly of copper and alloys; and

(iii) to cover the demand for wire rod, wire, cable and insulated conductors; shapes, rods, strip, tubes and tube fittings; sheet; castings; and manufactures of copper and alloy.

These definitions have been chosen to accord with the headings used in the standard industrial and trade classifications. The headings covered and their appropriate numbers in each classification are listed below:

	Brussels Tariff Nomenclature	Standard International Trade Classification	International Standard Industrial Classification
Raw Copper and Alloys			
Copper matte	74.01A	283.1(2)	
Copper waste and scrap	74.01B	284.0(2)	
Unrefined copper	74.01C	682.1(1)	
Refined copper	74.01D	682.1(2)	
Master alloys	74.02	682.1(3)	
Semi-manufactures of copper and copper alloys			
Wrought bars, rods, shapes, sections and single wire of copper........	74.03	682.2(1)	342
Wrought plates sheet and strip...	74.04	682.2(2)	342
Copper foil not exceeding .15mm ..	74.05	682.2(3)	342
Copper powders and flakes	74.06	682.2(4)	342
Tubes, pipes and blanks therefor and hollow bars	74.07	682.2(5)	342
Tube and pipe fittings (e.g. joints, elbows, sockets)	74.08	682.2(6)	350

	BTN	SITC	ISIC
Manufactures of copper and copper alloys			
Reservoirs, tanks, vats and similar containers exceeding 300 litres (not fitted with thermal or mechanical equipment)	74.09	692.1(2)	350
Stranded wire, cables, plaited bands etc (uninsulated)	74.10	693.1(2)	350
Gauze, cloth, grill, netting and fencing etc	74.11	693.3(2)	350
Expanded metal	74.12	693.4(2)	350
Chain and parts thereof	74.13	698.8(1)	350
Nails, tacks, staples, drawing pins etc. (of copper or of steel with copper heads)	74.14	694.1(2)	342 & 350
Bolts, nuts, screws, rivets, washers etc.	74.15	694.2(1)	342 & 350
Springs	74.16	698.6(2)	350
Cooking and heating apparatus - non-electric for domestic use	74.17	697.1(2)	350
Other articles of kind commonly used for domestic purposes, builders' sanitary ware for indoor use and parts	74.18	697.2(2)	350
Other articles of copper	74.19	698.9(2)	342 & 350
Insulated Conductors			
Insulated electric wire cables, bars, strip etc (of any conductor notably copper and aluminium)	85.23	723.1	370

1.5 Uses of copper products

The principal uses for copper arise from one or more of the following properties:-

(i) its high electrical conductivity (second only to silver);

(ii) its high heat conductivity;

(iii) its resistance to corrosion by the atmosphere and most chemicals;

(iv) its malleability and ductility which make working relatively easy;

(v) the mechanical properties of its alloys, notably brass and bronze;

(a) brass is harder and stronger than copper - though it lacks the high electrical conductivity of pure copper;

(b) bronze can be very hard while maintaining the corrosion resistance of copper.

The uses of the principal products are outlined below:

(i) sheets, plate and strip are used in the construction industry for

roofing where high corrosion resistance or decorative effect is required; in the electrolytic refining process a starting sheet of electrolytic copper is used as a base for cathodes; for the manufacture of tanks, vats, etc. principally where corrosion resistance or thermal conductivity is required;

(ii) wire rods are used for drawing into wire;

(iii) other rods and certain extruded (or rolled) shapes in copper are often used as conductors in electrical generating or transforming stations;

(iv) complex extruded shapes are used primarily in the construction industry (e.g. window frames) and also as engineering components;

(v) tubes are also used extensively in the construction industry where their corrosion resistance and thermal conductivity make them valuable as hot water pipes. A considerable quantity of tube is used in machinery, e.g., car engines, for similar purposes;

(vi) bare conductors: single wire is used for overhead telephone distribution networks and in winding electrical coils. Thick wire, of a special shape, called trolley wire, is used to convey current to electric trains. Stranded wire (or cable) is used in the overhead transmission and distribution of electricity; and

(vii) insulated conductors: the simplest insulated conductors, usually based on single or bunched wire, are used for building wire and domestic purposes. More complex types of cable are used in underground power distribution, telephone networks, railway signalling systems and mining. A certain proportion of insulated conductors is also incorporated into machinery manufactured by the electrical engineering industry.

Note: The use of copper in coins and the feasibility of minting coins in the Region has been excluded from the scope of the survey because of the specialised nature of the process, the limited scope of its application and because copper is only one of several metals used for coinage.

CHAPTER 2

SUMMARY OF FINDINGS AND RECOMMENDATIONS

This chapter summarises the detailed findings of the later chapters and the recommendations which spring from them. The remainder of the report should be consulted for a more comprehensive examination and justification of the findings.

2.1 The Market for Copper Products

Demand for copper products in 1966 in East and Central Africa was about 8,940 tons in terms of metal content of which 5,870 tons were consumed in the East sub-region and 3,070 tons in the Central sub-region.

The copper content of insulated conductors accounted for nearly half this demand; bare conductors for a further 22 per cent; extruded and rolled products (except wire rod) for 18 per cent; and castings and other manufactures for 12 per cent.

The principal user was the construction industry which accounted for about 30 per cent of demand. The mining, power and engineering industries are estimated each to have consumed about 15 per cent, while the transport and communications sectors each accounted for about 11 per cent of demand.

Demand for copper products is expected to grow at an average rate of about 9.9 per cent per annum up to 1980. Total demand will then be about 33,600 tons of copper per annum. Demand for insulated copper conductors is expected to grow at 9.0 per cent per annum, a slightly slower rate than average, because of the increasing substitution of aluminium for copper. Substitution of aluminium for copper bare conductors used by the electricity supply industry is already far advanced in most countries and is not likely to be reversed even if the price of copper falls from the high level of recent years.

2.2 The Existing Copper Fabrication Industry

There are already 10 copper fabrication plants in the Region. The most important of these is Latreca at Lubumbashi in the Congo (Kinshasa). This plant has a rod rolling mill, sheet mill, extrusion press, wire drawing and cabling plant and a foundry. However, its equipment is old and small by modern standards and it has been primarily orientated to serving the local Congolese mining and associated industries. Consequently, Latreca has been working well below capacity, its products are expensive, and it has not met the import requirements of neighbouring countries to any significant degree.

Six of the plants in the Region produce insulated housewire from copper rod or wire. These housewire plants are Splendor and Congacec at Kinshasa, East African Cables at Nairobi, The Cable Corporation of Uganda at Lugazi, Ethioplastics at Addis Ababa and an associated plant at Asmara. There are also a number of bronze foundries in the Region, all of which are either part of a steel foundry or operated by the railway system. Two firms fabricate copper for specialised purposes: Afromeche in the Congo (K) makes explosives fuses and Congacec (Likasi) in the Congo fabricates copper wire and sections for repairing electrical machinery.

Plans exist for the expansion of several of the existing fabrication plants and the establishment of others. The most important development is Zamefa, which is establishing the Region's first full scale wire and cable factory at Luanshya in Zambia. Zamefa will produce its own wire rod using an extrusion press and will also manufacture aluminium wire and cable. At a later stage a rolling mill may be installed and the extrusion press used only for the manufacture of tubes and shapes. Splendor intends to make sheathed and armoured power cables and Latreca has considered installing cabling and armouring machinery in co-operation with Congacec, to complement its existing wire drawing and cabling machinery. The Cable Corporation of Uganda intends to increase its capacity and

range of wire and cable products. Consideration has been given to the establishment of a housewire plant at Dar-es-Salaam and a continuous casting rod mill in Zambia which would produce for export. Both projects have been shelved for the time being as a result of technical and economic difficulties.

2.3 Projected Evolution of Regional Demand and Fabricating Capacity

Table 2.I shows the relationship between demand and potential supply from existing capacity for copper products in the Region. Similarly the table summarises the demand forecast and recommended total capacity in 1980.

In the following sections we summarise the principal technical, economic, locational and market factors behind the recommendations for each type of plant.

2.3.1 Housewire Plants

Housewire plants produce the simple types of insulated wire and cable which are used predominantly in the building industry. The simplest type of plant merely insulates bare wire which is purchased from a wire and cable factory. The more sophisticated plants also draw their own wire from wire rod. The minimum capacity for a housewire plant with only one insulation line and one wire drawing machine is about 600 tons of copper wire per annum. It appears to be possible to operate such a plant profitably below full capacity depending on local circumstances.

In general there are limited economies of scale in housewire production because expansion involves the duplication of existing facilities and machines. In addition there are significant advantages in being located close to the consumer. Therefore expansion of the housewire industry is likely to be located in several small units near regional centres.

The demand for housewire in 1966 was about 1,850 tons. Since then several new plants have come into production so that total capacity now slightly exceeds the 1966 level of demand. Nonetheless most housewire plants are operating well below capacity because they serve only a local market. Housewire can, of course, be produced in wire and cable factories as well as in specialised housewire plants.

Demand for housewire is expected to reach 7,640 tons (metal content) per annum by 1980. We have assumed that some 15 per cent of this will be too specialised to be produced locally (or will be made of aluminium). The remaining 85 per cent will all be produced in local housewire plants and wire and cable factories. To meet the increased demand we recommend the establishment of small housewire plants at Douala, Dar-es-Salaam and Tamatave. The existing housewire plants have scope for increasing production without adding to their existing and planned capacity, with the exception of those we recommend should be expanded into wire and cable factories.

2.3.2 Wire and Cable Factories

Wire and cable factories produce a wide range of bare, insulated and armoured wire and cable suitable for use by the power, telephone, engineering, mining and railway industries. They are also, of course, able to produce the products manufactured by housewire plants.

Wire and cable plants are not subject to very significant economies of scale, although their minimum size of production is much larger than that of a housewire plant. A capacity of about 5,000 tons per annum (metal content) is about the smallest that will provide an adequate range of cable products. Locational factors are fairly evenly balanced between siting factories near the main consumers (particularly in order to co-ordinate with them in drawing up users' specifications) and siting them near a foundry or refinery to recirculate

scrap. Housewire plants can be developed into wire and cable factories by the purchase of bunching, cabling, armouring and other machinery plus additional wire drawing machines and extrusion lines. The location of new wire and cable factories may therefore be influenced by the location of existing housewire plants.

The demand for wire and cable in 1965 is estimated at 4,450 tons. There was no full scale wire and cable factory in the Region at that time, although Latreca in the Congo (K) has the capacity to produce 2,200 tons of bare wire and cable. A complete wire and cable factory with a capacity of 5,000 tons will be established in 1969/70 by Zamefa in Zambia. The latter plant will be capable of meeting the whole Region's demand for wire and cable at the 1966 level, though the market is expected to grow rapidly and will therefore soon exceed Zamefa's capacity.

Table 2.I Balance of Demand and Capacity 1966 and 1980 (tons of metal content)

Type of plant/ product	Sub-region	Demand in 1966	Capacity in 1966-68	Existing plans to install new capacity	Estimated demand in 1980	Recommended capacity in 1980
Wire and Cable Mill	East	2,990	-	5,000	9,618	10,000
	Central	1,459	(2,200)*	-	4,989	7,200
	Total Region	4,449	(2,200)*	5,000	14,607	17,200
House-wire Plant	East	1,383	1,450	350	3,917	3,400
	Central	462	500	-	3,727	1,000
	Total Region	1,845	1,950	350	7,644	4,400
Total House-wire, wire and cable	East	4,373	1,450	5,350	13,535	13,400
	Central	1,921	2,700	-	8,716	8,200
	Total Region	6,294	4,150	5,350	22,251	21,600
Wire Rod Mill	East	200	-	10,000**	14,740	18,000
	Central	700	7,000	-	9,410	7,000
	Total Region	900	7,000	10,000**	24,150	25,000
Extrusion Press Tubes & Shapes	East	723	-	(6,000)**	3,030	6,000
	Central	577	3,500	-	2,620	3,500
	Total Region	1,300	3,500	(6,000)**	5,650	9,500
Sheet Mill	East	167	-	-	710	-
	Central	133	500	-	620	500
	Total Region	300	500	-	1,330	1,500

* Wire drawing and cabling capacity only. No insulation or armouring plant available.

** Refers to Zamefa's extrusion press which will initially produce mainly wire rod at an annual production rate of 10,000 tons. Will be switched to production of tubes and shapes about 1975.

By 1980 demand for wire and cable will be some 14,600 tons. We recommend that the East African Cables plant at Nairobi be expanded into a wire and cable factory similar to that planned by Zamefa. It would supply wire and cable to Addis Ababa, Asmara, Jinja, Kisumu, Mogadiscio, Mombasa, Mwarza, Nairobi, Port Louis and Tamatave, and housewire to Mombasa and Nairobi. The existing wire drawing and cable machinery at Latreca's plant should be supplemented by insulation and armouring machinery. The Latreca plant would then supply its own area (including the local mining industry) and Kisangani with housewire and wire and cable. Splendor's insulation plant at Kinshasa (if possible in conjunction with Congacec's plant) should be expanded into a full scale wire and cable factory supplying wire and cable to the rest of the Central Region and housewire to Kinshasa* and Bangui.

Zamefa will supply the whole of Zambia and Malawi with both housewire and wire and cable and will export wire and cable to Dar-es-Salaam.

2.3.3 Wire Rod Production

Wire rod may be made by extrusion, rolling or continuous casting. Extrusion is an expensive method but has certain advantages for small scale production in that an extrusion press can also be used to produce tubes and shapes. Rod rolling is the most common method of making wire rod. The smallest rolling mill which is currently manufacturing has a capacity of about 8,000 tons per annum and is hand operated. Semi-automatic mills are available with a minimum capacity of about 16,000-20,000 tons per annum while over a level of about 40,000 tons per annum fully automatic mills become economic. Continuous casting is a relatively new technology and several different methods are being developed. Unicast is the smallest in scale (plants exist producing as little as 3,000 tons per annum) but it does not appear to be economical or technically perfect yet except for producing alloy or special high quality rod. The dip forming process cannot yet be considered competitive with rod rolling, though for the production of over 15,000 tons per annum it may eventually be competitive. The Southwire cathode to rod process is the furthest advanced and is already in commercial production and is considered to be competitive with a fully automatic rod mill for an output of about 40,000 tons per annum.

Within any method there are very important economies in capital cost per ton of capacity with an increase in the size of plant though economies in conversion cost are less significant. It is, therefore, desirable to concentrate production in as few plants as possible. Furthermore, proximity to the customer is not essential, so the only two desirable locations are the Copperbelt in Zambia or South Katanga in the Congo (K) - the only two sources of refined copper in the Region.

Relatively little wire rod was used in 1966 as a number of housewire plants drew and insulated copper wire rather than wire rod. All the wire rod used outside the Congo was imported. Latreca's small wire rod mill (capacity 7,000 tons per annum) was, therefore, largely under-utilised. As the number of housewire plants in the Region has increased since 1966, and some existing plants now intend to draw rod rather than wire, the market for wire rod is likely to have increased substantially. Zamefa plan to install an extrusion press which will initially be used to manufacture wire-rod for drawing in their wire and cable factory, though it will have some spare capacity to be used either for extruding wire rod for export or, more probably, for extruding other products.

Because of the greatly increased proportion of housewire, wire and cable which we recommend should be manufactured locally the demand for wire rod will expand even more rapidly than the increase in demand for wire products. Furthermore, it is suggested that Zamefa's extrusion press should, by 1980, be used entirely for the extrusion of tubes and shapes. There will therefore be sufficient demand to justify the establishment of a wire

* The Kinshasa consumption area comprises the Lower Congo and Congo (Brazzaville).

rod plant with a capacity of up to 18, 000 tons per annum. Technological and economic data show that a semi-automatic rolling mill would be the most suitable type of plant for this level of output.

Our approximate costing suggests that such a plant would be viable if copper wire bar were bought at the LME price less transport costs. Indeed, it would be able to cover its costs and sell wire rod substantially below the price of imported rod in order to foster the growth of wire drawing plants in the Region. However, because of the considerable economies of scale in capital cost per ton of production capacity a larger mill than this would be more economical if it could export its excess production. Our analysis of the potential market for copper products in North and West Africa suggests that wire rod produced in the Region would be competitive* with European produced rod. However, the North African sub-region is likely to have its own rod mill so only the West sub-region, with an annual demand for some 16, 900 tons by 1980, would be open to exports from Central and East Africa. The possibility of exporting rod elsewhere is outside the scope of this survey, but it should be noted that wire rod is traded in substantial quantities.

If demand for wire rod for export is thought likely to prove sufficient serious consideration should be given to the establishment of a Southwire type cathode-to-rod plant with an output of over 40, 000 tons per annum. This would be less likely to face technical obsolescence than a rolling mill and would produce jumbo coils which are convenient for export and may fetch a premium over ordinary rod. In addition, such a plant would use cathode as its input which, if realistically priced, would be significantly cheaper than wire bar.

2.3.4 Extrusion Press Plant

Extrusion presses are used principally for the extrusion of shapes and tubes in copper and brass, though wire rod can be made by extrusion as has been mentioned above. It is possible to extrude aluminium products with the same press as used for copper products. The extrusion of tubes involves the use of extensive draw bench facilities as well as the press itself. Because of the high rate of scrap formation and the use of alloys, it is necessary to operate an extrusion plant in conjunction with a foundry.

The larger the press the greater the diameter of rod and tube which may be extruded. But production is more flexible and capacity is more efficiently used if a number of presses are operated in a single plant. The pattern and level of demand therefore jointly determine the most suitable form for extrusion facilities.

As extrusion presses usually produce partly for jobbing orders it is desirable to locate the plant near the main source of such orders.

Demand for extruded products in the Region in 1966 was only about 1, 300 tons. Latreca in Lubumbashi operate a press which because of its small size can only produce at all efficiently the smaller sizes of tubes, rods and shapes. Consequently it is operated at a level well below its theoretical capacity of 3, 500 tons per annum. Zamefa plan to install a larger press capable of producing about 6, 000 tons per annum of extrusions (or 10, 000 tons per annum of wire rod). Initially it will produce mainly wire rod though some production time will be available for extrusion of copper, brass or aluminium semis. Before 1980 it is intended to devote this press entirely to the extrusion of products other than wire rod. This will involve further investment in furnaces for casting alloy billets and draw benches for tube making.

By 1980 the Region's demand for copper and alloy products will be about 5, 650 tons per annum. The combined capacity of Latreca's and Zamefa's presses will by that date be 9, 500 tons p.a. Both presses will, however, be able to employ their apparent spare capacity for the extrusion of aluminium products but there will be no case for the install-

* On the basis of transport costs only.

ation of any additional presses before that time. As Latreca's and Zamefa's presses are most economically employed extruding respectively smaller and larger sizes, we recommend the negotiation of a specialisation agreement between the two concerns.

2.3.5 Sheet Mill

Sheet mills produce copper and alloy sheet and strip. They can also be used to roll aluminium sheet but are extemely capital intensive. Total demand for sheet and strip is estimated at about 300 tons in 1966. Latreca operates the only sheet mill in the Region and has a capacity of only 500 tons per annum. However, its capacity is limited only by the cold rolling mill; the hot rolling stands could handle up to 3,500 tons per annum. It should be possible to increase the capacity of the cold rolling section by increased mechanisation. We recommend that this be done in order to meet the demand forecast of 1,300 tons per annum by 1980.

2.3.6 Foundries and Other Fabrication Plants

Bronze and brass foundries generally cast spare parts and fittings, mainly for railways and other users of heavy industrial machinery*. Consequently they are frequently owned and operated by railway systems. Independent bronze and brass foundries usually form a small department of a larger steel works since they share similar technologies and clientele. Because they are not operated as independent units we have not made specific recommendations on the establishment or expansion of jobbing foundry capacity.

2.4 Sales, import saving, and economic viability of the copper fabrication industry by 1980.

The gross output (excluding scrap) of the plants outlined above will be valued at approximately $69,000,000 in 1980 assuming an LME wire bar price of $1,000 per ton. However, only $45,800,000 will be sales by the copper fabricating industry to firms outside the industry, the difference being accounted for by sales of wire rod to housewire plants and wire and cable factories.

Although the majority of these products is at present imported, the foreign exchange saving to the Region will be considerably less than the total value of sales. This is because the copper used as the industry's primary raw material would otherwise be exported. Furthermore, the secondary raw materials such as plastics, additives, steel wire and tape, and fuel oil will be imported and the employment of expatriates involves a certain burden of foreign exchange. The net import saving will therefore be of the order of $11,750,000 per annum.

The total new fixed investment required to finance the expansion of existing plants and the establishment of new ones will be of the order of $9,100,000.

All the existing, planned and recommended copper fabrication plants are expected to be viable (given the assumptions of this survey) by 1980. Because of the saving on the cost of transportation of copper to and from Europe the Regional industry should not require tariff protection after 1980 (except possibly to offset price cutting by importers).

It should be emphasised that the development of production recommended in this report is dependent on the forecast growth in demand being achieved. A slower or more rapid rate of growth would necessitate the rephasing of investment. Furthermore, a different pattern of production would be possible without significantly raising the overall costs borne by the industry since the economies of scale and location do not lead to a single clear cut optimum pattern.

* Foundries casting billets for extrusion are invariably operated in conjunction with an extrusion press and have been considered above.

CHAPTER 3

THE DEMAND FOR COPPER PRODUCTS IN EAST AND CENTRAL AFRICA

3.1 The complex structure of the copper fabrication industry and the variety of its products were summarised in Section 1.4 and shown in diagrammatic form in Figure 1.I. As was explained, some of the industry's output is in the form of intermediate products which undergo further treatment by the copper fabrication industry before being ready for end use. For example, wire rod must be drawn into wire, and wire may be stranded and insulated before being sold to users outside the fabrication industry. These different processes are not necessarily carried out within a single enterprise: a wire drawing plant might purchase wire rod from a rod rolling mill and an insulation firm buy copper wire from a wire and cable mill.

Consequently, if trade in copper products between firms in the copper fabrication industry were included in the total demand for copper there would be considerable double counting of the copper content. To avoid this the figures quoted in the tables in this Chapter and Chapter 5 only cover purchases of copper products by firms outside the copper fabrication industry. The output of intermediate products by the Region's copper fabrication plants is covered in Chapter 4.

All copper wire is drawn from wire rod and all insulated copper cable is, of course, based on copper wire. Because of scrap formation a greater weight of wire rod is required to produce the final weight of wire and more wire is required than the final copper content of insulated cables (because of breakages, joins, ends etc.). Nonetheless it is possible, using average proportions for scrap formation, to estimate the amount of each input required if the weight of metal in the final product is known. For this reason all quantities in the tables in Chapters 3, 4 and 5 refer to the weight of metal *content in metric tons. Thus, even insulated cables are estimated in terms of the weight of copper conductor and not in terms of the total weight of the conductor, insulation and sheath.

The average percentages of scrap occurring during fabrication are assumed to be as follows:-

Wire bar to wire rod	10%
Wire rod to wire	20%
Wire to insulated cable	5%

It should be remembered that although all wire is derived from wire rod the drawing process is not necessarily carried out in the Region. Most bare and insulated conductors are imported at present so they do not represent an equivalent demand for local rod.

The products of the industry have been grouped into four main types for purposes of analysing regional demand. These types are:-

Type 1 - Semi-manufactures i.e.

(i) Copper and alloy sheets, plate and strip;

(ii) Copper and alloy rods and shapes; and

(iii) Copper and alloy tubes and tube fittings.

* i.e. weight of copper or of copper alloy.

(Wire rod is excluded from this category since it is used entirely within the industry for drawing into wire. Tube fittings, although strictly speaking not a semi-manufacture, are included because they are often not distinguished from tubes in the statistics - they are also small in quantity);

Type 2 - Bare Conductors.

This category comprises bare, single and stranded copper and alloy wire sold to firms outside the copper fabrication and insulation industry;

Type 3 - Manufactures and Castings.

This category comprises products made entirely of copper and alloy e.g. nuts, bolts, screws, etc; containers, utensils, chains, domestic and builders' fittings; and castings - usually spare parts in brass or bronze; and

Type 4 - Insulated copper conductors.

This category covers insulated single and stranded copper wire. Insulated aluminium wire is not included.

3.2 Sources and Method of Estimation

The total demand for copper products in the region is satisfied partly by imports and partly by local production. The two major sources of information about total demand are, therefore, the import statistics of each country and the output or sales figures of each plant.

The import statistics of most countries in the region are based on either the Brussels Nomenclature or the SITC definitions which were shown in detail in Section 1.4. Unfortunately, for several countries the full breakdown is not given. To supplement the import statistics, therefore, additional information was obtained from the export statistics of the industrialised countries and from the World Bureau of Metal Statistics. The latter provide a detailed breakdown of exports of copper semis by country of destination and type of product. Figures obtained from the exports statistics of industrial countries do not always agree with the import statistics of countries in the region. This is partly because each refers to slightly different periods, i.e. exports are recorded some weeks or months before they are recorded as imports in the country of destination. More important reasons are, (i) the final destination of exports is often incorrectly or incompletely entered in the exports statistics - this is particularly true if the exports are to pass through a port of transit such as Beira or Mombasa from which they may be transported to any of several countries; (ii) the import statistics of some countries are subject to considerable errors of classification; and (iii) in certain countries, particularly those inland, smuggling accounts for a significant proportion of trade.

Import statistics have been used as the basic source of information. However, where a major divergence from past and other countries' importing patterns has been observed and this is not confirmed by the export statistics, the import figures have been amended in the light of the export statistics. Also, where insufficient detail was available, the figures of the World Bureau of Metal Statistics were used.

The category of insulated conductors raised two specific problems:-

(i) in no country's trade statistics are insulated copper conductors distinguished from insulated aluminium conductors. Since aluminium is outside the scope of the survey, estimates of the proportion of each country's imports of insulated conductors which are of copper have had to be made. In general the bulk of aluminium conductors is used by the electricity authorities, so where the electricity authorities' demand for insulated aluminium conductors is known the total demand for insulated copper conductors has been estimated by subtraction; and

(ii) the quantities recorded in the import statistics refer to the total weight of insulation and conductor. It has been estimated that on average 40 per cent of the weight of the normal range of insulated copper conductors is accounted for by copper. This factor has been found to apply to the range of insulated conductors used by several authorities in a variety of countries in the Region and has also been confirmed by two cable importers.

Information on the output of the major copper fabrication plants in the Region was obtained during the field study. Sales of intermediate copper products (e.g. wire for insulation) to other fabrication plants were subtracted from total output and purchases of imported intermediate products were subtracted from total imports to avoid double counting. This is in accordance with the definition of demand for copper products used in this chapter which covers only purchases of copper and copper alloy products by firms not engaged in copper fabrication.

Information on the composition of demand by industry was obtained in the course of the field survey for the main users in the major countries. Certain industries could not, however, be covered by this method since they were too fragmented for the information to be gathered in the time available. For example, both the construction and engineering industries are typically divided into a large number of firms, many of them small in size. Estimates had therefore to be made of the demand for copper products from these industries in every country, subject in each case to the constraint provided by the estimated total demand for each product in the country. In the case of the construction industry demand for building wiring is known to account for about 1 per cent of construction costs - a figure confirmed through local interviews. In addition, certain products are invariably used predominantly in certain industries e.g. castings are used largely for the repair of locomotives, whereas tube fittings are used mainly in the construction industry.

Wherever possible import, production and demand figures were obtained for 1965, 1966 and 1967. The average for these three years was then taken to even out unrepresentative fluctuations which may occur in any one year.

3.3 Total Demand by Type of Product

The total demand for final products of copper in East and Central Africa in 1966 is estimated at 8,936 metric tons. This was broken down as follows:

Table 3.I - Composition of Demand in 1966 - Metal Content

Type 1	Copper and alloy semis (excluding wire)	- 1,599	metric tons
Type 2	Bare copper and alloy conductors	- 1,926	" "
Type 3	Copper and alloy manufactures and castings	- 1,038	" "
Type 4	Copper in insulated conductors	- 4,373	" "
		8,936	" "

Taken together, therefore, bare conductors and copper wire and cable in insulated conductors account for 6,299 tons which is 70 per cent of all copper products.

Copper semis are the next largest group, though they amount to only 18 per cent of the total. They are composed as follows:

Table 3.II - Composition of Demand for Copper and Alloy Semis in 1966

Sheet, plate & strip	- of copper	- 230 tons
	- of alloy	- 70 tons
Rods, bars and shapes	- of copper	- 190 tons
	- of alloy	- 290 tons
Tubes, pipes & fittings	- of copper	- 400 tons
	- of alloy	- 410 tons
Total semis	- of copper	- 820 tons
	- of alloy	- 780 tons
	Total.	-1,600 tons

N.B. The above table excludes demand for wire rod since it is further treated for manufacture into wire and cable. All 6,299 tons of wire and insulated wire and cable is, of course, ultimately derived from rod, though less than 1,000 tons is at present drawn from rod within the Region.

Copper manufactures and castings is the smallest group with current demand at a little over 1,000 tons. The largest component of this is believed to be castings, notably bronze castings. Also important are copper and brass nails, screws, nuts bolts and washers. Other items such as copper and brass containers, kitchenware, chains, brass buildersware, etc., each account for only small quantities.

3.4 Demand for copper by country

Table 3.III - Estimated Total Copper Consumption by Country in 1966

CENTRAL REGION	m. tons	EASTERN REGION	m. tons
Cameroon	311	Ethiopia	655
Chad	61	Kenya	784
C.A.R.	109	Madagascar	609
Congo (B)	156	Malawi	207
Congo (K)	2,432	Mauritius	231
		Somalia	61
		Tanzania	431
Total:	3,069	Uganda	409
		Zambia	2,480
		Total:	5,867

Total Eastern and Central Region = 8,936 metric tons

Table 3.III shows estimates for the total copper consumption by country in 1966, based in most cases on the average of figures for 1965, 1966 and 1967.

The two largest consumers are the Congo (K) and Zambia who together account for over half the total consumption of the Region. They are, of course, the only two countries producing refined copper and also the two most industrially developed countries in the regions largely on account of their mining industries. The orientation to copper of both countries, and of their traditional suppliers, Belgium and the U.K., has led to its use in preference to other materials even though much of the fabricated copper is imported.

No other country approaches either of these in terms of market size. All the other sizeable markets - Kenya, Ethiopia, Madagascar, Tanzania and Uganda are in the Eastern region; a reflection of its higher level of industrial development and larger population. The Cameroons are the only other sizeable market in the Central region, apart from the Congo (K).

3.5 Demand for copper by industry

Table 3.IV - Estimated Total demand for Copper by industry in 1966 in East and Central Africa

	Mining	Engineering	Other Manufacture	Construction	Power	Transport	Communications	Total
Total consumption of copper (tons)	1,344	1,200	516	2,625	1,316	972	963	8,936
% of Total consumption	15.0%	13.4%	5.8%	29.3%	14.7%	10.9%	10.8%	100.0%

Table 3.IV shows the estimated demand for copper by industry in 1966. The figures have been estimated on the basis of the field survey, product breakdown and total imports and production on a country by country basis. Purchases of intermediate products which are further processed and sold to another industry are ignored to eliminate double counting. For example, copper rod drawn into wire and insulated by the electrical engineering industry and then sold to the construction industry is counted only under the construction industry.

The main end user of copper is the construction industry which accounts for nearly a third of final demand.

3.6 Demand for copper by country and industry

Table 3.V shows the estimated consumption of copper in each country, analysed by industry, for 1966. Using these estimates and figures for the output of each industry in 1966 (derived from U.N. framework data), it has been possible to calculate input coefficients for each industry and country. These are shown in table 3.VI. Each coefficient represents the average amount of copper, in tons, required to produce $1m. of output in that industry and country.

There are very considerable variations in the coefficients from country to country. Some of these differences result from real differences in the structure and policy of each country's industry, but it should be remembered that both input and output data are, in many cases, unreliable or subject to wide margins of error. Individual coefficients should, therefore, be treated as orders of magnitude only.

Nevertheless, significant patterns and deviations do occur.

(i) The input coefficients of Zambia and the Congo (K) are abnormally high for almost all industries. This confirms that the relatively high consumption of these two countries results not only from their high industrial output but also from a predisposition to use copper.

(ii) The wide variation in the coefficients of the power industry partly represents differences in the extent to which copper has been replaced by aluminium. For example, Kenya, with a relatively low coefficient of 5.79, already uses mainly aluminium while Ethopia, with a high coefficient of 23.7 uses only copper.

Table 3.V - Estimated total demand for copper by country and industry in 1966 (metric tons)

Country	Mining	Engineering	Other Manufacture	Construction	Power Etc.	Transport	Communications	Total
Cameroons	–	53	20	116	69	37	16	311
Chad	–	4	2	32	14	2	7	61
C.A.R.	2	9	4	47	32	3	12	109
Congo (B)	1	14	8	42	51	6	34	156
Congo (K)*	453	392	106	573	380	485	43	2,432
Etniopia	20	66	55	226	204	37	47	655
Kenya	21	128	48	305	12	84	186	784
Madagascar	15	94	73	178	76	132	41	609
Malawi	2	43	14	62	38	18	30	207
Mauritius	–	30	16	116	34	10	25	231
Somalia	–	5	7	28	11	3	7	61
Tanzania	10	75	26	158	17	44	101	431
Uganda	16	78	11	162	21	41	80	409
Zambia	804	209	126	580	357	70	334	2,480
Total East & Central Regions	1,344	1,200	516	2,625	1,316	972	963	8,936

*Including Burundi and Rwanda

Table 3.VI - Input Coefficients for Total Copper (tons per $ mill)

Country	Mining	Engineering	Other Manufacturing	Construction	Power	Transport	Communications
Cameroons	–	3.27	0.133	3.71	5.61	0.426	1.28
Chad	–	1.38	0.0763	2.73	6.08	0.755	1.75
C.A.R.	–	3.09	0.159	5.73	15.6	0.158	4.00
Congo (B)	–	2.10	0.122	5.43	10.2	0.276	11.3
Congo (K) *	1.29	9.73	0.279	14.0	14.6	2.37	1.44
Ethiopia	10.5	6.73	0.571	3.90	23.7	4.22	36.1
Kenya	4.20	6.31	0.228	8.00	5.79	0.909	13.7
Madagascar	2.58	8.24	0.675	2.54	9.86	1.76	3.73
Malawi	–	17.2	0.598	4.59	11.9	1.15	13.0
Mauritius	–	2.70	0.153	4.72	4.59	0.436	7.35
Somalia	–	3.58	0.533	7.17	27.5	0.420	7.00
Tanzania	0.373	10.7	0.387	3.38	2.03	0.767	12.0
Uganda	0.976	7.29	0.108	5.74	1.65	1.02	13.6
Zambia	1.58	22.4	1.41	9.67	17.6	1.44	46.2
Total East & Central sub-regions	1.38	7.78	0.356	5.87	8.19	1.30	8.90

* Including Burundi & Rwanda

(iii) The construction industry shows a fairly uniform coefficient varying around the order of magnitude found in several European countries.

(iv) A major reason for variations between countries is the fact that demand for many copper products is related to the rate of expansion of output as well as the size of output. Consequently, those countries with a rapid expansion in, say, their telephone services may have higher coefficients for communications than countries whose systems, whether larger or smaller, are growing less fast. This is also true of the power industry - but is not the case with the construction industry whose requirements for copper are only a function of the level of output.

3.7 Consumption by industry and type of product in 1966

Table 3.VII shows estimated consumption by product and industry for the whole of the East and Central regions in 1966.

It will be seen that the principal end users of semis (Type 1) are the construction industry - which uses large quantities of tubes and fittings and most of the extruded shapes such as window frames etc. - and engineering which also takes a large quantity of tubes, mainly for repairing machinery, as well as some rod, sheet and shapes.

Roughly half of the bare wire and cable (Type 2) is used in the power and

communications industries for distribution of power and signals. The transport industry also uses a fairly large amount of overhead cable and trolley wire for electrified railway lines. The engineering industry uses it principally for the repair and manufacture of electrical machinery.

Type 3 consists of other manufactures and castings. A large proportion of castings is used in the repair and maintenance of railway locomotives and rolling stock. Screws, nuts, bolts etc. are largely distributed between the construction and engineering industries. Other manufactures also require castings for the maintenance of machinery and a fair proportion of miscellaneous manufactures have been attributed to this group.

The principal user of insulated wire and cable (Type 4) is the construction industry where it is used for household and industrial wiring. Large quantities are also used in the power industry though here much demand for cable is already met by aluminium (which is not included in this table). Other important uses are mining and telephone cables.

Table 3.VII - Type of Copper Consumed by Industry - 1966 in East and Central Africa (Metric tons)

INDUSTRY	Type 1 Semi-manufactures	Type 2 Bare wire & cable	Type 3 Other mfrs. & castings	Type 4 insulated copper wire & cable	TOTAL (metal content)
Mining	171	228	40	905	1,344
Engineering	318	366	200	316	1,200
Other manufactures	120	72	241	83	516
Construction	832	90	185	1,518	2,625
Power	26	386	8	896	1,316
Transport	124	226	360	262	972
Communications	8	558	4	393	963
TOTAL	1,599	1,926	1,038	4,373	8,936

3.8 Types of Copper used by country

Table 3.VIII shows the estimated consumption of copper by country and type of copper in 1966.

Table 3.VIII - Types of Copper consumed by Country in 1966

	Type 1	Type 2	Type 3	Type 4	TOTAL
Cameroun	47	74	60	130	311
Chad	4	9	4	44	61
C.A.R.	5	21	8	75	109
Congo (B)	20	23	13	100	156
Congo (K)	633	465	354	980	2,432
Ethiopia	47	295	100	213	655
Kenya	106	180	98	400	784
Madagascar	71	87	251	200	609
Malawi	27	44	6	130	207
Mauritius	42	8	20	161	231
Somalia	17	7	7	30	61
Tanzania	62	60	37	272	431
Uganda	98	53	20	238	409
Zambia	420	600	60	1,400	2,480
TOTAL East and Central	1,599	1,926	1,038	4,373	8,936

CHAPTER 4

THE COPPER FABRICATION INDUSTRY IN EAST AND CENTRAL AFRICA

Although the two sub-regions each contain one of the world's major suppliers of raw copper, the bulk of the copper products used in the Region is fabricated abroad and re-imported. However, there is already a fairly well developed fabrication industry in a number of countries within the Region. In this section we review the development of the regional copper fabrication industry and analyse the extent to which Regional demand is met by local production or could be met by existing capacity.

4.1. The Local Copper Fabrication Industry by Country and Process

There is a total of 15 copper fabrication plants existing or proposed in the two sub-regions. Of these, eight are in the Congo and three are planned in Zambia. Only twelve plants are currently in operation; these are listed with their location and the processes carried out in table 4.I. Plans and proposals to extend the range of processes carried out by these plants and to set up new ones are listed in table 4.II.

Only two of the plants carry out a wide range of fabrication processes. The first of these is Latreca which is at present the most important copper fabrication plant in either sub-region. The second is Zamefa which is in the process of being established in Zambia and will be the most up-to-date plant in the Region.

Rod rolling and extrusion plants

Latreca was founded during the second world war when the shortage of, and perils to shipping made the importation of raw materials to feed Congolese industry difficult and unreliable. Nonetheless the products of Congolese industry, particularly those of the mining industry, were in great demand to meet war needs. Consequently it was an economic proposition to produce semis and wire locally to supply the mines, railways and electricity authorities.

The plant was initially equipped with second-hand machinery. Originally it possessed plant only for rod rolling, wire drawing and cabling. In 1953 the firm was taken over by Société Cuivre et Zinc of Liége who installed a sheet rolling plant and an extrusion press. In addition to producing copper wire and cable, (which are its main products) rods and shapes, and tubes and sheet, Latreca also rolls a certain amount of zinc and aluminium sheet for roofing.

In Table 4.I Latreca is listed as possessing a foundry. This, however, is used almost entirely for casting ingots in the form of slabs and billets suitable for rolling to sheet and for extrusion. It also enables scrap to be recirculated. No casting of end products is carried out.

As most of Latreca's machinery was installed in 1944 and much of that installed then and since is secondhand, there are considerable problems of repair and maintenance. Furthermore, the machinery, though adapted and improved by Latreca's workshop, does not contain the refinements which enable modern equipment to improve quality and finish.

The capacity of Latreca's equipment (see table 4.III) reflects the availability of secondhand machinery during and after the war rather than the market potential or the requirements of a balanced plant. As a result of this and the low level of demand in recent years, Latreca has long been working below capacity. Furthermore, many individual items of equipment have capacities well below or above the plant they feed. For example, hot rolling (sheet) capacity is far greater than cold rolling capacity.

Table 4.I - Copper Fabrication Plants in Operation in 1966/67; Location and Processes Carried out in Each

Country	Town	Name of firm	Foundry	Sheet Rolling mill	Extrusion Press	Wire Rod Rolling Mill	Wire drawing and stranding	Insulation
Congo (K)	Lubumbashi	Latreca	Yes (for own requirements)	Yes	Yes	Yes	Yes	-
Congo (K)	Lubumbashi	Somkat	Yes	-	-	-	-	-
Congo (K)	Kinshasa	Chanimetal	Yes	-	-	-	-	-
Congo (K)	Lubumbashi	Texal	Yes	-	-	-	-	-
Congo (K)	Kinshasa	Splendor	-	-	-	-	-	Yes
Congo (K)	Kinshasa	Congacec	-	-	-	-	-	Yes
Congo (K)	Likasi	Congacec	-	-	-	-	Yes	Yes (coating)
Congo (K)	Likasi	Afromeche	-	-	-	-	Yes	-
Kenya	Nairobi	East African Cables.	-	-	-	-	Yes	Yes
Uganda	Jinja	Cable Corp. of Uganda Ltd.	-	-	-	-	(from 2.5mm. wire)	Yes
Ethiopia	Addis Ababa	Ethioplastics	-	-	-	-	Yes	Yes

Table 4. II - Copper Fabrication Plant Planned or Proposed: Location,new processes to be introduced and likely date of installation

Country	Town	Name of firm	Foundry	Sheet Rolling Mill	Extrusion Press	Wire Rod Rolling Mill	Wire Drawing and Stranding	Insulation
Congo (K)	Lubumbashi	Latreca (possibly with Congacec)	+	+	+	+	+	Possible*
Congo (K)	Kinshasa	Splendor	-	-	-	-	-	Yes ** 1969
Zambia	Luanshya	Zamefa (firm founded in 1968)	-	-	Yes 1969-70	Possible 1973	Yes 1969-70	Yes 1969-70
Zambia	Copperbelt	Continuous casting project	Possible* (for continuous casting)	-	-	-	-	-
Zambia	Kitwe	South Wales Electric Co.	-	-	-	-	Yes-1969 (transformer wire)	Yes-1969 (coating)
Uganda	Jinja	Cable Corporation of Uganda	-	-	-	-	Yes-1970++	Yes-1970++
Tanzania	Tanga	-	-	-	-	-	Project considered and temporarily rejected	

\+ Plant already existed in 1966/67. See Table 4.I.

* In the indefinite future. Progress conditional on technical or commercial factors.

++ At present draws down thick wire, will draw from wire rod.

** At present insulates only building wire, will extend range of types.

Fuller use of Latreca's excess capacity could, in principle, be made by exporting to neighbouring countries none of whom possess comparable copper fabrication facilities. In practice, however, exports have been low and fluctuating. Small quantities of all types of semis and bare cables are regularly exported, particularly to Zambia, but they meet only a fraction of Zambia's requirements. In 1965 large quantities of bare wire were exported to Afghanistan, Pakistan, Libya and South Africa but these sales have not been repeated. The reasons for this failure to penetrate export markets are not known: but it may be due partly to the quality of the product (which is unlikely to match that produced by modern mills); partly to a lack of competitiveness because production costs are high and marketing costs cannot be spread over a large volume of sales; and partly because little effort has been put into exporting.

Plans for the establishment of a plant to produce insulated telephone and power cables at Lubumbashi have been discussed with Congacec. If put into effect, these would create an additional outlet for Latreca's output of wire and cable, but until the profitability of the existing plant can be improved capital is unlikely to be forthcoming for the project.

An outline study of the implications of the establishment of such a plant was drawn up by I.R.E.S. in consultation with Latreca and published in 'Etudes sur la Diversification Industrielle du Congo'. This study suggests that the plant should operate in conjunction with Latreca's wire drawing and cable making department. It would produce low tension (under 1,000 v) house wire and power cable using only synthetic insulants. An annual output of 300 tons of house-wiring and 640 tons of armoured and sheathed underground cable was suggested. Total investment required was estimated at $1,200,000 and the annual turnover at $1,360,000 (assuming the categories manufactured accounted for 75% of imports). To make the plant competitive a tariff of 25 - 30%, as against the present level of 10% was recommended. In return, the Congolese economy would benefit by the creation of 127 jobs, the increased use of Latreca's capacity, and the saving of $510,000 of foreign exchange per annum.

It must be emphasised that the establishment of a plant on these lines is not imminent though its long term desirability is recognised.

Zamefa, (Metal Fabricators of Zambia Ltd.) was formed in 1968 to undertake the fabrication of wire, cable and extruded products at Luanshya on the Zambian Copperbelt. The five partners in this venture are the Government-owned Industrial Development Corporation, Phelps Dodge, Svenska Metallwerken International Corporation of New York, the two Zambian mining companies - Zambia Anglo American Corporation and Roan Selection Trust - and Continental Ore Company of New York.

A 1,250 ton extrusion press wil be installed to extrude copper wire rod, other copper and brass semis, and aluminium semis. The extrusion press will be capable of producing the equivalent of about 10,000 tons of copper wire rod per annum; but in practice it is planned to produce only some 3,000 tons per annum of wire rod, for the wire and cable mill; the remaining capacity is to be used for the production of other copper and brass semis and aluminium semis. The wire rod will be drawn to wire and the majority of it stranded and insulated. The cabling and insulating plant installed will be capable of producing a wider and more complex range of products than any currently in operation in the Region.

Although designed to meet the requirements of the local market, the project was based on an assumption that there would be a potential for exporting rod and bare and insulated wire and cable to neighbouring countries.

Future plans for the development of Zamefa are not known. However, it has been suggested that a rolling mill might be acquired before 1975. In this eventuality the

extrusion press would be used principally for the manufacture of shapes, strip etc. of copper and brass.

Continuous Casting Plant - Consideration was given in 1967 to the establishment of a continuous casting plant to produce oxygen free high conductivity copper. The rod would be cast direct from cathode copper thus by-passing the production of wire bars or billets and their subsequent rolling or extrusion into rod. This project has encountered technical difficulties and is unlikely to proceed until these problems have been overcome.

The principal market for the high quality product envisaged would be outside Africa and, for this reason the project falls outside the scope of this report. However, as a potential source of copper rod for subsequent wire drawing within the Region, the project could be significant.

Foundries

The three foundries in the Congo (K) (leaving aside Latreca which, as explained, casts only for internal use) make brass or bronze castings principally as replacement parts for the railways and for users of heavy machinery. In addition to these, various railway authorities do have small foundries to meet their own specific requirements. These are not detailed in the study.

Somkat is the most important of the three firms in Congo (K). It was set up to meet the needs of the Katangese mining and transport industry. Its principal activity, however, is not casting bronze but casting iron and steel. It has recently expanded capacity to meet increased local demand.

Texal, a neighbouring firm, is far smaller and meets the smaller jobbing orders which are of minor interest to Somkat.

Chanimetal is a highly diversified firm in Kinshasa which operates a ship repair yard, engineering shops, and a steel foundry as well as its bronze foundry. The latter has been operating below capacity for a long while.

Insulation Plants

There are five firms already producing insulated wire in the region. Zamefa, which was described above, when it enters production in 1969/70 will be the seventh and by far the largest and most versatile producer of insulated wire and cable. Two other insulation plants have been under consideration but are not likely to be established in the immediate future.

All existing plants produce only house wiring insulated with PVC. Zamefa will produce a wider range including power and telephone cables.

East African Cables is the largest of the five firms currently manufacturing insulated wire. It is also the only firm at present drawing its wire from rod. It produces some 120 different types of wire all for house wiring and domestic use. At present the 6mm rod used is imported from its parent company in the UK - Enfield Cables Ltd.

Splendor is the larger of the two firms insulating wire in the Congo (K). It purchases its wire from Latreca. Plans exist to produce lead sheathed cables for power and telephone authorities in 1969. In addition to making insulated wire, Splendor makes a range of plastic products.

Congacec (Kinshasa),the smaller of the two firms insulating wire in the Congo (K) is a subsidiary of ACEC, the Belgian electrical giant. It also imports products from its parent firm, but like Splendor, it insulates Latreca's wire. Its range of cables is

being increased to include up to 16 pair telephone cable in 1969. Congacec have been considering the establishment of a joint cable factory at Lubumbashi to produce power and telephone cables. The project is not likely to proceed in the immediate future.

The Cable Corporation of Uganda Ltd currently imports 2.5mm wire, draws it to the required size and insulates it with plastics for the Ugandan market. Plans are well developed to install additional machinery to draw from wire rod and equipment for making steel wire armoured low tension power cables. Aluminium rod will also be drawn to wire and insulated particularly for power cables. This will involve a tripling of capacity.

Ethioplastics - produces housewire from imported rod. It could in theory handle up to 600 tons of copper per annum but current throughput is only about 200 tons.

Tanzania - Detailed studies have been made for a proposed house-wiring plant to be established at Tanga. The project was to have involved drawing 2.6mm wire to fine wire, stranding and plastic insulation. Because of the limited size of the local market the project is unlikely to go ahead at present.

Other Manufacturers

The remaining firms undertake the fabrication of copper entirely for their internal requirements. Two are engaged in electrical repairs requiring winding wire. The third produces ignition fuses for mining explosives.

Congacec (Likasi) is the electrical repair workshop of ACEC's Congolese subsidiary. Repairs of all electrical equipment are undertaken, including much rewinding of electric coils. Wire is purchased from Latreca for this purpose but if special shapes or thicknesses are required Congacec possesses its own drawing machines.

South Wales Electric Company in Kitwe, Zambia rewind and manufacture electrical transformers. At present they import all their transformer wire but plans are under way to install drawing and coating facilities to meet these requirements. The annual capacity will be only about 50 tons.

Afromeche is the subsidiary of Gecomin producing very fine wire for explosive fuses. These are for use entirely within the mining company in its blasting operations. A potential export market could be Zambia, whose copper companies also use fuse wire but do not manufacture it themselves. However, this has not been exploited so far.

4.2. Estimated Output and Capacity of the Regional Copper Fabrication Industry

Table 4.III shows the estimated output of each plant in 1966. Where possible output has been averaged over the years 1965, 1966 and 1967 to obtain a representative level. Where details were not available, estimates have been made on the basis of local information to provide a rough guide to size.

The table indicates output at each stage of production so the total copper mentioned far exceeds the copper content of final output.

Comparison with table 4.IV, which shows the capacity of each plant, indicates that the industry is working well below its capacity. This is true principally of Latreca and is due partly to insufficient demand and partly to an imbalance in the capacity of complementary machines. Thus the rod rolling mill at Latreca could produce 7,000 tons of wire rod in a year (working 2 shifts), but the wire and cable plant can only handle 2,200 tons.

East African Cables have only recently begun production so do not expect to reach capacity for several years.

Table 4. III - Output of Existing Copper Fabrication Plants in 1966 (metric tons of metal)

Plant	Country	Foundry	Sheet Rolling Mill	Extrusion Press	Wire rod Rolling Mill	Wire drawing and cabling Plant	Insulation Plant
Latreca	Congo (K)	1,500	100	460	870	700	-
Somkat	Congo (K)	150 (will be 240)	-	-	-	-	-
Chanimetal	Congo (K)	25	-	-	-	-	-
Texal	Congo (K)	20	-	-	-	-	-
Congacec (Kinshasa)	Congo (K)	-	-	-	-	-	20
Splendor	Congo (K)	-	-	-	-	-	180
Congacec (Likasi)	Congo (K)	-	-	-	-	50	-
Afromeche	Congo (K)	-	-	-	-	50	-
East Africa Cables Ltd.	Kenya	-	-	-	-	200	200
Cable Corporation of Uganda	Uganda	-	-	-	-	100 (1967)	100 (1967)
Addis Ababa	Ethiopia	-	-	-	-	200	200

Table 4. IV - Capacity of Existing Copper Fabrication Plants in 1966 (metric tons of metal - two shift working)

Plant	Country	Foundry	Sheet Rolling Mill	Extrusion Press	Wire rod Rolling Mill	Wire Drawing and Cabling Plant	Insulation Plant
Latreca	Congo (K)	3, 500	Hot rolling 3, 500 Cold " 500	3, 500	7, 000	2, 200	-
Somkat	Congo (K)	180	-	-	-	-	-
Chanimetal	Congo (K)	100	-	-	-	-	-
Texal	Congo (K)	40	-	-	-	-	-
Congacec	Congo (K)	-	-	-	-	-	e. 100
Splendor	Congo (K)	-	-	-	-	-	e. 300
Congacec	Congo (K)	-	-	-	-	e. 100	-
Afromeche	Congo (K)	-	-	-	-	n.a.	-
East African Cables Ltd.	Kenya	-	-	-	-	600	600
Cable Corporation of Uganda	Uganda	-	-	-	-	150	150
Addis Ababa	Ethiopia	-	-	-	-	600	600

e. = estimated
n.a. = not available

Table 4.V - Capacity of Planned or Expanded Copper Fabrication Plants (metric tons of metal - two shift working)

Plant	Country	Foundry	Sheet Rolling Mill	Extrusion Press	Wire rod Rolling Mill	Wire drawing and cabling Plant	Insulation Plant
Latreca (Congacec)	Congo (K)	+	+	+	+	+	Power cable plant Capacity unknown (Indefinite future)
Somkat	Congo (K)	240 (since 1968)	-	-	-	-	-
Splendor	Congo (K)	-	-	-	-	-	(1969) - Power cables* New capacity unknown
Zamefa	Zambia	-	-	10,000 (1969/70)	20,000 Possibly (1973)	5,000 (1969/70)	5,000 (1969/70)
Continuous Casting projects	Zambia	Possibly 7,000 (Idefinite future)	-	-	-	-	-
South Wales Electric Co.	Zambia	-	-	-	-	50 (1969)	50 coating (1969)
Cable Corporation of Uganda	Uganda	-	-	-	-	500*	500* (1969/70)
Proposed plant at Tanga	Tanzania	-	-	-	-	Possibly 500 (Indefinite future)	Possibly 500 (Indefinite future)

* For existing capacity see Table 4.IV

South Wales Electric Company expect to have a small amount of excess capacity above their own requirements for a number of years which would be available for jobbing orders.

Both Congolese housewiring firms have spare capacity, possibly larger than that indicated, owing to the relatively depressed state of demand.

4.3. Local Production as a share of total demand

Table 4.VI shows local output as a share of total demand for end products in 1966. A third of semis used as end products are already produced locally. All the locally produced semis are made by Latreca and, apart from a very small quantity exported mainly to Zambia, they are consumed within the Congo.

The major part of Regional (i.e. Latreca's) production of semi-manufactures consists of shapes, rods and bars and 83 per cent of demand for these categories is met locally. This is principally because the only major demand for extruded shapes (there is little demand for rods and bars) comes from the Congolese building industry. Other countries without locally produced copper and brass products tend to use cheaper materials such as aluminium or steel for builders' hardware. A third of the demand for copper sheet, that is to say the Congolese share of demand, is met by Latreca. Other countries import the remaining two-thirds from outside the Region. Tubes, pipes and fittings is the largest category of semi-manufactures used as a final product yet less than 10 per cent is produced locally. This is believed to be because the small press at Latreca can extrude only small diameter tubes and consequently even the Congo currently imports a substantial proportion of its requirements of tubes.

Less than a quarter of the demand for bare conductors is met locally. However, there is more than adequate capacity in Latreca to meet the total demand.

Table 4.VI - Local Production as a Share of Total Demand in 1966

		Estimated total consumption	Estimated local production	Estimated by local production
		tons	tons	%
Type 1.	Semi-manufactures (except wire)	1,599	560	35
	of which sheet, plate and strip	300	100	33
	Shapes, rods * and bars	480	400	83
	Tubes, pipes and fittings	810	60	7
Type 2.	Bare conductors	1,926	450	23
Type 3.	Other manufactures and castings	1,038	200	19
Type 4.	Insulated copper conductors	4,373	700	16
	TOTAL	8,936	1,910	21

* excluding wire rod.

A fifth of the category 'other manufactures and castings' is produced locally. This is a miscellaneous category, the biggest item within it, however, is probably castings of brass and bronze for repairing transport equipment and heavy machinery. The Congo (K) is virtually self-sufficient in this, but there is little opportunity for export as the main plant is working at full capacity and the nature of demand is such as to require close co-operation between client and foundry. The other major items are nuts, bolts, nails, screws etc. in copper and alloy, domestic appliances such as pots and pans, sanitary and builders' fittings and a number of miscellaneous items made wholly of copper or alloys. None of these are manufactured locally except possibly at an artisan level.

Only sixteen per cent of insulated conductors was produced locally. The proportion is rising as the output of the East African Cables Company and the Cable Corporation of Uganda grows. Even so, current local capacity could meet little more than 40 per cent of Regional demand. All the Region's plants are, of course, insulating with PVC and at present produce only housewiring and the simpler domestic telephone wires. The larger and more complex cables, e.g. power, telephone and mining cables, all have to be imported. The situation will be improved when Zamefa comes into production. Initial capacity will be about 5,000 tons of copper cables insulated in PVC and polythene, though only 3,000 tons of copper will be produced as the remaining capacity will be used for aluminium. Zamefa will have equipment to produce steel wire armoured and multi-cored cables enabling it to extend the range of cables produced. Splendor is also intending to introduce machinery to manufacture more complex power and telephone cables locally and Latreca have been considering producing both telephone and power cables in co-operation with Congacec.

It is possible to obtain an approximate functional breakdown of insulated cables by considering the breakdown by user industry. (See Table 3.VII). The existing plants in the Region can supply only housewiring. The demand for insulated wire and cable from the construction industry was estimated to be about 1,520 tons in 1966. On the assumption that local industry could produce types of cable accounting for 90 per cent of this, the demand capable of being met by local production was roughly 1,400 tons of housewiring. A small proportion of demand for insulated wire and cables from other industries is essentially for types similar to that used for housewiring. This may raise demand for housewiring to about 1,700 tons. Maximum current insulation capacity is believed to be somewhat above this level - about 1,450 tons. The new plant to be introduced by Zamefa will raise this capacity by some 3,000 tons (though Zamefa will also be producing cables other than for housewiring).

Current demand from the telephone authorities is estimated at roughly 400 tons of insulated copper. Splendor, Zamefa and possibly Latreca/Congacec all aim to be able to produce the types of cable required. Their joint capacity will presumably exceed current demand.

The mining industry accounted for about 900 tons of cables much of which was of specialised types. Zamefa aim to produce cables suitable for mining use, as would Latreca/Congacec.

The power industry also uses special cables accounting for much of its 930 tons consumed in 1966. Again Zamefa and Latreca/Congacec would aim to produce cables suitable for most of their requirements. It should be pointed out, however, that Zamefa plan to produce cables based entirely on synthetic insulants, PVC or polythene, and steel wire armouring. Conventionally, power cables have used paper or oil impregnated paper as an insulant, often with a lead sheathing. Other types - especially mining cables - have rubber sheathing. A process of re-education of the consumer will in many cases be required if the locally produced cable with synthetic

insulation is to prove acceptable. This may require governmental pressure on users to speed the changeover.

To summarise existing wire and cable plants (which at present only produce housewiring), have capacity to meet about three-quarters of the 1966 regional demand for housewiring. Zamefa will have sufficient capacity to meet the remaining 25 per cent while still leaving capacity to produce some 2,700 tons of power, mining or telephone cables for which regional demand was 2,200 tons. Splendor's development plans, which are certain, and those of Latreca/Congacec, which are more problematical, are likely to raise capacity considerably above the 1966 level of demand for these types of cable. Moreover, not all the remaining demand for cables, some 600 tons of miscellaneous types, is likely to be susceptible to manufacture in existing or planned plants.

It must be re-emphasised that Table 4.IV shows only the demand for final products and excludes intra industry trade between copper fabrication plants. If all the insulated cables had been produced locally total demand for copper wire and cable would have been 6,300 tons.* Had this been drawn from locally made rod, demand for rod would have been roughly 7,900 tons (allowing 20 per cent for scrap). Latreca has roughly sufficient capacity to produce all this rod (capacity is up to 7,000 tons p.a. working only two shifts) though it is doubtful whether the quality and specifications of its rod would meet the requirements of all wire drawers. Total wire drawing capacity in the Region, however, is only about 2,200 tons. Zamefa will increase that capacity by up to 5,000 tons, meaning that the Region will be self-sufficient for wire at the 1966 level of demand, even if all insulated cable were made from local wire. Zamefa will also add to the capacity for production of wire rod (currently sufficient at the 1966 level of demand) but Zamefa's rod is likely to be superior in quality to that of Latreca. This is because it is possible to produce rod virtually free of surface oxidation by extrusion whereas rolling, particularly on Latreca's relatively slow mill, allows a certain amount of oxidation which may be rolled into the rod.

* See Table 3.I.

CHAPTER 5

FUTURE DEMAND FOR COPPER PRODUCTS

5.1 Method of Forecasting

There are two possible ways of forecasting future demand for copper products. The first is to project past trends into the future. This approach has been rejected for a number of reasons:

(i) the recent past of most countries includes a period of colonial administration and a period of post colonial reorientation. In neither period is the past pattern of demand likely to be indicative of future developments;

(ii) the data for several countries are only available for a relatively few years. This is particularly true of Malawi and Zambia who, up to 1963, were members of the Central African Federation and because of this little data is available on the individual member countries until 1964; and

(iii) much of the data is subject to fairly large margins of error so that year to year changes have no statistical significance. In addition, many of the products considered in this survey are associated with large, discrete capital investment projects. Consequently buying occurs unevenly and year to year changes have little significance.

The second method relies on finding an empirical or theoretical relationship between the demand for copper products and a set of variables susceptible to firm prediction. Predictions are made of the future value of these variables, from which the likely demand for copper is calculated. This, with various modifications, is the method adopted in this report.

Estimates have been made of the current consumption of each type of copper product in each industry for each country. On the basis of this data, input coefficients have been calculated for each industry and type of product by dividing the consumption of copper by gross output. Projecting the growth of output of each industry on the basis of the planning decisions made by each country, and adjusting the input coefficients for predictable variations in copper use, it is possible to derive the likely future demand for copper.

5.1.1 The Input Coefficients. Table 5.I shows the average input coefficient for each type of copper product for each industry in the region. In fact, to calculate future demand, input coefficients were estimated for each type of product in each industry in each country. This tends to reduce the statistical variance of the final answer even though the 420 individual coefficients are subject to such margins of error as to be of little individual significance.

Table 5.I - Input coefficients for each type of copper product by industry in 1966
(tons of copper & alloy /$ millions)

	Mining	Engineering	Other Manufacturing	Construction	Power	Transport	Communications
Type 1 Semi Manufactures	.187	2.09	.0832	1.88	.160	.171	.0751
Type 2 Bare Conductors	.250	2.40	.0499	.203	2.37	.311	5.24
Type 3 Other Manufactures and Castings	.0438	1.31	.167	.417	.0491	.496	.0376
Type 4 Insulated Copper Conductors	.992	2.07	.0576	3.42	5.50	.361	3.69
Total All Types	1.47	7.87	.358	5.92	8.08	1.34	9.04

The principal change in the input coefficients to be expected by 1975 and 1980 will result from the substitution of cheaper or recently developed alternative materials for copper, principally aluminium. A detailed discussion of the factors affecting substitution is given in appendix B. The main conclusions are:

(a) the principal trends in substitution in Africa can be expected to be similar to those occurring in Europe. This is inevitable because, at present, Africa does not possess technologically advanced copper or aluminium industries so that new products, developments and uses must be initiated largely by foreign suppliers;

(b) substitution of copper by other materials is not simply the result of the exceptionally high price of copper over the last few years. Even at a historically more normal copper price, aluminium has a considerable cost advantage in most areas threatened by substitution. The increasing use of aluminium therefore depends on the surmounting of the technical problems faced by users and fabricators. However, the rate of substitution may be accelerated by a high copper price;

(c) the price of copper is likely to remain historically high for a number of years although it can ultimately expect to fall if military demand decreases, recently discovered reserves are bought into production and substitution reduces the growth of demand. Even at a lower price of copper, substitution which has taken place will not be reversed;

(d) the principal areas in which copper is vulnerable are

(i) overhead conductors - in many countries of the Region copper is already no longer used for these,

(ii) underground power cables, particularly those requiring few connections; replacement is already well advanced in a number of countries in the Region.

(iii) aluminium is likely to be used increasingly in electrical coils (e.g. transformers, generators etc.), this will reduce demand for replacement wire but only towards the end of the period, and

(iv) copper tubes for water and heating are vulnerable to galvanised steel and plastics. The latter is not yet proved suitable for hot water tubes. The main effect will be to encourage the use of thin walled tubing thereby reducing copper input by 25 per cent.

(e) copper is likely to be reasonably safe at least until 1975 in

(i) telephone wires and cables though these are increasingly made in aluminium in the U.K.

(ii) household wiring, where aluminium is only likely to be a threat if governments encourage its use, and

(iii) mining cables, where requirements for very thick insulation, flexibility and limpness encourage the retention of copper - as does the natural preference of the copper mining companies.

Certain coefficients have had to be adjusted for reasons other than general trends in substitution. For example construction has a very high coefficient for Type 1 copper. This is due to the traditional use of locally made brass and copper fittings, particularly in the Congo. It cannot be expected that these expensive materials will be used so much in the future when locally made aluminium, steel and possibly zinc fittings become available within the Congo.

The net result of these expected changes is shown in the set of average modified input coefficients for each industry in Table 5.II. The modified coefficients have been weighted by the predicted output of each country to work out the average coefficients shown in this table. As a result some of the substitution effects are masked by changes in weighting. For example, the input coefficients for bare conductors in the power sector have been reduced in every country but the average coefficient in 1980 is higher than in 1966 because the output of electricity is expected to grow fastest in countries with above average coefficients.

The principal changes made, however, are

(i) a reduction in the input coefficient for bare conductors in the power sector;

(ii) a reduction in the input coefficient for insulated conductors in the power sector;

(iii) a reduction in the input coefficient for semi-manufactures in the construction sector.

Table 5.II - Adjusted input coefficients for copper products by type of product and industry in 1975 & 1980

1975

	Type 1 Semi-Manufactures	Type 2 Bare Conductors	Type 3 Other Manuf. & Castings	Type 4 Insulated Copper Conductors	Total
Mining	.153	.316	.0371	1.04	1.55
Engineering	1.72	2.04	1.29	2.92	7.97
Other Mfg.	.120	.0595	.165	.0554	.400
Construction	1.64	.158	.296	3.36	5.45
Power	.182	2.56	.0776	3.59	6.41
Transport	.202	.320	.480	.392	1.39
Communications	.0712	6.83	.135	3.43	10.5

1980

	Type 1 Semi-Manufactures	Type 2 Bare Conductors	Type 3 Other Manuf. & Castings	Type 4 Insulated Copper Conductors	Total
Mining	.148	.328	.0376	1.11	1.62
Engineering	1.60	2.44	1.29	2.45	7.78
Other Mfg.	.103	.0572	.171	.0538	.385
Construction	1.84	.127	.250	3.49	5.71
Power	.190	2.23	.0821	2.36	4.86
Transport	.201	.358	.467	.385	1.41
Communications	.0730	7.34	.135	4.58	12.1

5.1.2 Projected Output Table 5.III shows projected output by industry and country in 1975 and 1980. Output has been estimated from value added using ratios developed by Komorowski*. The projected value added for most sectors was obtained from the UNECA reference frameworks for Central Africa+ and East Africa. As these referred to broader industries than was required for this analysis, additional estimates had to be made for engineering, transport and communications. Komorowski's estimates for engineering have been accepted for the Central sub-region. For the Eastern sub-region, the projections made by the UNECA in E/CN 14/INR/90, 'The Development of the Engineering Industries in East Africa'. have been used.

Demand for each type of product in 1975 and 1980 is obtained by multiplying the output of each industry in each country by its input coefficient. The aggregate results are discussed overleaf.

5.2 Total Demand for Copper Products in 1975 and 1980

Total demand for copper of all four types will rise to some 21,400 tons in 1975 and 33,600 tons in 1980. This compares with the estimated consumption of 8,940 tons in 1966. The estimated average compound rate of growth over the fourteen year period is therefore 9.9 per cent per annum. This compares with a predicted growth rate for the regional economy as a whole of between 5 and 6 per cent per annum during this period.

5.2.1 Demand for Copper Products by type

Table 5 IV. shows the predicted changing pattern of copper consumption.

* UNECA - The non-ferrous metals industry in Central Africa - Komorowski.

\+ Lacroix' Reference Framework for Sectoral Studies in Central Africa.

Table 5.III - Part (i) Projected gross output by industry and country in 1975 ($ millions)

	Mining	Engineering	Other Manufacturing	Construction	Power	Transport	Communication	Total
Congo (K)	240.0	132.8	1,334.0	203.0	63.5	233.2	34.4	
Cameroon	3.3	57.4	326.6	125.0	35.4	149.2	22.1	
Congo (B)	13.3	33.1	123.0	30.0	16.9	31.3	4.7	
C.A.R.	26.6	8.7	79.0	41.0	20.0	35.8	5.3	
Chad	–	2.9	97.0	69.0	6.1	49.9	7.4	
Central sub Region	283.2	234.9	1,959.6	468.0	141.9	499.4	73.9	
(Brundi)	–	9.7	37.0	9.2	2.0	12.0	1.8	
Ethiopia	15.0	28.8	232.8	103.6	23.2	89.3	13.2	
Kenya	17.0	106.1	314.2	88.8	39.6	132.6	19.6	
Madagascar	7.1	50.5	275.9	128.8	27.5	102.9	15.2	
Malawi	1.0	4.4	89.2	21.4	11.2	21.9	3.2	
Mauritius	.4	16.9	209.4	37.7	11.3	32.0	4.7	
Ruanda	7.9	9.5	16.9	9.0	1.9	11.3	1.7	
Somalia	–	5.8	31.0	7.9	1.9	9.7	1.4	
Tanzania	51.5	136.3	98.5	96.3	25.5	94.4	14.0	
Uganda	25.5	44.1	259.1	69.1	25.8	70.3	10.4	
Zambia	613.9	82.9	385.4	151.7	49.1	87.0	12.9	
Eastern sub Region	739.3	495.0	1,949.4	723.5	219.0	663.4	98.1	
Total Central & Eastern sub-Regions	1,022.5	729.9	3,909.0	1,191.5	360.9	1,162.8	172.0	

Table 5.III - Part (ii) Projected gross output by industry and country in 1980 ($ millions)

	Mining	Engineering	Other Manufacturing	Construction	Power	Transport	Communication
Congo (K)	312.0	252.6	1,825.0	472.0	135.0	275.8	40.8
Cameroon	6.6	134.6	544.1	197.0	47.8	199.8	29.6
Congo (B)	25.0	112.6	141.0	45.0	29.7	37.7	5.6
C.A.R.	43.0	23.0	150.0	65.0	40.3	50.5	7.4
Chad	–	5.0	238.0	86.0	12.3	70.0	10.3
Central Sub-Region	386.6	527.8	2,898.1	865.0	265.1	633.8	93.7
Burundi	–	17.1	57.5	14.9	4.1	14.5	2.2
Ethopia	25.7	54.0	393.6	142.7	39.2	114.6	16.9
Kenya	25.3	172.8	448.8	138.9	62.1	162.7	24.1
Madagascar	12.2	93.8	456.9	147.0	54.0	126.8	18.7
Malawi	2.0	9.3	173.6	27.7	21.6	26.2	3.9
Mauritius	.5	26.2	291.3	46.9	24.3	38.0	5.6
Ruanda	14.0	19.3	26.7	19.2	4.1	17.1	2.5
Somalia	–	10.5	50.7	11.7	4.1	11.5	1.7
Tanzania	89.0	256.3	143.9	143.3	45.9	124.2	18.4
Uganda	37.3	70.9	372.5	127.8	37.8	94.8	14.0
Zambia	833.2	117.3	468.7	172.5	81.0	119.5	17.7
Eastern Sub-Region	1,039.2	847.5	2,888.2	992.6	378.2	849.9	125.7
Total Central & Eastern Sub-Region	1,425.8	1,375.3	5,786.3	1,857.6	643.3	1,483.7	219.4

Table 5. IV Demand for copper products by type in 1966, 1975 & 1980 & growth of demand

		Type 1 Semi- manufactures.	Type 2 Bare Conductors	Type 3 Other Manufactures	Type 4 Insulated Conductors	TOTAL
1966	Tons	1,600	1,930	1,040	4,370	8,940
	%	17.9	21.6	11.6	48.9	100.0
1975	Tons	4,150	4,700	2,590	9,980	21,420
	%	19.3	21.9	12.1	46.6	100.0
1980	Tons	6,860	7,970	4,060	14,680	33,570
	%	20.4	23.7	12.1	43.7	100.0
Average rate of growth p.a. 1966-1980 %		11.0	10.6	10.3	9.0	9.9

There are no very major changes in the consumption pattern predicted by our analysis. However, it is important that demand for insulated copper conductors is rising less rapidly than for other products. This is largly because of the substitution of aluminium for copper expected in many types of insulated cable.

There is less scope for substitution of aluminium for copper in bare conductors since aluminium is already used for this purpose by a number of electricity authorities.

Demand for manufactures and for bare conductors is expected to rise fastest and they are increasing their proportion of the total output.

It is not possible from the available data to predict changes in the composition of each of the four broad categories. Assuming that the pattern remains much the same as at present future demand for semis can be broken down as follows:-

Table 5.V Demand for semis for end use in 1966, 1975 and 1980

(tons)

			1966	1975	1980
Sheet, plate or strip	-	copper	230	600	990
	-	alloy	70	190	310
Rods, bars and shapes	-	copper	190	490	810
	-	alloy	290	760	1,250
Tubes, pipes & fittings	-	copper	400	1,040	1,720
	-	alloy	410	1,070	1,780
Total semis	-	copper	820	2,130	3,520
	-	alloy	780	2,020	3,340
	-	both	1,600	4,150	6,860

The above table, of course, excludes semi-manufactures and wire used for conversion into other products of the copper fabrication industry. Thus demand for wire drawing is not included; nor is demand for bare wire for insulation.

If all insulated and bare copper conductors were manufactured locally, demand for wire rod would be a total of 28,300 tons by 1980, allowing twenty per cent for scrap (total requirement for both bare and insulated copper conductors being 22,650 tons by 1980).

5.2.2 Demand for copper products by country in 1975 and 1980

Table 5. VI shows projected demand by country and type of copper in 1975 and 1980.

Table 5. VI - Projected Demand for Copper by Country & Type of Product in 1975 & 1980 (tons)

1975

Country	Type 1 Semi-Manufactures	Type 2 Bare Wire & Cable	Type 3 Other Manuf. & Castings	Type 4 Insulated copper wire and cables	Total
Cameroon	142	187	128	401	863
Chad	15	17	13	188	233
C.A.R.	19	96	32	318	465
Congo (B)	62	62	35	234	393
Congo (K)	1,445	946	679	2,211	5,291
Ethiopia	147	928	326	665	2,066
Kenya	459	518	189	708	1,874
Madagascar	137	212	592	379	1,320
Malawi	39	91	14	206	350
Mauritius	55	11	28	233	327
Somalia	36	17	17	67	137
Tanzania	295	108	237	1,109	1,749
Uganda	221	115	43	798	1,177
Zambia	1,076	1,393	256	2,460	5,185
TOTAL	4,148	4,700	2,589	9,978	21,415

1980

Country	Type 1 Semi-Manufactures	Type 2 Bare Wire & Cable	Type 3 Other Manuf. & Castings	Type 4 Insulated copper wire and cables	Total
Cameroon	255	332	258	596	1,441
Chad	19	28	25	238	310
C.A.R.	32	181	61	494	768
Congo (B)	121	198	66	361	746
Congo (K)	2,828	1,551	1,017	3,909	9,305
Ethiopia	215	1,431	497	936	3,079
Kenya	717	753	271	1,071	2,812
Madagascar	199	362	953	491	2,005
Malawi	63	225	25	302	615
Mauritius	75	17	37	293	422
Somalia	59	27	27	89	202
Tanzania	522	791	428	1,882	3,623
Uganda	384	166	62	936	1,548
Zambia	1,373	1,908	335	3,080	6,696
TOTAL	6,862	7,970	4,062	14,678	33,572

5.2.3 Demand for copper products by industry.

Table 5.VII shows the changing pattern of demand by industry between 1966 and 1980.

Table 5.VII - Estimated Demand for Copper Products by Industry 1966, 1975 and 1980

		Mining	Engineering	Other Manufactures	Construction	Power	Transport	Communication	TOTAL
1966	tons	1,344	1,200	516	2,625	1,316	972	963	8,936
	%	15.0	13.4	5.8	29.4	14.7	10.9	10.8	100.0
1975	tons	1,579	5,816	1,565	6,504	2,375	1,622	1,954	21,415
	%	7.4	27.2	7.3	30.4	11.1	7.6	9.1	100.0
1980	tons	2,208	10,709	2,228	10,543	3,131	2,094	2,660	33,572
	%	6.6	31.9	6.6	31.4	9.3	6.2	7.9	100.0

Table 5.VIII - Projected Demand for Copper Products by Type and Industry in 1975 and 1980 (tons)

Industry	Type 1 semi-manuf.	Type 2 Bare wire & cable	Type 3 Other manuf. & castings	Type 4 Insulated copper wire and cable	TOTAL
1975					
Mining	157	323	38	1,061	1,579
Engineering	1,253	1,485	943	2,135	5,816
Other manufacturing	471	233	645	216	1,565
Construction	1,954	188	353	4,009	6,504
Power	66	924	28	1,357	2,375
Transport	235	372	559	456	1,622
Communications	12	1,175	23	744	1,954
TOTAL	4,148	4,700	2,589	9,978	21,415
1980					
Mining	210	467	54	1,477	2,208
Engineering	2,203	3,357	1,778	3,371	10,709
Other manufacturing	595	331	991	311	2,228
Construction	3,418	236	464	6,425	10,543
Power	122	1,437	53	1,519	3,131
Transport	298	532	693	571	2,094
Communications	16	1,610	30	1,004	2,660
TOTAL	6,862	7,970	4,062	14,678	33,572

It will be seen that the most rapid growth is expected in the engineering industries whose share of total copper consumption is expected to rise from 13 per cent to 32 per cent between 1966 and 1980. This is principally because of the very high projected growth rate for this industry in the sub-regional development plans of the UNECA (see Table 5.III), particularly for the Eastern sub-region. If this rate of growth is not achieved as envisaged, the demand for copper in the Region will be reduced substantially.

The share of copper taken by the electricity authorities is expected to fall, as a result of aluminium substitution, despite a more twofold increase in their absolute requirements. The mining industry's share is also expected to fall but this is because of the relatively low rate of growth expected for this already well developed industry.

5.2.4 Projected demand for copper products by industry and type in 1975 and 1980

Table 5.VIII shows the projected demand for copper by industry and type in 1975 and 1980.

Engineering, which by 1980 is expected to be the largest generator of demand for copper, will require large quantities of each type of copper. It will be by far the largest user of bare conductors - almost all of which will be used in electrical engineering applications e.g. making electric motors, transformers, resistors etc. and rewinding and repairing electrical equipment. We do not expect substitution of aluminium wire for copper in these applications to become widespread in the Region before 1980.

The most important user of insulated copper conductors will increasingly be the construction industry where competition from aluminium is not expected to be significant before 1980.

The majority of semi manufactures will go to either the construction or the engineering industries - mainly tubes and extruded shapes are involved.

CHAPTER 6

TECHNOLOGY OF COPPER FABRICATION

6.1 Introduction

It is more appropriate to discuss copper fabrication in terms of the processes involved than of the products made since some products can be made by several different methods. For example, rod may be extruded from billet, rolled from wire bar or obtained from one of several types of continuous cathode-to-rod process. There are eight principal types of fabrication within the scope of this survey: foundry work, continuous cathode-to-rod processes, sheet rolling, rod rolling, extrusion, tube piercing, wire drawing and cable making (including insulation). The order in which the various processes are considered in this chapter follows that of actual production so far as is possible.

6.2. Description of inputs.

Raw copper may be purchased in, or converted into a number of forms, the type selected varying in accordance with the process to be used. The various main types of input are as follows.

6.2.1. Cathode

Unmelted plate produced by electrolytic refining. The customary size is about 90 cm. square and about 1.25 cm. to 2.25 cm. thick, weighing up to 125 kg. It must be melted before use in fabrication.

6.2.2. Ingot and Ingot bar.

Refinery shapes designed primarily for their handling convenience. Usually made from refined scrap, although some blister copper (or occasionally cathode) may be used to sweeten the charge and improve its quality. They are remelted for alloy production (not used for fabrication directly). Ingots usually weigh from 9 kg. to 16 kg. and ingot bars from 23 kg. to 32 kg.

6.2.3. Wire Bar.

The most widely used and handled refinery shape for rolling to rod (subsequently drawn to wire) and also to strip. A 9 cm. to 13 cm. square in cross section usually from 1.0 m. to 1.4 m. in length and weighing from 60 kg. to 190 kg. When cast horizontally, it is tapered at both ends to facilitate entry between the rolls. It is sometimes cast vertically complete with nose, otherwise the end is pointed by machining.

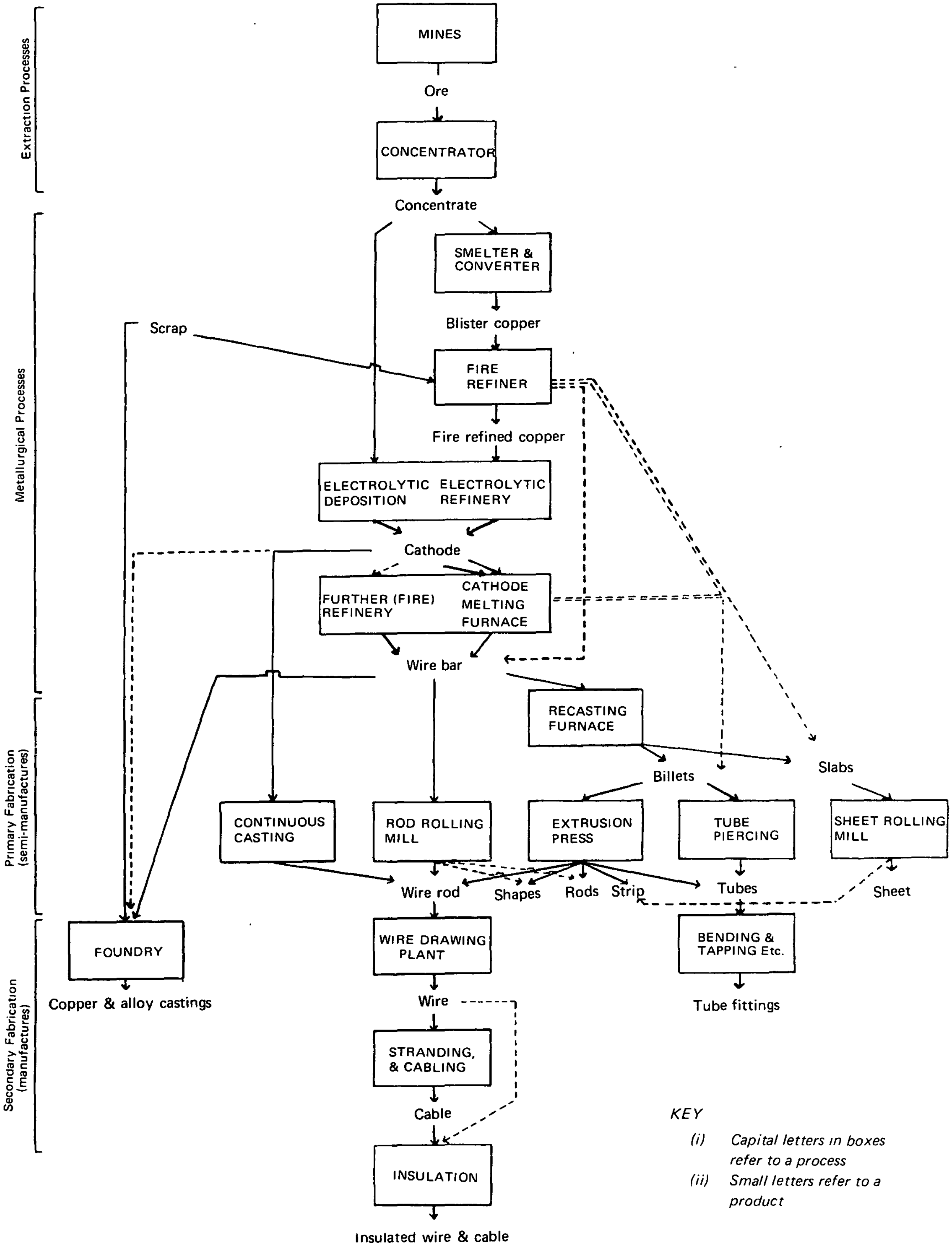
6.2.4. Slabs and Cakes

These are refinery shapes for rolling into plate, sheet, strip or shape. They are rectangular with a variety of cross sections. Cast either horizontally or vertically, they have a range of weights from 64 kg. to 1,800 kg. or more.

6.2.5. Billet.

This is the refinery shape primarily used in extrusion presses for manufacturing tube, rod, wire rod and strip. Circular in cross section they are usually 7.5. cm. to 25 cm. in diameter, with lengths of up to 1.3 m. and weigh from 45 kg. to 680 kg. or more.

Fig. 6. I - Flow Chart of the Copper Mining and Fabrication Industry.



6.3 Casting.

There are two broad types of foundry which produce castings - those which cast a wide variety of shapes (usually from brasses or bronzes), for end consumers, and those producing a few specific shapes (commonly of copper) for further fabrication. The former largely form a craft industry and can be operated, from technical considerations alone, on a very small scale. The latter normally require a mechanised production process, as they concentrate on the production of much longer runs of far fewer products.

A brass foundry producing ingots for subsequent fabrication will customarily employ electric induction furnaces and the smallest of these produces a theoretical output of about $\frac{3}{4}$ ton per hour. An annual furnace reconstruction will be necessary, and this may be expected to take between 4 and 6 weeks under African conditions. The more furnaces there are the better, in terms of raising the actual output as near to the theoretical as possible. It has been suggested, although detailed figures are not presently available to support the assertion, that if three furnaces are employed, the achieved output may be expected to constitute about $\frac{2}{3}$ of the theoretical, if two furnaces are employed the proportion will be around $\frac{1}{2}$, and if one furnace is employed about $\frac{1}{3}$ of theoretical output is all that may be expected. This suggests that furnaces near the minimum available size will be employed, if there are no other economic considerations which counterbalance the supposed potential savings.

If three furnaces are used each of which has a potential output of $\frac{3}{4}$ ton per hour, the output produced by two shift working will lie between 5,000 and 6,000 tons of castings per year.

Additional requirements for a large foundry are moulds, storage space, handling equipment etc. Furthermore, it is necessary to have standby generating capacity. This is needed (in case of power failure,) to keep the charge molten or at least to permit the emptying of the furnaces and thus to avoid excessively costly damage.

Foundries of the type which produce castings for local end users (more or less on a jobbing basis) will be on a substantially smaller scale than ingot producing foundries. They may be able to use unrefined scrap in their production, although this will depend on customer specifications. The principal input will usually take the form of foundry ingots. The advantages of small scale in this type of business are marked in that they lead to far greater flexibility in production. As an example, the use of smaller furnaces greatly facilitates changes in the charge. In general, jobbing work requires skilled craftsmen in view of the need for flexibility and this holds true for small scale foundry work. For instance, new moulds will have to be prepared for customers quite frequently (to their specifications) and this will entail skilled work.

For all foundry work a supply of sand of suitable quality and in quite large quantity is essential. In Europe early foundries were traditionally sited according, in large part, to the availability of sand. As transport facilities improve this factor becomes of somewhat diminished strategic importance, although sand costs will still be highly significant.

6.4 The Rod Rolling Mill.

A rod rolling mill takes wire bars as its input. Aluminium and copper can both be rolled in the same mill, although if the mill has been designed for the production of copper rod the furnaces will be less efficient when used for aluminium than if they are designed for aluminium. The changeover period from copper to aluminium is from one to four days depending on the circumstances.

Brasses can only be rolled if they have a copper content of over 65 per cent. This excludes the possibility of rolling free cutting brasses. A rod rolling mill can also be used to produce strip of up to 2.5 cm. wide.

The rod production process may be divided into three stages: reheating, rolling and pickling. The last operation is, in a sense, optional. Pickling is customarily undertaken, but if the rod has to be sent a long distance it will oxidise during transit. In this case, the mill may well sell black (oxide covered) rod, which will be pickled by the customer.

Wire bars are heated to a hot-working state (850-900 C.) in a reheating furnace. This furnace can vary widely in type although the most usual is one fired either by oil or gas and loaded by means of a walking beam or a pusher loading mechanism. With the latter type, the wire bars may be damaged by sliding. Control of the furnace atmosphere is needed to avoid oxidation, and in general this presents no special problems. A further type is the electric induction furnace, in which the copper is heated very quickly indeed, and the control of the atmosphere therefore assumes diminished importance. In general, electric furnaces of this type produce a higher quality product. They are more expensive to run, but lead to savings in capital cost and space requirements. The principal disadvantage of the electric induction furnace for use in conjunction with a rolling mill is that technical factors limit its size. They are, in fact, seldom used for a rolling mill.

From the reheating furnace the copper goes to the mill stands. Rolling operations are normally divided into three stages - breakdown, intermediate, and finishing stands. In the breakdown stage, the initially square section of the wire bar is progressively changed to an elongated hexagon, an oval, a square, an oval and finally again into a square. In the intermediate and finishing stands, square and oval shapes alternate until the final round section is formed. In addition the rod is given a 90° twist between successive passes through the rolls, and this may be done automatically with twisting guides. The arrangement of the different mill stations within a rod rolling mill can be either as a train (that is side by side necessitating looping) or in a straight line. A typical mill consists of a three-high breakdown stand, one or two two-high intermediate stands, and eight or more two-high finishing stands. The rod is coiled immediately after rolling.

Rod from the finishing stand is normally 6 mm. or 8 mm., the customary sizes for subsequent wire drawing.

Pickling removes the oxide film from the copper which accrues during rolling, and can be undertaken in a number of ways. One is the straightforward Carrousel system by which coils of rod are loaded on to a multi-armed crane which periodically rotates the coils through different tanks. The first one or two of these contain a solution based on sulphuric acid which actually effects the pickling, and the remainder contain various washing solutions to remove any traces of acid from the rod. Methods are continually being sought to reduce oxidation during rolling and thereby reduce the need for pickling. Although the pickling solutions are processed in order to recover the copper and to recirculate the acid, losses are still significant.

A substantial amount of handling equipment is required in addition to the basic processing machinery, in particular cranes and forklift trucks are pre-requisites for an efficient plant.

Three categories of mill are normally distinguished, on the basis of the degree of automation between the mill stands which they incorporate. The most elementary form is the hand mill, where the embryonic wire rod is manually transferred from one stand and inserted into the next. This operation requires skill, dexterity and large resources of manpower. In semi-automatic mills the embryonic rod is transferred from one pass to the next by semi-automatic means, although most of the stands may still

Fig. 6. II - Layout of Automatic Conventional Rolling Mill

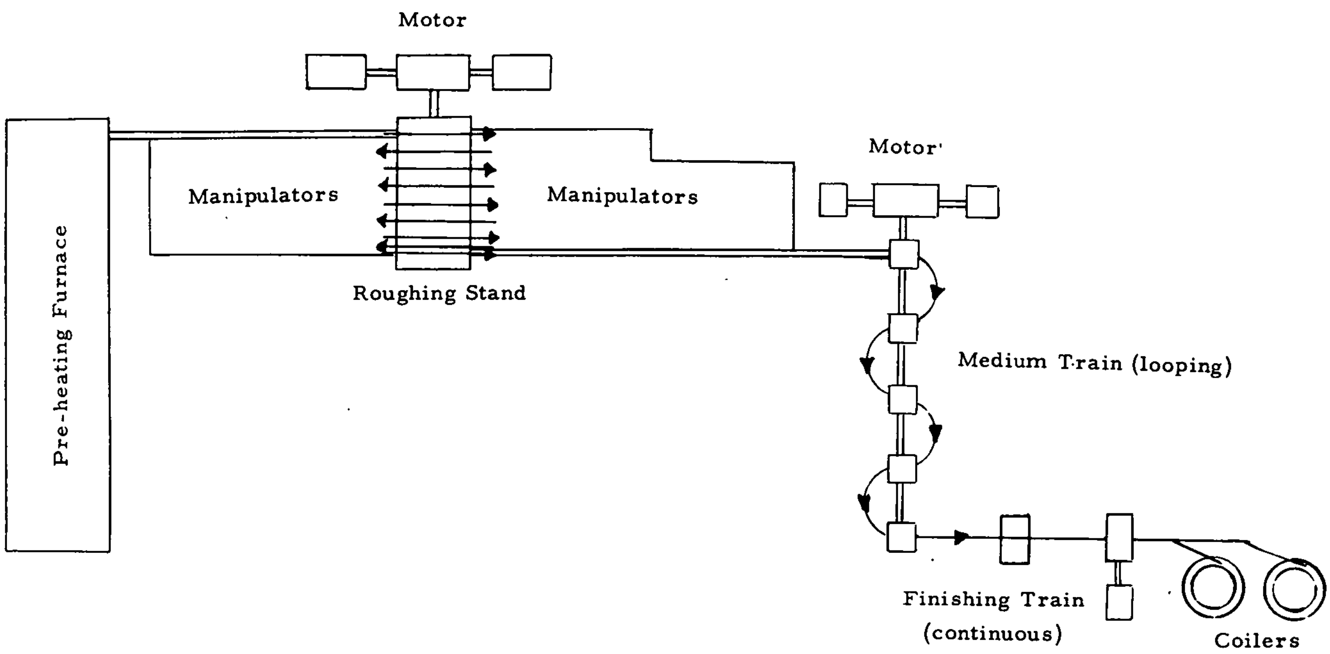
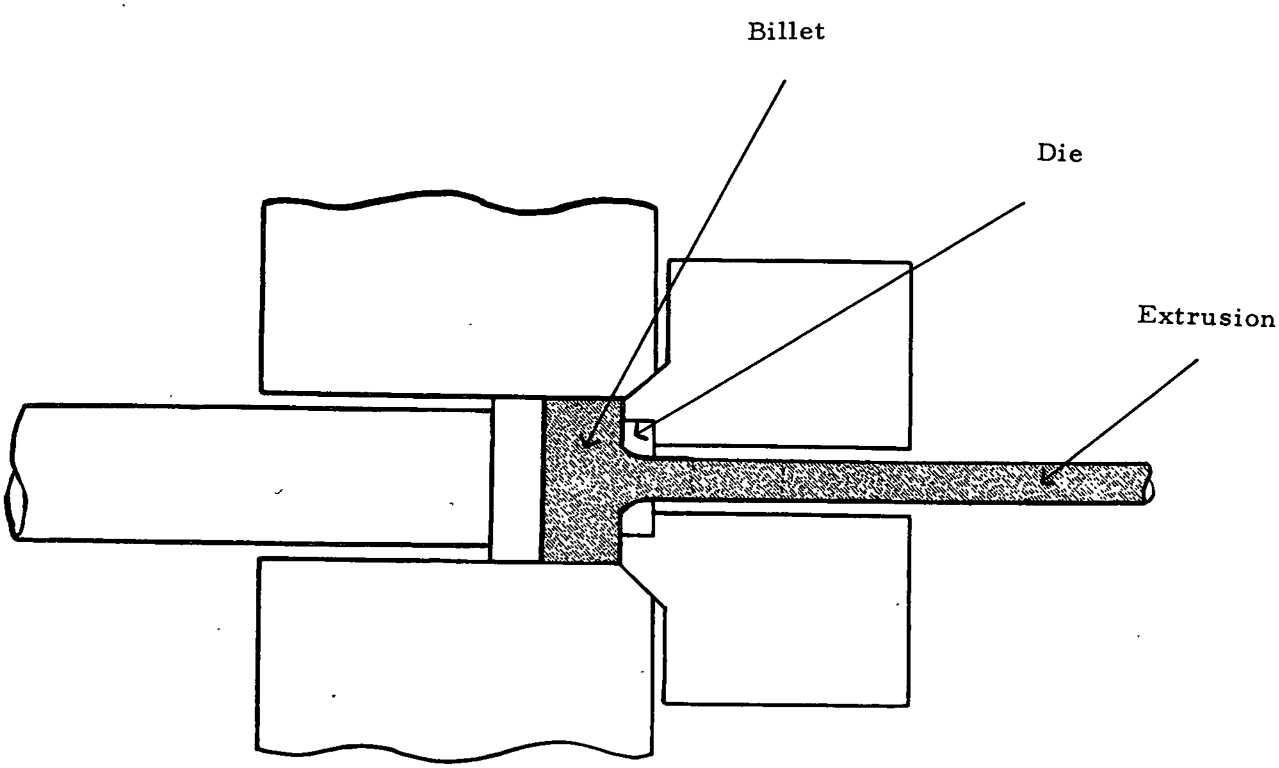


Fig. 6. III - Extrusion of Rod by the Direct, or Forward Extrusion Method.



be in train formation. The most advanced mills are fully automatic, and the rod passes directly from one stand to the next by means of automatic repeaters. In general more of the stands will be in line, the roll speeds being continually adjusted to minimise tension and, during finish rolling, to ensure the absence of twist. Such automatic mills require a complex electronic control system since, in the absence of looping between stands, the speed at which the rod leaves a particular stand determines its optimum speeds in all subsequent stands.

The distinction between hand, semi-automatic and fully automatic rod rolling mills is not clear cut and it is possible to increase the extent of automation of an existing mill. Historically, semi-automatic mills have been developed from hand mills, although fully automatic mills have been purchased as such.

6.5 The Extrusion Press

The extrusion process normally uses round billets as its input. These are presently priced at a substantial premium above wire bars, but if, for any reason the differential becomes unacceptably high, it is also possible to extrude cut and scalped horizontally cast wire bars, although this does involve additional copper loss.

The extrusion method of production is highly flexible, and changes of product can be effected in one or two hours. The same press can also handle brass and aluminium products. However, the preheating furnace is less efficient for aluminium when originally designed for copper. Extrusion presses are particularly used for the processing of brasses, as the majority of brass rod has a lower copper content than 65 per cent and therefore cannot be handled in a rolling mill. Strip can be extruded up to 12-15 cm. width, and extrusion is particularly suited to the manufacture of tubes, shapes and angles. In general the extrusion process produces a higher surface quality rod than that produced in a rolling mill, as the metal is in contact with the tool for a far shorter period than is the case with the latter. Oxidisation would be completely avoided if current efforts to cool and coil the rod in an oxygen free atmosphere prove successful. One possibility is that rod may be cooled under water, as is done for tube shells. With rod, however, the increased length poses problems which have not yet been solved.

As with the rolling mill, copper is initially reheated to a hot working temperature. The advantages of low frequency electric induction furnaces vis à vis fuel furnaces of the pusher or walking beam variety are more pronounced in the case of extrusion, as they tend to reinforce further the quality aspects of extrusion as a method of production, by keeping oxidisation to a minimum. In addition, electric induction furnaces take up less space and can be used far more flexibly as the heating time is far shorter and no preheating is necessary. This reinforces the flexibility of the press.

The actual extrusion of the metal is similar in concept to a toothpaste tube. The copper billet is enclosed within a cylinder which has a small aperture at the end, the size and shape of this being determined by the die in use. The copper is then forced through this die, the extrusion speed reflecting the ratio of the die aperture to the cylinder bore, the speed of the forward movement of the piston or ram and the properties and temperature of the extrudate. The product is then subjected to final processing in accordance with its type. In the case of rod, a coiling operation is immediately undertaken. As technology stands at the moment pickling is still necessary immediately after the material has been extruded and coiled.

6.6 Continuous Cathode to Rod methods of production

Considerable investment in research and development is being devoted to various methods of continuously casting rod, both with and without an in-line rolling stage. Continuous casting has been in commercial use for casting copper for some time. Only

three methods are discussed below, but certain characteristics are common to all of them.

(i) Continuous casting leads to far larger coils than other methods of producing rod. This permits higher running speeds for wire drawing machines, particularly in the initial drawing operation where one of the principal constraints is the time needed to weld coils together.

(ii) Metal losses throughout the process are very low and, in particular, trimming losses are substantially reduced.

(iii) The quality of rod is at least as good as and usually of a higher quality than that produced either by a coventional rod rolling mill or an extrusion press.

(iv) Only minimal pickling, if any, is required.

(v) The continuous inspection of rod for defects, utilising electronic detectors, is facilitated.

6.6.1. General Electric Dip Forming Process.

The following discussion relates to one specific plant, which has been widely discussed, as the documentation is otherwise somewhat scanty. The dip forming process relies on the internal 'heat sink' principle. A copper input rod is passed through a bath of molten copper and the molten metal freezes on to it. In the case of copper on copper an accretion of about 2.8:1 is achieved. An output rod of about 9.6mm. diameter is used and an output rod of about 1.59 cm. is obtained. The input or core rod moves through the system at about 65 m. per minute yielding a net output of about 3.3 tons per hour, discounting the initial core rod. This corresponds to an annual production of just over 13,000 tons for this particular plant. In general outputs of up to 5 tons an hour have already been achieved and outputs up to 10 tons an hour may well be attainable. The output rod is subsequently reduced to diameters of between 8 mm. and 9.5 mm. by hot rolling. Recirculated rod is drawn and shaved to give a clean surface. The shaving die constitutes a vacuum seal and the entire drive chamber is evacuated so that the rod travels through a vacuum from the time it is shaved until it passes into the dip forming chamber (which is filled with molten metal).

The molten copper is obtained from a melting furnace which takes cathodes as its input and is fed by a pusher type mechanism. A protective furnace atmosphere in conjunction with carbon floating on the bath is a pre-requisite of the method, as an essentially oxygen free melt is a necessary condition of the dip-forming process.

Hot rolling is an integral part of the process as the bonding of case to core rod is not a fusion weld. However, as the "intermediate surface" between core and case is clean it welds perfectly with subsequent hot rolling through two or three stands. Reduction to wire rod diameters is, of course, a guarantee of a sound, homogeneous rod.

6.6.2. Southwire (Properzi Concept) Continuous Casting and Rolling process.

This method was evolved by a company with very wide experience in the continuous casting and rolling of zinc and aluminium rod. As for the dip forming process, the melt furnace atmosphere is oxygen free, although oxygen is deliberately introduced as the metal is transferred from the melting furnace to the casting wheel. From the furnace the metal goes to a substantially modified Properzi casting wheel consisting of a vertical ring type of mould which has a groove in its outer periphery, a metal band which goes half way round the casting ring to enclose the casting groove during pouring and a tensioned idler wheel for the metal band. The continuous casting

groove produces a rectangular bar of up to 6 cm. square, and the temperature range as the rod leaves the casting wheel is controlled so as to provide for an optimum hot rolling temperature. At the present time pickling treatment is still required after rolling and quenching, although it is confidently expected that it will soon be possible to by-pass the the pickling stage.

The Southwire continuous cathode to rod process involves a large number of rolling stands after casting, but these are all in line. It was, in effect, developed as a substitute for a fully automatic rolling mill and the typical output of a plant is in the region of 60,000 tons per year.

6.6.3. Unicast Method of Continuous Casting

The Unicast method was primarily developed for the production of copper based alloys, and has been successfully used to cast phosphor bronze, leaded bronzes, brass alloys and nickel silver. In certain cases where alloys are particularly difficult to deform, the Unicast method is preferred. The process involves a melt furnace, a casting die, a rod withdrawal machine, a coiling unit, and a cold rolling mill. Up to eight rods are produced simultaneously, and for each rod there is a separate coiler. The rods are subsequently cold rolled as a separate operation. The avoidance of hot working in the production of rod has advantages in terms of minimising the scale of operation required. The chief disadvantage of cold rolling is that the ensuing work hardening may well require an additional anneal - over and above the requirement for hot rolling - if too large a reduction in diameter is undertaken.

The scale of the Unicast method can be very small indeed, and plants with a capacity as small as 3,000 tons a year have been proposed. The quality of the copper rod produced, in terms of surface finish, is very high.

6.7 Production Methods currently in the Development Stage.

A large number of alternative methods for producing copper wire rod are currently being investigated, and it is not possible to enter into detailed discussion on them all. Several new methods are being developed from techniques already used in the production of copper based alloy rod. The Unicast method, already discussed in 6.6.3. is an example of this 'school'. The other methods are similar in some respects.

(i) They are generally flexible methods of production,

(ii) they are capable of production on a fairly small scale, and

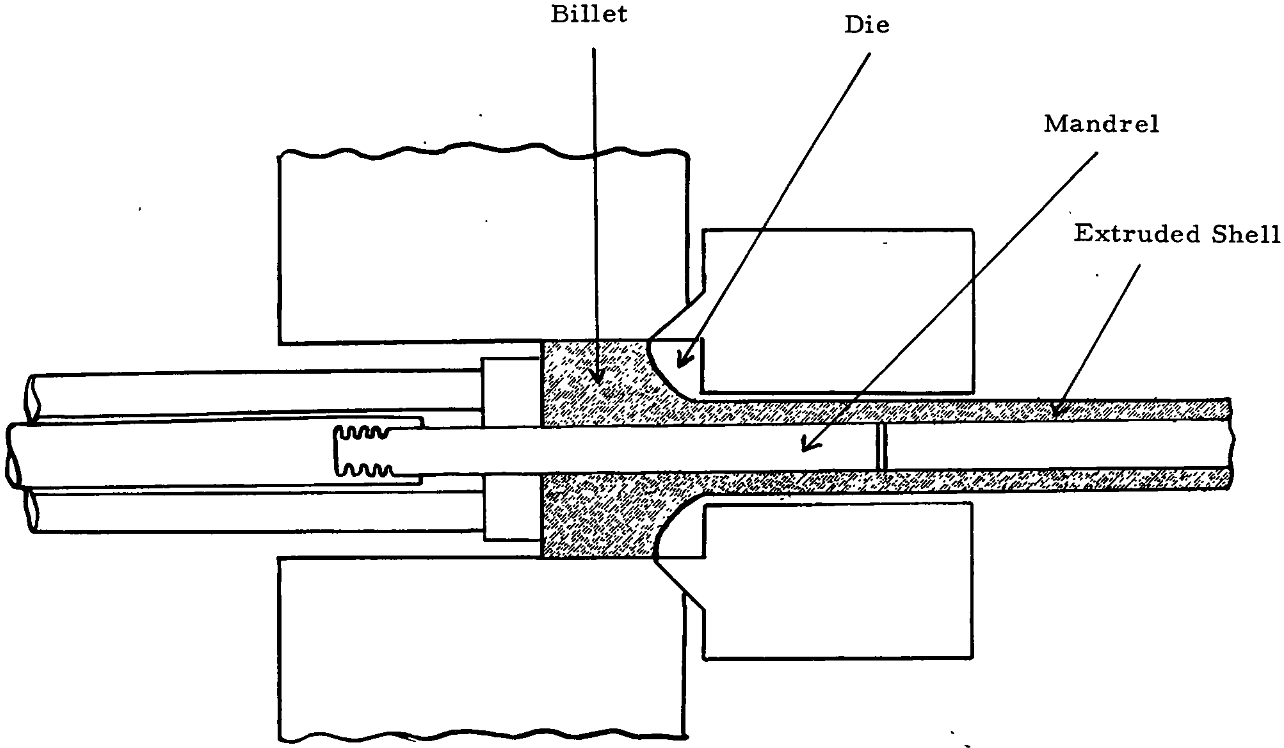
(iii) the chief problem experienced in obtaining an economic production of copper rod tends to lie in gearing up the rate of production from the fairly low speeds acceptable in alloy production.

Either of two other distinct processes may eventually revolutionise copper production, although it is unlikely that any dramatic change will be witnessed for some time. The first of these would be based on copper powder, which would be compacted to wire rod dimensions by subsequent rolling before being processed in the normal manner. As the production of powder would take place at the concentrating stage (see fig 6.1), at least two melting processes would be by-passed, each of which involves very significant energy costs. The second process - into which considerable research is being undertaken involves the production of rod directly by electro-forming. The problem with this process is that, although the actual production of wire by this method is already possible, the time required for electro-forming at the present moment is far too protracted.

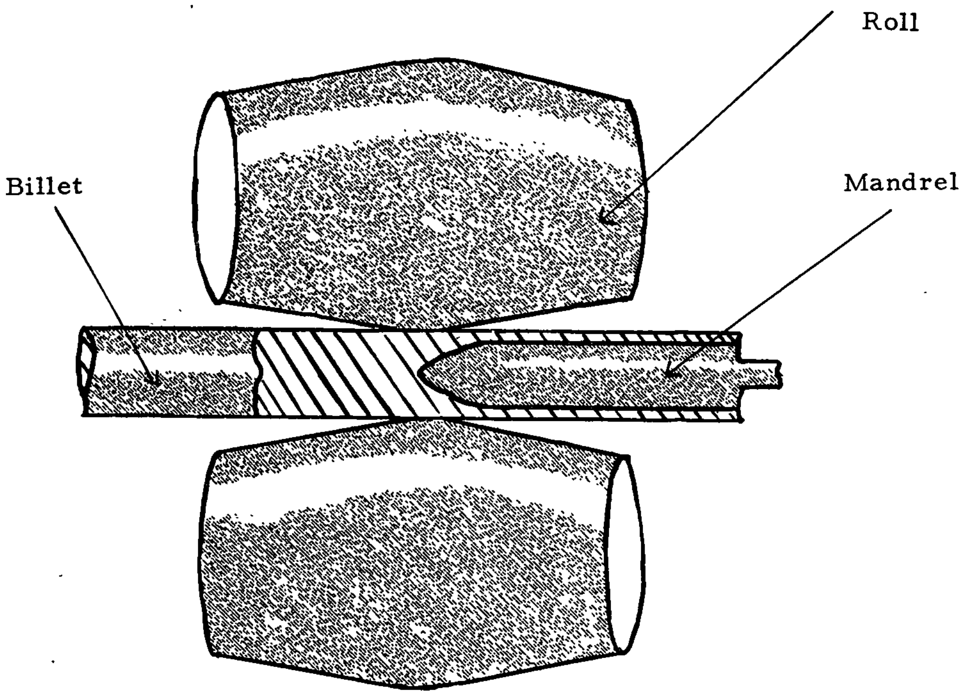
6.8. The Sheet Mill

A sheet mill requires access to casting facilities, since cast slabs form its input.

Fig 6. IV - Methods of Tube Manufacture

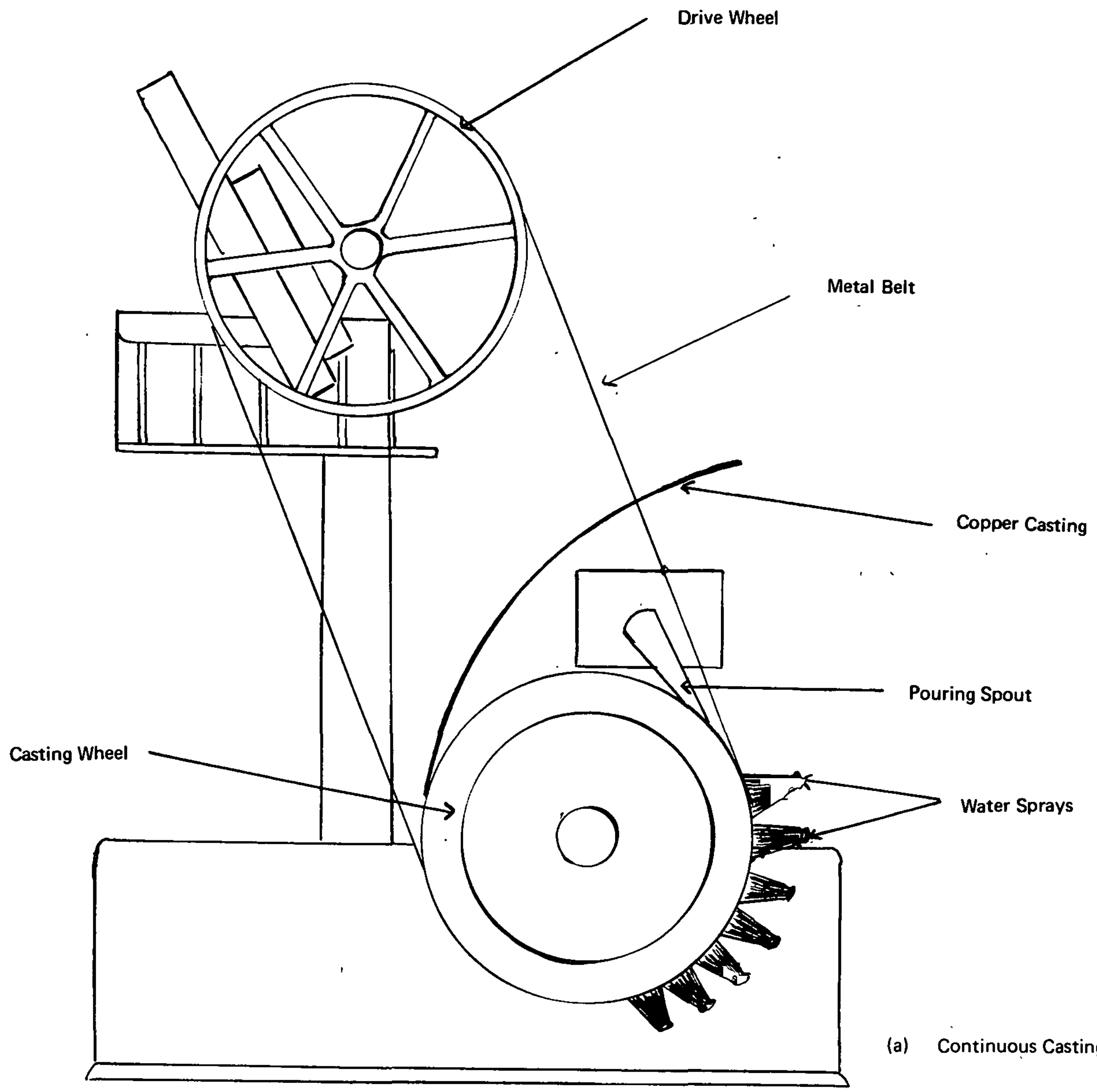


(a) Direct extrusion of tube shell

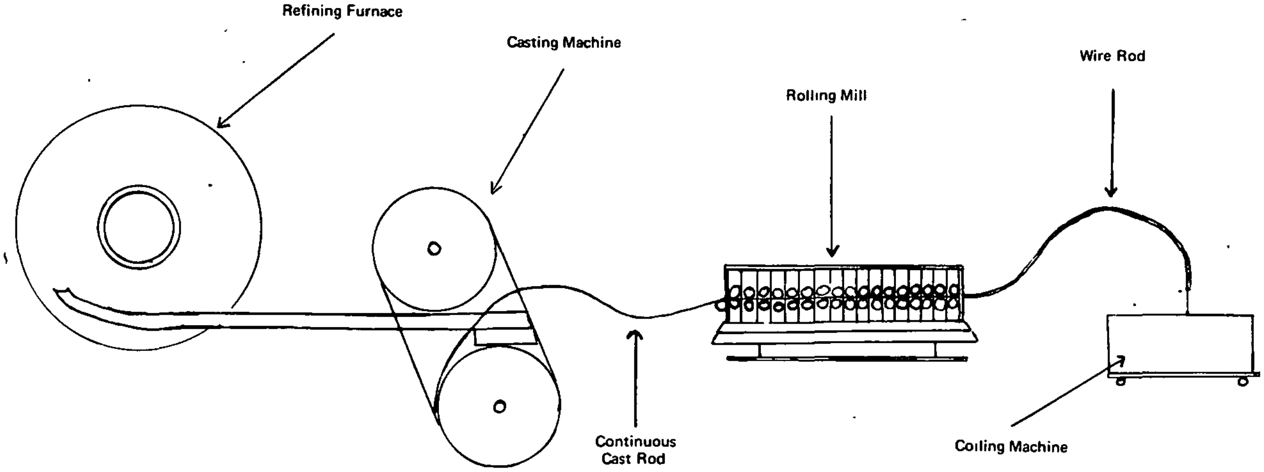


(b) Piercing of tube shell: The billet passes through the rolls and emerges over the plug (from left to right) in the form of a hollow shell.

Fig. 6. V - Continuous Casting by Southwire (Properzi) Method



(a) Continuous Casting Machine



(b) Schematic Drawing of Integrated Melting, Casting & Hot Rolling Mill

These are sometimes milled all round prior to hot rolling. The scalped slabs are preheated in a furnace, usually oil-fired, and loaded by some variant of the pusher system. Electric resistance furnaces can also be used and they may offer some advantages in terms of quality.

Rolling practices vary, although the breakdown or first stage, is inevitably a hot working process. Soft sheet copper may be cold rolled to finish, although at least one anneal will be required. On the other hand, sheet copper can be hot rolled to finish when the accuracy of the final gauge and the surface quality are not critical.

Pickling is undertaken after sheet rolling, as some hot working is practically unavoidable. Annealing facilities are also required as production which involves substantial amounts of cold rolling leads to undesirable (and frequently unacceptable) work hardening characteristics.

6.9. Tube Manufacture.

Tube manufacture may be divided into four stages:

(a) the preliminary forming of a shell by piercing or extrusion,

(b) pointing and cold drawing,

(c) annealing, and

(d) straightening and finishing.

(a) Extrusion methods have already been discussed in 6.5 although a marginally more sophisticated press is required when the production programme includes tubes. Piercing is undertaken in a mill based on a Mannesmann type machine. Billets, which comprise the input, are heated to about 700° C and then passed between barrel shaped driving rolls set at an angle so that their high points take the path of a screw thread. The billet is therefore forced through the two driving rolls and on to a conically ended piercing mandrel. The action of the rolls on the periphery of the solid billet sets up the tensile stresses radiating from the centre, and causes the billet to open up along its central axis. The mandrel is used to smooth or enlarge a fissure which has already been opened rather than actually to pierce.

Piercing is limited to metal possessing a sufficiently high ductility to withstand the considerable stresses produced in this method without cracking. The process normally uses 7.5 cm. billets and produces at least 10,000 tons of tubes per year, on a two-shift basis.

(b&c) Pointing or swaging consists of bringing the end of a tube to a point, the diameter of which permits insertion in to the required die on a draw bench. They are repointed when necessary, and it is usual for the first point to permit insertion into the first two dies only as after the first two drawing operations the tube usually needs to be cut in order to reduce its length. If long coiled lengths are required bull blocks may well be used in preference to a draw bench.

Cold drawing causes work hardening, and annealing is frequently necessary. The amount of annealing required is conditioned by the nature and specifications of the tube. These also determine the type of draw bench required, as large diameter piping requires draw benches with very high power (in terms of pull pounds). Draw benches which are able to handle large tubes will tend to be of such a size as to operate most suitably with an annual throughput of about 5,000 tons. However, a wide range of smaller draw benches may be readily purchased and these are able to handle smaller tubes quite adequately.

(d) There are a number of techniques in common use for straightening, and these include roll straightening, Medart straightening, block straightening and hand straightening. The latter two methods are largely used for handling tubes which are either too thick or too short for either of the first two methods. Tube which is to be Medart straightened must be annealed first.

Finishing covers an immense variety of operations, frequently undertaken on a jobbing basis, depending on the nature and specifications of the particular tube.

6.10. Production of Wire and Cable

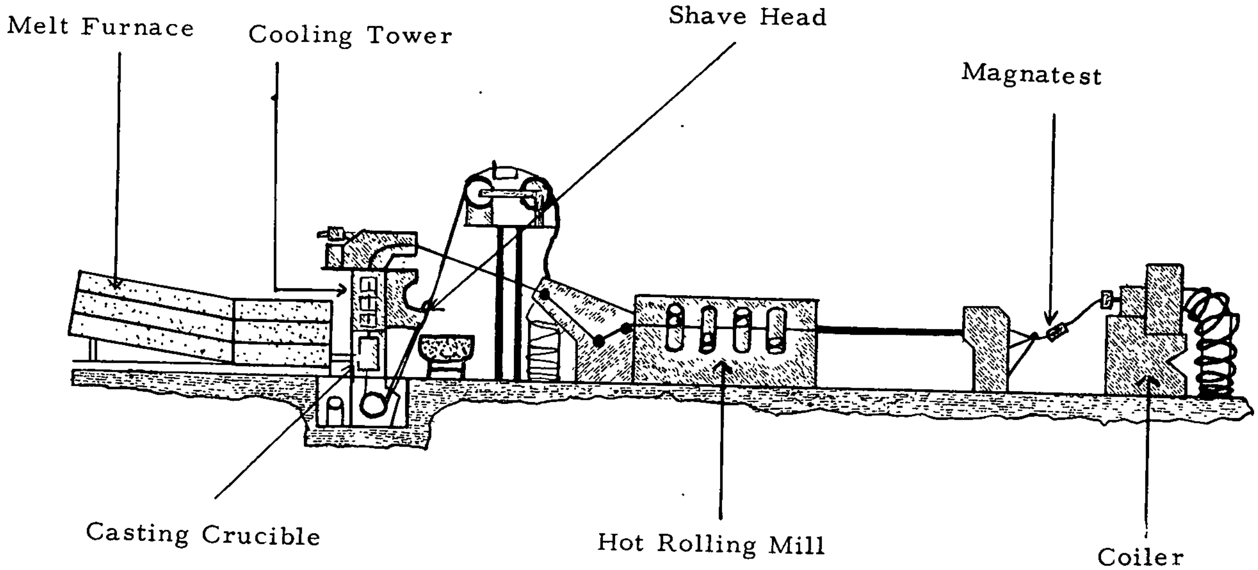
Wire and cable production takes 6 mm. or 8 mm. copper wire rod as its input and draws the rod down to the required size prior to stranding, insulating, twisting, bunching and cabling according to the particular specifications required. As drawing operations involve entirely cold working processes no pickling is required, although annealing is normally needed as result of work hardening.

Drawing consists of pulling the rod through dies of specially hard construction - encased Tungsten Carbide for the larger dies and encased diamond stones for the smaller. Successive dies decrease in area by some 20 per cent, that is to say a reduction of 20 per cent is obtained by each pass. Drawing is usually divided into three distinct categories: breakdown - which involves drawing rod down to between 4 mm, and 1.6 mm; intermediate drawing - when wire of 4 mm.or smaller is reduced to between 1.4 mm. and 0.4 mm; fine wire drawing - where an input of about 1.6 mm, is drawn down to somewhere between 0.4 mm. and 0.1 mm.

There are two alternative methods of carrying out the breakdown stage and part of what is normally considered the intermediate drawing stage - that is down to about 0.8 mm. Most commonly a rod breakdown machine will be used for the breakdown stage, and the wire will then be put into an intermediate wire drawing machine for drawing down to 0.8 mm, or thereabouts. In these drawing machines the rod input (or wire) is passed directly from die to die in the machine and the process is continuous. A single die or twin die bull block provides a reasonable basis for the small scale production of relatively large wires (e.g. trolley wire) but as soon as the size of wire diminishes significantly or the scale of production increases to any substantial extent, it becomes increasingly uneconomic. In particular, the availability of wire rod in Jumbo coils further enhances the production advantages of large plants employing multi-die machinery.

When multi-die machines form the basis of production, it is usual for three distinct types of machine to be employed - one for each of the three stages defined above. There are a variety of reasons why the entire reduction should not be undertaken continuously in one machine. One underlying truism is very important - that as the diameter of wire is reduced its elongation is substantially increased. The important corollary to this fact is that speed of travel will undergo an increase as the elongation increases. The more passes undertaken continuously, therefore, the greater is the difference between the input and exit speed. This means that the maximum permissible exit speeds - given by difficulties in handling and attempts to minimise breakages - frequently constrain input speeds to unattractively low levels if too large a reduction is attempted continuously. Throughputs of machines, in terms of copper weight processed, diminish directly with the diameter of the wire, in spite of the fact that until very fine wire is reached, maximum exit speeds tend to increase as diameters decrease. The maximum output speed for a rod breakdown machine is about 1,050m. per minute, for an intermediate drawing machine 1,500m. per minute, for a fine wire drawing machine 2,750m. per minute, and for a super fine wire drawing machine 1,800m. per minute.

Fig. 6. IV - Schematic Representation of Dip Forming Equipment System



If the minimum size reduction is obtained from the rod breakdown machine, it corresponds roughly to the maximum size input which may be used with the fine wire drawing machine. However, for the type of reason given above, such a routing of product flows is unlikely to constitute the production rationale of any factory.

Pointing is undertaken before insertion into each machine, and this clearly constitutes a further disadvantage of bull block production of wire, as the wire has to be repointed after every second pass at least. Annealing is normally restricted to the final size wire, but occasionally work hardening may necessitate annealing between operations. This is then called intermediate annealing.

Stranding involves the twisting together of a number of wires to form a conductor with a larger cross-section than any of its component parts. It is used when a solid conductor of a similar cross section would prove too rigid. The flexibility of stranded conductors increases as the total number of wires is increased and their individual diameters decreased. Stranded conductors may be bunch-roped or concentric stranded. The former are composed of a number of wires twisted together without any pattern and the latter by assembling the wires in successive concentric layers. Stranders are classified according to the number of individual strands of wire which they are able to handle.

Insulation takes the form of PVC, polyethylene, dry and impregnated paper or varnished cambric. Modern investment is increasingly concentrated on the first two insulants (thermoplastics), which involve less complicated manufacturing processes and possess greatly improved dielectric and mechanical properties as compared to other insulating and jacketing materials. This section, and ensuing discussion and recommendations, concentrate entirely on thermoplastic insulants. The thermoplastic insulation is applied by the extrusion method. The compound is introduced into the extruder in the form of granules, powder or strip and then heated electrically until it softens and flows easily. A screw, acting as a pump, compresses the compound into a die-head through which the copper wire passes. The thickness with which the compound is applied to the wire is controlled by the clearance between the die and the core point. In the case of PVC, the insulation is cooled off as it comes out of the die-head in a stainless steel trough through which there is a continuous flow of cool water. The insulation is then high voltage tested before being coiled on an appropriate reel. For polyethylene the process is substantially similar and the same insulating line can handle both polyethylene and PVC insulation.

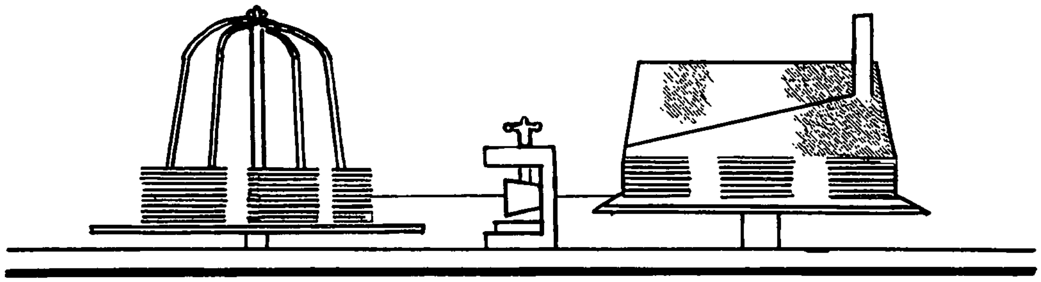
The appropriate size for an insulating line is determined by the dimension of the wire or cable to be insulated. The output of an insulation line is effectively determined by the weight of insulating compound which it handles per hour. Thus an insulation line of a given size (with a constant throughout of insulating material) will extrude a covering over a large cable far more slowly than over a small wire. Also, a large capacity insulating line will extrude a covering over a conductor of a given size at a faster speed than a smaller insulating line is able to. Once again there are various factors which constrain the maximum permitted take-off speed. These technical constraints, taken in conjunction, mean that a very large insulating line is not well suited for applying insulant to a small wire, although it constitutes the only feasible way of insulating a large cable.

After insulation different types of end product undergo different processes. Power cables are often composed of three or four conductors as they are used for three phase circuits. In this case, three or four insulated conductors of different colours are assembled on a cabling machine and copper or bronze tape is applied to provide protection.

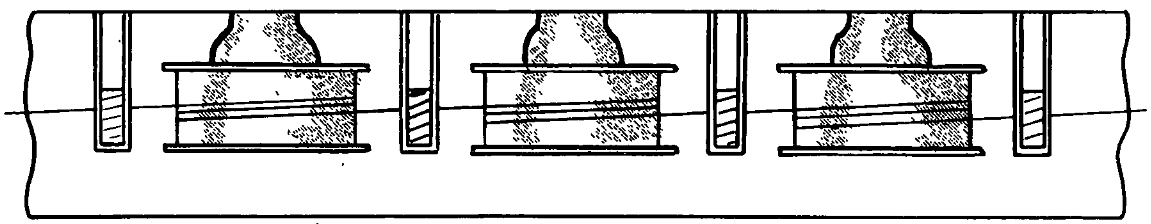
For telephone cables insulated wires are then twisted together in twinners to form pairs which are assembled by the telephone cable bunching machine to form units consisting of 25 or 50 pairs. These units are cabled together on a large cabler to obtain the required number of pairs.

In addition some cables require armouring. This is increasingly effected by means of a steel wire or steel strip armouring machine which applies a number of steel wires over the cable core to provide protection against physical damage. Previously lead sheathing was a popular method, but the cost of lead now makes it uneconomic.

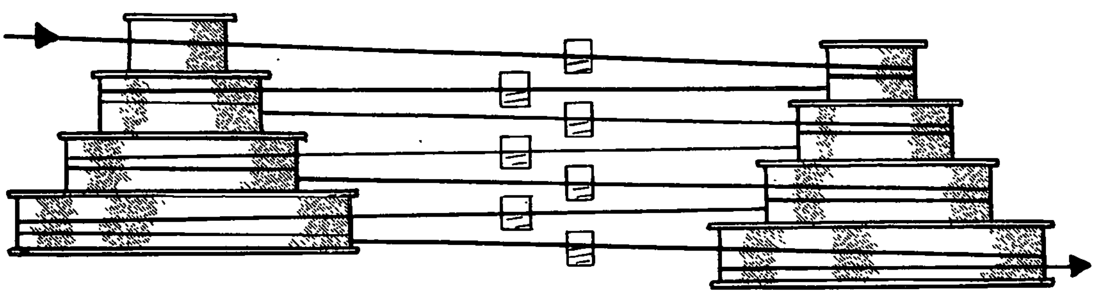
Fig. 6. VII - Wire-drawing Methods



(a) Single-hole block drawing, in which the rod is placed on a free-running swift, pointed, threaded through the die and attached to the block. The wire so drawn is then lifted off the block and placed on the next swift in order along the bench. This sequence is replaced until the wire is reduced to the required size.



(b) Tandem drawing. The dies are first strung on a rod in a stringing-up machine. They are then placed in brackets interposed between the draw drums and several turns of wire are twisted around each draw drum. When the machine is running, each draw drum draws the wire through each successive die and each increases in speed to allow for the extra length of wire being made by virtue of the reduction in diameter of each die.



(c) Cone drawing. The wire is drawn back and forth through the dies by stepped cone pulleys. The increase in speed after the wire is reduced in area at each die is attained by the increasing peripheral speeds of the steps in the cone pulleys.

CHAPTER 7

THE ECONOMICS OF COPPER FABRICATION

7.1 The information presented in this chapter reflects, to a substantial extent, the experience of the copper fabricating industry in Europe. Particular areas where European data must be modified to conform to the African environment are mentioned in section 7.9, at the end of the chapter. The principal differences arise from transport considerations and chapter 9 is largely devoted to considering these.

In a comparison between different techniques and scales of production it is customary to look at the total capital cost and the conversion cost and to express both of them in terms of costs per ton produced at comparable (and realistic) production levels.

Conversion costs are normally taken to include:

metal loss
billet premium (relative to wire bar)
scrap devaluation
power (electric or oil)
water
supplies (including tool costs)
direct and indirect labour
maintenance
depreciation
administration and overheads.
(Return to capital employed is not included in the conversion cost, nor is the value of metal incorporated in the end product).

The above breakdown shows quite clearly that capital and conversion costs are not independent, as both depreciation and insurance are directly related to capital costs and logically separate from what may straightforwardly be considered economies of scale on the production side. Depreciation is an important constituent of conversion costs, and the point may not therefore be ignored. This study postulates a return to total capital employed of 10% and in addition assumes that fixed capital costs comprise 50% of total capital employed. In other words a return to fixed capital (before tax) of 20% is added to conversion costs as a basis for comparisons.

The conversion cost per ton of copper is believed to decrease the greater the size of plant but these economies of scale are difficult to quantify and in any case are less significant than the savings in capital cost per ton with increased size of plant. However, it is generally true to say the quality of the product often improves with higher production rates. This arises from shorter contact with tools for extrusion, and increased mechanisation in rolling. Larger production units will also tend to be preferable to small in terms of:

(i) work to ensure quality control and uniformity of product;

(ii) maintenance; and

(iii) provision of social capital for employees (including good working conditions).

Some advantages which might be thought to accrue on grounds of size alone arise principally because of integration, although the distinction between the two terms is

extremely nice, owing to the substantial shared requirements for different parts of the copper fabricating industry (external economies in production if the industry is viewed atomistically). Integrated plants offer the possibility that they may constitute a back door method of obtaining at least some of the benefits which acrue to large individual units.

This chapter deliberately focuses attention at the smaller end of the production spectrum, in view of the expected level of demand revealed by the market analysis. In particular, an attempt is made to identify the relevant minimum scales of production for the products required in the Region. In some cases the minima are quite well defined technologically although it is not always possible to separate technological considerations from economic ones. Wire rod is the only product in this study for which there are genuine alternative methods of production. It is also the most likely type of semi-manufacture to be exported, as it constitutes the principal input for further fabrication and is both universally homogeneous and widely traded. Accordingly, wire rod production has been considered in particularly close detail, and some information is presented on plants which are on a larger scale than is justified by the intra-regional market forecast.

7.2 Rod Rolling Mill

The smallest rolling mill which can be purchased produces at a rate of about 2 tons per hour. Assuming that a two shift system is worked and that each shift is the conventional 2,000 hours per year annual production will be 8,000 tons. A mill with this capacity will be hand operated as described in section 6.4. A semi-automatic mill becomes feasible at production levels somewhere between 16,000 and 20,000 tons per year, and a fully automatic mill at levels of 40,000 tons per year and above.

Increased size does tend to lower conversion costs as a greater degree of mechanisation enables a more consistent quality of rod to be produced and thereby lowers the rate of scrap formation. However, other considerations, such as the degree of effective utilisation of capacity, tend so to overshadow possible economies of scale that the latter are extremely difficult to quantify. Providing any mill is run at near full capacity and produces an acceptable quality rod, it is unlikely to be too uncompetitive. Conversion costs for rod rolling will, in general, lie in the range $ 14.4 to $ 24.0 per ton, although it is not unknown for them to reach as high as $ 48.0 per ton.

When capital costs are analysed with a view to highlighting economies of scale the predominant cost is inevitably the mill stands, although the furnaces and coilers are expensive items in themselves. It is, in fact, customary to quote for rolling mills giving the mill stands together with appropriate furnaces and coiling equipment. An important point to note is that most rolling mills in Europe have been evolved to their present state rather than purchased directly, except in the case of large and sophisticated fully automatic rolling mills. There is no substantial discontinuity in the economies of scale for rolling mills until outputs between 18 and 20 tons per hour are reached and these lie outside the range which concerns this study. Quotations appear to indicate a reasonably competitive suppliers' market.

Table 7.1 Capital Cost and Expected Return per ton Production

Annual Production Tons	Type of Mill	Capital Cost+ per ton produced $	Expected Return to capital per ton (20% on Fixed $ Capital)
12,000	Hand	66.0	13.2
14,000	Hand	60.0	12.0
20,000	Semi-Automatic	48.0	9.6
40,000	" "	36.0	7.2
80,000	Fully Automatic	30.6	6.1

+ Fixed Capital only, erection inc. but exc. transport from European port.

7.3 Extrusion Press Plant

Rod Production

The minimum size extrusion press which would normally be considered for a production programme centred on wire rod manufacture is one of 1,500 tons. This can produce rod to about 12.5 cm. and tubes to about 10 cm. in diameter. Extrusion of rod from billet is also possible on presses of 1,000 tons and slightly smaller, but these are unable to extrude divided wire bars even if the economics of the billet premium makes this a sensible course of action. Large presses produce rod more quickly than small ones and the heat loss is less. However, presses of above 1,500 tons will not normally be purchased with this attribute in mind but rather for their increased flexibility. A 1,000 ton press can produce both rod and tube to 5cm. in diameter whereas a 2,000 ton press can produce tube to 12.5 cm. and rod to 15.5 cm.

The output from a 1,250 ton press will be about 6,000 tons of wire rod per year, and the cost of a plant based on such a press will be about $ 660,000 including building, civil engineering works and equipment but excluding transport from a European port. This corresponds to a capital cost of about $ 110 per ton of annual production, which means that the expected return to capital per ton will be $ 22.0 per ton. A 1,500 ton press will produce about 10,000 tons of wire rod per year, and when incorporated in a plant the capital costs for building, civil engineering works, and equipment will be $ 840,000 on the same basis as above. This means a cost per ton produced of $ 84.0 which implies an expected return to capital of $ 16.8 per ton.

The capacity of a press plant can be expanded to a limited extent by the purchase of ancillary equipment, frequently involving the mechanised handling of input and output, in order to minimise the dead cycle time of the press. When the production of wire rod is the concern of the extrusion plant, and considerations of range flexibility are not particularly important, any substantial increase in production is most likely to be effected by the purchase of a further 1,500 ton press. This does not necessarily mean that there will be no economies of scale on the capital side, as the cost of the

press itself will only account for at the most 40% of the total plant cost. However, the savings in capital costs per ton are not likely to be dramatic. The capital costs for a plant based on two 1,500 ton presses with a combined output of 20,000 tons are unlikely to be below $ 72.0 per ton of annual production, involving an expected return to capital of $ 14.4 per ton. Conversion costs for wire rod by the extrusion process in general critically depend on the premium which has to be paid for billet over wire bar. At present this is in the region of $ 40.8 per ton. When this premium is included, conversion costs lie in the range $ 62.4 to $ 72.0 per ton.

Tube Production

The type of extrusion press chosen for tube production will depend on the probable composition of demand for tubes. In general powerful presses are only justified where significant demand for large diameter tube is expected. Piercing will not be undertaken until the demand for tubes reaches about 10,000 tons per year, and extrusion is therefore the unchallenged technique up to that level (for producing the tube shell). The press does not differ substantially from that used in rod production, and a list of presses showing their production range and approximate price is given below.

Size Press	Max. tubes dia. cm.	Max. rod dia. cm.	Approx. price* $
1,000 tons	5	5	228,000
1,500 "	10	13	324,000
2,000 "	13	15	358,000
2,500 "	15	18	468,000
3,000 "	18	20	552,000

* Press, with pumping equipment only, f.o.b. European port.

The cost of ancillary equipment when tubes are produced in an extrusion plant is far higher than that required if wire rod is the principal product, as extensive drawbench work is involved for tubes and annealing facilities are also essential. It is very difficult to talk about typical plants producing outputs of so many tons per year in order to compare the economies of scale, since the output of tubes is not homogeneous in the sense that the output of wire rod is. In general, larger presses may be expected to concentrate on the production of larger tubes as this is where their competitive advantage is strongest, and they require a high rate of utilisation of their larger and more expensive drawbench facilities. However, if the market is of such a size that only one press is justified for the whole range of tube production it is quite clear that the press selected will not normally be able to concentrate its production near to its technical limit, in order to maximise its comparative advantage. It will, in fact, probably produce a substantial amount of tube which might be produced at least as profitably on a smaller size press. The smaller press would, however, be precluded from operating more cheaply in this instance, at this location, as by virtue of its range limitations it would be unable to produce other than a fairly limited proportion of demand, and would therefore suffer from under-utilisation.

A situation of this sort is likely to be encountered within the Region considered by this report. In view of the complexity of the conflicting desiderata it is difficult to lay down a basis for decision in the abstract, away from the market context, and this

section restricts itself to the consideration of the economics of tube production in a typical, middle-range, extrusion plant.

A plant chiefly to produce tubes, based on a 1,600 ton press, costs in the region of $ 1,680,000 and produces about 6,000 tons of an average mix of tubes per year. This gives a capital cost per ton produced of $280, with a concommitant investment return expected of about $ 56 per ton (at a rate of 20% on fixed capital). Conversion costs average about $ 192 per ton, including billet premium, which is somewhat higher than for rod. The chief extra costs in producing tubes as against wire rod, with the same size press, are explicable in terms of the greatly increased scope of finishing operations after the extrusion stage. Extensive use of drawbenches and annealing facilities, together with the need for swaging and straightening, lead to substantial increases in both labour and general running costs. In addition, scrap devaluation is three times that for rod production.

Conversion costs are substantially less favourable in the case of an exceptionally fragmented demand structure, as long runs of particular products are inevitably more economic. These circumstances would also result in a reduction of total output from the figure of 6,000 tons quoted above.

7.4 Continuous Cathode to Rod Processes

Details on the capital costs and production costs of the three continuous cathode to rod processes described in Section 6.6 are difficult to ascertain. In particular, conversion costs for all methods will depend on the relative price between cathode and wire bar. The discount below wire bar (if any) at which cathode may be purchased must be subtracted from the conversion of the three methods in the same way as the billet premium is added to those for extrusion.

Experience with copper alloys suggests that conversion costs for the Unicast process will be about $ 74.4 per ton from cathode to wire rod. A deduction for cathode discount of $ 2.4 is made giving a conversion cost for the purposes of comparison of $ 72.0 per ton. Fixed capital costs for an annual production of 1,500 tons amount to about $ 360,000. This means a cost per ton produced of $ 240 and an implied financing charge of $ 48.0.

The capital costs for a G. E. Dip forming plant producing 12,000 tons per year are believed to be roughly similar to those for a rolling mill of the same size. At the present time all information on production costs is highly confidential, although it is understood that, as yet, conversion costs are extremely unattractive compared to those for a rod rolling mill.

The same confidentiality surrounds the Southwire (Properzi concept) process, although it is known that such plants are comparable to fully automatic rolling mills at production rates of 40,000 tons and over, when both capital costs and conversion costs are taken into account.

One common feature of the three methods is that they are all the property of patentees, and royalty (know-how) payments have therefore to be made. In addition, hiring manpower with the requisite knowledge for operating either of the latter two plants will be difficult, as the necessary experience is, as yet, restricted. In particular the G.E. Dip Form process will require experienced vacuum technologists.

7.5 Alternative Methods of Wire Rod Production

7.5.1 The Structure of Input Prices

The principal processes for producing wire rod discussed in 7.2, 7.3 and 7.4 each use a different type of input. Rod rolling mills use wire bars, extrusion presses use billets and continuous cathode to rod processes use cathode. Wire rod rolled from wire bar in a conventional rod rolling mill accounts for an overwhelming proportion of world trade at the present time. This means that the underlying basis of the trading price for wire rod is the price of wire bar taken in conjunction with conversion costs plus the normal mark-up. The difference between wire bar and wire rod prices quoted in the Metal Bulletin is very stable, implying that both stock-holding costs and costs of scrap wastage - both of which are quite significant and vary directly with the price of copper-tend to be absorbed and averaged out by producers. The overall price of copper is, therefore, not of particular significance in a consideration of the comparative economics of producing wire rod.

What is of the utmost importance is the relative prices of the three inputs. At the present time cathode stands at a discount of $ 2.4 compared to wire bar, and billets are at a premium of about $ 40.8. The difference between cathode and billet appears reasonable in the light of what is known of the conversion costs. Billets are more expensive to produce than wire bar for two principal reasons. Firstly, wire bar production is on a far larger scale because it is the principal traded shape and is highly standardised (although the American wire bar is larger than the one commonly used in Europe). Secondly, billets have to be cast vertically whereas the standard wire bar is cast horizontally. Vertical casting takes far longer than horizontal casting which means that production rates are slower. In addition more costly moulds and ancillary equipment are needed. (Vertically cast wire bars are at a premium of $ 31.2 over horizontally cast).

The discount obtainable for cathode below the price for wire bar is widely held to be unrealistically small. It is felt that a more realistic discount would be about $ 24.0 Fuel costs alone are likely to account for more than double the present discount. This false differential between cathode and wire bar means that cathode is overpriced and as a corollary that the premium paid for billet over wire bar is too high, although some premium (say $ 16.8) is justified. The suspicion must be that because of supply factors, copper refiners are able to keep cathode prices high in order that the casting of wire bars remains within their sphere of operations. In addition, committed investment in equipment for the production of wire bars gives them a vested interest in the continued use of wire bars - rather than other shapes - by copper fabricators.

Two factors may change this situation, one is the introduction of Chilean copper on the world market direct rather than via the USA, as at the present time, and the other is the likelihood of increasing pressure for lower cathode prices, as continuous cathode to rod techniques come to account for a larger share of the annual production of rod even outside the vertically integrated U. S. industry.

It is not possible to foresee either of these factors being of major importance within the time horizon of this study, and the following comparison of techniques is therefore based on the assumption that the future premium structure will be roughly the same as the present one i. e.

Cathode at a discount of $2.4 compared to wire bar

Billets at a premium of $40.8 compared to wire bar.

7.5.2 Extrusion/Rod Rolling/Continuous Cathode to Rod Methods - A Comparison.

A brief summary of the data given in preceding sections is given below:

Table 7.II Summary of Comparative Costs Per Ton For Producing Wire Rod

	Rolling Mill			Extrusion			Continuous Cathode to Rod			
Annual Production m.tons	Conversion Costs $	Return to Capital $	Total $	Conversion Costs $	Return to Capital $	Total $	Conversion Costs $	Return to Capital $	Total $	
1,500							72.0	48.0	120.0	(Unicast)
6,000				67.2	22.1	89.3	67.2	40.0	107.2	"
10,000				67.2	16.8	84.0				
12,000	24.0	13.2	37.2							
14,000	24.0	12.0	36.0							
20,000	19.2	9.6	28.8	62.4	14.4	76.8				
40,000	19.2	7.2	26.4				?	7.7	Competitive	(Southwire
80,000	14.4	6.0	20.4							Cathode to rod)

The assumption of any comparison on the basis of these figures must be two-fold. Firstly that, as discussed above, relative prices (the premium structure) remain unchanged. Secondly, that the product may be considered homogeneous; that is that quality considerations may safely be ignored. This is true at the present time, and will remain true for as long as rod rolling remains the dominant method of production. Rod rolling leads to a somewhat lower surface quality, but until rod produced by other methods of a higher quality becomes widely and readily available it will not command a substantial premium, as machinery and work methods will be designed in such a way as to handle rod of a lower surface quality to produce wire to the standard specifications. If for any reason the demands of wire consumers become increasingly severe in terms of quality, the position of rolled rod may become less secure, but this is somewhat difficult to foresee. In addition, if copper rod becomes relatively plentiful, pressure for jumbo coils may trim back rolling mill production at the margin. Given these assumptions the overwhelming superiority of rod rolling as a method of producing wire rod is clearly demonstrable at levels of output between about 12,000 and 40,000 tons per year. One possible situation in which extrusion rather than rod rolling may be considered, is when the annual market for rod lies in the region 4,000 to 6,000 tons, and any spare capacity of the press may be used to produce other extruded items - thus taking advantage of the wide capabilities of the extrusion process. Production by extrusion at slightly higher levels - say up to 8,000 tons - may be justified if the nature of demand is such that it fluctuates to a considerable extent, in which case the extrusion press could again be used to produce other items during periods of slack demand.

If, therefore, the premium for billet relative to wire rod were not so large this facility would also be of importance in higher output ranges, as demand forecasts are always subject to a wide margin of error. At a premium for billet over wire bar of about $16.8 extrusion might well be considered as a method of production up to 14,000 or 15,000 tons per year, in cases where considerable uncertainty clouds demand forecasts.

It appears unlikely that production of copper rod by the Unicast method can be justified at the present time, and it is difficult to foresee improvements to the method of

such magnitude as to reduce costs to attractive levels. If the discount allowed for cathode were widened to a truer level the cost would be substantially reduced, but the chief alternative method to Unicast - extrusion with a small press - would benefit to the same degree.

Production by means of the G.E. Dip Form process is not yet at the stage where it can be regarded as competitive with rod rolling, and even if the cathode discount were widened this would still be the case. It is, however, likely that conversion costs will be substantially reduced in the near future, and that Dip Form will be competitive with a semi-automatic rod mill at production levels of 15,000 tons per annum and higher within the next 10 years.

The Southwire cathode to rod process is at a considerably more advanced stage of development than the other continuous processes. As has already been remarked, it is considered in some circles already to be competitive with a fully automatic rod mill at production rates of 40,000 tons per year and over. Any increase in the discount for cathode would reinforce the position of the process vis à vis an automatic rod mill.

In brief, the dominance of rod rolling as a technique depends to a quite significant extent on the maintenance of what may be considered an unrealistic structure of input prices. It is, however, probable that if at the present time the structure of these prices were changed, new investment would still tend to favour production by rolling mill which is an established technique in which a wealth of experience may be drawn upon. The obverse of this is that rolling has a largely static technology, whereas considerable advances are being made in the technologies of other methods of production. These may well be of such magnitude as to make rolling an uneconomic method of production within the life of any new mill installed at the present time.

7.6 Foundry and Sheet Mill.

7.6.1. Foundry

It is difficult to cost foundry facilities in isolation as they normally constitute part of a larger (fabricating)plant. Substantial savings in capital costs per ton produced may be looked for with increased scale, as expansion tends to involve duplication until three furnaces are in use, at which stage the furnace size will probably be increased at the most convenient furnace reconstruction. The relation between theoretical and actual output depends critically on the number of furnaces, and the relevant figures are to be found in section 6.3. This factor alone accounts for a sharp decline in capital costs as the size of plant is increased. Additional advantages accrue to duplication in the form of a lower requirement for spares, and the possibility of cannibalisation if necessary plus the economic employment of specialist technical and maintenance staff. Overall stocks of moulds, repair shops and handling equipment all tend to diminish in terms of cost per ton as the size of the foundry increases.

It is unlikely that foundry facilities will be expanded beyond, say, three furnaces. At this level the economies associated with duplication decline in importance compared with other factors which tend to constrain the size. One important factor is the availability of scrap from outside the fabricating industry (old scrap), which normally accounts for more than 50% of the charge. As the foundry size increases, so the scrap catchment area must be enlarged, with the consequent effect of raising the cost of scrap to the factory. A foundry located as part of a fabricating unit must be large enough to produce the requirement, for alloy and copper ingots and other shapes, of the parent plant and utilise such plant (or new) scrap as circumstances may justify. The advantages of incorporating casting facilities within an integrated plant are of such magnitude as severely to diminish the possibility of selling alloy ingots and shapes to other fabricating units on any scale.

However, when size is being decided account will be taken of the ingot requirements of any small ("cottage industry") foundries in the area.

7.6.2 Sheet Mill

It is unusual for a sheet mill to be erected separately from other fabricating, and especially foundry, facilities. It is therefore, difficult to identify the capital and running costs attributable to a sheet mill alone. A further difficulty is that the term sheet covers a wide range of products, and capital costs increase very significantly as the range of output is extended. For instance, a rolling mill producing 35, 000 tons of sheet and strip with a "normal composition" will entail investment costs of about $650 per ton of annual production. A similar mill specialising in thin strips will increase the investment cost per ton by up to $312 on account of the additional specialised equipment involved. In general, it is considered that the minimum size for a sheet mill is about 3, 000 tons per year and a mill of this size will produce a somewhat limited range.

7.7 Wire drawing and Cable Making (Including Insulation)

In this section it is useful to distinguish two types of enterprise; one which draws specialised wire in addition to the standard household wire, and manufactures quite a wide range of bare and insulated cable, and the other which draws and insulates, or perhaps only insulates, a very limited range of wire primarily for the building trade. The former is described throughout as a wire and cable factory and is a highly technological industry, whilst the latter can be on a far smaller scale and is referred to as a housewiring plant.

7.7.1 Wire and Cable Factory

One of the main requirements of a wire and cable factory is that the range of production should be sufficiently broad to cover most of the needs of its chief potential customers, such as the telephone and electricity authorities. If this is the case then a local producer should be in a position to cement firm relationships so that future requirements will be specified in a way that takes account of his plant's capabilities. In general, expansion in a market such as the Region considered here will mean an extension in the range of production, involving the purchase of different types of machinery. In cases when expansion within a particular range is justified by market circumstances it will almost inevitably be effected by increasing the number of machines rather than purchasing machines of increased capacity. (The constraints on capacity and the determination of optima are fully discussed in 6.9). This means that the economies of scale of production are somewhat limited although potential economies exist in ancillary departments. For instance, it is only worthwhile to incorporate a die maintenance shop within a factory of a certain size and above, and the economics of such an incorporation become increasingly attractive as production levels increase. It is of particular interest to this study to determine the smallest reasonable size for a wire and cable factory in the Region, and to assess the salient characteristics of such a mill. The discussion below attempts to do this.

A typical range of products would cover the following:

- stranded bare copper wire;
- grooved trolley wire for electric railway and other transport equipment;
- insulated cords (e.g. for domestic electrical appliances) consisting of about 140 to 150 fine wires each;
- power cables (up to 11KV), for taking electricity from low and medium voltage mains to individual houses; and
- telephone cables (aerial and underground for area exchange and interior use.

The machinery required for such a range of products will usually include:

Drawing

one multi-die rod-breakdown (tandem type) machine;

two intermediate wire drawing machines (cone type);

two fine wire drawing machines (cone type);

one or two bull blocks for trolley wire;

Cabling

one bunching machine;

one large capacity strander (planets in motion type so that each wire is only required to twist through 120°);

one or two smaller stranders (tubular - each wire twists through 360°);

one laying up (cabling) machine;

Insulating (thermo plastics only)

one smaller extrusion line (6.5cm. or 9.0cm.);

one larger extrusion line (9.0cm. or 11.5cm.);

Other

pickling facilities;

annealing facilities;

A factory producing the range described with the machinery listed above would normally produce between 4,000 and 5,000 tons copper content wire and cable per year. This can be considered the smallest output for a wire and cable factory producing a sufficiently wide range to begin to satisfy the conditions described on the market side. The total cost of such a factory is about $1,600,000 Central Africa, or $1,520,000 sea board Africa.

7.7.2 Small Scale Housewire Plant

A plant to produce, in the main, insulated wires used in the building trade, will need to produce or obtain wire drawn down to between 1.6mm. and 0.75mm. diameter. If rod is taken as input it will probably be passed through the same tandem machine twice in order to obtain the necessary reduction. Insulation will probably be by means of a 6.5cm. extrusion line or just possibly a 3.8cm. line, although the latter size is primarily used in laboratory type work. The annual output from this type of plant is in the region of 600 tons copper content, and the total fixed capital cost is about $72,000. This output could be increased to about 1,000 tons p.a. by adding a further extruder, and this would raise the fixed capital cost to about $120,000.

Plants do exist both within the region and elsewhere which simply insulate wire drawn to their requirements by larger enterprises. The only equipment which such plants need is an insulation line with some form of spooler. The fixed capital costs involved for a plant of this type are in the region of $44,000 and annual outputs of between 300 and 400 tons copper content are probable.

The economic justification for such plants is not immediately obvious. There is no reason to suppose that they will produce more economically than larger plants, in fact their operating costs are likely to be higher and capital savings are improbable. They will also lack tinning facilities which may become important in the future. However, such plants

are still being established . One possible and plausible explanation centres round the supposedly non-economic motivation of small enterpreneurs who are willing to work harder for less return in their own plants and who are imbued with the optimism of the newcomer, which sustains many small scale industries. Another reason, and a very notable justification, is that these small plants are viewed by their owners as a means of gaining experience in the industry which, when acquired, will form the basis on which the plant will gradually expand its range of operations. Such expansion (or vertical integration) is likely to be backwards i.e. the probable sequence is: insulation only; drawing down large gauge wire and insulation; drawing rod and insulation; production of some cables in addition to household wire (and their insulation); and finally expansion to the type of plant outlined in 7.1.

Some significant advantages also accrue on the marketing side as a result of proximity to the market. These are discussed under the economies of location in chapter 8.

7.8 The advantages of integrated plants.

Some advantages which are normally only considered to accrue to scale may also be obtained by integrated plants. Here, although the scale of individual units will tend to make for costly operation, the scale of the copper fabricating facilities considered in aggregate can help to compensate. This possibility arises in part from the high degree of similarity between certain fabrication processes, but other, less intuitively obvious external economies are also present. Some of the chief advantages are identified below.

7.8.2 Office facilities and Senior Personnel

In general, the same advantages accrue to integrated plants as to large individual units, in that as the aggregate scale of operation increases highly paid professional posts will not normally require duplication. The accountant and the buying executive may require additional clerical help, but this is relatively inexpensive. The extent to which the advantage holds is determined by the degree of similarity between operations. Purchasing copper for a wire rod rolling mill, an extrusion press, a foundry and a sheet mill does involve different problems, especially for the foundry where a knowledge of the scrap market is essential. However, the same company will constitute the seller for all its items with the exception of scrap. If the range of integration is assumed to cover a wire and cable mill also, one buying problem is entirely eradicated, as the purchase of rod is merely an internal transfer. On the other hand, selling wire and cable does tend to involve different problems from selling other products - wire rod for instance. This is because wire and cable are sold direct to a large variety of end users.

In this section the production of wire and cable is termed second stage fabrication, and all the other processes considered in this study are referred to as first stage fabrication.

7.8.3 Social Facilities

The provision of adequate social facilities for employees becomes less expensive as the number of employees increases, regardless of the work involved. This may have an important economic corollary in that labour stability will tend to be greater relative to other plants which pay the same wages and invest the same amount, but operate on a smaller scale. The trend in the future is undoubtedly toward more and more stringent regulations concerning working conditions, and minimum acceptable standards for social facilities.

7.8.4 Technical Expertise

All of the first stage production processes involve either melting furnaces or reheating furnaces. They all encounter analagous problems arising from handling molten or hot metal. Other similarities underline these examples, and taken in conjunction significant economies may be looked for in the employment of mechanical and also

metallurgical expertise. On the capital side, savings will be made in the sphere of maintenance workshops, mechanical handling equipment for moving heavy machinery requiring overhaul or repair, and laboratory facilities. In addition, on the labour side if there are two or three similar processes being undertaken at the same location, it may pay to have a common skilled emergency repair team on a shift basis, although such a provision would not be economical for either process in isolation.

7.8.5 Casting facilities

The importance of a foundry being incorporated within a fabricating plant is discussed in 7.6.1. Scrap circulation considerations are important throughout all stages of copper fabrication including wire and cable production. The relevant rates of scrap formation are listed in section 3.1. A particular example of the type of advantage which integration offers can be clearly seen in the hypothetical case of a plant incorporating a sheet rolling mill, extrusion press and foundry facilities. In this case the extrusion scrap rate is high and the scrap is of top quality. It can therefore be put into the melting furnace with only a limited amount of virgin metal and cast into slabs for subsequent rolling in the sheet mill.

7.8.6 Balance of advantages & disadvantages

The advantages of integrated plants can be seen clearly in the case of first stage fabrication. The advantages of combining wire and cable production with first stage fabrication plant is not so clear cut. Scrap handling remains a highly important consideration in this case, and other circumstances already mentioned are also significant. However, the importance of marketing predominates to a far larger extent for a wire and cable mill, and if it runs contrary to the advantages that integration can offer, the greater is the likelihood that marketing considerations will prevail. For first stage processes the advantages offered by integration are more marked, and similar criteria in decisions as to location are likely to be in evidence. It is therefore less likely that the costs of integrated plants will outweigh the benefits.

7.9 Application of information to the African context

Copper fabricating economics within the Region are singularly poorly documented. In particular, the present facilities within the Region are either somewhat antiquated, as at Latreca, or else still in the foundation period, as is the case with the Zamefa plant. One substantial copper fabricating unit is in operation at Phalabora in South Africa, but information regarding this is closely guarded.

The conversion costs given must, therefore, be drawn primarily from European information, with a small increase allowed for the increased cost of high level technical manpower. Several points may be considered somewhat dubious in this assumption. Firstly, it is not clear that depreciation rates adopted for Europe will be equally valid for any African country. Secondly, the relative costs for different types of power may differ substantially and this might well lead to the installation of different types of machinery with different running costs. Maintenance will undoubtedly by more expensive in Africa where workshop facilities are both less available and more expensive. Unskilled labour will tend to be more plentiful, which will give lower labour costs in this respect, and lead to the consideration of the use of labour intensive methods. Although the extent to which the factors above differ as between Europe and Africa is larger, it must not be permitted to obscure the fact that differences will similarly exist between countries within the Region. It is not possible to take these factors into account in the presentation of conversion costs.

The principal factor which leads to differences between the capital costs for identical plants in different areas within the Region is distance from the sea board. The chief cost in shipment by sea is to be found in the loading and unloading of cargo on despatch and at arrival, once this has been subtracted it can be seen that the length of the sea journey

in itself is not a factor of great significance. However, the cost of land transport does increase very substantially with distance. At present the cost of shipping a compact ton to Zambia from a port will be about $50. When this sort of addition is made to heavy plant and machinery it clearly becomes quite important.

The costs of breakdowns are far higher in Africa than in Europe, as either large stocks of spares have to be maintained by the plant, or else production has to be interrupted while the faulty component is mended. The alternative of waiting until a new part is sent from Europe is likely to be even more expensive.

These considerations tend to favour the installation of proved techniques which although not hyper-efficient and up to date, are unlikely to go wrong. With this in mind it seems reasonable to suggest that the potential for installing second hand machinery is substantial. Leaving aside savings in capital costs, machinery of a more proved design will tend to be easier to run, and it will be far easier to obtain skilled operatives to train local labour to use the machines. Second hand machinery which is in good condition offers the additional advantage that it is well run in and the initial intensive servicing is thereby by-passed.

The second-hand market in primary fabricating plant is less active than that in secondary fabricating machinery. However, present indications suggest that suitable second-hand primary fabricating plant will be available in the coming decade.

CHAPTER 8

ECONOMICS OF LOCATION

8.1 Factors affecting location of plant

8.1.1. Transport Costs

Other things being equal a plant will be located to minimise the sum of the transport costs of raw materials and the transport costs of finished products. Consequently, if raw materials are more costly to transport than finished products, the manufacturing plant will be located at the nearest point to the source of raw materials; if the finished product is more costly to transport than the raw materials the plant will be located near the market to minimise the cost of distribution of the product to consumers.

In the latter case there will be a transport saving by establishing separate production facilities in each of the main consumption areas. This will, of course, conflict with the need to centralise production capacity if the process is subject to economies of scale.

In the case of the copper fabricating industry the unit cost of transporting fabricated products is the same as the cost of transporting the copper input. According to the COMITRA tariff classification, which ex hypothesi applies to the whole central sub-region rail and river network, all fabricated copper products (including insulated wire and cable) are subject to the same tariff per ton/km. The same is true of the East African Railways' goods classification which has been assumed to apply to all Eastern sub-region railways.

Unfabricated copper in the form of wire-bars for export is the only category of copper subject to a different tariff. The precise rate is not published, being negotiated by the copper companies, but it is lower than the tariff for fabricated copper goods. However, the copper companies are able to negotiate a favourable rate for wirebars because of the vast quantity transported. Smaller quantities travelling irregularly over different routes are unlikely to obtain such a discount so we have assumed a similar cost to that of other copper products.

It is, of course, true that there is a scrap loss in most production processes so that finished products are lighter than the input from which they were made. However, this is counter-balanced to a varying degree by the fact that the value of finished products is necessarily greater than the value of the raw materials so that the cost of insuring finished products and of financing goods in transit will generally be higher.

The balance between these factors can be calculated using a formula derived in section 8.3 of this chapter. Briefly, the difference between the cost of transporting raw materials and finished products is given by the formula

$$st - (a + b) (P_2 (1 - s) - P_1)$$

where s = scrap formation per ton of input

t = average rail transport cost per ton kilometre

a = the average cost of financing goods in transit per dollar and kilometre

b = the average cost of insuring goods in transit per dollar and kilometre

P_2 = the price per ton of the finished product

P_1 = the price per ton of copper input

If this formula has a value greater than zero, the cost of transporting raw materials is greater than the cost of transporting finished products so the ideal location is near the source of raw materials.

The formula is evaluated for each type of plant using the appropriate values for each variable in sections 8.2.1. - 8.2.5. of this chapter.

The inputs for some fabrication processes come from different sources e.g. imported plastic and local wire for insulation plants. The relative transport costs of each material must then be taken into account.

8.1.2. Scrap Recirculation

Most copper fabrication processes give rise to scrap copper, which may amount to between 5 and 30 per cent of the copper input. Given the value of copper, the scrap is not wasted but recirculated i.e. melted down and recast. If the plant has no foundry of its own or if scrap requires refining it must be sent back to a refinery. Consequently, location near a refinery or a foundry is important for copper fabrication plants not possessing their own foundries. If the scrap is of high purity it will be 'too good' to send to a bronze foundry so a location near a refinery is preferable.

8.1.3. Stockholding

Because of the high value of copper in relation to the value added by most copper fabrication processes, the burden of financing stocks of copper and copper products can be extremely significant. Stocks of copper and copper products frequently amount to over a third of total capital (see Chapter 7 for reference to particular types of plant) and the cost of financing this can be correspondingly high. It is important, therefore, to locate plants so as to minimise the value of stocks held. The importance of stockholding costs is particularly pronounced at the present high level of prices, especially as the converter's premium* does not appear to alter with the price of copper although his stockholding costs do. Should the price of copper decline during the period of this study, the relative importance of this factor will diminish also.

Stocks of finished products are held to meet peaks of demand and strategic stocks of raw material are held to safeguard production against delays in delivery. In general, location near the source of raw materials will reduce the need to hold stocks of raw materials and the quantity of raw materials in transit. On the other hand a location near the market will reduce the need for stocks of finished products and the quantity of finished products in transit.

Two general factors suggest that the value of stocks of finished products are likely to be greater than the value of stocks of raw materials so that a saving in the total quantity of stocks will be made by locating the plant close to the market. Firstly, the unit value of finished products is necessarily greater than the unit value of raw materials. Secondly, the range of different products will almost always be greater than the range of input. For example, a wire drawing plant will have one major input, wire rod, but will produce a range of different wires. It is conventionally reckoned that the amount of stocks held of any product (or input) is proportional to the square root of the sales (or purchases) of each product (or input). So the total stocks of finished products are likely to exceed the total stocks of raw materials if a range of products is produced.

However, there are other factors which may decrease the relative value of stocks of finished goods as against stocks of raw materials:

(i) Firms producing to jobbing orders will not need to keep stocks of finished products since they will produce only to order. They will, nonetheless, need stocks of raw materials in order to meet orders immediately and will, therefore, be able to minimise stocks by siting themselves near the source of raw materials. (However, communications

* The difference between the prices of the fabricated copper product and the copper input used.

with the customer demand proximity to the customer which counteracts this - see section 8.1.4.)

(ii) Plants which have a high cost of starting up need large stocks of raw materials to avoid the need for enforced stoppages if supplies are delayed.

(iii) If the scrap rate is high the unit value of input can actually exceed the unit value of output. This apparent anomaly is resolved by the fact that the scrap produced is sold.

To summarise; the value of stocks of finished products normally tends to exceed the value of stocks of raw materials so that total stockholding costs will be minimised by siting a plant near the market. This will be true whenever:

(a) the conversion premium raises the value of output by more than the extra value of metal required because of scrap formation.

(b) the plant does not work primarily to jobbing orders.

(c) the number of products is large in relation to the number of inputs.

(d) the starting up time is great so the cost of stopping production because of insufficient raw material stocks is high.

8.1.4. Communications

One of the most important factors affecting location is ease of communication with clients and with suppliers. It is, however, almost impossible to quantify although the qualitative importance of communication for each type of manufacturing plant can be evaluated.

Where a large number of consumers and a wide range of products is involved close proximity between plant and consumer is likely to be important. If a plant is producing to jobbing orders i.e. working to the idiosyncratic specifications of consumers, proximity to the consumer is essential.

At the other extreme, if a standardised product is produced for sale to a limited number of users, the need for proximity to them is very small.

Close communication with a supplier is rarely so important, though it is usually desirable in order to maintain a continuous flow of supplies of consistent quality. In the case of the copper industry, however, proximity to the mining companies is important since they are a reservoir of expertise on copper metallurgy and can be called upon to offer technical advice, laboratory assistance etc. This is only of major importance to fabrication plants engaged in fabrication of primary copper.

8.1.5. Availability of industrial infrastructure

Copper fabrication, like any other industry, benefits from the existence of a developed industrial infrastructure. In particular, supplies of electricity and water are required. All types of copper fabrication are to some extent reliant on electric power either to drive machinery or to heat furnaces. Water is required for cooling and pickling.

Also of major importance is proximity to an engineering workshop. The transport from Europe of spare parts for advanced machinery is expensive and involves long delays. The alternative of stocking spare parts involves prohibitively high inventory costs. Consequently it is essential that means be available, either within the plant or nearby, to repair all but the most complex parts. Latreca, for example, possesses a number of universal machine tools for the repair and modification of its equipment. Major jobs can, however,

be undertaken in the Gecomin workshops at Likasi which are among the best equipped in the Region.

The more costly and complex the machinery involved the more important is the availability of workshop facilities in order to minimise the time plant must spend idle because of breakdowns.

The availability of labour adapted to an industrial environment is important for recruiting the unskilled and semi-skilled labour force of any fabrication plant. In general there will be an adequate supply in all the major industrial centres of the region. The specific skills peculiar to each fabrication process will of course only be possessed by employees of the existing fabrication plants. Where it is not possible or desirable to install new capacity in an existing plant it may therefore be necessary to recruit expatriate staff. The copper mining areas are likely to provide a reservoir of labour and technical personnel with skills in an industrial setting related to that of copper fabrication.

8.1.6. Location of existing plant

The establishment of new copper fabrication plants cannot be considered in isolation from the location of existing plants in the region. In some cases it will be most economical to increase capacity by expanding existing plants even though these are not optimally placed to meet the future distribution of demand. On the other hand, where the expansion of existing factories is not economic it may be desirable to site new plant in another part of the region to minimise transport costs.

In some cases there are economies to be gained by the integration of two or more processes in the same plant. Where this is so the optimum location for carrying out a new process will be determined by the position of an existing complementary plant.

8.2. The influence of locational factors for each type of plant

The six factors discussed above have been considered primarily in terms of whether they tend to favour a location near the source of raw materials or near the customer. In this section we evaluate the net influence of all these factors on the optimum location of each type of plant. Where the balance of factors favours proximity to the customer a conflict arises between the economies of location and the economies of scale because, to maximise proximity to the customer, there would have to be one plant in virtually every main consumption centre.

8.2.1. Wire-rod rolling and extrusion

(i) Transport costs. The availability of primary copper in the Region means that the copper fabrication industry has a competitive advantage in supplying the Region over European firms who must pay transport costs to and from Europe. Using the transport cost formula derived in section 8.3 and substituting the following values:

scrap rate	s	=	5% for rod rolling
wire bar price	P_1	=	$1,000
wire rod price	P_2	=	$1,080

it is demonstrated that the cost of transporting wire bars exceeds the cost of transporting wire rod by about 4 per cent of the average transport cost (assuming the intra-regional transport tariff for wire bars is the same as for fabricated copper).

If the rod is extruded the scrap loss will be about 15 per cent and the cost of transporting the copper input will be some 14 per cent greater than

the cost of transporting rod.

Both rolling and extrusion methods of producing wire rod will minimise costs by siting near the refinery. The incentive in the case of extrusion is particularly great.

(ii) Scrap recirculation. The above calculation does not take into account the cost of recirculating scrap. This reinforces the need to be located near a refinery, especially as the high purity of the copper means that a high proportion of plant scrap will be 'too good' to be sold economically to a normal bronze or brass foundry.

(iii) Stockholding. In section 8.1.3. four factors were mentioned as influencing the ratio of stocks of finished products to stocks of raw materials.

(a) Ratio of conversion premium to scrap formation. The premium of rod over wire bar for African producers will be at the most $150 per ton. This is equal to about 15 per cent of the wire bar price used in this report. In rod rolling only 5 per cent extra wire bars are required to allow for scrap formation so the value of stocks of rod will exceed the value of stocks of wire bar. For extrusion about 15 per cent extra billets will be required so that the value of stocks of input and output will be virtually identical.

(b) Jobbing orders. Wire rod is not produced to jobbing orders since it is a standardised product. Some stocks of raw materials will therefore be needed to meet unexpected orders. Extrusion presses do work to jobbing orders in the production of other products. Such extrusion plants are considered in 8.2.2.

(c) Number of inputs and products. Rod is an homogeneous product produced from a single copper input. Some other inputs are used, such as fuel oil for furnaces, but their value is negligible in comparison to that of copper.

To summarise; the net difference in the value of stocks of rod and of raw materials is small in the case of a rod rolling mill and negligible in the case of an extrusion press producing only rod. Stockholding costs therefore have little influence on location.

(iv) Communication. Because of the standardised nature of the product and the relatively small number of customers (wire rod is sold exclusively to wire drawing plants of which there are few), communication with customers is of little importance. However, close contact with the copper refineries is important because of the technical advice and laboratory facilities the latter can provide.

(v) Infrastructure and Labour. A rod mill is based on expensive and complex machinery. Consequently, to minimise losses due to breakdowns, it is an advantage to be near a workshop such as those possessed by the mining companies, notably at Likasi, but also in Zambia. Electricity and water must be available. Only in the Copperbelt of Zambia and in Katanga is there a substantial number of indigenous workers with skills in a related field to that of copper fabrication. Latreca, of course, already has a rod mill and employees skilled in its operation. However, it would not be difficult to train operatives for a mill anywhere in the region, as the principal requirements are dexterity and strength, though technical staff would always need special experience and expatriates

would probably be employed initially.

(vi) Location of existing plants. The only rod mill at present in operation is Latreca at Lubumbashi. Zamefa is installing an extrusion press at Luanshya which will initially produce mainly wire-rod. When demand exceeds the present capacity of these two plants, it may be possible to increase the capacity of Latreca's mill by introducing some degree of mechanisation or installing additional stands. However, the scope of such expansion is likely to be severely limited and beyond a certain level it will be more economic to establish a new wire-rod plant. Certain economies, particularly in sharing technical staff, could be obtained by siting any new rod plant near either Latreca or Zamefa.

Summary. None of the above factors clearly indicate that a rod plant should on balance be near the customer while several factors, notably the effect of scrap on transport and recirculation costs, suggest that the most economic location would be near the copper refineries and also near the existing rod fabrication firms. The economies of scale in rod production are so great that, especially as there is no need to be sited near the customer, any new capacity should be in a single new plant.

8.2.2. Extrusion press

(i) Transport. Like other fabrication processes whose input is refined copper, there is a saving in transport costs that favours fabrication in the region.

The scrap formation of an extrusion plant producing a wide range of products is usually at least 25 per cent of the input. Inserting this and the price of extruded products, which averages around $1,350 per ton if the price of billets is about $1,017 per ton, the difference in cost between transporting the billets and the extruded products is some 20 per cent. There is, therefore, a transport saving by siting the plant near a refinery.

(ii) Scrap Recirculation: Extrusion presses normally extrude brass as well as copper so they must normally have access to a foundry to produce alloy billets. The same foundry can recast the plant scrap. Where this is the case the transport saving calculated above disappears and there are no transport costs of recirculation.

(iii) Stockholding:

(a) The ratio of conversion premium to scrap formation. The average conversion premium for extruded products is about $340 per ton which is about 30 per cent over the price taken for billets. Scrap formation raises the quantity of billets needed by 25 per cent so the value of stocks of products is only slightly greater than the value of stocks of inputs.

(b) Jobbing orders. Extrusion presses usually carry out a proportion of jobbing orders. These necessitate no stocks of finished products (but see below (iv) Communication).

(c) Relative number of products and inputs. The range of products of an extrusion press is extremely varied - tubes, rods, shapes, etc. - and within each category there are many different specifications. By contrast the input is either alloy billets or ingots of copper and the alloying metals. Few different specifications of billets are required.

To summarise, the value of stocks of products will exceed the value of stocks of raw materials because of the large range of products. Hence it is desirable to be near the main market to minimise stock costs.

(iv) Communication: To meet jobbing orders the extrusion press must be in good communication with its customers. However, standardised products such as tubes, rod and certain shapes require no special contact with the customer. Communications with the supplier on the other hand are important as it may be necessary to reach agreement on billet shapes and specifications and to negotiate the billet premium which seriously affects the fabricator's margins.

(v) Infrastructure and labour. Electricity is needed for both machinery and the furnace (which for preference would be electric induction). Water is also needed for cooling and pickling. Proximity to a workshop is desirable.

Labour skilled in operating an extrusion press will exist only at Latreca and Zamefa. But as mentioned before, both mining areas contain technicians with experience of copper metallurgy.

(vi) Location of existing plants. Certain economies can be gained by installing any new press required in the same plant as an existing extrusion press - peaks of demand can be met more economically, and longer runs can be programmed on each press. However, if any new press is installed elsewhere it can more easily meet the jobbing orders in its own vicinity.

Summary: Different factors conflict in their influence on optimum locations. To meet jobbing orders and minimise stocks of standard products a location near the market is desirable. Communication with suppliers and the desirability of access to a refinery for scrap favour a site in the mining areas. In practice important sources of jobbing orders and other demand are located in the mining areas.

8.2.3. Housewiring plants

(i) Transport costs: Housewiring plants in the Region will only have a competitive advantage (resulting from transport savings) over imported housewire if some of the transport saving of locally produced wire or rod is passed on to them. It would be in the interest of a local wire or rod producer to encourage the establishment of housewiring plants by selling wire or rod below the imported price.

A simple insulation plant creates little scrap but adds quite a high value to the wire insulated. In addition, the cost of insuring housewire in transit is high because of the danger of pilfering of small reels. The cost of transporting raw materials is therefore less than the cost of transporting the finished product, so costs will be minimised by a location near the market. The difference, however, is only of the order of 5 per cent of unit transport costs. In practice the different inputs (plastics and copper wire) will not be obtained from the same place so that it would be impossible as well as uneconomic to locate an insulation plant near both sources of supply.

A housewiring plant drawing its own wire from thick wire or rod creates rather more scrap; about 10 per cent and 20 per cent for drawing respectively from wire and rod. In both cases the cost of transporting inputs exceeds the cost of transporting the final product. However, its

effect on location is minimised; firstly, because the scrap rates apply only to the copper input and not to plastics which account for up to half the product by weight; secondly, because the two inputs are likely to come from different places; and thirdly, because the rail tariff for plastics is cheaper per ton mile than for insulated wire.*

(ii) Scrap recirculation. Housewire plants are rarely associated with foundries so scrap will have to be sold to an outside foundry or refinery. The amount of scrap in the case of an insulation line is minimal so location near foundry facilities is not of primary importance. If wire drawing is carried out, larger quantities of scrap are created so that location near a foundry or refinery is desirable. Scrap plastic can usually be recirculated within the plant since thermoplastics are used.

(iii) Stockholding.

(a) Ratio of conversion premium to scrap formation. The conversion premium raises the value of the finished product to more than offset the extra input needed because of scrap formation.

(b) Jobbing orders. Housewire plants do not usually work to jobbing orders since the range of wires used by most customers within a locality or country is fairly standardised.

(c) Relative numbers of inputs and products. Housewire plants produce a wide range of products, for example East African Cables of Nairobi have a range of 120 different types of housewire and cables.** The range of a simple insulation plant is smaller but still considerable. Splendor at Kinshasa, for example, produces 25 different types.+ The number of inputs is far smaller. A plant drawing rod needs only rod and plastics, though several colours of plastics will be required. A plant drawing wire needs only one or two thicknesses of wire and plastics. And even a simple extrusion line needs only two basic wire thicknesses for most types of housewire plus some fine wire gauges if flexible cords are made.

Summary of stockholding costs: The value of stocks of end products will far exceed that of stocks of inputs because of the range of wiring normally produced and the high conversion premium. In general housewire plants are too small to market their own products. Stocks are therefore held by a local factor who is in effect acting as the housewire plant's marketing department. As the factor will wish to minimise his stocks he will find it advantageous to buy from the nearest housewire plant who can then meet peaks of demand or special orders by working an extra shift. Consequently a location near the factor (who will be in the main centre of demand) is important.

(iv) Communication: Close communication with the local customer or factor is important in a small wire plant to take maximum advantage of the flexibility of production and to meet any special specifications or urgent orders. There is little need for close contact with suppliers.

*This is true only of the Central Sub-Region COMITRA Tariff. In the East African Railways Tariff, both plastics and insulated cable travel at the same tariff. This has been applied to all the East African Sub-Region's railways even though Rhodesia Railways also have a cheaper rate for plastics than for insulated wire.

** See Annex I for East African Cables' price list.

\+ See Annex C for Spendor's price list.

(v) Infrastructure and labour. Electricity and water are, of course, required. The plant is not vastly complex and sufficient facilities for simple repairs would be available in most industrial centres in the Region. However, small plants are unlikely to be able to reset their dies themselves. These may have to be sent to Europe or to a more sophisticated plant in the Region.

Few technical skills are required to operate the simplest housewire plants which is part of their attraction to the small entrepreneur. If the plant is gradually developed from a basic insulation line, to drawing thick wire and then to drawing wire from rod, a skilled labour force can be trained locally. This is not, therefore, an important factor in determining location.

(vi) Location of existing plants: In view of the importance to be attached to proximity to the market there are few economies to be gained from expanding existing plants especially as expansion comes principally from duplication of machinery. Moreover, the close supervision and control exercised in a small plant by an owner/manager will be lost in larger plants. The chief reason for the expansion of a plant is the production of an increased range of products.

Summary. In general, therefore, increased demand should lead to the setting up of additional plants away from existing plants (in order to gain advantages of proximity to the market) though some existing plants should increase the range of wiring made and begin to develop into wire and cable factories by the purchase of sophisticated cabling machinery. In the case of plants drawing from rod the advantages of proximity to the consumer are partially offset by the cost of scrap recirculation if there is no local foundry.

8.2.4. Wire and Cable Factories

(i) Transport costs. Wire and cable plants have a higher proportion of inputs of raw materials other than copper than any other type of plant. In general, around half the weight of the finished product is accounted for by the insulation, armouring and sheathing materials. Since the plastics, steel wire and tape etc. will generally be imported, the location of the plant is influenced by transport costs from the nearest port as well as transport of rod from the mill.

Because of the variety of inputs, possible production programmes and possible scrap rates depending on the amount of fine wire drawn, it is not possible to calculate the balance of advantage on transport costs. In general, however, the rate of scrap formation will mean transporting sufficient extra rod to offset the extra cost of insuring and financing the more valuable finished product.

(ii) Scrap recirculation. Wire and cable mills generally create about 20 per cent plant scrap, starting from rod. This clearly means a site near a refinery is desirable unless there is a demand for scrap from a local foundry. However, although the scrap formation is high compared with, say, rod rolling, it is not so significant when it is remembered that copper accounts for only about half of the input.

(iii) Stockholding

(a) Ratio of conversion premium to scrap formation. The value added in cable making more than offsets the extra input required because of scrap formation.

(b) Jobbing orders. Cable factories do not produce to jobbing orders in the normal sense but a high proportion of output will be executed for large organisations, such as electricity or telephone authorities, who put out an annual tender for their forthcoming requirements. This means that stocks of finished products need not be held.

(c) Relative number of inputs and products. The range of products is extremely large, ranging from housewire to complex cables. The number of inputs, though large, is not nearly as great . The principal inputs are rod, plastics, steel wire and tape.

Summary of stockholding costs: The value of stocks of products will probably not greatly exceed the value of stocks of inputs because a large proportion of production will be made to advance order. Location near the market will not, therefore, significantly reduce stocks. However, a conflict arises between location near the rod plant to economise on stocks of rod and location near a port to reduce delays on imported inputs.

(iv) Communication. As mentioned above, the principal customers are a few large organisations - the electricity authorities, telephone authorities, railways and mining companies. Because orders are given by yearly or half-yearly tender, day-to-day contact with the customer is unnecessary. However, consultation with each organisation during the formulation of its requirements is highly desirable. This is because the tenders usually give extremely detailed and precise specifications of cable requirements. It should be possible for a local producer to influence the formulation of these specifications to ensure that he can produce advantageously the highest proportion of the authorities' requirements. Communication between cable factory and rod mill is not of comparable importance.

(v) Infrastructure and labour. Electricity, water and repair facilities are essential. A die-shop will normally be incorporated in any full scale cable factory. The skills acquired in the operation of a housewire plant are closely related to those used in a cable factory. This is part of the reason that housewire plants form a natural first step in developing a wire and cable factory.

(vi) Location of existing plants. Because of the logical development from insulation, through wire drawing to cable making, existing housewire plants form a natural nucleus for future wire and cable factories. Such plants exist at Kinshasa, Jinja, Nairobi, Addis Ababa and Asmara. In addition, Latreca has wire drawing and stranding machinery (though no insulation equipment) and Zamefa will be the first fully equipped wire and cable factory.

Summary: The factor with the most clearly defined influence on location is the location of existing housewire plants. However, it would not be economic to develop all of these into cable plants because of economies of scale and the technological minimum in the capacity of cable making machinery. From the point of view of communications and co-ordination, it is desirable to have at least one cable factory in each language zone; not merely to simplify language problems but also because the French speaking countries tend to work on metric units while the English speaking countries use inches. Where possible it is desirable that cable factories should be near a foundry or refinery to whom plant scrap may be sold.

8.2.5. Sheet mill.

Demand for sheet in the Region is low and a fairly high proportion comes from the mining companies themselves. It is, therefore, logical to site a sheet mill near the mines as it is then near both customers and suppliers. In practice the only sheet mill existing or planned is Latreca's at Lubumbashi. Regional demand is expected to exceed the installed capacity there only towards 1980 and it should be possible to increase the capacity of this plant by mechanisation to meet this potential increase.

8.2.6. Foundry.

Bronze and brass foundries produce almost entirely to jobbing orders. They can, therefore, only effectively meet orders of customers close enough for consultation. This determines both the market area which a foundry can serve and its location. Another important factor is the availability of sand of casting quality. Brass and bronze foundries tend for this and other reasons to be part of a larger iron and steel or non-ferrous foundry.

8.3. Net transport cost (Derivation of cost formula).

The total cost of transporting merchandise is the sum of the railway* tariff, the cost of financing goods in transit and the cost of freight insurance. The railway tariff depends on the class of goods carried and its weight. The cost of financing goods in transit depends on the rate of interest, the time taken by the journey and the value of the goods. The insurance premium depends on the value of the goods and the likelihood of theft. So the total cost of transport of copper input per ton per kilometre is given by the formula:

$$T_1 = t + aP_1 + bP_1$$

Where: T_1 = total cost of transporting one ton of copper input for one kilometre

t = rail tariff/ton km

a = cost of financing one dollar of goods during time taken to travel 1 km.

b = average cost of insuring one dollar of goods per kilometre

P_1 = price of the copper input.

The finished product will weigh less than the input because of scrap formation. Therefore, T_2, the total cost of transporting copper product per ton/km, is given by the formula:

$$T_2 = t(1 - s) + aP_2(1 - s) + bP_2(1 - s)$$

Where: s = proportion of input converted to scrap

P_2 = price of the copper product.

The difference in transport costs is given by the formula:

$$T_1 - T_2 = st - (a + b)\ (P_2(1 - s) - P_1)$$

The rail tariff, t, for copper fabricated goods over an average distance is about \$.05 per ton per km.

* Almost all freight transport between distribution centres is by rail - see Chapter 9.

The length of time in transit for the 2,500 km. journey from Ndola to Beira is about five weeks so the time per kilometre has been taken as .002 weeks/km. The normal borrowing rate for commercial credit on goods in transit is about 10 per cent per annum. So the financial cost per dollar per km. is about \$4 x 10^{-6} per dollar per km.

The insurance cost averages about \$.25 per cent per journey which is equivalent to about a value for b of \$5 x 10^{-6} per dollar per km.

Inserting these values in the equation we obtain

$$T_1 - T_2 = .05\, s - 9 \times 10^{-6} \left(P_2 (1 - s) - P_1\right)$$

This formula has been used to calculate relative transport costs in the preceeding sections of this chapter.

CHAPTER 9

TRANSPORT, DISTRIBUTION AND PRICING

9.1 Demand for copper products by distribution centre

To calculate transport costs and the catchment area served by each fabrication centre a finer geographical breakdown of demand is required than that calculated in Chapters 3 and 5 which was only on a country by country basis. The Region has therefore been broken down into twenty consumption areas each of which is assumed to be served from a single distribution centre. The demand for each product within each country has been apportioned to the distribution centre on the basis of population. The location of each demand centre is shown on Fig. 9.I.

In Chapter 5 a different input coefficient was calculated for each type of copper product, industry and country in order to project future demand. This method minimises the error in the aggregate estimate of Regional demand. However, the individual coefficients are subject to wide margins of error which tend to cancel out in the estimates of aggregate demand but which exaggerate the difference between each country. The demand in each industry and country was therefore recalculated by multiplying the mean coefficient for the industry in the Region by the projected output in each industry in each country. This new set of values, of course, suffers from the opposite disadvantage in that an industry is assumed to have the same input coefficient in every country thereby ignoring differences in copper usage between countries. So the average was taken of the values estimated by the first and second methods for the demand for each industry in each country in 1980.

We are interested in the distribution of demand for the products of five types of plant:

(i) Extrusion press. Extruded products (other than wire rod) are included in Type 1 - semi-manufactures. On the basis of present demand it has been assumed that 81 per cent of this category is extruded products (of which 37 per cent are shapes and 63 per cent tubes and tube fittings).

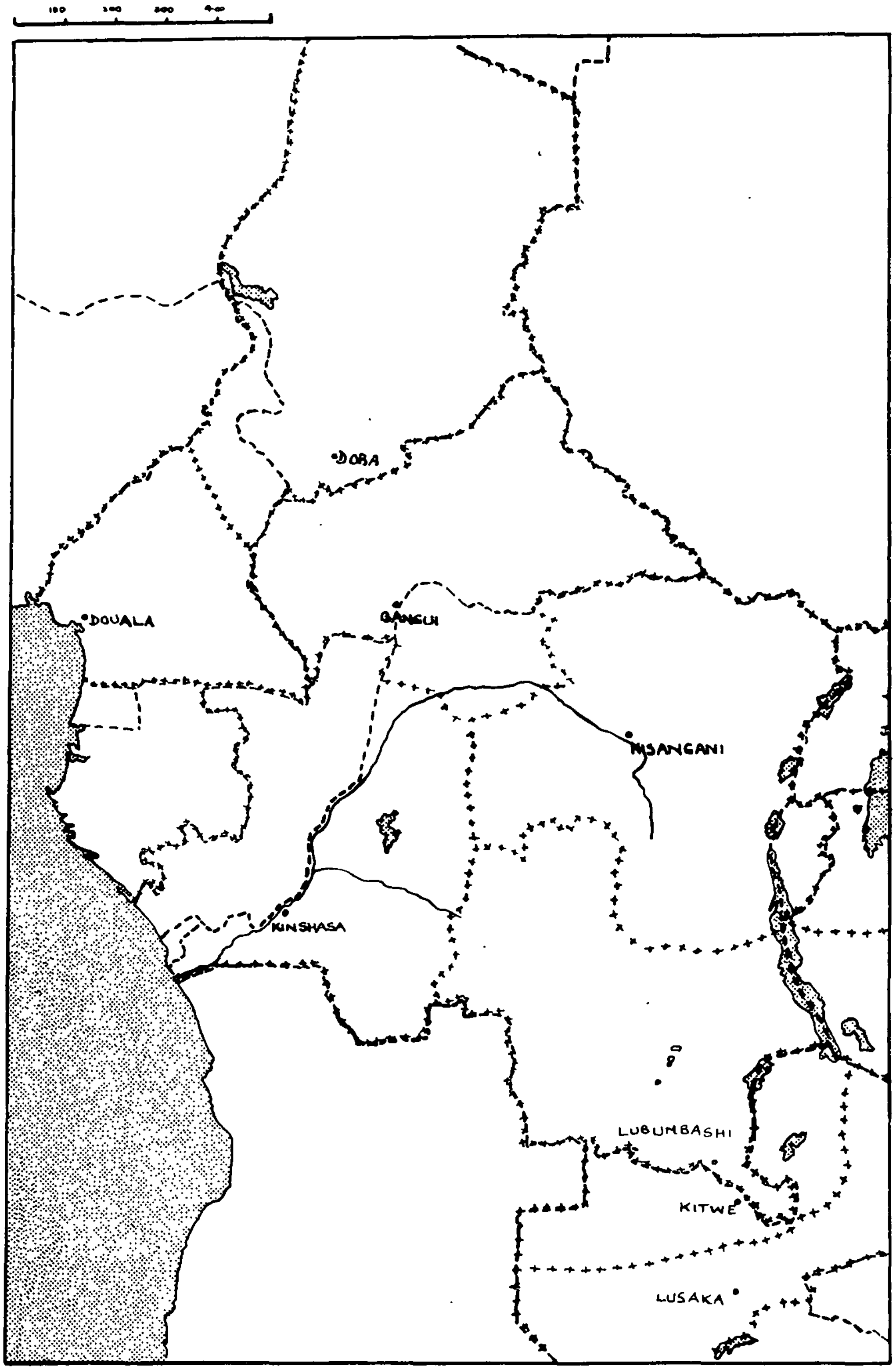
(ii) Sheet mill. Sheet and strip are also included in Type 1 semi-manufactures and account for the remaining 19 per cent.

(iii) Housewire plant. Housewire plants produce predominantly for the building industry so demand in each distribution centre has been taken as 85 per cent of the demand for housewire from the construction industry. The remaining 15 per cent is assumed to be of more complex specifications than can be made in the Region. Some bare wire and cable can be made in a housewire plant - we have assumed an arbitrary 15 per cent.

(iv) Wire and cable factory. Wire and cable factories can make housewire as well as the more complex types of insulated cable and bare conductors. It has been assumed that about 15 per cent of all types of conductors will be too complex or specialised to make locally and will therefore continue to be imported.

(v) Wire Rod plants. The demand for wire rod is not included in any of the four types of product into which demand has been analysed in Chapters 3 and 5, since it is a product sold entirely within the copper fabrication industry for further transformation. However, the quantity used can be derived from the demand for bare and insulated conductors. We have assumed 20 per cent scrap formation in drawing wire from rod and a further 5 per cent during insulation.

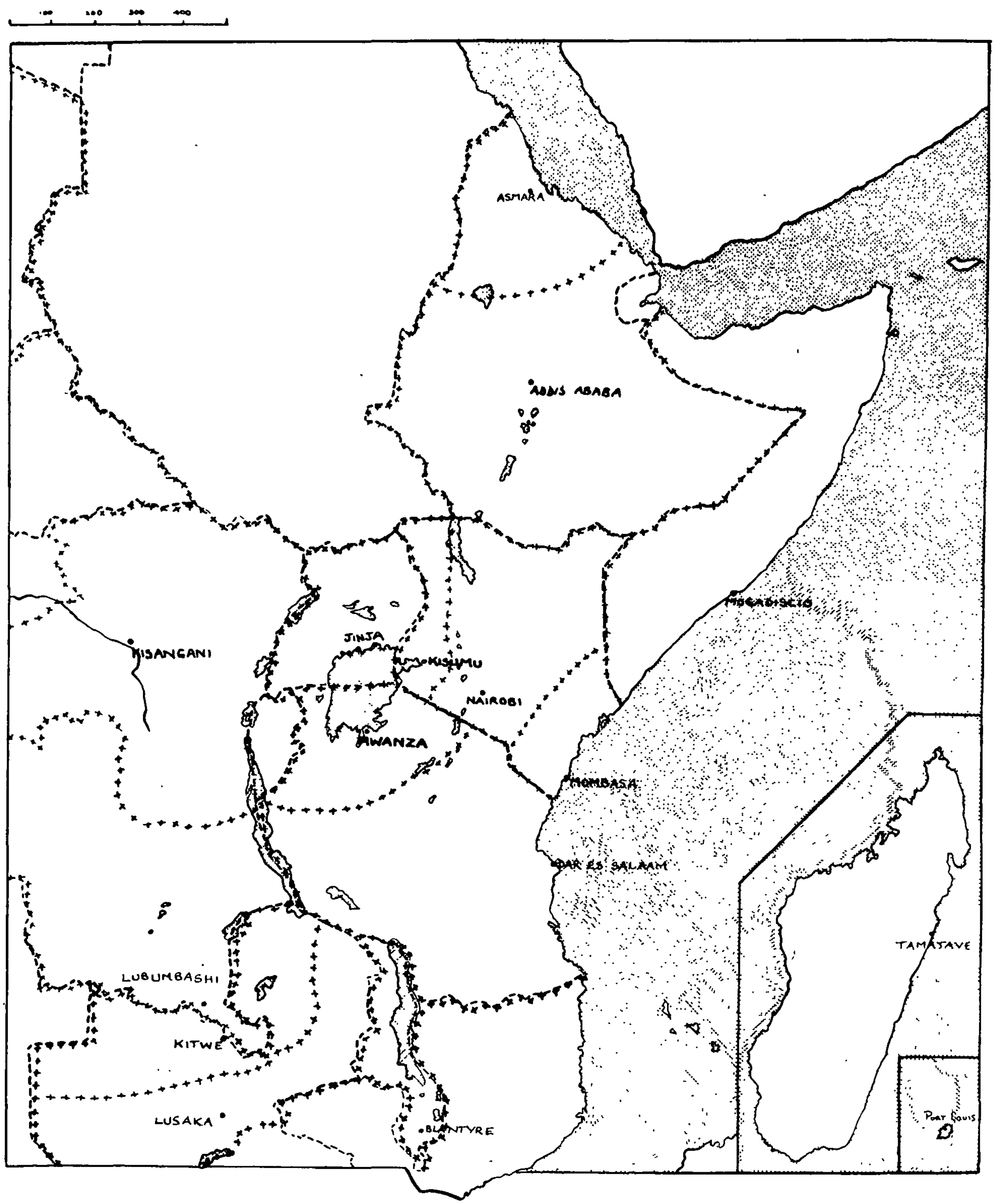
Fig. 9. I (a) - Location of Demand Centres and Consumption Areas in Central Africa



------------ National boundaries
(does not imply recognition by the U.N. of disputed borders)

++++++++++++ Approximate borders of consumption areas.

Fig 9. I (b) - Location of Demand Centres and Consumption Areas in East Africa



- - - - - - - - - National boundaries
(does not imply recognition by the U.N. of disputed borders)

+ + + + + + + + + Approximate borders of consumption areas.

The demand in each distribution centre for the products of the first four types of plants based on the revised calculations of demand is shown in Table 9. I. As wire rod is only sold to wire drawing plants the distribution of demand for rod depends on the location and output of each wire rod drawing plant. The distribution of derived demand for rod is therefore given in Table 9. VIII following the allocation of demand to each production centre.

9.2 The distribution centres

The distribution centres in the Central sub-region each serve a consumption area defined in 'Reference Framework For Central Africa' by J.L. Lacroix. Thus Kinshasa serves the Kinshasa and Lower Congo districts of Congo (K) as well as the whole of Congo (B). Also the north of Cameroon and Chad are in a consumption area served from the distribution centre of Doba. In the East sub-regions each country is broken up into one or two consumption areas based on the principal industrial centres. The consumption areas are outlined in figure 1.

9.3 Possible production centres.

The factors affecting location and their relevance to each type of copper fabrication plant have been discussed in Chapter 8. On the basis of this discussion it is possible to suggest suitable locations for each type of plant that will be needed to meet the demand projections for 1980. For several types of plant a location near the copper refineries or based on the expansion of existing plants was considered most suitable. However, in the case of housewire plants a location near the market was recognised to be desirable. Consequently the choice of location and the number of plants that can most economically meet the demand must be decided partly on the basis of transport costs. At this stage, therefore, a number of possible sites have been selected and the least suitable will be rejected after a consideration of the transport costs.

9.3.1. Wire rod production:

Total demand for wire rod from within the region in 1980 will be approximately 24,000 tons. Present and planned capacity comprises a 7,000 tons per annum rod mill at Latreca and 5,000 tons per annum from the extrusion press to be installed by Zamefa. However, Zamefa plan to use their extrusion press entirely for extrusion of other copper products and aluminium by 1980. There will, therefore, be a need for an extra 17,000 tons of rod making capacity by 1980.

Because of the considerable economies of scale, particularly in capital cost, it is recommended that only one new rod plant be established. The most suitable type of mill for an output of 17,000 tons per annum is a semi-automatic rod mill. The most appropriate location is near a refinery (see chapter 8) and, therefore, either in Katanga or the Copperbelt. Given the fact that the largest single customer for rod will be Zamefa's wire drawing plant the logical location for a new mill would be in close proximity to Luanshya.

9.3.2. Extrusion Press

Latreca already has a small extrusion press and Zamefa will have a substantially more powerful one. In view of their different production capabilities and advantages, these facilities are likely to be complementary rather than competitive. The total demand for extruded copper products (other than wire rod) will be 5,500 tons in 1980. The combined capacity of Latreca and Zamefa in terms of the same demand structure will be about 9,500 tons. The apparent problem of overcapacity will not in fact be met as the scope for extruding aluminium should absorb the excess. However, there will be no case for a further extrusion plant in the region within the time horizon of this study.

Table 9.I - Demand for Distinctive Products of Each Type of Plant in Each Distribution Centre

(tons of metal content)

Distribution Centre	Extrusion Press (tubes, shapes etc.)	Sheet Mill (sheet and strip)	Housewire Plant (housewire and some bare wire)	Wire & Cable Factory (all conductors except those produced in housewire plant)
Addis Ababa	199	47	350	806
Asmara	66	16	117	267
Blantyre	65	15	102	254
Dar-es-Salaam	413	97	373	1,339
Jinja	332	78	408	633
Kisumu	83	19	65	181
Kitwe	385	90	399	1,095
Lusaka	471	110	488	1,338
Mogadiscio	44	10	42	68
Mombasa	83	19	65	181
Mwanza	93	24	93	334
Nairobi	386	91	301	844
Port Louis	112	24	147	201
Tamatave	293	69	380	638
Bangui	328	77	502	611
Doba	239	56	440	377
Douala	246	58	365	437
Kinshasa	880	206	923	1,367
Kisangani	518	122	552	648
Lubumbashi	414	97	385	716
Total	5,650	1,325	6,497	12,335

9.3.3. Sheet Mill

The only sheet mill existing or planned is Latreca's. It has a capacity at present of only 500 tons of cold rolled sheet. However, demand for sheet in 1980 is not expected to be much greater than this as some will be more economically produced outside the region. It should be possible to meet this by further mechanisation of Latreca's cold rolling mill since hot-rolling capacity is already adequate.

9.3.4. Housewire Plants

Housewiring plants of various degrees of sophistication exist at Nairobi, Jinja, Addis Ababa and Kinshasa. The wire and cable factory at Luanshya (Zambia) will also manufacture housewire and Latreca already has wire drawing and cabling plant around which it has been proposed to establish a wire and cable factory.

There are no housewire plants in the central sub-region apart from the Congo (Kinshasa). We therefore consider Douala in the Cameroons and Bangui in the Central African Republic as possible locations. In the Eastern region possible locations for new plants are Dar-es-Salaam and Tamatave. Dar-es-Salaam is a centrally placed distribution centre where there is likely to be considerable local demand, and Dar-es-Salaam will, when the TanZam rail link is completed, be connected direct to the rod mill in Zambia. Tamatave is an appropriate site to serve both Madagascar and Mauritius and as it is a port, cost of transporting both rod and plastics will be low.

9.3.5. Wire & Cable Factories

The first wire and cable factory in the region will be Zamefa at Luanshya. However, plans exist to extend a number of housewire plants already in existence into wire and cable factories. This is a logical development as explained in chapter 7. Splendor in Kinshasa intend to make armoured and lead sheathed cables next year. Latreca has been considering adding armouring and other equipment to wire drawing and cable-making equipment. The Cable Corporation of Uganda at Jinja is to install rod drawing and other equipment next year. The East African Cables Company at Nairobi already draw from rod and produce a wider range of housewire than any other plant in the region. They might logically extend their range of cables.

9.3.6. Summary of possible production centres

The possible production centres for each type of fabrication are shown in table 9.II

Table 9.II - Possible Production Centres

		Rod Rolling Mill	Extrusion Press	Sheet Rolling Mill	House-Wire Plant	Wire & Cable Factory
Addis Ababa	Ethiopia	-	-	-	✓	-
Dar-es-Salaam	Tanzania	-	-	-	✓	-
Jinja	Uganda	-	-	-	✓	-
Luanshya	Zambia	✓	✓	-	*	✓
Nairobi	Kenya	-	-	-	*	✓
Tamatave	Madagascar	-	-	-	✓	-
Bangui	Central African Republic	-	-	-	✓	-
Douala	Cameroon	-	-	-	✓	-
Kinshasa	Congo (K)	-	-	-	*	✓
Lubumbashi	Congo (K)	✓	✓	✓	*	✓

*All wire and cable factories manufacture housewire as well

9.4 The Transport System

To cost the transport of goods from each production centre to distribution centres which fall within its possible hinterland it is necessary to make certain assumptions about the transport network that will exist in 1980 and the cost of each method of transportation.

9.4.1. The transport network in 1980

The railway and river networks in the East and Central sub-regions are shown in figs. 9.II and 9.III. Planned routes whose existence by 1980 is assumed are indicated by dotted lines.

The network assumed for the Central sub-region is taken from the Working Hypotheses for the Transport System*. The principal existing routes have been developed to open up mineral, agricultural and forestry areas to the sea. The rivers, particularly in the Congo basin, are an important part of the transport system so they reinforce this coastward orientation of the transport system. Consequently communications between inland areas are difficult and must often pass by the coast.

Some of the new rail links planned are designed to improve lateral communications within the region. For example it is hoped that Bangui will eventually be joined to Mbalmayo in the Cameroons. It is not possible to count on this railway being complete by 1980 though its existence has been taken as a working hypothesis. The same applies to the branch line from the C.A.R./Cameroon border to Ouesso which will link up with the Congo basin river system. A proposal to connect the CFMK[+] and CFCO[++] railways by a bridge between Kinshasa and Brazzaville awaits a joint decision by both governments.

Two other projects aim to improve communications between the coast and the interior. The TransCameroon railway will reach Ngaoundere by 1970 and is to be extended into the Chad before 1975. In the Congo (K) engineering studies are being commissioned on a railway from Port Franqui to Kinshasa which would provide a continuous railway from the mining areas of South Katanga to the port of Matade, thus cutting out two expensive transhipments.

In the Eastern sub-region the basic rail network has also been developed primarily to send mineral and agricultural wealth to the coast. However, there is no system of river transport comparable to that of the Central region, although the Great Lakes do form a natural means of communication between the various populous areas in the Great Rift Valley.

The principal link between the mining industry of the Copperbelt and the sea used to be the Ndola-Beira railway through Southern Rhodesia. Since UDI efforts have been made to develop alternative routes to the North though the old Rhodesian Railways still have to be used to export much of the copper. The principal new route is the road through Mbeya in Tanzania to Dar-es-Salaam. This is only a temporary solution since the road, though it has been improved, suffers heavy wear and tear from the goods traffic it now carries. Extensive studies have therefore been made of the possibility of building a railway from Zambia to Dar-es-Salaam. It is hoped that construction will begin soon. We have assumed the railway to be in existence before 1980 and that there will be a connection (including a marshalling yard) at Mikumi with the existing East African Railways system.

The only other major rail project affecting the sub-region is one to build a railway line through the Kafue gap in Rhodesia. This would shorten the journey from Ndola to Beira by 1,000 kms. This project will be of little interest to the sub-region and most unlikely to materialise so long as UDI and the policy of sanctions persist. Should a line

* UNECA document M67-826 Louis Gelineau

\+ Chemin de Fer Matadi Kinshasa in Congo (Kinshasa)

++ Chemin de Fer Congolais in Congo (Brazzaville)

through the Kafue gap ever be built following a settlement of UDI it would reduce the rail distance from the copperbelt to Beira to less than that by the TanZam rail link. We have assumed it will not be built before 1980.

In addition to rail, river, and lake transport, the principal means of transport is coastal shipping. The principal ports on the West coast are Matadi (in Congo (K)) and Pointe Noire (in Congo (B)), both of which are deep water ports and Doula (in the Cameroons) which is an estuary port in shallow water. The principal ports in the East are Dar-es-Salaam and Tanga (in Tanzania), Mombasa (in Kenya), Beira (in Mozambique for Zambia), Mogadiscio (in Somalia), Djibouti (French Somaliland), Massawa (in Ethiopia), Tamatave (in Madagascar) and Port Louis (in Mauritius).

Rail transport will generally be used in preference to road for the transport of copper products wherever the alternative exists, though road may be used for short hauls and for urgent deliveries. In practice, rail links do exist or are planned between nearly all centres relevant to this study.

9.4.2. The Tariff System

The tariff hypotheses for the Central sub-region are given in UNECA document M67-826*. They presuppose that the goods classification used throughout the Central sub-region rail and river network will be that developed by COMITRA, the joint organisation of the four Congolese rail systems. The tariff for each class of goods will also be common throughout the region and is based on a declining marginal rate per ton kilometre with increasing distance. The river tariff is based on the same system except that journeys by river are valued at two thirds their real distance. A handling charge equivalent to 50 kms. travel is charged for each trans-shipment from rail to river and vice versa.

According to the COMITRA tariff all fabricated goods including insulated cables are in category 4. Copper wire bars are charged at a special rate negotiated by the copper companies. Plastic granules are classified in category 6, steel wire in category 5 and steel tape in category 7, they therefore travel at a cheaper rate than fabricated copper.

The road tariff is given as 4 U.S. cents per ton per kilometre which is low by current values but will be more realistic in the period for which predictions are being made.

A tariff of $20 per ton is charged for sea journeys between any two ports in the Central sub-region. This tariff includes all handling, storage, and port charges as well as basic freight costs.

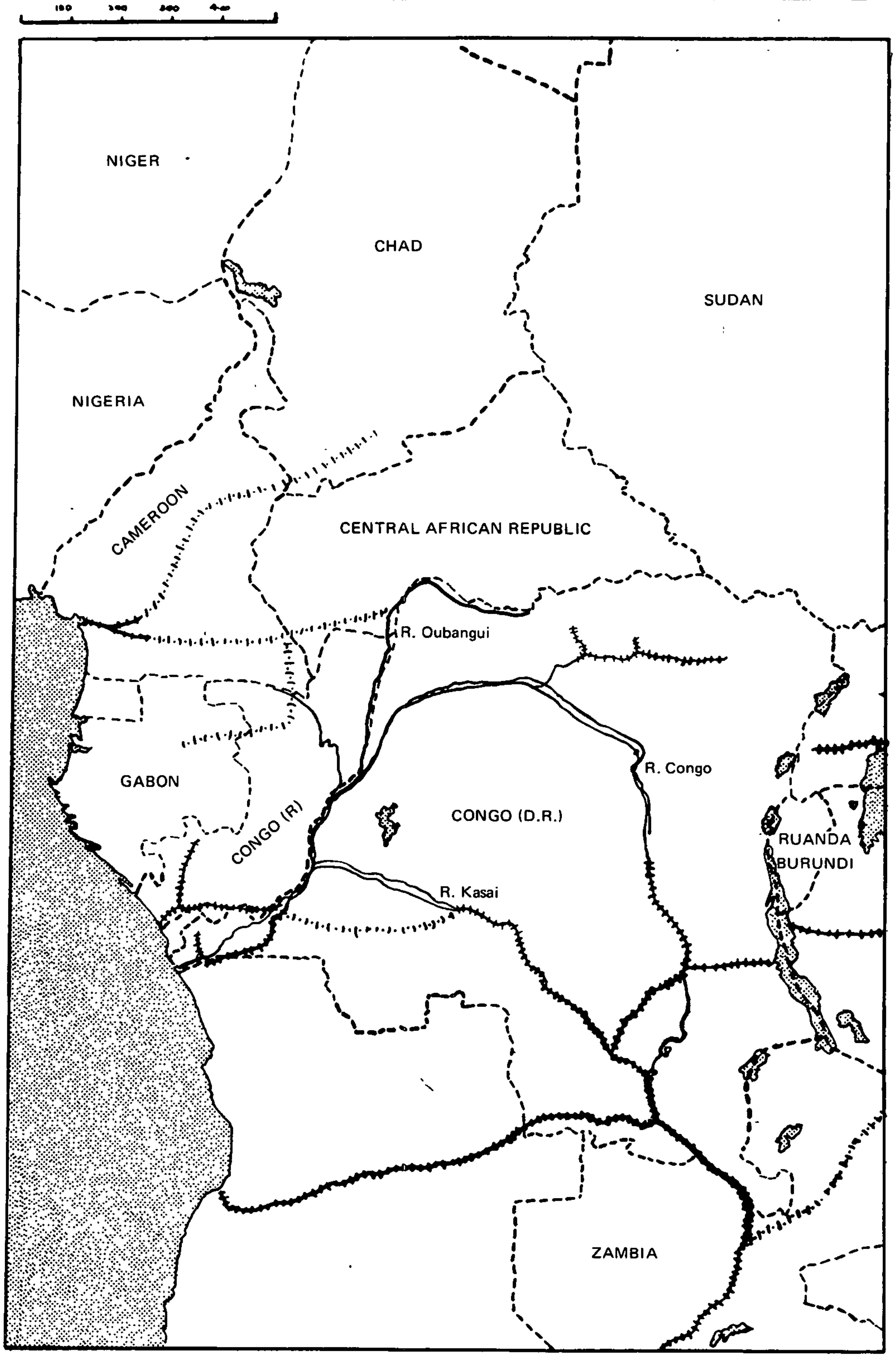
The tariff and classification assumed for rail and lake travel in the Eastern sub-region is that of the East African Railways and Harbour Board which controls the most extensive rail system in the Eastern sub-region. Freight carried on the Ethiopian Railways or Zambia/Rhodesia Railways is charged at the same rate as for a similar distance on the East African system.

All fabricated goods are classified as category 2. Plastics, steel wire and tape are also in this category in contrast to the Central sub-region.

Shipping rates between different ports are given in Table 9.III. Each sea fare includes a uniform provision of $10 for handling, stocking and harbour dues.

* Gelineau - Working Hypotheses for the Transport Sector.

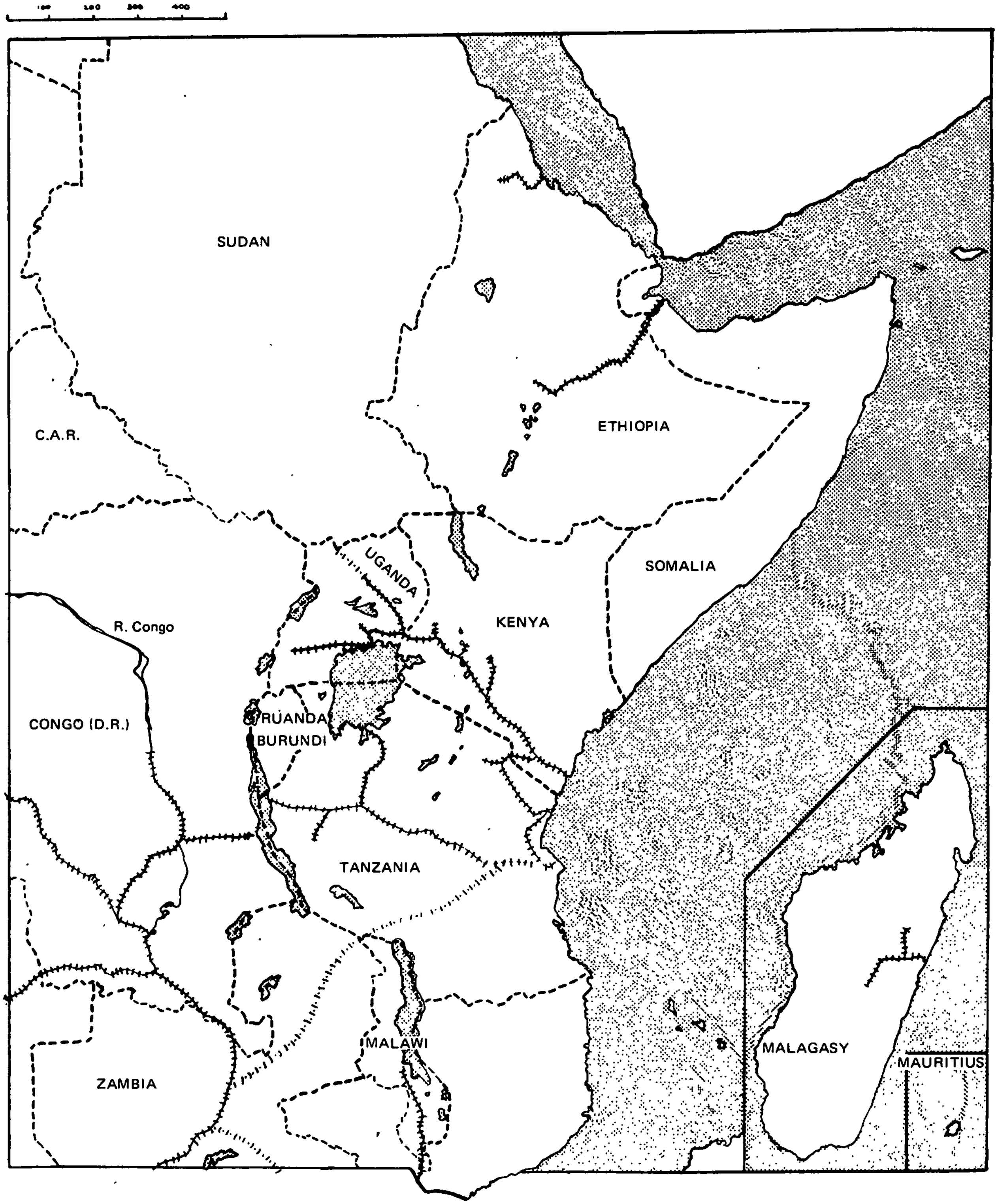
Fig. 9. II - Existing and Planned Railway and River Transport Network in Central Africa



National boundaries
(does not imply recognition by the U.N. of disputed borders)

Existing railways
Planned railways
Navigable rivers

Fig. 9. III - Existing and Planned Railway and River Transport Network in East Africa



National boundaries
(does not imply recognition by the U.N. of disputed borders)

Existing railways
Planned railways
Navigable rivers

Table 9.III - Shipping costs between different ports in the East African sub-region

($ per ton)

	Beira	Dar-es-Salaam	Mombasa	Massawa	Tamatave
Beira	-	21.9	21.9	25.7	28.1
Dar-es-Salaam	21.9	-	18.2	22.5	23.5
Djibouti	22.9	22.0	20.4	n.a	30.1
Massawa	25.7	22.5	22.5	-	30.1
Mombasa	21.9	18.2	-	22.5	24.5
Mogadiscio	22.1	20.5	19.7	22.5	28.1
Port Louis	26.7	24.5	24.5	30.1	18.2
Tamatave	28.1	23.5	24.5	30.1	-

The road tariff has been taken as 4.4 cents per ton per kilometre.

9.5 The transport cost matrix

Table 9.IV shows the cost of transporting copper fabricated goods between the possible production centres and the distribution centres they may conceivably serve.

In practical terms it turns out that the Eastern and Central sub-regions are at present virtually separate. With one exception, every distribution centre in the East can more cheaply be supplied from a possible production centre in the same sub-region than from any in the Central sub-region and vice versa. The exception is Kisangani which is most cheaply served by Jinja, if it is assumed that the road to Kisangani from the rail head at Kasese can be used. However, in this case Jinja has to pay a transport cost of $74.1 per ton on its wire rod from Luanshya so there is a net saving if Kisangani is supplied from Lubumbashi.

9.6 Distribution centres best served by each production centre for each type of good

On the basis of the transport cost matrix it is possible to decide which distribution centres are best served by which production centre for each type of product. It is also possible to discriminate between the postulated housewire production centres and to eliminate those which serve too limited a catchment area to be economically viable.

9.6.1. Wire rod mill.

The two wire rod production centres are Lubumbashi and Luanshya. They are separated by only 316 kms. so that transport costs to any distribution centre are not dissimilar. However, Luanshya is the nearer source for all distribution centres in the Eastern sub-region and Lubumbashi for all in the Central sub-region. In practice, of course, rod is only purchased by housewire plants and wire and cable factories. As the total demand for wire rod derived from demand for wire and cable in the Central Region will exceed the capacity of Latreca's rod mill some rod will have to be supplied to the Central sub-region from Luanshya.

9.6.2 Housewire.

Both housewire plants and wire and cable factories can supply housewire.

Addis Ababa.

The housewire plant at Áddis Ababa will be able to serve both Addis Ababa and Asmara distribution centres economically.

Dar-es-Salaam.

The proposed plant at Dar-es-Salaam can also supply the Mogadiscio distribution centre.

Jinja.

Jinja can also supply the Kisumu and Mwanza distribution centres.

Luanshya.

The wire and cable plant at Luanshya can most economically supply housewire to both the Kitwe and Lusaka distribution centres. It is also best suited to supplying Blantyre even though transport costs from Dar to Blantyre are less than from Luanshya to Blantyre. This is because the plant at Dar must in any case import its wire rod from Luanshya.

Nairobi.

The wire and cable factory at Nairobi will be able to supply housewire most economically to Mombasa.

Tamatave.

The proposed housewire plant at Tamatave will be best situated to serve both the internal Madagascan market and Mauritius. There will be sufficient demand for wire drawing facilities.

Bangui.

The production centre postulated at Bangui would only be able to supply its own local market (the C.A.R. plus the Ubangui Region of the Congo). This is not sufficient to support another housewire plant (though an insulation line could be considered about 1980), so the idea of a plant at Bangui has been discarded.

Douala.

The proposed housewire plant at Douala will be suitably placed to serve the hinterland of Douala and the distribution centre of Doba.

Kinshasa.

The housewire and wire and cable plants at Kinshasa will be able to serve the Kinshasa/Brazzaville distribution centre and also Bangui given that the latter has no housewire plant of its own.

Lubumbashi.

The wire and cable plant based on Latreca's equipment would be able to supply local demand for housewire and also the demand from the distribution centre at Kisangani. The transport matrix shows that Kisangani can be supplied more cheaply from Jinja but this neglects the extra cost of transporting rod which Jinja must bear and which Lubumbashi does not.

9.6.3. Wire and Cable Factories.

Two wire and cable factories have been postulated in the Eastern Region: the Zamefa plant at Luanshya and an expansion of the East African Cables plant at Nairobi. The Nairobi factory would buy rod from Zamefa which would therefore be dearer by the cost

of transport from Luanshya ($68.6 per ton). On the other hand Luanshya would have to import plastics and other raw materials through Dar-es-Sallaam at a cost of about $50.0 per ton while Nairobi would import from Mombasa at only $16.4 per ton. Assuming that two fifths of the materials required in cable making are imported from Europe, Nairobi would have a net disadvantage of $27.7 per ton of finished cable. Taking this into account Luanshya will be best situated to supply Kitwe, Lusaka, Blantyre and Dar-es-Salaam with wire and cable whereas Nairobi will be best situated to supply Addis Ababa, Asmara, Jinja, Kisumu, Mogadiscio, Mombasa, Mwanza, Port Louis and Tamatave.

In the Central sub-region it has been suggested that Latreca at Lubumbashi could form the basis of a wire and cable plant and at Kinshasa Splendor is expanding its insulation plant into a wire and cable plant. The Lubumbashi plant would have a transport advantage in supplying its own distribution centre and that at Kisangani. For all other centres in the Central sub-region Kinshasa would have the lowest transport costs.

9.6.4. Extrusion presses.

As mentioned in section 9.3.2 the two extrusion presses at Latreca and Zamefa will be complementary rather than competitive since each is best suited to producing a different range of products. They will each therefore tend to serve both regions though supplying somewhat different ranges of products.

9.6.5. Sheet mill.

The sheet mill at Latreca will supply the whole Region with sheet.

9.7 Price of Product in each distribution centre

It is a fundamental assumption of this study that copper fabrication facilities established in the Region should be able to compete with imported products without the benefit of tariffs or restrictions on trade. The price at which locally fabricated products will be sold in each distribution centre will therefore be less than or equal to the price of equivalent import products.

The price of imported products in any distribution centre will be the European price plus the cost of sea freight to the nearest port, plus handling charges, plus the cost of transport inland to the distribution centre. The total transport cost from Europe to each distribution centre is shown in Table 9.VI. A common freight rate of $40 per ton is assumed from Europe to all African ports plus a $5 port charge at each end. This will only be valid when the Suez Canal reopens. Until then the East coast ports will benefit from a small additional protection.

Because of the fluctuations in the price of copper it is necessary to break down the European price into the converter's premium and the basic copper price. Quotations in the London Metal Bulletin reproduced in Table 9.V. show that the converter's premium is fairly constant and independent of the price of copper.

The copper fabrication industry within the Region will be able to obtain copper cathode or wire bar net of the cost of transport to Europe. (The London Metal Exchange prices in Table 9.V. give the price of copper wire bars and cathode landed in Amsterdam).

The transport cost from Zambia to Europe is estimated to be about $84 per ton when the Suez Canal route is open.* The transport cost from Katanga to Europe is thought to be greater because of the higher cost of transport to the coast though, of course, the cost varies depending on which of the four possible routes are taken.** An average cost

* The cost via the Cape route is somewhat greater. The advantage to local fabricators will therefore be larger if the Canal stays closed.

** The four possible coastal ports are Matadi, Lobito, Beira and Dar-es-Salaam. Most of the Congolese copper industry's output is exported through Matadi.

Table 9.IV - Transport cost matrix

Distribution Centres	Addis Ababa	Dar-es-Salaam	Jinja	Luanshya (nr. Kitwe)	Nairobi	Tamatave	Bangui	Douala	Kinshasa	Lubumbashi
Addis Ababa	–	45.8	76.7	95.8	60.6	53.9	+	+	+	107.8
Asmara	44.0	25.9	58.9	76.4	42.8	34.0	+	+	+	88.4
Blantyre	67.4	42.6	75.1	66.0	59.0	48.8	+	+	+	78.0
Dar-es-Salaam	45.8	–	42.0	50.0	30.5	23.5	+	+	+	62.0
Jinja	76.7	42.0	–	74.1	19.3	57.0	+	+	+	86.1
Kisumu	72.3	38.3	7.0	74.1	12.3	+	+	+	+	86.1
Kitwe	95.8	50.0	74.1	–	68.6	73.5	+	+	+	25.2
Lusaka	95.8	50.0	74.1	9.9	68.6	73.5	+	+	+	30.2
Mogadiscio	46.3	20.5	52.2	70.5	36.1	28.1	+	+	+	82.5
Mombasa	44.2	18.2	32.5	62.7	16.4	23.5	+	+	+	74.7
Mwanza	79.9	34.1	11.4	66.6	24.7	+	+	+	+	78.6
Nairobi	60.6	30.5	19.3	68.6	–	40.9	+	+	+	80.6
Port Louis	53.9	24.5	57.0	74.5	40.9	18.2	+	+	+	86.5
Tamatave	53.9	23.5	57.0	73.5	40.9	–	+	+	+	85.5
Bangui	+	+	+	129.3	+	+	–	57.8	44.3	117.3
Doba	+	+	+	201.2	+	+	88.8	62.7	96.6	180.5
Douala	+	+	+	151.3	+	+	57.8	–	42.5	130.5
Kinshasa	+	+	+	117.3	+	+	44.3	42.5	–	94.7
Kisangani	+	+	52.9	92.2	+	+	59.8	90.4	56.6	80.2
Lubumbashi	107.8	62.0	86.1	25.2	80.6	+	117.3	139.3	105.3	–

+ Not a feasible journey

Table 9.V - Prices of Copper Products and Converter's Premium

(LME price in $ per ton)

Date	1.7.66	4.10.66	3.1.67	4.4.67	4.7.67	3.10.67	2.1.68*	2.4.68*	2.7.68	2.8.68	1.10.68	3.1.69
Electrolytic Cash Wirebar	1,677	1,274	1,271	1,067	988	1,103	1,397	1,478	1,142	1,046	1,123	1,214
Cash Cathode	1,649	1,254	1,249	1,056	974	1.092	1,354	1,454	1,142	1,046	1,123	1,212
Cathode Discount	28	20	22	11	14	11	43	24	0	0	0	2
Black H.R. Wire Rod ¼" to 5/16"	1,753	1,336	1,313	1,109	1,036	1,145	1,370	1,476	1,195	1,099	1,171	1,262
Rod premium (over wire bar)	76	62	42	42	48	42	–27	–2	53	53	48	48
Rods ½" to ¾"	2,008	1,596	1,568	1,366	1,294	1,403	1,601	1,721	1,464	1,339	1,411	1,505
Rod premium (over wire bar)	359	342	319	310	320	311	247	267	322	293	288	293
Sheet	2,027	1,534	1,604	1,389	1,316	1,462	1,639	1,745	1,474	1,378	1,442	1,567
Sheet premium (over cathode)	378	280	355	333	342	370	285	291	332	332	319	355
Tubes ¾" nom. size	n.a.	1,725	1,725	1,593	1,520	1,658	–	–	–	1,440	1,517	1,572
Tubes premium (over cathode)	n.a.	471	476	537	546	566	–	–	–	394	394	360
H.C. Wire 10 s.w.g.	1,876	1,450	1,428	1,221	1,148	1,260	1,474	1,582	1,296	1,198	1,272	1,366
Wire premium (over wire bar)	199	176	157	154	160	157	77	104	154	152	149	152
" " (" " rod)	123	114	115	112	112	115	104	106	101	99	101	104

* These months followed the devaluation of the U.K. pound when the markets were very disturbed – hence certain anomalous premia.

from Katanga to Europe of $96 per ton has been assumed. This of course implies that copper will be sold to local fabricators in Katanga at $96 below the L.M.E. price whereas local fabricators in Zambia will only get a discount of $84 below the world price. The discrepancy between the two prices is such that there will be no incentive for Zambian fabricators to buy from the Congo because transportation between the two countries costs more than the presumed price differential.

The net advantage local products possess over imported products in each distribution centre is shown in Table 9.VI. In every distribution centre local fabricators have a positive net competitive advantage on the basis of transport costs, (assuming part of the discount given to rod producers is passed on to wire drawing and insulating plants).

Table 9.VI - Net advantage of locally fabricated products due to transport and transport discount ($ per ton)

Distribution centre	From primary fabrication plant to distribution centre	Discount of cost from refinery to Europe	From Europe to distribution centre	Net advantage to local fabricator
Addis Ababa	95.8	84.0	73.8	62.0
Asmara	76.4	84.0	53.9	61.5
Blantyre	66.0	84.0	70.7	88.7
Dar-es-Salaam	50.0	84.0	50.0	84.0
Jinja	74.1	84.0	82.5	92.4
Kisumu	74.1	84.0	78.1	88.0
Kitwe	-	84.0	100.0	184.0
Lusaka	9.9	84.0	100.0	174.1
Mogadiscio	68.5	84.0	50.0	65.5
Mombasa	62.7	84.0	50.0	71.3
Mwanza	66.6	84.0	84.1	101.5
Nairobi	68.6	84.0	66.4	81.8
Port Louis	74.5	84.0	50.0	59.5
Tasmatave	73.5	84.0	50.0	60.5
Bangui	117.3	96.0	94.3	73.0
Doba	180.5	96.0	112.7	28.2
Douala	130.5	96.0	50.0	15.5
Kinshasa	94.7	96.0	72.5	73.8
Kisangani	80.2	96.0	120.4	136.2
Lubumbashi	-	96.0	169.3	265.3

However, it is to be expected that conversion costs in the region will be higher than in Europe because of:

(i) a smaller scale of production

(ii) higher capital costs because of the cost of shipping machinery

(iii) higher running costs due to the high cost of imported materials, maintenance etc.

(iv) higher management overheads because of expatriate labour.

These will only be partly offset by lower labour costs.

We estimate that African conversion costs are liable to be about 15 per cent higher than European conversion costs in those processes subject to large economies of scale. The extra cost for each process is given in table 9.VII.

Table 9. VII - European and African conversion premiums ($ per ton)

Process	European Conversion Premium	Approximate African Conversion Premium	Net Disadvantage
Rod rolling	48	55.2	7.2
Extrusion (tubes, shapes etc.)	385	442.8	57.8
Sheet rolling	355	408.3	53.3

The additional premiums required for extrusion and sheet rolling in Africa are particularly high. However, the protection provided by transport costs will still make regionally produced sheet and extrusions competitive in all distribution centres except Douala and Doba. Locally produced wire rod will be competitive with imported wire rod throughout the Region.

Conversion costs in African housewire plants and wire and cable factories will not be much higher than in Europe and the difference should be largely offset by the advantages of proximity to the market.

9.8 Estimated output of each fabrication plant

The distribution centres which could be most economically served by each fabrication plant were elaborated in section 9.5 and the distribution centres where certain locally made products cannot compete with imported products were derived in section 9.6.

The net output of each proposed plant can now be calculated and is shown in table 9.VIII.

Table 9. VIII - Output of each production centre by 1980 (tons of metal content)

	Wire Rod	Housewire (+15% of bare)	Wire and cable (+ 85% of bare)	Sheet	Rod, bars and shapes	Tubes
Addis Ababa	-	467	-	-	-	-
Dar-es-Salaam	-	415	-	-	-	-
Jinja	-	565	-	-	-	-
Luanshya	17,100	989	4,024	-	1,220	2,050
Nairobi	-	365	4,155	-	-	-
Tamatave	-	528	-	-	-	-
Douala	-	805	-	-	-	-
Kinshasa	-	1,425	2,792	-	-	-
Lubumbashi	7,000	937	1,364	1,212	710	1,190

CHAPTER 10

INVESTMENT IMPLICATIONS

10.1 The location, output and catchment area of the fabrication plants which will be required to meet the Region's demand for copper products were set out in detail in Chapter 9. This section analyses the investment required by each plant and assesses its profitability and economic performance.

The production and financial data for each plant in 1980 are presented in the form required in UNECA document "Reference Framework for Sectoral Studies in Central Africa", to facilitate integration with parallel ECA studies of other industries.

Inevitably this process of quantification is subject to a wide margin of error, the figures should therefore be considered only as orders of magnitude. In particular, housewire plants and wire and cable factories enjoy considerable flexibility in the range of products they produce and, consequently, in the precise types of machinery they require. Both types of plant can draw and insulate aluminium wire and cable, as well as copper, and it is to be expected that a proportion of production time in most plants will be devoted to this, which would enable fuller or different use to be made of some plants than is indicated here.

Approximate financial and production data are presented for a number of existing plants. Where detailed information about labour force, value of capital equipment etc., was not available, estimates were made on the basis of the standard economic data presented in Chapter 6.

Certain assumptions have had to be made as to the prices charged for each type of product. As mentioned in Chapter 9, the price charged in each distribution centre will be less than, or equal to, the price of imported products in that centre. Maximum revenue would of course be obtained if all final products were sold at the same price as imported products. However, this would mean that none of the benefits of local fabrication would be passed on to the consumer and also that local fabricators would have to offer different ex-factory prices for consignments to different distribution centres. We have therefore assumed that each product will be sold at the same price as European products landed at a Regional port. Assuming base LME prices of $1,000 per ton for cash copper wirebars and $280 per ton for zinc, the following table shows the price used for each product:

Table 10.1 - Prices of Copper Products Landed in African Ports

	$/ton (of metal content)
Bare wire and cable	1,500
Housewire	1,800
Other insulated wire and cable	2,300
Copper tubes	1,385
Alloy* tubes	1,170
Copper rods and shapes	1,300
Alloy* rods and shapes	1,085
Copper sheet and strip	1,360
Alloy* sheet and strip	1,140
Wire rod	966

In the case of intermediate products, principally wire rod, the optimum price to charge will be below that of imported products, since if rod were sold at a discount, more wire drawing plants would be viable and consequently demand would be increased. We have, therefore, assumed that wire rod will be sold at the lowest price consonant with a reasonable rate of return on rod making plant. This means that most of the Region's savings in

* Alloys are assumed to be, on average, 70% copper and 30% zinc.

transport cost (due to locally produced copper) are passed on to wire drawing plants. In practice, rod producers are likely to charge the highest price they can obtain without threatening the viability of their customers but this price can only be determined empirically. Consequently, more of the gross operating surplus accruing to the fabrication industry as a whole will accrue to rod producers and less to wire drawers than is shown in the operating accounts in section 10.3. The total gross operating surplus should, however, remain the same.

Because a standard price equal to the landed price of imported products has been assumed, inland plants will have to absorb the cost of transport to distribution centres nearer the coast. Where an intermediate product (wire rod or bare wire for insulation) is being sold to another fabrication plant, the transport cost is, of course, only counted in the operating costs of the purchasing plant.

10.2 Viability of proposed plants

The three new housewire plants which we recommed to be established at Douala, Dar-es-Salaam and Tamatave, all show substantial gross operating surpluses at the level of output and prices of inputs and products assumed. They would clearly be viable even if a higher price were charged for wire rod. All the existing housewire plants also show substantial gross operating surpluses.

The four wire and cable factories recommended and planned, all show considerable gross operating surpluses. The Lubumbashi plant based on Latreca's existing wire drawing equipment will be viable despite its relatively small turnover, because it has low transport costs for wire rod and finished products as well as the benefit of some existing, fully depreciated equipment.

Our calculations are based on the assumption that imported wire and cable would sell at the prices listed in section 10.2. Under this assumption all the plants should be viable even without tariff protection. In practice, however, foreign producers are likely to cut their prices in order to retain a share of the market. There is likely to be considerable scope for foreign importers to do this because, at present, prices of imported wire and cable appear to be fixed by agreement between importers' agents in a number of countries. If substantial price cutting did develop it would be necessary to retain an external tariff to protect the Regional fabrication industry. The tariff needed would not, of course, raise prices above their present level.

The two extrusion presses, two rod mills and the expanded sheet mill all have large gross operating surpluses. It should, however, be mentioned that all Latreca's plant is already old. By 1980, most of it will be over 25 years old and although rolling mills forty years old are known to be in operation in some parts of the world, they obviously need expensive maintenance which is difficult to cost.

The main data in the detailed tables of each plant in section 10.3 are summarised in Table 10.II. They show that the total value added by the industry in 1980 will be of the order of $12,300,000. Sales of principal products (excluding scrap) will amount to $69,000,000 of which $45,800,000 will be sales outside the industry and $23,200,000 will be sales of wire rod to other copper fabrication plants.

The total new fixed investment required will be approximately $9,100,000 of which $1,930,000 will be in buildings and $7,180,000 in plant and equipment. However, a large amount of working capital (of the same order of magnitude as fixed capital) will also be required to finance stocks of goods and raw materials.

The total revenue accruing to the transport industry in the Region as a result of

Table 10. II - Summary of Production, Investment & Transport Data in 1980 - ($)

TYPE OF PLANT	LOCATION OF PLANT		Value of Sales (Excluding Scrap)	Total Operating Costs	Wages	Depreciation	Gross Operating Surplus	Value Added	Cost of Transport of Inputs	Cost of Transport of Products
HOUSEWIRE PLANTS	Douala	Cameroon	1,426,500	1,433,600	34,100	10,800	144,500	189,400	145,300	46,600
	Addis Ababa	Ethiopia	806,100	831,300	26,500	6,400	52,500	85,400	64,100	8,200
	Dar-es-Salaam	Tanzania	720,000	712,400	26,500	6,400	73,700	106,600	26,800	1,400
	Lugazi	Uganda	994,200	1,014,300	42,200	36,200	39,300	117,700	67,100	2,500
	Tamatave	Madagascar	930,300	947,000	36,600	6,400	68,200	111,200	50,100	16,200
		Total Housewire	4,877,100	4,938,600	165,900	66,200	378,200	610,300	353,400	74,900
WIRE AND CABLE FACTORIES	Luanshya	Zambia	9,717,500	7,810,900	169,200	128,000	2,807,100	3,104,300	143,800	170,600
	Nairobi	Kenya	8,622,000	7,206,700	169,200	128,000	2,152,700	2,449,900	432,900	178,700
	Kinshasa	Congo (K)	7,878,100	7,005,700	140,200	128,000	1,586,700	1,854,900	535,800	158,700
	Lubumbashi	Congo (K)	4,348,000	3,694,800	81,200	44,200	1,086,800	1,212,200	80,600	152,900
		Total Wire and Cable	30,565,600	25,718,100	559,800	428,200	7,633,300	8,621,300	1,193,100	660,900
Wire rod mill	Luanshya	Zambia	16,518,600	15,960,000	65,800	78,600	414,200	558,600	–	+
Wire rod mill	Lubumbashi	Congo (K)	6,678,000	6,530,500	48,300	*	99,200	147,500	10,500	+
Extrusion press	Luanshya	Zambia	5,560,500	4,117,700	232,600	198,000	1,012,200	1,442,800	84,300	155,400
Extrusion press	Lubumbashi	Congo (K)	3,239,400	2,548,500	129,200	*	561,700	690,900	9,200	220,700
Sheet mill	Lubumbashi	Congo (K)	1,587,000	1,314,100	96,700	8,400**	167,800	272,900	700	85,400
GRAND TOTAL			69,026,200	61,127,500	1,298,300	779,400	10,266,600	12,344,300	1,651,200	1,197,300

\+ included as input of housewire plants and wire and cable factories

* Residual value of Latreca's plant not known. Old machinery is assumed to be fully depreciated

** Depreciation charge on new investment only. Old plant assumed fully depreciated.

transport of raw materials and finished products between production and distribution centres will be $2,850,000. There will also, of course, be a considerable amount of distribution within each consumption area, largely by short-haul road transport.

Import savings will be lower than the value of total sales since some of the industry's inputs (plastics, steel wire, fuel oil, etc.) will be imported; furthermore all the copper which accounts for much of the value of turnover would previously have been exported from the Region. The net foreign exchange saving is therefore likely to be only of the order of $11,750,000 p.a. However, this will be more than sufficient to offset the foreign exchange cost of new equipment (which will be almost entirely imported) within a single year.

10.3 Financial, Operating and Transport Data of Fabrication Plants in 1980

PRODUCT(S)	Housewire Plant
LOCATION OF FACTORY	Douala - Cameroon

PRODUCTION

Type of product	Quantity (tons)	Value (ex factory) $
Housewire - PVC insulated	730 (copper content)	1,314,000
Bare wire	75	112,500
Scrap	238	196,500
TOTAL:	805	1,623,000

CAPITAL INVESTMENT

Commencement of construction year - 1975	
Commencement of operations year - 1976	
Fixed capital investment - total	$ 120,000
of which: buildings and civil engineering:	$ 15,000
: equipment	$ 105,000

STAFF

	Number	Wages and Salaries
Upper level staff	1	$ 8,500
Office workers	2	3,200
Skilled labour	8	11,200
Unskilled labour	14	11,200
		$34,100

OPERATING ACCOUNT IN 1980

I. INPUTS

	Quantities Tons	Value (ex origin) $
Wire rod	1,043	955,000
Plastics and additives	570	288,000
Transport of inputs		145,300
Electricity		15,300
Other costs		30,000
TOTAL:		$1,433,600

II. VALUE ADDED

Wages and salaries	$ 34,100
Depreciation	10,800
Gross Operating surplus	144,500
TOTAL VALUE ADDED:	189,400

III. EX FACTORY TURNOVER: $1,623,000

COST OF TRANSPORT

A. INPUTS

	(primary raw materials)	Wire rod	Plastics and additives
-	Origin	Lumbumbashi	Douala
-	Tonnage	1,043 tons	570 tons
-	Cost of transport per ton:	$139.3 ton	-
-	Total cost of transport	$145,290	-

B. PRODUCTS

-	Consumption areas (other than that in which the factory is located)	Doba
-	Tonnages (exported from the area in which the factory is located)	743 tons
	Transport cost per ton	$62.7
	Total cost of transport	$46,560

PRODUCT(S) Housewire Plant

LOCATION OF FACTORY Addis Ababa - Ethiopia (Ethioplastics)

PRODUCTION

Type of product	Quantity (tons)	Value (ex factory) $
Housewire	352	633,600
Bare wire	115	172,500
Scrap	134	110,600
TOTAL:		$916,700

CAPITAL INVESTMENT

(Estimated on basis of standard plant)
Plant already installed.

Fixed capital investment - total	$72, 000
of which: buildings and civil engineering:	$10, 000
: equipment	$62, 000

STAFF

	Number	Wages and salaries
Upper level	1	$ 8, 500
Office workers	2	3, 200
Skilled labour	6	8, 400
Unskilled labour	8	6, 400
		$26, 500

OPERATING ACCOUNT IN 1980

I. INPUTS

	Quantities	Value (ex origin) $
Wire rod	601 tons	580, 600
Plastics and additives	275 tons	139, 000
Transport of inputs		64, 100
Transport of products		8, 200
Electricity		9, 400
Other services		30, 000
TOTAL:		831, 300

II. VALUE ADDED

Wages and salaries	$ 26, 500
Depreciation	$ 6, 400
Gross Operating surplus	$ 52, 500
TOTAL VALUE ADDED:	$ 85, 400

III. EX FACTORY TURNOVER: $916, 700

COST OF TRANSPORT

A. INPUTS

(primary raw materials)	Wire rod	Plastics and additives
- Origin	Luanshya	Djiboubi
- Tonnage	601	275
- Cost of transport per ton:	$95.8	$23.8
- Total cost of transport	$641, 20	

B. PRODUCTS

- Consumption areas (other than that in which the factory is located)	Asmara
- Tonnages (exported from the area in which the factory is located)	186
Transport cost pér ton	$44.0
Total cost of transport	$8,180

PRODUCT(S)	Housewire Plant
LOCATION OF FACTORY	Dar-es-Salaam, Tanzania.

PRODUCTION

Type of product	Quantity (tons)	Value (ex factory) $
Housewire	325 (copper content)	585,000
Bare wire	90	135,000
Scrap	120	99,000
TOTAL:		$819,000

CAPITAL INVESTMENT

Fixed capital investment - total	$72,000
of which: buildings and civil engineering	$10,000
: equipment	$62,000

STAFF	Number	Wages and Salaries
Upper level staff	1	$ 8,500
Office workers	2	3,200
Skilled labour	6	8,400
Unskilled labour	8	6,400
		$26,500.

OPERATING ACCOUNT IN 1980

		Quantities (Tons)	Value (ex origin) $
I.	INPUTS		
	Wire rod	535	517,000
	Plastics and additives	254	128,400
	Transport of inputs		26,800
	Transport of products		1,400
	Electricity		8,800
	Other		30,000
	TOTAL:		$712,400

II.	VALUE ADDED	
	Wages and salaries	$ 26,500
	Depreciation	6,400
	Gross Operating surplus	73,700
	TOTAL VALUE ADDED:	$106,600
III.	EX FACTORY TURNOVER:	$819,000

COST OF TRANSPORT

A. INPUTS

	(primary raw materials)	Wire-rod
-	Origin	Luanshya
-	Tonnage	535 tons
-	Cost of transport per ton:	$50.0
-	Total cost of transport	$26,750

B. PRODUCTS

-	Consumption areas (other than that in which the factory is located)	Mogadiscio
-	Tonnages (exported from the area in which the factory is located)	70 tons
	Transport cost per ton	$20.5
	Total cost of transport	$1,435

PRODUCT(S)	Housewire Plant
LOCATION OF FACTORY	Lugaji - Uganda (Cable Corporation of Uganda)

PRODUCTION

Type of product	Quantity (tons)	Value (ex factory) $
Housewire	489 (copper content)	880,200
Bare wire	76	114,000
Scrap	167	137,800
TOTAL:		1,132,000

CAPITAL INVESTMENT

Plant already in operation but additional equipment accounting for a large part of total capital investment is to be installed in 1969/70.

Fixed capital investment - total	$450,000
of which: buildings and civil engineering:	$110,000
: equipment	$340,000

STAFF

	Number	Wages and Salaries
Upper level staff	2	17,000
Office workers	2	3,200
Skilled labour	10	14,000
Unskilled labour	10	8,000
		42,200

OPERATING ACCOUNT IN 1980

I. INPUTS

	Quantities (Tons)	Value (ex origin) $
Wire rod	732	707,100
Plastics and additives	397	200,500
Transport of inputs		67,100
Electricity		9,600
Other services		30,000
TOTAL:		1,014,300

II. VALUE ADDED

Wages and salaries	$ 42,200
Depreciation	36,200
Gross Operating surplus	39,300
TOTAL VALUE ADDED:	117,700

III EX FACTORY TURNOVER: $1,132,000

COST OF TRANSPORT

A. INPUTS

		Wire rod	Plastics
	(primary raw materials	Wire rod	Plastics
-	Origin	Luanshya	Mombasa
-	Tonnage	732	397
-	Cost of transport per ton:	74.1	32.5
-	Total cost of transport	$67,144	

B. PRODUCTS

-	Consumption areas (other than that in which the factory is located)	Kisumu	Mwanza
-	Tonnages (exported from the area in which the factory is located)	105	151
	Transport cost per ton	$7.0	$11.4
	Total cost of transport	$2,470	

PRODUCT(S) Housewire Plant

LOCATION OF FACTORY Tamatave, Madagascar

PRODUCTION

Type of product	Quantity (tons)	Value (ex factory) $
Housewire - PVC insulated	461 (copper content)	829,800
Bare wire	67	100,500
Scrap	155	127,900
TOTAL:		1,058,200

CAPITAL INVESTMENT

Fixed capital investment - total	$72,000
of which: buildings and civil engineering:	$10,000
: equipment	$62,000

STAFF

	Number	Wages and Salaries
Upper level staff	2	$17,000
Office workers	2	3,200
Skilled labour	6	8,400
Unskilled labour	10	8,000
		36,600

OPERATING ACCOUNT IN 1980

I. INPUTS

	Quantities (Tons)	Value (ex origin) $
Wire rod	682	658,800
Plastics and additives	360	181,900
Transport of inputs		50,100
Transport of products		16,200
Electricity		10,000
Other		30,000
TOTAL:		$947,000

II. VALUE ADDED

Wages and salaries	$ 36,600
Depreciation	6,400
Gross Operating surplus	68,200
TOTAL VALUE ADDED:	$ 111,200

III. EX FACTORY TURNOVER: $1,058,200

COST OF TRANSPORT

A. INPUTS

(primary raw materials)	Wire rod and Plastics
- Origin	Luanshya
- Tonnage	682 tons
- Cost of transport per ton:	$73.5 ton
- Total cost of transport	$50,100

B. PRODUCTS

- Consumption areas (other than that in which the factory is located)	Port Louis (Mauritius)
- Tonnages (exported from the area in which the factory is located)	888
Transport cost per ton	$18.2 per ton
Total cost of transport	$16,200

PRODUCT(S)	Wire and Cable Factory
LOCATION OF FACTORY	Luanshya - Zambia - (Zamefa)

PRODUCTION

Type of product	Quantity (tons)	Value (ex factory) $
Housewire	796 (copper content)	1,432,800
Other insulated conductors	2,449	5,632,700
Bare wire and cable	1,768	2,652,000
Scrap	1,409	1,197,700
TOTAL:		10,915,200

CAPITAL INVESTMENT

Fixed capital investment - total	$1,600,000
of which: buildings and civil engineering:	$ 400,000
: equipment	$1,200,000

STAFF

	Number	Wages and Salaries $
Upper level staff	8	68,000
Office workers	15	24,000
Skilled labour	42	58,800
Unskilled labour	23	18,400
		169,200

OPERATING ACCOUNT IN 1980

I. INPUTS

	Quantities (Tons)	Value (ex origin) $
Wire rod	6,422	6,203,700
Plastics, etc.	1,651	833,800
Steel wire etc.	1,225	270,700
Transport of inputs		143,800
Transport of products		170,600
Electricity		88,300
Other services		100,000
TOTAL:		7,810,900

II. VALUE ADDED

	$
Wages and salaries	169,200
Depreciation	128,000
Gross Operating surplus	2,807,100
TOTAL VALUE ADDED:	3,104,300

III. EX FACTORY TURNOVER: 10,915,200

COST OF TRANSPORT

A. INPUTS

	(primary raw materials)	Wire rod and plastics,	additives, steel wire etc.
-	Origin	Rod mill in same plant	Dar-es-Salaam
-	Tonnage	6,422	2,875
-	Cost of transport per ton:		$50.0
-	Total cost of transport	$143,750	

B. PRODUCTS

-	Consumption areas (other than that in which the factory is located)	Lusaka	Blantyre	Dar-es-Salaam
-	Tonnages (exported from the area in which the factory is located)	2,871	544	2,125
	Transport cost $ per ton	$9.9	$66.0	$50.0
	Total cost of transport		$170,580	

PRODUCT(S)	Wire and Cable Factory
LOCATION OF FACTORY	Nairobi-Kenya - (East African Cables)

PRODUCTION

Type of product	Quantity (tons)	Value (ex factory) $
Housewire	284	511,200
Other insulated conductors	2,196	5,050,800
Bare conductors	2,040	3,060,000
Scrap	1,254	1,034,600
TOTAL:		9,656,600

CAPITAL INVESTMENT

	Existing (est.)	Additional
Fixed capital investment - total	$500,000	$1,100,000
of which: buildings and civil engineering:	$100,000	$ 300,000
of which: equipment	$400,000	$ 800,000

STAFF

	Number	Wages and Salaries
Upper level staff	8	$ 68,000
Office workers	15	24,000
Skilled labour	42	58,800
Unskilled labour	23	18,400
		$169,200

OPERATING ACCOUNT IN 1980

I. INPUTS

	Quantities (Tons)	Value (ex origin) $
Wire rod	5,774	5,577,700
Plastics and additives	1,144	577,700
Steel wire and tape etc.	1,100	243,100
Transport of inputs		432,900
Transport of products		178,700
Electricity		96,600
Other		100,000
TOTAL:		7,206,700

II. VALUE ADDED

Wages and salaries	$ 169,200
Depreciation	128,000
Gross Operating surplus	2,152,700
TOTAL VALUE ADDED:	2,449,900

III. EX FACTORY TURNOVER: $9,656,600

COST OF TRANSPORT

A. INPUTS

		Wire Rod	Plastics and Steel-wire etc.
	(primary raw materials)	Wire Rod	Plastics and Steel-wire etc.
-	Origin	Luanshya	Mombasa
-	Tonnage	5,774	2,244
-	Cost of transport per ton:	$68.6	$16.4
-	Total cost of transport	$432,900	

B. PRODUCTS

Consumption areas (other than that in which the factory is located)	Addis Ababa	Asmara	Jinja	Kisumu	Mogadiscio	Mombasa	Mwanza	Port Louis	Tamatave
Tonnages (exported from the area in which the factory is located)	1,099	365	1,000	272	105	373	530	324	939
Transport cost per ton	$60·6	$42·8	$19·3	$12·3	$34·3	$16·4	$24·7	$40·9	$40·9
Total cost of transport				$178,730					

PRODUCT(S)	Wire and Cable factory
LOCATION OF FACTORY	Kinshasa - Congo (K) - (Splendor/Congacec)

PRODUCTION

Type of product	Quantity (tons)	Value (ex factory) $
Housewire	1,266	2,278,800
Other insulated conductors	1,466	3,371,800
Bare conductors	1,485	2,227,500
Scrap	1,191	928,500
TOTAL:		$8,860,600

CAPITAL INVESTMENT

(Incorporating existing plant valued at appoximately $100, 000 included in total below)

Fixed capital investment - total	$1, 600, 000
of which: buildings and civil engineering:	$ 400, 000
: equipment	$1, 100, 000

STAFF

	Number	Wages and Salaries
Upper level staff	6	$ 51, 000
Office workers	10	14, 000
Skilled and simi-skilled labour	40	56, 000
Unskilled labour	24	19, 200
		$140, 200

OPERATING ACCOUNT IN 1980

I. INPUTS

	Quantities Tons	Value (ex origin) $
Wire rod	5, 408	5, 159, 200
Plastics and additives	1, 604	810, 500
Steel wire and tape etc.	733	162, 000
Transport of inputs		535, 800
Transport of products		158, 700
Electricity		79, 500
Other		100, 000
TOTAL:		$7, 005, 700

II. VALUE ADDED

	$
Wages and salaries	140, 200
Depreciation	128, 000
Gross Operating surplus	1, 586, 700
TOTAL VALUE ADDED:	1, 854, 900

III. EX FACTORY TURNOVER: 8, 860, 600

COST OF TRANSPORT

A. INPUTS

(primary raw materials)	Wire rod and Plastics, Additives, Steel Wire and Tape.	
- Origin	Lubumbashi	Matadi
- Tonnage	5,408	2,337
- Cost of transport per ton:	928	14.5
- Total cost of transport	$535,800	

B. PRODUCTS

- Consumption areas (other than that in which the factory is located)	Bangui	Doba	Douala
- Tonnages (exported from the area in which the factory is located)	1,780	545	624
Transport cost per ton	$44.7	$96.6	$42.5
Total cost of transport		$158,733	

PRODUCT(S) Wire and Cable Factory

LOCATION OF FACTORY Lubumbashi - Congo (K) - (Latreca)

PRODUCTION

Type of product	Quantity (tons)	Value (ex factory) $
Housewire	839	1,510,200
Other insulated conductors	806	1,853,800
Bare conductors	656	984,000
Scrap	658	559,000
TOTAL:		4,907,000

CAPITAL INVESTMENT

Fixed capital investment - total	$450,000
of which: buildings and civil engineering:	$ 10,000
: equipment	$440,000

STAFF

	Number	Wages and Salaries
Upper level staff	4	32,000
Office workers	5	8,000
Skilled labour	18	25,200
Unskilled labour	20	16,000
		81,200

OPERATING ACCOUNT IN 1980

I. INPUTS	Quantities (Tons)	Value (ex origin) $
Wire rod	2,959	2,822,900
Plastics and additives	984	502,300
Steel wire, etc.	403	89,000
Transport of inputs		80,600
Electricity		50,000
Other services		150,000
TOTAL:		3,694,800

II. VALUE ADDED	
Wages and salaries	$ 81,200
Depreciation	44,200
Gross Operating surplus	1,086,800
TOTAL VALUE ADDED:	1,212,200
III. EX FACTORY TURNOVER:	4,907,000

COST OF TRANSPORT

A. INPUTS

(primary raw materials)	Plastics, Additives, Steel wire, Others
- Origin	Matadi
- Tonnage	1,400/tons
- Cost of transport per ton:	57.6
- Total cost of transport	$80,600

B. PRODUCTS

- Consumption areas (other than that in which the factory is located)	Kisangani
- Tonnages (exported from the area in which the factory is located)	1,906
Transport cost per ton	$80.2/ton
Total cost of transport	$152,860

PRODUCT(S)	Wire Rod
LOCATION OF FACTORY	Luanshya - Zambia

PRODUCTION

Type of product	Quantity (tons)	Value (ex factory) $
Wire Rod	17,100	16,518,600
TOTAL:	17,100	16,518,600

CAPITAL INVESTMENT

Fixed capital investment - total	$930,000
of which: buildings and civil engineering:	$180,000
: equipment	$750,000

STAFF

	Number	Wages and Salaries
Upper level staff	4	$34,000
Office workers	2	3,.200
Skilled labour	9	12,600
Unskilled labour	20	16,000
		65,800

OPERATING ACCOUNT IN 1980

I. INPUTS

	Quantities (tons)	Value (ex origin) $
Wire Bars	17,100	15,663,600
Fuel Oil	400	36,400
Scrap Loss		110,000
Electricity		50,000
Other		100,000
TOTAL:		15,960,000

II. VALUE ADDED

	$
Wages and salaries	65,800
Depreciation	78,600
Gross Operating surplus	414,200
TOTAL VALUE ADDED:	558;600

III. EX FACTORY TURNOVER: 16,518,600

COST OF TRANSPORT

A. INPUTS

		Wire bars	Fuel Oil
	(primary raw materials)	Wire bars	Fuel Oil
-	Origin	Luanshya	Pipeline head, Sambia
-	Tonnage	17,100	400
-	Cost of transport per ton:	-	-
-	Total cost of transport	-	-

B. PRODUCTS

-	Consumption areas (other than that in which the factory is located)	Whole of Eastern sub-region and some to Central sub-region.
-	Tonnages (exported from the area in which the factory is located)	Tonnages and transport costs included in operating data of wire drawing plants.
	Transport cost per ton	-
	Total cost of transport	-

PRODUCT(S) — Wire Rod

LOCATION OF FACTORY — Lubumbashi - Congo (K) - (Latreca)

PRODUCTION

Type of product	Quantity (tons)	Value (ex factory) $
Wire Rod	7,000	6,678,000
TOTAL:		6,678,000

CAPITAL INVESTMENT

Already in operation. Investment presumed to be fully depreciated and residual value not known.

Fixed capital investment - total	$-
of which: buildings and civil engineering:	$-
: equipment	$-

STAFF

	Number	Wages and Salaries
Upper level staff	3	25,500
Office workers	2	3,200
Skilled labour	6	8,400
Unskilled labour	14	11,200
		48,300

OPERATING ACCOUNT IN 1980

I. INPUTS

	Quantities (tons)	Value (ex origin) $
Wire bar	7,000	6,328,000
Fuel Oil	200	17,000
Scrap loss		45,000
Transport of inputs		10,500
Electricity		30,000
Other Services		100,000
TOTAL:		6,530,500

II. VALUE ADDED

	$
Wages and salaries	48,300
Depreciation	-
Gross Operating surplus	99,200
TOTAL VALUE ADDED:	147,500

III. EX FACTORY TURNOVER: 6,678,000

COST OF TRANSPORT

A. INPUTS

	(primary raw materials)	Wire Bar	Fuel Oil
-	Origin	Lubumbashi	Matadi
-	Tonnage		200 tons
-	Cost of transport per ton:		52.5/ton
-	Total cost of transport		$10,500

B. PRODUCTS

- Consumption areas (other than that in which the factory is located)	Wire rod exported to housewire plants in the Central sub-region.
- Tonnages (exported from the area in which the factory is located)	Costs and tonnages included in data on wire-drawing plants.
Transport cost per ton	-
Total cost of transport	-

PRODUCT(S)	Extruded Tubes, Rods, Shapes, etc.
LOCATION OF FACTORY	Luanshya Zambia - (Zamefa)

PRODUCTION

Type of product	Quantity (tons)	Value (ex factory) $
Tubes - of copper	1,010	1,398,900
Tubes - of brass	1,040	1,216,800
Rods and shapes - of copper	480	624,000
Rods and shapes - of brass	740	802,900
Aluminium extrusions	2,730	1,517,900
TOTAL:	6,000	5,560,500

CAPITAL INVESTMENT

Fixed capital investment - total	$2,300,000
of which: buildings and civil engineering:	$ 400,000
: equipment	$1,900,000

STAFF

	Number	Wages and Salaries
Upper level staff	8	68,000
Office workers	5	8,000
Skilled labour	65	91,000
Unskilled labour	45	65,600
		232,600

OPERATING ACCOUNT IN 1980

I. INPUTS	Quantities (Tons)	Value (ex origin) $
Copper cathode	2,736	2,500,700
Zinc	534	104,700
Aluminium	1.365	795,800
Transport of inputs		84,300
Transport of products		161,900
Electricity		185,000
Scrap loss		85,300
Other		200,000
TOTAL:		4,117,700

II. VALUE ADDED	$
Wages and salaries	232,600
Depreciation	198,000
Gross Operating surplus	1,012,200
TOTAL VALUE ADDED:	1,442,800
III. EX FACTORY TURNOVER:	5,560,500

COST OF TRANSPORT

A. INPUTS

(primary raw materials)	Copper cathode	Zinc	Aluminium
- Origin	Luanshya	Metalkat (Likasi)	Dar-es-Salaam
- Tonnage	2,736	534	1,365
- Cost of transport per ton	-	$30	$50
- Total cost of transport	-	$84,270	

B. PRODUCTS

Consumption areas	Tonnages	Transport cost per ton from Luanshya
Addis Ababa	199.0	95.8
Asmara	66.4	76.4
Blantyre	65.0	66.0
Dar-es-Salaam	413.5	50.0
Jinja	331.9	74.1
Kisumu	82.7	74.1
Lusaka	470.8	9.9
Mogadiscio	43.7	70.5
Mombasa	82.7	62.7
Mwanza	93.4	66.6
Nairobi	386.1	68.6
Port Louis	112.3	74.5
Tamatave	292.9	73.5
TOTAL COST OF TRANSPORT:	$155,351	

PRODUCT(S)	Extruded Tubes, Rods, Shapes, etc.
LOCATION OF FACTORY	Lubumbashi - Congo (K) (Latreca)

PRODUCTION

Type of product	Quantity (tons)	Value (ex factory) $
Tubes of copper	590	817,200
Tubes of brass	600	702,000
Rods, shapes of copper	280	364,000
Rods, shapes of brass	430	466,600
Aluminium products	1,600	899,600
TOTAL:		3,239,400

CAPITAL INVESTMENT

Fixed capital investment - total Equipment written off residual value unknown
of which: buildings and civil engineering: " " " "
: equipment " " " "

STAFF

	Number	Wages and Salaries
Upper level staff	5	68,000
Office workers	2	3,200
Skilled labour	30	42,000
Unskilled labour	20	16,000
		129,200

OPERATING ACCOUNT IN 1980

I. INPUTS

	Quantities (tons)	Value (ex origin) $
Copper cathode	1,590	1,434,200
Zinc slab	310	57,000
Aluminium	800	466,400
Transport of inputs		9,200
Transport of products		163,400
Electricity		120,000
Scrap loss		48,300
Other		250,000
TOTAL:		2,548,500

II. VALUE ADDED

	$
Wages and salaries	129,200
Depreciation	-
Gross Operating surplus	561,700
TOTAL VALUE ADDED:	690,900

III. EX FACTORY TURNOVER: 3,239,400

COST OF TRANSPORT

A. INPUTS

	(primary raw materials)	Copper cathode	Zinc	Aluminium
-	Origin	Lubumbashi	Likasi	Likasi
-	Tonnage	1,590	310	800
-	Cost of transport per ton:		8.3	8.3
-	Total cost of transport		9,210	

B. PRODUCTS

-	Consumption areas (other than that in which factory is located)	Bangui	Kinshasa	Kisangani
-	Tonnages (exported from the area in which the factory is located)	328	880	518
	Transport cost per ton	$117.3	$94.7	$80.2
	Total cost of transport	$220,709		

PRODUCT(S) Sheet

LOCATION OF FACTORY Lubumbashi Congo (K) (Latreca)

PRODUCTION

Type of product	Quantity (tons)	Value (ex factory) $
Sheet and strip-of copper	929	1,263,300
Sheet and strip-of brass	283	323,700
TOTAL:		1,587,000

CAPITAL INVESTMENT

* Existing plant written off but new investment required to increase mechanisation of cold rolling mill.

Fixed capital investment - total	$100,000 (new)*
of which: buildings and civil engineering:	$ 20,000
: equipment	$ 80,000

STAFF

	Number	Wages and Salaries $
Upper level staff	5	42,500
Office workers	2	3,200
Skilled labour	25	35,000
Unskilled labour	20	16,000
		96,700

OPERATING ACCOUNT IN 1980

I. INPUTS

	Quantities (Tons)	Value (ex origin) $
Copper cathode	1,127	1,016,600
Zinc slab	85	15,600
Transport of inputs		700
Transport of products		85,400
Scrap loss		25,800
Electricity		70,000
Other services		100,000
TOTAL:		1,314,100

II. VALUE ADDED

Wages and salaries	96,700
Depreciation	8,400
Gross Operating surplus	167,800
TOTAL VALUE ADDED:	272,900

III. EX FACTORY TURNOVER: 1,587,000

COST OF TRANSPORT

A. INPUTS

(primary raw materials)	Copper cathode	Zinc
- Origin	Lubumbashi	Likasi
- Tonnage	1,127	85
- Cost of transport per ton:		$8.3 ton
- Total cost of transport	$705	

B. PRODUCTS

Consumption areas	Tonnages	Transport cost from Lubumbashi
Addis Ababa	46.7	197.8 $/ton
Asmara	15.6	88.4
Blantyre	15.2	78.0
Dar-es-Salaam	97.1	62.0
Jinja	77.9	86.1
Kisuma	19.4	86.1
Kitwe	90.3	25.2
Lusaka	110.4	30.2
Mogadiscio	10.3	82.5
Mombasa	19.4	74.7
Mwanza	24.3	78.6
Nairobi	90.6	80.6
Port Louis	24.0	86.5
Tamatave	68.7	85.5
Bangui	76.9	117.3
Kinshasa	206.4	94.7
Kisangani	121.6	80.2
TOTAL COST OF TRANSPORT	$85,400	

CHAPTER 11.

THE COPPER MINING INDUSTRY

11.1 As it is a presupposition of this study that locally mined copper would form the basis of the Region's copper fabrication industry it is important to summarise some of the main characteristics of the Regional copper mining industry.

Table 11.I shows the relative importance of the copper producing countries within the Region. It will be seen that in 1966 Zambia accounted for 11% of world production, Congo (K) accounted for nearly 6%, whilst Uganda production was only a fraction of that produced by Zambia and Congo (K), and Congo (B) and Kenya were almost negligible. It will be noticed from the table that refined copper is produced in Zambia and Congo (K), blister copper in Uganda and concentrates in Congo (B) and Kenya. Given the present knowledge on reserves only Zambia and Congo (K) are really significant producers. Table 11.II relates the importance of these two main producers to the other major world producing countries.

Table 11.II - World Mine Production of Copper (i)

(thousand tons)

	(thousand tons)			Ratio of outputs	
	1947	1957	1967	1967/1947	1967/1957
USA	769	987	1,337 (i)	1.74	1.36
USSR	165	405	800	4.85	1.98
Zambia	197	435	663	3.36	1.52
Chile	426	480	661	1.55	1.38
Canada	205	326	547	2.67	1.68
Congo (K)	151	243	320	2.12	1.32
Elsewhere	316	684	1,196	3.76	1.73
	2,229	3,560	5,524	2.47	1.55

(i) Recoverable copper content of ore raised or of concentrates.

(ii) Actual production was 950,000 tons and the 1966/67 figure has been substituted to remove distortions following the USA strike.

It will be seen from this table that over the period as a whole the Zambian copper mining industry has grown faster than that of any other major producers except the USSR. The Congolese industry has been growing at a slow rate during the last decade.

11.2 Reserves

Although copper is produced on a large scale only on the Copperbelt and in the Katanga mining zone, ore bodies are known to exist in several other countries.

Zambia

The Copperbelt of Zambia, a strip 160 kms long and 50 kms wide, constitutes the world's second largest concentration of copper after the State of Arizona, U.S.A. The Zambian copper ore bodies are amongst the world's richest sulphiae deposits and proven ore reserves exceed 800 mn. tons.

The grade of ores currently being mined varies considerably between the seven main areas. In the largest mine - Nchanga - the ores mined average 4.0 per cent copper which represents a decline from the average 5.5 per cent three years ago, whilst at Rhokana the predominantly sulphide ores average just over 2 per cent copper.

Table 11.I - World Trade in Unwrought Copper, 1966 (tons)

	Zambia	Congo (K)	Uganda	Congo (B)	Total East & Central Africa	Other Africa	Total World
Mine Production	623,400	316,900	16,200	100	956,600	180,500	5,474,800
net exports	—	—	—	—	100	14,500	—
stock change	+ 27,900	—	—	—	+ 27,900	+ 1,000	+ 100,500
secondary blister	—	—	—	—	—	—	360,100
Smelter Production	595,500	316,900	16,200	—	928,600	165,000	5,725,900
net exports	90,400	159,300	16,200	—	265,900	128,500	—
stock change	+ 11,400	—	—	—	+ 11,400	+ 6,800	+ 57,200
Refined Production	493,700	157,600	—	—	651,300	29,700	6,350,300**
Exports to:							
W. Europe	410,300	134,700	—	—	545,000	14,900	1,546,500
N. & S. America	2,000	—	—	—	2,000	1,500	234,800
Africa	25,400	6,500	—	—	31,900	—	36,600
Asia	49,600	900	—	—	50,500	—	115,800
Australasia	1,000	—	—	—	1,000	—	2,100
Soviet bloc	13,300	700	—	—	14,000	—	59,800
Unknown	—	14,800	—	—	14,800	10,500	83,700
Stock change*	— 7,900	—	—	—	7,900	—	— 234,800

* Including release from U.S. stockpile

** Includes refined scrap

Source . World Bureau of Metal Statistics

Congo (K)

The Congo's only exploited concession is that worked by Gecomin (La Generale Congolaise des Minerais) - a strip 320 kms long and 60 kms wide stretching from Kolwezi to Lubumbashi. Proven reserves are believed to be about 20 million tons of copper in ores of $4\frac{1}{2}\%$ or more and 100 million tons of copper in ores of 2% or more.

No information is available about the reserves in the Nippon Mining concessions which lie either side of Gecomin's area along the Zambian border. However, these together with the proven and unproven reserves in Gecomin's concession are likely to be nearly as large as those of Zambia. The concentration of Nippon Mining's reserves is expected to be between 3% and 5% copper.

Uganda

The Ugandan copper mining area is at Kilembe on the South Western border of Uganda. Proven reserves are only $6\frac{1}{2}$ million tons of ore above 1.25% copper. As ore is extracted at about 1 million tons p.a. the life of the mine is limited unless further reserves are located.

At present only ore over 1.25% copper is extracted though three years ago, when production costs were lower, ores down to 0.75% copper were mined.

Congo (Brazzaville)

Only the reserves of ore at M'passa are currently being exploited. These are mixed lead, zinc and copper ores of very limited extent. Until 1935 the black earths of Mindouli were exploited but costs were extremely high. Reserves in this area are some 400,000 tons of 4.5% copper ore, however exploitation would only be feasible if the Torco process should prove suitable for their treatment.

Kenya has proven reserves of 700,000 tons of ore averaging 2.3 per cent copper in the South West near the Tanzanian border. Exploitation used to be carried out in conjunction with gold mining but has been discontinued.

Ethiopia

Copper deposits are known to occur in a number of places but would require considerable research before exploitation could be considered.

Cameroon

No deposits are exploited but interesting indications of copper exist in the district of Poli.

None of the other countries in the Region appear to have workable deposits of copper ores.

11.3 Mining Organisations

The Zambian mining industry is controlled by two financial groups. In recent years, the mines controlled by the Anglo-American Corporation have produced roughly 54% of Zambia's copper output. They form part of a vast international mining and industrial group headed by the Anglo-American Corporation of South Africa Limited. The other four producing mines are administered by Roan Selection Trust Limited in which American Metal Climax, Inc., has a 43% interest. The Anglo-American Group operates three mines - Nchanga, Nkana and Bancroft, all of which have concentrators. The metallurgical plant consists of the Rhokana smelter, the Rhokana refinery and the Nchanga leach plant. RST operate mines and concentrators at Mufulira, Luanshya, Chibuluma and Chanbeshi. Their metallurgical plant comprises the Mufulira and Luanshya smelters, the Mufulira and Ndola refineries, and the Chambishi roast leach electrowinning plant. The two groups jointly own companies providing various services.

The Congolese industry is entirely controlled by Gecomin which is the state owned successor to the Union Miniere du Haut-Katanga. Gecomin have a management and commerical agreement with the Société Génerale des Minerais de Belgique who are the old holding company of UMHK. Under this agreement the Société Génerale is responsible for production, marketing, procurement and personnel functions. Copper mining is undertaken in three zones; centred on Kolwezi, Likasi and Lubumbashi. At present Kipushi and Kambove are the only underground mines in operation, all other mines being opencast. In future underground mining will play a greater part and another underground mine is being prepared at Kamoto. The metallurgical plant consists of a smelter at Lubumbashi, the Shituru refinery at Likasi and the Luilu refinery at Kolwezi.

Nippon Mining Company, a Japanese consortium, is the only other company with a concession to mine copper in the Congo (K). Nippon's concession lies either side of Gecomin's. Their first mine to be developed is at Musoshi and this should become fully operational in 1972/3, mining about 125,000 tons of ore per month (about 3.5% copper). Ore has been located in economic deposits in other areas and under the terms of Nippon's concession, if more than 60,000 tons of copper are extracted smelting will be carried out locally. Initially, however, ore will be concentrated and exported to Japan unless the spare capacity of Gecomin's Lubumbashi smelter is available.

The Ugandan mining and smelting company is Kilembe Copper Cobalt Ltd. which is owned by Falconbridge (the American mining group), the Ugandan Development Corporation and the Commonwealth Development Corporation. Most of the copper produced is exported to Japan on a long term contract.

The Congo (Brazzaville) mine is operated by the Société Minière de M'Passa.

The Kenya mine was operated by the Macalder Mine Company which produced mainly copper ore but also gold and silver.

11.4 Costs of Production

The cost of copper production in most of the countries in the Region is extremely high by world standards and has risen considerably in recent years for reasons peculiar to each country. This high cost structure has been more than covered by the exceptionally high price of copper but this cannot be relied upon to persist. It is not conceivable that either of the main mining areas, Zambia or the Congo, would be allowed to become extra-marginal but to avoid this, considerable cost reductions will be needed. Naturally, if a decline in the world copper price should ever threaten the continuation of mining in either country the viability of the local fabrication industry would be seriously affected.

The comparison of copper production costs is extremely difficult because of problems resulting from exchange rates, accounting differences, organisational differences and product or quality differences. One of the few studies available* shows the unfavourable position of both Zambia and the Congo (K). See Table 11.III.

* Sir Ronald Prain: Constraints in the Zambian Mining Industry in Charles Elliott ed. Constraints in the Zambian Economy (O.U.P. forthcoming)

Table 11.III - Relative cost of competitive copper in leading countries

$ per ton

	1952	1957	1962	1967
USA	286	444	456	530 (i)
Zambia	280	440	451	841
Chile	343	382	370	453
Canada (ii)	342	451	444	636
Congo (K)	154	410	571	1,012
Average for Non-Soviet World (incl. other countries)	286	430	448	621

(i) Pre-strike, estimated from 1966 data.

(ii) 57% of Canada's production is by/co-product at nominal cost.

Sir Ronald Prain in discussing this table points out that costs are known for about 80% of non-Soviet world primary copper production. This 80% is known in the industry as "competitive" copper which comes from mines worked only or mainly for their copper. The other 20% consists of cases where products other than copper pay for all or most of the cost of production of copper, protected copper and small miscellaneous mines with unknown costs.

It will be seen from Table 11.III that the world average competitive cost rose rapidly in the 1950's and at the end of 1963 there was a dramatic upsurge in consumption price and cost. Between 1962 and 1967 the biggest increases were in the Congo (77%) and Zambia (86%), both countries where an export tax was imposed in 1966. Other factors have also been responsible for the increase in costs.

Data on Uganda costs are not available, but it is probable that costs of production are very high due partly to rapid rises in labour costs, and to the increasing cost of mining.

11.5 Marketing

Table 11.I shows that the bulk of the copper is exported to Europe (i.e. the U.K. and Belgium). Each of the main mining organisations have their own arrangements for marketing. Gecomin exports are handed over to the Société Génerale des Minerais de Belgique at the African Port which is either Matadi, Lobito, Dar-es-Salaam or Beira. In Zambia the Government announced on the 31st October, 1968, the setting up of the Metal Marketing Company of Zambia, in which the two mining interests are represented. The marketing of copper will continue to be done by the existing international marketing organisations set up by the two mining groups, but the proposed Metal Marketing Company will be in overall supervision of all the market arrangements. As with the Congo, the Zambian producers sell their copper to their marketing organisations at the African Port - mainly Dar-es-Salaam, Beira and Lobito.

The price of copper is currently determined by the London Metal Exchange and both Congo (K) and Zambia have similar structures. Although several attempts have been made to control the price of copper none has been successful except in the short term. The last attempt to keep to a producer's prices was abandoned in April, 1966. Since then the LME has been used as a pricing basis. Most of the Congolese and Zambian copper is sold at the LME settlement price, although the three months' forward price was used before 31st May 1968.

11.6 Future Outlook

The problems of predicting the future pattern of mining within the Region are fraught with the usual problems of estimation due to a large number of imponderables. One constraint which neither the Zambain or Congolese mining industry suffers from is a depletion of ore reserves. However, the tendency of costs of production to rise could impair considerably the development of the industry, especially if the price of copper is to follow a downward trend. The following estimates attempt to give only an indication of possible future developments.

'000 metric tons

	Zambia	Congo (K)	Uganda	Congo (B)	Kenya
1966	623.4	315.7	16.2	.07	0.8
1967	663.0	319.0	15.0	n/a	-
1975	790.0	531.0	n/a	n/a	n/a
1980	810.0	690.0	n/a	n/a	n/a

No estimates are given for Uganda as future production will be dependent on the discovery of new reserves. The Congo (K) figures assume a 5 per cent rate of growth for Gecomin and an additional 52,000 tons of copper in 1975 and 90,000 tons in 1980 being supplied by the Nippon Mines.

SUBSTITUTION

Copper faces competition from a number of new materials, particularly plastics, aluminium and stainless steel. In the following section we evaluate the likely impact of these competitive materials on the demand for copper in the East and Central African sub-regions.

1. Electrical wire and cables

To be suitable for an electrical conductor a material must first and foremost possess a high electrical conductivity. In addition it must have a high thermal conductivity (to prevent overheating), reasonable mechanical strength and a resistance to fatigue (especially if it is to be self supporting), good corrosion resistance, reasonable ease of fabrication and freedom from high resistivity surface films (to facilitate jointing).

Copper most nearly fulfils these requirements. It is the best conductor apart from silver, having a specific conductivity of about $59 \times 10^{\cdot 6}$mhos/metre; it also has among the highest thermal conductivities. It is easily drawn into ductile wire which is resistant to corrosion from most atmospheric conditions and it can easily be joined. However, its tensile strength and resistance to creep are rather poor. These properties may be ameliorated by addition of small quantities of cadmium at slight loss of electrical conductivity.

In the earliest decades of the development of electricity copper was virtually the only material readily available which could offer these properties. Electrical conductors were therefore made almost exclusively from copper until the post-war period.

Aluminium does, however, offer a combination of properties which makes it a serious contender in the field of electrical conductors. Its specific conductivity is only two thirds that of copper. But since it is a much lighter metal it is weight for weight nearly twice as good a conductor as copper. It is also stronger than copper which can be a considerable advantage for overhead lines. Aluminium is generally more diffucult to work than copper and although it is fairly resistant to corrosion it forms a surface film which makes jointing difficult. One of the most serious disadvantages from which aluminium suffers results from the fact that nearly all established distribution networks were intitially based on copper. The difficulties of joining aluminium to copper are considerable and the labour force needs retraining. In addition it is not advisable to use the same tools for copper as for aluminium since if small particles of one metal are deposited on the other they may in certain circumstances initiate corrosion. A duplicate set of mechanical equipment may therefore be required. For certain applications one of the properties or technological factors mentioned above may determine which material should be used. But for many applications the choice must depend on the relative prices of the two metals.

A major reason for the increasing use of aluminium in cables since the Korean war was the fact that its price has been low and stable while the price of copper has more than doubled and has been subject to enormous fluctuations. Moreover, even when the copper producers maintained their price below the exceptional levels reached on the free market they could only do so by rationing supplies to consumers. Fig. A.1 shows the changes in the world price of copper and aluminium over the years. The conductivity of aluminium is only 60% of that of copper so aluminium cables need to be of larger cross section. But as aluminium is a much lighter metal only half the weight of aluminium is needed to provide an equivalent conductor. Theoretically, therefore, aluminium has a price advantage so long as it costs less than twice as much per ton as copper. However, this is true only if aluminium is used as a bare conductor. In insulated wire and cables the situation is less

Fig A.I. - Variations in the Price of Copper 1957-1968.

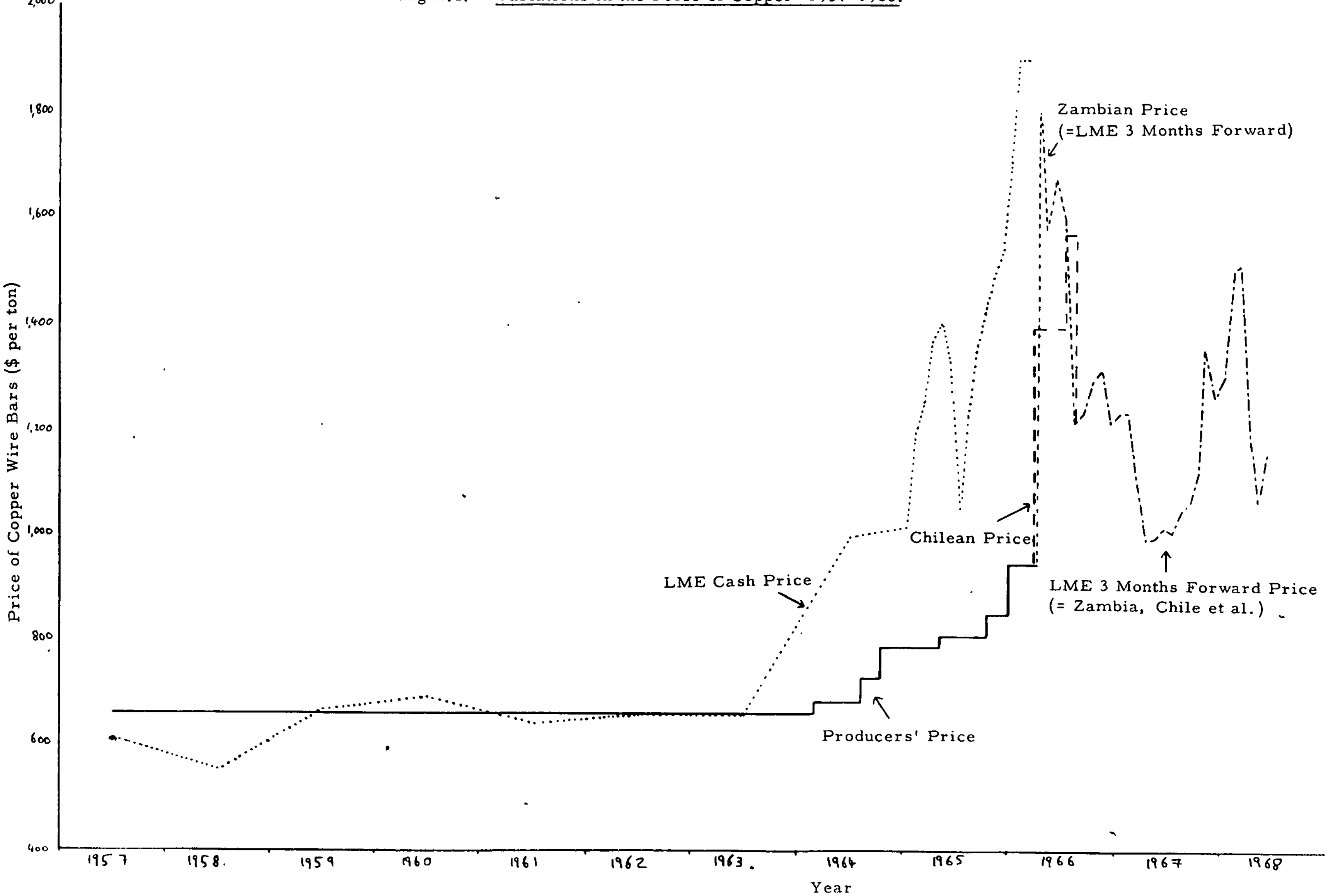
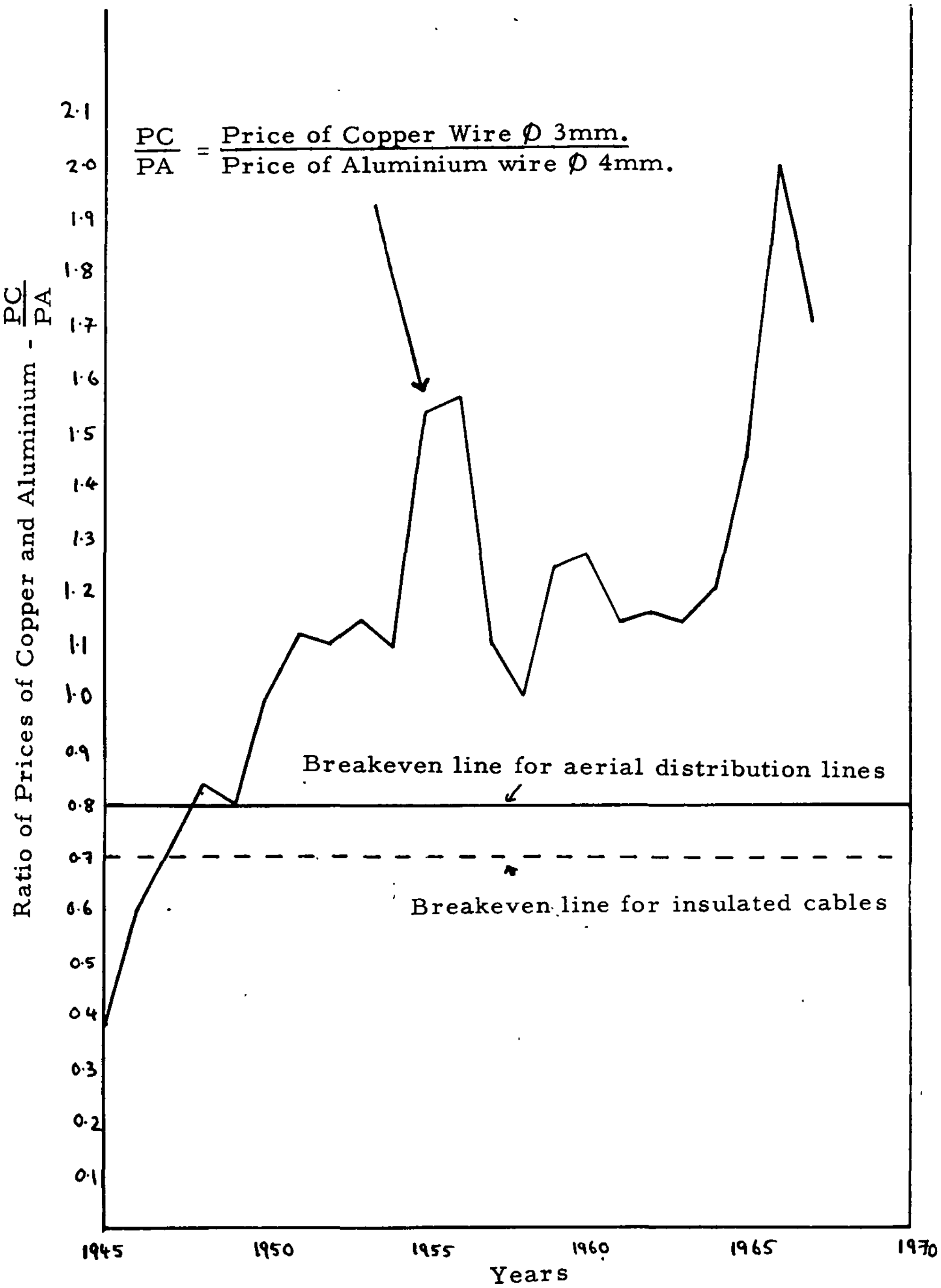


Fig A. II - Relationship Between Copper and Aluminium Prices (1945-1967)



favourable because an aluminium conductor has a larger cross section than an equivalent conductor in copper and so requires a greater amount of insulation. It can be calculated that for normal cables if the ratio of the price per ton of aluminium wire to copper wire is less than .7 or .8 aluminium is economically preferable. The changes in this ratio since 1945 are shown in Fig. A.II. It shows that despite considerable fluctuations the tendency has been for aluminium to maintain and increase its economic advantage.

Even in the face of the substantial price advantage of aluminium, copper cables have only gradually and for certain functions been replaced by aluminium cables. This is partly because the numerous technical factors outlined above have only slowly been overcome. In addition the dominant manufacturers of wire and cables have been used to using copper rather than aluminium. Their equipment, know-how and sources of supply tended to tie them to copper. The copper price has had to remain at a high price for a number of years before many of them could be persuaded to reorientate their production programmes towards the use of aluminium. We consider below the types of cable which have been most vulnerable to substitution by aluminium and the areas where, for technical reasons, copper has proved less vulnerable.

1.1 Electricity transmission and distribution

Overhead lines were among the first types of cable to be successfully made in aluminium. This is because such lines require a good strength to weight ratio which aluminium possesses, though long spans still require a steel or alloy core. Also, since no insulation is required the greater thickness of aluminium needed is not a disadvantage.

High tension transmission lines have proved particularly susceptible to construction in aluminium because

(i) they require long spans

(ii) they are costly so users are more sensitive to savings

(iii) they require fewer joints and branches than low tension lines.

Where theft is a problem aluminium has the advantage of a lower scrap value than copper which diminishes its attractiveness to thieves. Copper is still used where the atmosphere is particularly corrosive. For similar reasons low tension lines in aluminium are also increasingly common throughout the world.

Underground cables must be insulated, are more expensive, and are consequently used only in towns. Substitution has been less rapid in insulated cables than in uninsulated because users have only gradually acquired the expertise in laying and jointing which represent more formidable problems in insulated than uninsulated cables. Also, as previously mentioned the added thickness of aluminium cables raises the cost of insulation and therefore reduces the attractiveness of aluminium. However, aluminium is still considerably cheaper. In general this advantage is greater in large than in small cables because:

(i) the total cost is greater and so savings are more significant; and

(ii) the proportion of total costs which is accounted for by insulation and installation is greater the smaller the cable so savings on the conductor are proportionately less important.

The introduction of new types of insulation - based entirely on plastics with an aluminium sheath instead of impregnated paper and a lead sheath - has made retraining of the installing company's labour force a necessity. Consequently there is a tendency to take the opportunity to acquire the expertise in handling aluminium conductors at the same time.

1.2 Housewiring

Virtually all household wiring uses copper wire. The principal reasons for this are

(i) that aluminium wires are bulkier than copper wires which is troublesome when they must be set in plaster or brickwork,

(ii) the ratio of material costs to installation costs is lower in house wiring than in, say, power distribution so the consumer is less sensitive to the saving involved,

(iii) most household fittings have copper connections, switches, etc. which would need to be replaced or altered to make connection with aluminium wire,

(iv) in many countries the electrical wiring code does not allow the use of aluminium wiring in houses.

However, experiments in the use of aluminium are being made and in one or two countries (e.g. India) the government is encouraging the use of aluminium rather than copper for policy reasons. It seems unlikely that aluminium wire will be at all commonly used in housing before 1980 unless governments positively encourage its use.

1.3 Mining Cables

Mining companies require large quantities of insulated cable to carry light and power to the workface. Because of the continual movement of the workface and the damp, cramped conditions, underground cables must be flexible, well insulated and as compact as possible. Consequently, copper cables are invariably used. Also as far as copper mining is concerned the mining companies will have a natural preference for copper cables.

1.4 Telephone Cables

Copper is used almost universally in telephone cables, since imperfect jointing produces distortion of signals and copper is better in this respect. There seems little likelihood of aluminium being widely used in the foreseeable future though it is being introduced in Britain on a fairly wide scale. The only communications cables using aluminium in Africa are certain coaxial cables where the outer screening is aluminium.

1.5 Railways

Copper must be used for bare overhead transmission lines for electrified railways since the best possible contact must be made with the locomotive's pick-up. Aluminium forms a non-conducting surface layer of alumina which renders it unsuitable at any price.

2. The effect of substitution on demand for copper wire and cable in East and Central Africa by 1980.

Direct information on purchases of copper and aluminium cables has been obtained from major electrical authorities in nine countries of East and Central Africa. From this it has been possible to build up a picture of the extent of aluminium substitution at present and the likely scope for it in the future. The situation varies substantially from country to country. At one extreme is the Congo (Kinshasa) where virtually no aluminium wire or cable is used, and at the other extreme is East Africa where there is little scope for further substitution of aluminium for copper.

2.1 Congo (Kinshasa)

Colectric, Regideso, Sogelec and Sogefor (the main electricity authorities in the country) use no aluminium cable for transmission or distribution of electricity. It is

believed that this is also true of the other Congolese electricity authorities. The Congo's continued exclusive use of copper results from the period of post independence troubles and the intense shortage of skilled labour and experienced administrators. Inevitably the primary concern has been and still is to maintain and repair the existing electrical installations. According to Colectric it is unlikely that the staff and skilled personnel will be available for at least five years to undertake the retraining and technical evaluation necessary to make use of aluminium. Thereafter a gradual introduction of aluminium, beginning as elsewhere with overhead high tension cables, can be expected.

Colectric have made available a breakdown of their cable purchases in 1967. In terms of copper content roughly 50% is unarmoured 6.6 KV overhead cable. This would be the first type of cable to be substituted by aluminium. We expect this process to be half complete by 1975. The bulk of the remainder is armoured low tension cable which is unlikely to be subject to replacement by aluminium until after 1975.

We therefore assume that 25% of the Congo's cable requirements for electricity authorities will be aluminium by 1975 and that by 1980 roughly 60% will be aluminium.

2.2 Cameroon

Information supplied by Electricité du Cameroon, the largest electrical authority in the Federation, suggests that fairly extensive use is already made of aluminium cables. At present almost all new insulated cables of over 100 mm^2 cross-section* are made of aluminium. In the case of bare overhead conductors the maximum copper cross section used is about 50 mm^2 of copper. In total, aluminium now accounts for about 58% of all requirement for cables (measured in terms of copper equivalent).

It seems probable that by 1975 no cables of over 25 mm^2 copper cross-section will be used. On the basis of the current demand pattern aluminium would therefore account for 85% of all requirements.

2 3 Congo (B)

Energie du Congo were not able to specify in detail their purchases of copper and aluminium. However, they state that aluminium already accounts for half their requirements of insulated cable and in a couple of years will account for about two thirds. Thereafter the rate of substitution will be slower. We estimate that by 1980 at most 15% of the Congo's electrical requirements will be met by copper cables.

2.4 C.A.R.

Energie Centrafricaine at present use no aluminium wire or cable. However, from 1969 onwards it is planned to replace the following types of copper conductors with aluminium:

(i) 15KV cables with non-radial field

(ii) CGPFV cables - section 4x25 mm^2 and 4x35 mm^2

(iii) Low tension armoured cables - all sections greater than 38mm^2.

These types of cable account for 20% of present consumption. By 1980 it is likely that the process of substitution will have been carried much further. We estimate that only 15% of the C.A.R.'s cable requirements will be met by copper cables in 1980.

* in copper or copper equivalent.

2.5 Zambia

In 1965 and 1966 as much as 90%* of all cables used by electrical authorities were in aluminium. This was, however, due almost entirely to the erection of the Kariba - Kitwe transmission line which contained nearly 3,000 tons of aluminium (equivalent to 6,000 tons * out of a total copper equivalent consumption of 11,300 tons in the two years).

If that particular project is ignored aluminium is seen to have accounted for only 70% of requirements * . Virtually all the aluminium wire and cable currently used is in overhead uninsulated conductors. All underground cables have copper conductors.

None of the electricity authorities or municipalities has any definite plans to use aluminium insulated conductors in future. It seems prudent to assume, however, that aluminium will eventually be used for the larger insulated cables particularly as the economy is becoming less dependent on South African and Rhodesian cables (which are predominantly copper). We have assumed that by 1980 all new cables of over 50 mm^2 cross section will be in aluminium. This will reduce the proportion of requirements met by copper to a quarter of its present level on the basis of current demand schedules.

2.6 Kenya

The main electricity supply authority in Kenya is East Africa Power & Lighting Company which effectively controls the other two electricity authorities. The E.A.P.L. used aluminium cables for all its requirements last year. Overhead lines have been aluminium for some time but the use of solidal - aluminium PVC insulated cables is more recent. There is likely to be some demand for copper wire and cables in future but only for installation in the coastal region, where the high humidity and salt would corrode aluminium, and also for earthing wire.

Even if copper were to return to its old price level the E.A.P.L. would not revert to using it since the initial problems of using aluminium have now been fully overcome. We, therefore, estimate that by 1980 a negligible quantity of copper wire and cable will be used.

2.7 Ethiopia

The Ethiopian Electricity Authority at present uses copper for most of its requirements of wire and cable. However, aluminium conductor steel reinforced cables are already used for $16mm^2$** and over bare overhead transmission lines. In future $10mm^2$** and even $6mm^2$** bare copper lines will be replaced by aluminium.

At present no aluminium insulated cables are used but substitution is expected to begin by 1970. Assuming that all insulated cables of over $50mm^2$ cross section will be replaced by copper by 1975 copper requirements will be reduced by 40% below the level that would have obtained had the present pattern of usage persisted. By 1980 cables down to $25mm^2$ are likely to have been substituted and a further 15% of copper will have been replaced.

3. Construction industry

The main uses for copper and copper alloy in construction are - tubes for water, sanitation, gas, heating and air conditioning: brass fittings for plumbing; brass window sections and fittings; boilers and hot water cylinders; locks, bolts and handles; screws, nuts and bolts; and roofing.

For many of these purposes builders have always had a choice between using copper and brass or traditional materials such as iron or steel. Copper and brass tended to be used where their corrosion resistance is valuable as in hot water tubes; where their ease of working was an advantage as in extruded sections; or where their pleasant appearance

* measured in terms of copper equivalent
** nominal copper area

was specifically required. The rise in the price of copper has intensified the search for alternative materials and methods of economising in its use. Surveys of European building industries have shown the following trends in substitution:-

3.1 Water and sanitation:-

(a) the trend is towards thinner walled copper pipes which has reduced the competitive advantage of other materials but also reduces copper consumption per tube by about 25%.

(b) Galvanised iron systems are cheaper if copper is above $1,000/1,300 per ton.

(c) PVC and Polythene pipes for cold water are cheaper than copper even if the price of copper falls to $300 per ton. However, few water authorities are yet satisfied that plastic tubing will meet their required service life. For hot water piping plastics are being developed but are unlikely to have been thoroughly tested for at least five years.

(d) Stainless steel thin walled tubes are cheaper than thin walled copper tube if copper is over $1,100.

(e) Heating tubes will be reduced in copper content by about 25% as a result of using thin-walled pipes. A new material - cold reduced close grain steel (CECAL) is said to be fully interchangeable with copper and cheaper if copper is above $700 per ton. However, it is not likely to be extensively used until proved to be satisfactory over a long period.

The net result of these developments, assuming copper remains at a price above $1,000 per ton, would be to encourage substitution at a rate of about 30% over a period of 5 years.

3.2 Plumbers brassware.

There is no alternative material, but savings in weight per fitting are likely to be made.

3.3 Boilers and hot water cylinders:

Stainless steel is competitive with copper if copper is above $850 per ton. However, it is unlikely to be much used in an African context for this purpose because of technical problems of assembly.

3.4 Window sections and fittings and other builder's hardware

Brass is not the cheapest material for this purpose. However, it has advantages from the point of view of corrosion resistance and appearance. If the price remains high some substitution will be inevitable. In the U.K. this was expected to amount to 16% over five years. In Africa, where a higher proportion of usage is determined by climate rather than appearance substitution may be less, say 10%.

3.5 Roofing:

Copper is too expensive for use in normal roofing situations when copper exceeds $560 per ton. It is still used where corrosion and appearance make it desirable but such uses are rare particularly as aluminium or galvanised steel are reasonably corrosion resistant. However, as usage of copper for roofing seems to be limited mainly to traditional copper areas (Katanga and the Copperbelt) further substitution is unlikely to be significant.

4. <u>Overall effect of substitution of copper by other materials in the construction industry</u>

The net effect of the trends mentioned above is likely to be to reduce the input coefficient for copper and its alloys in construction (excluding housewire) by about 25% by 1975 assuming the price of copper remains at or above $1,000 per ton. After 1975 little further substitution would be possible unless plastic hot water pipes become available.

5. <u>Future trends in the price of copper</u>

Substitution of copper by other materials has received much attention since the world shortage of copper developed in 1964. However, as explained above, aluminium had a considerable advantage in price terms even at the old producer price of about $660 per ton and substitution was steadily taking place. The effect of the rise in price has been to increase that advantage and to accelerate the rate at which technical difficulties have been overcome. Consequently a return to the old price would cause little reversion to the use of copper although it might affect the rate of future substitution.

The high price of copper which has persisted since 1964 has been due to :-

(i) demand for military uses resulting primarily from the Vietnam war.

(ii) the sustained high growth of industrial activity throughout the developed world.

(iii) a series of strikes in the mines which have reduced output of copper.

(iv) political troubles, such as UDI and the Congolese rebellions, which have reduced the rate of growth of output and caused users to stockpile against the threat of similar events.

By their nature the future influence of such factors is difficult to predict. However, it seems unlikely that any will increase in intensity, and most will diminish. It is possible that a settlement of the Vietnam war will be reached in due course so, in the absence of any other major conflict or crisis provoking increased military expenditure, the main 'abnormal' element of demand will disappear. The high rate of growth in industrial production continues unabated but it could be threatened by international monetary disorders. In addition there appears to be a tendency for growth rates of advanced countries to decline as their economies become more mature. The incidence of strikes in the mines is impossible to predict. Nonetheless, the number and seriousness of strikes in the last few years do seem fortuitously high even for such a strike prone industry as copper mining. The troubles in the Congo appear to be over and unlikely to recur, though the Rhodesian problem still persists. However, alternatives to the Rhodesian railways and coal supplies are being developed so that the difficulties arising from sanctions are likely to diminish as times goes on. Zambian output should then be able to rise at the planned rate. It is of course possible that unforeseen political problems such as these will from time to time plague one or more of the world's copper producers.

Three additional factors may tend to decrease the price of copper in the future:

(i) The high price of copper has intensified the search for copper and a number of major new deposits have recently been discovered or are being brought into production. Among them are those at Bougainville in New Guinea, High Valley in British Columbia; Berenguela in Peru; Akjoujit in Maurentania; Iran; Phalabora in South Africa, Philewe/Selibe and Matsitamma in Botswana.

(ii) New methods of extracting copper are being developed. Most noteworthy of these is Anglo-American's Torco method (standing for Treatment of Refractory Copper Ores). This should make possible the extraction of copper from certain rich but difficult ores notably oxides, which are at present generally left in the ground. Improvements in the normal concentration technology

make the opencast mining of low grade ores increasingly attractive.

(iii) The substitution of copper by other materials which has been encouraged by the high price of copper and improvements in aluminium technology are likely to reduce the rate of growth of demand for copper.

To summarise, a large number of factors suggest that supplies of copper can expect to increase more rapidly in future than in the recent past while demand for copper may increase less rapidly. In consequence the price of copper must ultimately decline. However, it should be emphasised that a decline in the world price has been predicted for some time but a variety of unexpected events has occured to sustain it. Also the expectation of an imminent drop in the price has discouraged mining companies from developing or reopening marginal mines as rapidly as might otherwise have been expected.

We have in our estimation of the effect of substitution assumed the world price of copper will remain 'abnormally' high, that is to say, over $1,000 per ton for a considerable time. The LME cash price of copper wire bars on 2nd January 1969 was about $1,210 per ton and peaks of nearly $2,000 have been recorded in the past few years so a considerable drop could occur without this assumption being falsified. At a lower price than $1,000/ton substitution would be expected to occur less rapidly. But unless the price were to decline almost immediately it would make little difference to our calculations since a large proportion of the expected substitution is likely to be carried out in the next few years. In any case substitution would be unlikely to cease and even less likely to be reversed.

ANNEX B

DEMAND FOR COPPER PRODUCTS IN THE NORTH AND WEST AFRICAN SUB-REGIONS

1. The North and West sub-regions of Africa do not, at present, possess significant copper mining and refining industries*. Virtually all their requirements for copper are therefore imported, principally in the form of fabricated products, though some primary copper is imported for fabrication within the sub-regions.

Although a certain number of local copper fabrication plants do already exist, the North and West regions do not possess the considerable comparative advantage of the East and Central sub-regions each of which has supplies of locally mined and refined copper which can be supplied net of transport costs to and from Europe.

It is possible that the copper fabrication industry of East and Central Africa based on local copper, will have a competitive advantage in North and West Africa over imported fabricated goods. In this Annex we consider the likely extent of such an advantage and the size of the potential export markets in North and West Africa.

A detailed examination of the pattern of demand for copper products in the North and West sub-regions was outside the scope of this survey. Consequently it has been possible only to produce a broad analysis of likely export demand sufficient to indicate whether study, in the same detail as was accorded the East and West sub-regions, would be valuable.

2. The level of demand for copper products in West and North Africa

Table B.I. shows the imports of worked copper and copper alloy products and insulated conductors from 1961-66 to the countries of North and West Africa. The figures are taken from O.E.C.D. statistics and are based on the SITC classification.

Imports of wrought copper products rose by only 7 per cent over the five year period whereas imports of insulated conductors rose by 20 per cent in the same period.

Most of the growth of imports of insulated conductors was accounted for by the rapid expansion of five countries: Libya, Morocco, Tunisia, Ghana and Nigeria. However, three countries registered a serious decline during the period, but for which, growth of imports would have been even more spectacular. Algeria's imports declined from the high level of 5,550 tons (due partly to the pre-independence war) to a mere 570 tons (due partly to that country's post-independence industrial stagnation). The United Arab Republic's imports have declined from 5,000 to 4,000 tons. The smaller decline in Sudan's imports is believed to be due partly to internal troubles and partly to imports of Egyptian manufactured cables which do not appear in these figures. Similarly, imports of fabricated copper would have grown more rapidly but for the decline in imports of Algeria, the U.A.R. and also Guinea.

To obtain a more realistic idea of the growth during the period the figures for Algeria have been extracted since the situation in that country has been entirely distorted by military and political troubles. The isolated figure for imports of wrought metals by Guinea in 1961 has also been ignored. It then appears that the rest of the two sub-regions recorded compound growth rates of 6.4 per cent per annum for imports of wrought copper and 9.4 per cent per annum for imports of insulated cables.

A number of adjustments have had to be made to the import figures to obtain estimates of total copper consumption broken down by detailed categories.

* The deposits of copper in Mauritania at Akjoujit are being developed and will alter this situation. They are discussed below.

Table B. I - Imports of Wrought Copper and Insulated Conductors in North and West Africa (1961-66) (Source OECD Exports)

	1961		1962		1963		1964		1965		1966	
	tons	$000s	tons	$000s	tons	$000s	tons	$000s	tons	$000s	tons	$000s
Algeria	1,269	1,492	472	576	472	568	639	822	687	1,048	527	992
	5,549	6,338	2,823	3,814	1,719	2,466	734	1,682	569	751	569	1,041
Libya	–	–	–	–	–	–	233	249	407	524	395	670
	1,212	1,149	1,174	1,201	1,328	1,330	2,004	2,319	2,379	2,760	3,695	4,471
Morocco	1,659	1,416	2,026	1,541	3,225	2,431	2,507	2,072	2,171	2,099	2,256	2,917
	786	748	1,015	876	924	886	992	982	2,004	2,057	2,613	2,807
Sudan	–	–	388	337	263	257	–	–	–	–	–	–
	1,282	1,030	1,764	1,135	2,020	1,359	1,062	804	686	565	582	547
Tunisia	351	350	395	359	422	397	611	583	407	506	1,163	1,812
	1,024	1,118	1,297	1,221	1,014	996	1,383	1,298	1,623	1,947	2,317	2,844
U.A.R.	655	752	274	370	293	539	507	783	–	–	431	842
	5,004	2,927	2,408	1,745	5,234	3,514	5,132	3,981	4,150	3,542	4,007	3,131
North: Total	3,934	4,010	3,555	3,183	4,675	4,192	4,497	4,509	3,672	4,177	4,772	7,233
	14,857	13,310	10,481	9,992	12,239	10,551	11,307	11,066	11,411	11,622	13,783	14,841
Dahomey	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	126	119	184	164	176	151	111	105	105	127
Ghana	552	596	485	582	450	547	194	304	964	1,395	294	515
	2,084	1,591	2,319	1,863	1,885	1,564	2,086	1,958	3,461	3,189	3,902	4,406
Guinea	411	337	–	–	–	–	–	–	–	–	–	–
	–	–	167	145	–	–	–	–	–	–	217	437
Ivory Coast	193	425	145	148	118	134	133	177	160	259	142	267
	560	533	941	783	1,226	912	1,396	1,182	1,219	1,191	879	1,095
Liberia	–	–	–	–	–	–	–	–	–	–	–	–
	352	431	849	898	517	563	965	795	391	500	341	510
Mali	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	93	112	156	159	–	–
Mauritania	–	–	–	–	–	–	–	–	–	–	–	–
	168	196	362	390	171	245	123	197	98	158	201	290
Niger	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	123	147	–	–	–	–
Nigeria	666	695	648	715	1,124	1,018	1,179	1,419	1,223	1,565	977	1,226
	2,729	2,291	3,034	2,545	3,095	2,532	2,822	2,544	4,487	4,505	5,807	6,740
Senegal	134	171	159	155	173	174	139	155	148	229	98	164
	713	704	719	713	879	897	582	599	681	696	445	549
Sierra Leone	–	–	–	–	–	–	–	–	–	–	–	–
	378	313	242	215	635	516	627	533	235	299	451	469
Togo	–	–	–	–	–	–	–	–	–	–	–	–
	71	105	–	–	–	–	–	–	217	346	229	296
Upper Volta	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	136	120	–	–	–	–	71	120	–	–
Total West	1,956	2,224	1,437	1,600	1,865	1,873	1,645	1,055	2,495	3,448	1,511	2,172
	7,055	6,164	8,859	7,791	8,592	6,877	8,993	8,218	11,127	11,268	12,577	15,919
Total N & West	5,890	2,634	4,992	4,783	6,540	6,065	6,142	6,564	6,167	7,625	6,283	9,405
	21,912	19,474	19,340	17,783	20,831	17,428	20,300	19,284	22,538	22,890	26,360	29,760

(i) Category 682 does not include stranded copper wire which is included under heading 689 and thus not distinguished from wire made of other metals. As this can be an important element of demand, estimates have been made on the basis of the proportion of stranded wire in the imports of those North and West African countries for which detailed statistics are available. These countries' imports are shown in Table B.II.

Table B.II - Imports of Semi-manufactures and Bare Stranded Conductors Analysed by Type for certain North and West African Countries 1966

	Algeria	Libya	Morocco	Sudan	Tunisia	U.A.R.	Ghana	Liberia	Nigeria
Wire – single strand	1	161	44	7	688	9	34	2	103
Wire – stranded	5	1,138	36	–	422	25	23	–	86
Wire rods	–	–	–	2	78	–	–	–	2
Rods, bars, sections	12	6	1,383	6	14	6	3	–	15
Plates, sheet, strip	116	47	264	2	23	96	4	6	34
Tubes	115	19	56	12	22	122	96	–	115
Total copper	249	1,371	1,783	29	1,247	258	160	8	355
Wire	50	9	53	5	207	18	20	–	7
Rods, bars, sections	16	17	109	22	43	5	49	2	84
Plate, sheet, strip	166	10	301	6	54	132	5	2	532
Tubes	25	25	35	–	20	39	3	4	39
Total alloy	257	61	498	33	324	194	77	8	662
Total copper and alloy	506	1,432	2,281	62	1,571	452	237	16	1,017
of which: Total wire	56	1,308	133	12	1,317	52	77	2	196

(ii) Similarly, a detailed breakdown of imports in category 682 has been estimated on the basis of those countries for which detailed statistics are available.

(iii) The category insulated conductors includes both copper and aluminium insulated wire and cable. To estimate the copper content of this category, therefore, it is necessary to make allowance both for the proportion of cables which are aluminium and for the weight of insulant, armouring etc. Since no distinction is made according to the nature of the conductor, approximations based on our findings in East and Central Africa must perforce be made. Electricity authorities were found to be the only major importers of aluminium insulated cables. The proportion of their requirements which were aluminium varied widely from country to country: some at present use none, others now use aluminium almost exclusively. The mean proportion was somewhat under half, so that as electricity authorities accounted for about 20 per cent of total demand for insulated copper cables, we have assumed that about 20 per cent of imported insulated cables are aluminium. Also on the basis of the survey of East and Central Africa, it has been assumed that copper accounts for about 40 per cent of the total weight of insulated copper conductors.

(iv) The only substantial fabrication of copper within North and West Africa is that carried out by Electro-Cable, Egypt in the U.A.R. This company's output of wire and cable is included in the final estimate of consumption given in Table B.III.

(v) To eliminate fluctuations, the mean imports for 1964-66 have been used for the base year 1965.

On the basis of these adjustments, copper consumption in 1965 has been estimated and is shown in Table B.III.

Table B.III Estimated Breakdown of Copper Consumption by Type of Product in North and West Africa (1965) (tons of metal content).

Type of Product	North sub-region	West sub-region	Total
Copper			
Wire - single strand	1,024	447	1,471
Wire - stranded	1,694	739	2,433
Rods, bars and sections	1,128	492	1,620
Plates, sheet and strip	437	191	628
Tubes	411	180	591
Total copper	4,694	2,049	6,743
Alloy			
Wire	272	120	392
Rods, bars and sections	256	112	368
Plate, sheet and strip	892	389	1,281
Tubes	141	61	202
Total alloy	1,561	682	2,243
Total Copper and Alloy	6,255	2,731	8,986
of which: Wire	2,990	1,306	4,296
Insulated Conductors (copper content)	6,710	3,487	10,197

3. Copper Fabrication Industry in North and West Africa

A number of countries in both sub-regions already have a small local copper mining and/or fabrication industry. The principal plants are outlined below.

3.1 Algeria

(i) Laminoir and Trefilerie d'Afrique (LATRAF)

Ownership: Subsidiary of Trefimetaux and Compagnie Francaise Thomas-Houston.

Plant: At Algiers. Wire draw benches.

Products: Principally aluminium wire and cable but some copper.

Capacity: 6,000 tons (of aluminium) per annum.

3.2 Libya

No copper mining or fabrication is carried out.

3.3 Morocco

(i) There are deposits of copper ore near Bon Skour with an estimated output of 6,000 tons per annum of copper content. This may be raised to 10,000 tons per annum and a small refinery built.

(ii) Société Africaine des Métaux et Alliages Blancs (SAMAB)

Ownership: Société Francaise des Métaux et Alliages Blancs.

Established: 1948.

Plant: Refining non-ferrous metal for local consumption.

Products:	Capacity:
Bronze and brass ingots	300 tons
Lead and Alloy ingots	1,500 tons
Tin and Alloy ingots	150 tons
Zinc and Alloy ingots	150 tons
Aluminium and Alloy ingots	120 tons

3.4 Sudan

(i) Important reserves of copper exist in the Hofrat en Nahas district and are being investigated.

(ii) No copper fabrication plants exist.

3.5 Tunisia

No copper mining or fabrication is carried out.

3.6 U.A.R.

(i) Egyptian Copper Works

Plant: Rolling mills at Alexandria

Products: Chiefly aluminium sheets, circles etc.

Capacity: 5,000 tons (of aluminium)

(ii) Electro-Cable Egypt Co.

Ownership: Capital £E. 900,000

Established: 1954

Plant: Pickling; wire drawing; annealing; tinning; stranding; rubber, PVC and Polyethylene insulation; paper and lead sheathing; armouring; etc. At Cairo.

Products:	1964 Output (tons)	1964 Capacity (tons)
Overhead bare copper transmission wire	947	1,500
Rubber insulated cables	637	900
Cotton insulated cables	51	90
Plastic insulated cables	1,980	2,000
Armoured power cables	4,040	4,950
Telephone cables (underground)	1,890	1,980
	9,545	11,420

Expansion plans: Total capacity was expected to increase from about 11,000 tons in 1964 to 40,000 tons (in two shifts) or 50,000 tons (in 3 shifts) by 1967.

3.7 Mauritania

(i) Copper deposits at Akjouit, about 280 Kms north-east of the capital are being brought into production by the Sociéte de Cuivre de Mauritanie (SOCUMA). This is a company in which American, Canadian, French and Mauritanian interests hold a share. Reserves of copper are estimated at about 22 million tons. Although they are of a difficult composition they will be concentrated in situ. Production is expected to begin in 1970 and will be about 25,000 tons of copper per year in the form of concentrates. There is no likelihood of copper being refined in Mauritania.

(ii) There is no local copper fabrication nor is there any plan as yet to associate copper fabrication plants with the mining development.

3.8 Other West African Countries

No other copper mining or fabrication activity except some small local scrap foundries exists in the other countries of West Africa. Ghana plans to establish an aluminium wire and cable factory in association with the Volta aluminium project.

4. Future Demand for Copper Products in North and West Africa

In the absence of a detailed breakdown of copper usage by industry sector we have assumed that the average rate of growth of demand for copper products in North and West Africa will be the same as for East and Central Africa i.e. the growth rate for semi-manufactures and bare conductors (excluding wire rod) will be 10.8 per cent per annum and for insulated copper conductors it will be 9.0 per cent per annum.

Table B.IV shows estimated consumption by type of product in 1975 and 1980 on the basis of these assumptions. The pattern of demand by product has been assumed to be similar to that obtaining in 1965.

Not all the copper products shown in Table B.IV will be imported in this form. It may be presumed that the copper fabrication industry within North and West Africa will have developed considerably in the interim. In particular, there is likely to have been an expansion of wire drawing and insulation facilities. Consequently there will be a derived demand for wire rod, which will be imported unless a rod rolling mill is established locally. The extent to which the North and West sub-regions will in future import or manufacture their own insulated wire, bare wire, or wire rod is discussed in the next section.

Table B. IV - Projected Demand for Copper by type of product in West and North Africa 1975 and 1980 (tons of metal content)

Type of Product	1975 North	1975 West	1975 Total	1980 North	1980 West	1980 Total
COPPER:						
Wire - single strand	2,854	1,246	4,100	4,766	2,080	6,846
Wire - stranded	4,720	2,061	6,781	7,881	3,447	11,323
Rods, bars, sections	3,142	1,372	4,514	5,249	2,291	7,540
Plate, sheet strip	1,218	532	1,750	2,035	888	2,923
Tubes	1,147	500	1,647	1,915	836	2,781
Total Copper	13,081	5,711	18,792	21,846	9,537	31,383

Table B. IV - Projected Demand for Copper by type of product in West and North Africa 1975 and 1980 (tons of metal content) Continuation

	North	West	Total	North	West	Total
ALLOY:						
Wire	760	332	1,092	1,270	554	1,824
Rods, bars, shapes	714	312	1,026	1,192	521	1,713
Plate, sheet, strip	2,485	1,085	3,570	4,150	1,812	5,962
Tubes	392	171	563	654	286	940
Total Alloy	4,351	1,900	6,251	7,266	3,173	10,439
TOTAL COPPER & ALLOY:	17,432	7,611	25,043	29,112	12,710	41,822
of which: Wire	8,334	3,639	11,973	13,917	6,076	19,993
Insulated Conductors (copper content)	15,915	8,272	24,187	12,524	12,746	37,270
Estimated demand for wire rod	21,775	10,711	32,486	34,494	16,915	51,409

5. Potential demand in North and West Africa for exports of Central and East African copper fabrication industry.

The export potential of North and West Africa depends firstly on the proportion of the area's demand which is fabricated locally and secondly on the competitive advantage of the East and Central sub-regions' fabrication industry over those of Europe and America.

5.1 Demand for Imports in North and West Africa

The principal fabricated copper products which are widely traded are wire rod and insulated conductors. Bare wire enters less into international trade, because it is subject to oxidation which makes subsequent insulation more difficult. However, bare conductors are traded for use as overhead uninsulated lines by electricity and telephone authorities. Extruded products, particularly tubes, thick rod and sheet are fairly widely traded though in smaller quantities than rod or insulated conductors. As explained in Chapter 8 there are advantages arising from ease of communications and stockholding which encourage the establishment of fabrication plants, particularly for making insulated conductors, near the market. It is to be expected, therefore, that North and West Africa will manufacture a large part of their own requirements for insulated and bare conductors by 1980. A reasonable target would be 70 per cent which is ambitious but not as high as the 85 per cent suggested for the East and Central sub-regions (which have the advantage of locally mined copper and an already partly developed fabrication industry). The total demand for copper wire rod in 1980 would therefore be 51,400 tons. This could either be imported or rolled locally. In UNECA document 68-838/40* it is proposed to establish a rod rolling mill in Egypt to meet the demand of the Northern sub-region. A parallel UNECA report for the Western sub-region+ concludes that demand in West Africa will not be sufficient to merit the establishment of a rod mill.

* ECA Study on Industrialisation and Economic Co-operation for the North African sub-region - Basic Metals, R. Robson.

\+ E/CN. 14/INR/138 'Pre-feasibility Study of Copper, Lead and Zinc Industries in West Africa'.

Our own estimates broadly confirm these two conclusions. Demand for rod in the Northern sub-region will be about 21,800 tons by 1975 and 34,500 tons by 1980 which would be sufficient to justify a semi-automated rolling mill even before 1975. Whereas demand in the West sub-region will be only 10,700 tons in 1975 and 21,800 tons in 1980 which means a rolling mill would only begin to be justified towards the end of the decade.* The demand in the Northern sub-region is largely concentrated in the U.A.R. coming from the already sizeable wire and cable factory in that country. There will, therefore, be a very good case for establishing a rod mill in association with this factory which would also supply neighbouring countries in North Africa all of which can be supplied by cheap coastal transport. Only the West sub-region would, therefore, continue to import wire rod.

Demand for sheet in both sub-regions will remain too low to justify the establishment of a sheet rolling mill (though it is possible that some copper sheet may be produced locally in the aluminium rolling mills which are or will be established).

Demand for extruded products will be too small to justify a press in the West sub-region before 1980. In the North sub-region, demand will just begin to justify the installation of an extrusion press by 1980 when demand is estimated at 9,000 tons. Before then, however, both Regions would more economically import their extruded products. The demand for imports on the basis of these expectations as to the development in the fabrication of copper products within the North and West African sub-regions is given in Table B.V.

Table B.V - Projected Imports of Copper Products in North and West Africa in 1975 & 1980

	1975 North	1975 West	1975 Total	1980 North	1980 West	1980 Total
Extruded products	5,395	2,355	7,750	*	3,938	3,938
Sheet mill products	3,703	1,617	5,320	6,185	2,700	8,885
Wire rod	*	10,711	10,711	*	16,915	16,915
Bare Conductors	2,500	1,092	3,592	4,175	1,823	5,998
Insulated Conductors (copper content)	4,774	2,482	7,256	7,357	3,824	11,181

* Presumed to be produced locally

Imports of bare and insulated conductors are expected to total nearly 7,300 tons in 1975 and 11,200 tons in 1980 if 70% of demand is satisfied by local production. However, these imports are likely to represent the more sophisticated and specialised types of conductor which cannot profitably be manufactured locally. It is unlikely, therefore, that the copper fabrication plants in Central and East Africa will be able competitively to produce a very large proportion of these conductors.

5.2 The competitive advantage of Central and East African fabricated copper exports to North and West Africa

At present West and North African markets import copper products largely from Europe though a certain quantity comes from the U.S.A. European exporters must pay the transport cost of copper (usually from Africa) as well as the transport cost of the finished

* Moreover, the estimates for the Western region do not take into account the war in Nigeria which will undoubtedly set back the growth of demand in the largest of the West African countries.

product to the North or West African country. Fabricators in East or Central Africa would have to bear only the cost of transport of the finished product to West or North Africa.

However, this apparently significant advantage is in practice of limited value for the following reasons.

(i) Copper wire bar and cathode travel in regular bulk consignments to the coast and are, therefore, charged at a lower tariff on the rail and river systems of East and Central Africa than are fabricated copper products.

(ii) The cost of sea travel is only a small part of total transport costs and increases less than proportionately with distance. So the added distance to Europe represents a very small burden on European industry.

(iii) Coastal shipping between Matadi and West and North African ports is irregular and limited to tramp freighters. By contrast, shipping to and from Europe is both frequent and regular by liner as well as tramp ships. Consequently, a considerable saving on stocks and waiting time will be available to European shippers.

In Table B. VI we show estimated shipping costs for wire rod from Europe and from Central Africa to several West and North African ports. These rates have inevitably had to be estimated for a number of these routes, particularly those from Matadi, as few quotes are available. No figures are available for East African ports since the Suez Canal is closed. It is clear that copper rod supplied to Port Soudan from Luanshya via Dar-es-Salaam will have much lower transport costs than European rod shipped round the Cape. When the canal is reopened it is likely that Dar-es-Salaam would also be able to supply the U.A.R. and Benghazi more cheaply than can European shippers.

Table B. VI - Transport Costs and Net Advantage of Central African Producers In Supplying West and North African Ports

($ per ton of wire rod)

			Net Advantage to Central African Fabricator	
	London	Matadi	Assumption (i)	Assumption (ii)
Lagos	36.7	20.5	1.7	63.4
Abidjan	34.2	23.0	- 3.3	58.4
Dakar	33.3	23.9	- 5.1	56.6
Casablanca	25.0	32.2	-21.7	40.0
Algiers	26.0	33.2	-21.7	40.0
Benghazi	30.0	37.2	-21.7	40.0
Lubumbashi	96.0+	(i)110.5 (ii) 48.8		

Note: Assumption (i) The tariff for wire rod from Lubumbashi to the coast is Class 4 as at present.

Assumption (ii) The tariff for rod from Lubumbashi to the coast is reduced by transferring wire rod to Class 6 (as for most steel products).

At present it is estimated that shipment of copper wire bar from Lubumbashi via Matadi to Europe costs about $96 per ton. But according to the COMITRA tariff, wire rod costs $110.5 per ton to ship from Lubumbashi only as far as Matadi. Consequently the Central African copper fabrication industry will have a net advantage only in Lagos. Elsewhere in West and North Africa, European producers will have the edge.

However, it is clearly anomalous that fabricated copper for export should be so much more expensive to transport than copper wire bar. We indicate the likely advantage that the Central African producers would have if fabricated copper were to be classified in category 6 of the COMITRA tariff (the same category as steel rods, sheet, etc. for the construction industry). A rod mill at Lubumbashi will then be able to undercut European producers (or cover its higher costs) in all West and North African ports.

It should be remembered that in these calculations it is not possible to quantify the problems of irregular coastal shipping mentioned earlier. These would undoubtedly substantially offset the advantage here evaluated.

Conclusion

Our analyses of the present and future market for fabricated copper products in West and North Africa suggests that these sub-regions will provide a substantial outlet for exports of certain products from Central and East Africa which the latter sub-regions would be advantageously placed to exploit. The development of local copper fabrication industries in North Africa and its greater distance from East and Central Africa will eventually limit the demand for imports of fabricated copper to that sub-region. However, West Africa is likely to continue to import fabricated products notably wire rod (to feed housewire plants and wire and cable factories which will be established there), extruded products and sheet. Although both sub-regions will continue to import some wire and cable this is likely to be the more sophisticated types which plants in Central and East Africa will either not manufacture or manufacture relatively uncompetitively.

COUNTRY REPORTS

ANNEX C

CONGO DEMOCRATIC REPUBLIC (Congo-Kinshasa)

COUNTRY REPORT

1. Introduction

The Congolese economy is one of the most highly industrialised in East and Central Africa. The mining and metallurgical industries are, of course, the principal sector of the economy (apart from agriculture) and have been the motor behind the development of other industries. In particular the purchasing power which they generate among the indigenous and European labour force has given rise to demands for consumer goods which have been met by the creation of local industries. In addition, the transport network and power industry were developed largely to serve the mining and metallurical industries as were a number of intermediate goods industries producing explosives, chemicals, spare parts etc.

Table C.I - GDP by Contributing Sector 1966

(at Factor Cost)'

	$ million
Agriculture - commercialised	147.84
non-commercialised	127.32
Mining Industries	69.30
Metallurgical Industries	88.88
Manufacturing Industry	75.40
Energy	20.08
Construction and public works	29.80
Transport and Telecommunications	58.32
Commerce and Services	276.00
TOTAL GDP	892.94

Copper is, of course, the principal product of the mining and metallurgical industries, accounting for two-thirds of the value added in 1966. The other principal products are tin, zinc, lead, diamonds, cobalt, manganese, cadmium and tungsten.

Copper accounted for 58 per cent of export revenue in 1966 as against only 32 per cent in 1959, the year before independence. This increase is largely due to the rise in the price of copper which has offset the relative stagnation of the mining industry. Also, exports of agricultural products such as palm oil, coffee, and cotton were severely reduced by the disturbances in agricultural areas. The period of troubles and disturbances following independence put a brake on the previously rapid growth of the economy. Agricultural production and mining were particularly affected though some sectors of manufacturing industry have benefited because of restrictions on imports and on the repatriation of profits. Investment of new foreign capital has, however, been negligible because of the political risks and restrictions on repatriation of profits. More recently, a greater degree of economic and political stability has returned to the country which should create a climate for renewed growth.

The mining industry is concentrated in South Katanga and consequently the metallurgical and complementary industries have also developed there. The other

principal concentration of industrial activity is at Kinshasa, which is the point of transhipment between the river system and the rail link to the estuary port of Matadi. Kinshasa, which has a population of over a million and is still growing rapidly, is the major growth centre for manufacturing industry. Two minor industrial centres exist at Kisangani and Bukavu. In both of these the principal industries are the treatment of local agricultural produce (coffee, tea, cotton, and sugar cane), and the manufacture of certain simple goods for the local market (beer, sugar, soap and cement).

2. The Copper Fabrication Industry

The vast bulk of the Congo's copper is, of course, exported to the industrialised countries of the world there to be manufactured into finished goods. However, the Congo does possess a number of firms which process copper into semi-finished and finished products largely for the home market.

The processes carried out include casting of copper, brass and bronze; sheet rolling; extrusion; wire drawing; cable making; and plastic insulation of wire. Several of the firms involved carry out more than one of these processes. We describe each firm below before summarising the overall activity in each product field.

2.1 LATRECA

2.1.1 Organisation, history and activities

This firm is the most important in the fabrication of copper in the Congo (and indeed in the whole of the Region) whether measured in terms of value added, consumption of copper, or the range of products produced. During the war the output of the Congolese mineral industry was desperately needed for the allied war effort but at the same time the importation of intermediate equipment required by the mineral industry was hampered by enemy activity. Consequently, during this period, there was a considerable expansion of efforts to produce in the Congo goods and spare parts which had previously been imported.

Latreca, which was founded by M. Stakke in 1944, was equipped, largely with secondhand machinery, to produce wire rod, wire and uninsulated cable. It also possessed a foundry for casting copper and brass. Most of Latreca's output of wire, and cable was destined for U. M. H. K. (now Gécomin) from whom it naturally obtained the copper.

In 1953 the Société Cuivre et Zinc de Liège took a share in the company and installed a cold rolling plant, cold drawing machinery and an extrusion press. Since independence the company has been transformed into a Société Congolaise though it is still controlled by the Société Cuivre et Zinc de Liège.

In addition to working copper and brass (which account for nearly 90 per cent of its output) the company casts and rolls a certain amount of aluminium and zinc to make roofing sections. The company has recently installed a machine to corrugate or shape roofing sheet to make self-supporting roofing elements.

2.1.2 Capacity and Type of Plant

The capacity of each machine or department, if working a two shift system is shown below. However, it should be borne in mind that:

(i) the company is working well below its theoretical capacity.

(ii) it would never expect to work all machines at full capacity since some, which produce semi-finished products, have a greater capacity than

the machines which process these semi-finished products and vice versa. The full capacity of each machine could therefore only be reached if the firm could find an outlet for some of its semi-products or install extra finishing machinery.

(iii) at present the firm would require extra expatriate personnel if it were to work to a shift system. Normally only one shift is worked at present with occasional overtime.

The main departments, their capacity, labour force, equipment and function are described below.

Rod Rolling

Work force: 2 foremen, 7 operatives (includes sheet hot rolling work force)

Process: Wire bar is rolled hot on the breakdown mill into a rod shape. This is passed to the finishing mill where it is further rolled to a diameter of 6-8mm.

Capacity: 7,000 tons of rod per annum.

Rod breakdown mill: Specification:-

Rolling speed 147 metres/min.
Work rate 120 tons/min.
Roll diameter 390mm

Rod Finishing Mill: Specification:-

Rolling speed 212 metres/min.
Work rate 272 tons/min.
Roll diameter 248mm.

Sheet Rolling

Work force: 3 foremen, 3 operatives (hot rolling work force is included under Rod Rolling).

Process: Slabs of copper (or aluminium or zinc) are heated in the furnace and hot rolled for several passes. The sheet is then pickled and cold rolled to final size. Cold rolled sheet must usually be annealed. Some sheet is profiled or corrugated to make self-supporting roof sheet.

Hot Rolling Mill: Specification:-

Rolling speed 44 metres/min.
Work rate 32 tons/min.
Rolled diameter 500mm.

Cold Rolling Mill: Specification:-

Rolling speed 28 metres/min.
Work rate 18.25 tons/min.
Roll diameter 498mm.

Profile Rolling Machine: Specification:-

Through speed 22 metres/min.
Width 800mm.

Extrusion Division

Work force:	2 foremen, 9 operatives.
Process:	Billets of copper or alloy are extruded as shapes or tube shells.
Capacity:	About 3,500 tons p.a. for a 'normal' pattern of output.
The press:	750 ton machine. Hydraulic press deliver 210 kg/cm^2 to the main cylinder.

Draw Bench Department

Work force: 1 foreman, 10 operatives.

Process: Both benches are used primarily for preliminary drawing of wire rod to dimensions suitable for wire drawing machines. They can also be used to draw tubes and shapes.

Large Draw Bench: Specification:-

Max. force 30 tons
Speed 24 metres/min.

Small Draw Bench: Specification:-

Max. force 10 tons
Speed 21.4 metres/min.

Wire Drawing Department

Work force: 2 foremen, 10 operatives (includes labour force for cable making and trolley departments).

Process: Draws wire rod from rolling mill, or partly drawn rod from draw benches, down to wire. The number of dies and the number of passes required depends on thickness of input used and of wire required. Very fine wires are drawn from normal wire.

Seven Wire Drawing Machines - Specifications:-

(i) Banc Gilly - 77 metres/min.

(ii) Kratos - 2 passes 82 metres/min.

(iii) 9 passes - 103 metres/min.

(iv) 11 passes - 530 metres/min.

(v) Fine wire 1 - 295 metres/min.

(vi) Fine wire 2 - 176 metres/min.

(vii) 22 passes - 975 metres/min.

Capacity: depends on range of wires to be drawn. For a 'normal' demand schedule capacity would be about 200 tons/month.

Cable Division

Work force: included in wire drawing department.

Process: wires are stranded (i.e. twisted together) or cabled (i.e. wound in alternate directions round a central core). Cables up to 37 strands are normally made but, by repassing, up to 61 strands are possible with difficulty.

3 Machines - Specification:

(i) 37 wires - speed 6.15 metres/min.

(ii) Olier 19 wires - speed 35 metres/min.

(iii) Olier 7 wires - speed 17.5 metres/min.

Capacity: The division can handle up to 200 tons per month.

Trolley Division

Work force: included in drawing department.

Process: draws rod by means of a bullblock into trolley wire i. e. thick wire with a groove for railway overhead electrification.

2 Machines : Specifications:

(i) Herborn throughput speed 26 or 52 metres/min.

(ii) Ancien banc throughput speed 36 metres/min.

Cathode Division

Work force: 1 foreman, 7 operatives.

Various home made machines for cutting sheet to shape for cathodes, bending and fitting supporting bars.

Foundry Division

Work force: 1 foreman, 9 operatives.

Four furnaces burning oil and air - Specification:

(i) Aluminium - capacity 10 tons per day

(ii) Zinc - capacity 10 tons per day

(iii) Copper, brass or bronze - capacity 20 tons per day.

Process: produces castings from scrap or ingots.

Castings in form of ingots for hot rolling to sheet and billets for extrusion.

Furnaces, Annealing and Pickling

Work force: included in rod and sheet rolling department.

Process: Wire bars, slabs or billets are heated in the furnaces for hot rolling or extrusion. Hot rolled sheet and rod and extruded products are pickled in an acid bath to remove oxide scale. Cold worked sheet, rod and some wire is annealed to remove work hardening.

Furnaces - the furnaces are oil fired.

Annealing furnaces - there are three Bell type vacuum furnaces.

Pickling baths - there are adequate and extensive pickling facilities.

Maintenance, services and office staff

Work force: 8 foremen, 57 operatives. Most of this manpower is employed in the maintenance and repair workshop which is equipped with machine tools for a variety of tasks.

If all machines and divisions were to work at full capacity some 12, 000 tons of copper could be cast, over 6, 000 tons could be hot rolled into sheets, but only 720 tons could be further cold rolled and annealed each year. Some 8, 400 tons of wire bars could be hot-rolled to wire rod but only 2, 400 tons could be cold drawn to wire and cable. Expansion of capacity would therefore require an expansion of cold rolling capacity and of wire drawing capacity. Alternatively, Latreca could supply wire rod for further drawing to other manufacturers. There is no conceivable market for hot rolled sheet.

2.1.3. Production

At present production is running at only a fraction of theoretical capacity and indeed it has never approached that limit. Over the last few years the amount of metal transformed has varied between 1,200 and 2,000 tons per annum.

Table C.II - Production in 1964-7 (tons)

1964	1965	1966	1967
1,240	2,010	1,490	1,550

The breakdown of sales in 1967 was as follows:

Table C.III - Output by product in 1967

	Weight (tons)
Copper sheet	101
" tubes	60
" wire and cables	627
" bars and strip	382
Total copper	1,170
Aluminium sheet	124
Brass	50
Zinc	44
Solders	24
Others	140
	1,552

2.1.4 Sales

Latreca's main customer is still the mining industry as is shown in the table below:-

Table C.IV - Proportion of sales accounted for by major customers.

	Approximate Proportion of Sales	Main products purchased
Gecomin	50%	Wire, cable, strip, bars, cathode sheets.
B.C.K.	15%	Wire, cable, trolley wire.
Other mining companies & ACEC	15%	Wire, cable, strip, bars.
Chanico and others	20%	
	100%	

Sales to companies outside Katanga are handled by Chanico of Kinshasa who act as Latreca's agents and stockholders.

2.1.5 Exports

Exports in 1967 were reported as:

Copper bar & flats	3,100 kg
Tubes	11,810 "
	14,910 "

All of these products went to Zambia. The official export statistics show a wider range of exports in earlier years of products made only by Latreca. Some of these went to countries as far away as Afghanistan; however the main customers have always been Zambia and Southern Rhodesia (until UDI).

2.1.6 Source of raw materials

Copper is purchased from Gecomin at a price below the world rate. The official discount is naturally confidential and subject to negotiation between Gecomin and its local customers. However, it is known that the discount is greater than the saving in transport costs to Europe (which are included in the world price).

The other main metals are also supplied locally. Zinc and cadmium are purchased from Metalkat, lead from Gecomin and tin from Géomines. The aluminium used is largely scrap - particularly from Metalkat's electrolytic plants. A considerable amount of scrap copper is also used.

Although all supplies are relatively close at hand occasional difficulties are met with in the supply of raw materials - even copper and tin. However, the major problems facing Latreca are:

(i) the supply of spare parts. Generally parts must be replaced by their own workshops. If this is impossible a machine may be out of action for as long as six months before spares arrive from Europe.

(ii) the age of the machines. Some were purchased second-hand during the second world war and are still in use. Most of the rolling plant was ten years old when installed in 1953. Consequently breakdowns are frequent, quality of finish is not always up to the highest modern standards, and production methods are slow and outdated. However, it is not economic to replace this machinery (which has presumably long been written off) until it can be guaranteed that new machinery would be working nearer full capacity.

(iii) a temporary difficulty is the government imposed obligation to maintain the labour force at 250 employees although only 150 are needed for production at its present level. The additional employees were taken on temporarily to run an extra shift in order to overcome a backlog of orders which had accumulated while the extrusion press was out of action.

(iv) a shortage of expatriate staff. At present only seven European technicians are employed but three additional staff are needed.

(v) transport difficulties within the Congo make the efficient delivery of customers' orders very difficult. One customer in Kinshasa said that delivery from Latreca took as long as from New York. Difficulties in supply do not arise from shortage of stocks, which are adequate, though not excessive, since production is very elastic. The problem arises largely from the transport and communications system which has suffered from the internal disorders of the last few years.

2.2 SOMKAT: Lubumbashi

2.2.1. Organisation, history and activities

Somkat, like Latreca, was founded to meet the demand for intermediate products generated by the Katangese mining industry. It is a Congolese company but is controlled by the Banque Lambert de Belgique. Another Banque Lambert subsidiary - Elakat - handles the commercial side of its operations. Somkat works in close association with Gecomin, its main clients, who provide technical advice. Somkat's main activities are the casting of iron and steel, bronze and anti-friction metal, though the last two are of relatively minor importance.

2.2.2 Capacity

The capacity of the bronze foundry until recently was about 180 tons a year. However, Gecomin engineers have recently helped the company to reorganise their production methods thereby increasing capacity to 240 tons p. a. Similarly, the steel foundry has increased its capacity from 3, 000 to 4, 000 tons. Anti-friction capacity is now 72 tons p. a.

2.2.3 Production

Its principal activity is in the casting of iron and steel products. But it also has a bronze foundry which produces castings to order. The growth of production over the last ten years is shown below:

Table C. V - Annual Production 1958, 1966/7/8 (in tons)

Year	Bronze	Iron & Steel	Anti-friction metal
1958	28	498	?
1966	145	1, 366	-
1967	172	2, 924	6
1968 (planned)	180	3, 600	25

2.2.4 Sales

The reason for the increase in capacity was, of course, that demand for the company's products has risen steadily until not all of it could be met. Part of the reason for this growth is that many of the company's products are replacement parts which are particularly in demand after the destruction caused by the various rebellions, the disrepair into which much equipment has fallen during the troubles, and the general ageing of the country's equipment which has not been replaced because of the scarcity of new capital.

The company's main customers for bronze castings are the railways, particularly BCK and OTRACO, but also CFL and Vicicongo. Together they take the overwhelming majority of Somkat's output of bronze. In addition firms such as SUCRAF, FELTESAF, SOGECHIM and others require mechanical parts in bronze, There is very little demand for bronze from the mining companies who are, however, large customers of Somkat's steel foundry.

2.2.5 Raw materials and other inputs

Many of the company's raw materials are produced locally, even the steel used being scrap. This is in particularly plentiful supply at present precisely because so much

equipment has been damaged during the troubles. Similarly, a certain amount of scrap copper and bronze is remelted.

Table C. VI - Purchases of raw materials 1967.

Local products	Weight tons	Value $
Copper	90	30,010
Tin	86	17,928
Steel Scrap	4,538	84,494
Other	-	76,646
Spare parts	10,460	20,482
Solder	–	11,386
		240,946
Imported Products		
Coke	1,555	-
Phosphor	1,565	-
Ferro-silicium	116	-
Bentorite	38	-
Mentronelt	10	-
	18,458	

The company employs a labour force of 230.

2.2.6 Future Plans

It is intended to expand production to the new limits of capacity in the next few years. No further plans for expansion have been made and it is possible that current high demand, arising from the factors mentioned, will represent a plateau. Certainly an upturn in industrial activity and investment will not necessarily lead to an increase in demand for Somkat's products and might even lead to a decline if new machinery replaces old. For example B. C. K. are replacing old steam engines which require considerable quantities of bronze spares by diesels which will be new and have fewer bronze parts.

2.3 TEXAL

Another foundry in Lubumbashi is owned by a small firm called Texal. It is similar to Somkat though only a tenth of the size.

Its major customers for bronze are the same as those of Somkat i. e. the railways and a few large industries. However, it receives orders for pieces wanted in small numbers whilst large orders go to Somkat. Production of bronze is believed to be of the order of 20 tons per year.

2.4 CHANIMETAL

2.4.1 History, organisation and activities

The forerunner of Chanimetal was Chanic, a Belgian company, which began operations in the Congo in 1928. Initially their activity centred round the shipyard but even before the war they operated an iron foundry, which was closed during the

depression. The foundry was reopened in 1943 and an additional electric furnace of 500 kg capacity was acquired to meet war time demands which could no longer be satisfied by imports.

The electric furnace produced largely iron and steel but also some bronze castings.

In 1961 Chanic was one of the first companies to convert its holdings into a Congolese company - all industrial activities being carried out by Chanimetal. This enterprise has expanded its activities into a number of spheres but has not moved into any new field of copper, or bronze processing. The commercial activities previously carried out by Chanic are now in the hands of Chanico. As previously mentioned they are agents for Latreca's products in Kinshasa and the rest of the Congo, apart from Katanga.

2.4.2. Production and Capacity

Total capacity was increased from 450 tons to 700 tons by modernising the furnaces. However, production has never reached this new limit and only a small proportion of production is in bronze.

Table C. VII - Production by Chanimetal

	1959	1960	1961	1962	1963	1964	1965	1966	1967
Bronze	40	20	27	31	76	78	24	25	n.a.
Other non-ferrous	44	n.a.	n.a.	12	51	32	10	4	n.a.
Steel	72	n.a.	n.a.	41	30	47	44	31	n.a.
Pig iron	370	n.a.	n.a.	185	239	360	342	153	n.a.
	527	n.a.	n.a.	269	396	517	420	214	280

2.4.3 Sales

The main bronze castings produced are spare parts for the railways; the overwhelming majority going to OTRACO. Bronze castings are also sold to other local industries mainly for replacement and repair.

2.4.5 Raw Materials

Copper and tin for the bronze are purchased from Gecomin at the market price.

2.4.6 Future Plans

Capacity is considerably in excess of demand and there are no plans for any expansion of the bronze foundry.

2.5. SPLENDOR - Kinshasa

Splendor is the larger of the two Congolese firms currently producing insulated wire. It is also engaged in the production of other plastic articles.

2.5.1 Production and capacity

Its range of products and prices is shown in table C. VIII. Essentially the range covers all plastic insulated house and domestic wiring, including telephone cables, with up to six pairs.

Detailed figures for capacity and past production are not known. However, production in 1968 is running at a level of about $72,000 p.a. which is below maximum output.

2.5.2 Sales

As the wiring is essentially for domestic or constructional use, sales are almost entirely to the large building firms, builders' merchants, electrical engineers and retailers. The two largest customers are electrical installation firms, Entrelco and Congowatt.

Before independence a proportion of production was exported to many African countries. This was disrupted by the disturbances but an effort is being made to expand into export markets again.

2.5.3 Raw Materials

The copper wire used is obtained from Latreca through Chanic - consumption of copper is currently about 15 tons per month. Plastics, mainly PVC, are imported.

2.5.4 Future Plans

Plans are well advanced for the installation of machinery to make underground power cable sheathed with lead. Production should begin in mid 1969.

Table C. VIII - Types of cable produced by Splendor

CODE	No. of wires	Section of wire	Description	Price (1.6.68)
RR3OR	4 x 4		Rigid - (Imitation rubber)	57.80
RR3OR	4 x 2.50		" " "	26.00
RR3OR	3 x 2.50		" " "	20.00
RR3OR	2 x 2.50		" " "	14.70
RR3OR	4 x 1.50		" " "	15.00
RR3OR	3 x 1.50		" " "	12.00
RR3OR	2 x 1.50		" " "	8.50
RR3DR	3 x 2.50		Rigid-Sheath Imitation lead	16.40
RR3DR	2 x 2.50		" " "	11.70
RR3DR	3 x 1.50		" " "	9.50
RR3DR	2 x 1.50		" " "	7.00
UR3	1 x 4		Rigid single conductor	6.60
UR3	1 x 2.50		" " "	3.80
UR3	1 x 1.50		" " "	2.80

Telephone Cables

1 Pair + 1 earth	Flexible-sheath imitation lead covered in PVC	4.00
2 " + 2 + 1	" " "	7.50
3 " + 2 + 1	" " "	11.20
4 " + 2 + 1	" " "	14.80
6 " + 2 + 1	" " "	20.70
T.V. 2 x 0.50	For aerials-polyethylene	3.50

Table C.III - Types of cable produced by Splendor (continued)

CODE	No. of wires		Section of wire	Description	Price (1.6.68)
FR2G	4	x	2.50	Flexible sheath (imitation rubber)	22.50
FR2G	4	x	1.50	" " "	14.80
FR2G	3	x	2.50	" " "	18.20
FR2G	2	x	2.50	" " "	13.50
FR2G	3	x	1.50	" " "	11.50
FR2G	2	x	1.50	" " "	9.10
FR2G	3	x	1.25	" " "	9.40
FR2G	2	x	1.25	" " "	8.00
FR2G	3	x	0.75	" " "	7.50
FR2G	2	x	0.75	" " "	5.50
FR2G	2	x	0.50	" " "	5.00
FR2H	2	x	0.75	Flexible side by side biconductor	3.50
FR2H	2	x	0.50	" " "	2.80
FR2X	2	x	0.75	Flexible cordonné biconducteur	3.00
FR2X	2	x	0.50	" " "	2.30
UFR2	1	x	4	" " "	8.20
UFR2	1	x	2.50	" " "	5.50
UFR2	1	x	1.50	" " "	3.50
UFR2	1	x	1.25	" " "	3.00
UFR2	1	x	1	" " "	2.50
UFR2	1	x	0.75	" " "	1.50
UFR2	1	x	0.50	Flexible cordonné biconducteur	1.30
UFR2V	1	x	0.60	Flexible for garage lamps	1.90
UFR2V	1	x	0.50	" " "	4.00
FR4G	2	x	1	" " "	6.10

R2, R3, R4, etc. refer to the thickness of the insulant.

2.6 CONGACEC - Kinshasa

2.6.1 Congacec is a Congolese subsidiary of the large Belgian electrical engineering firm A. C. E. C. It acts principally as an importer and representative for A. C. E. C.'s products, including wire and cables, in the Congo. However, it also has some important manufacturing activities in the Congo. At Kinshasa it engages in the insulation of wire and cable. It also has interests in I. E. C. (which assembles radios) and Agripile (which makes dry batteries).

At Likasi Congacec possesses a workshop for the repair of all electrical machinery, the assembly of electric motors and the manufacture of fluorescent lamps.

2.6.2 Production of wire and cables

The types of insulated wire produced and their prices are listed below:-

Table C. IX

1 conductor	1.5mm ^{2}	PVC insulation -	Price 3.5^{Z}	for 100m roll
1 ..	2.5 ..	.. .. -	.. 4.2^{Z}	100m roll
1 ..	4.0 ..	.. .. -	.. 6.90^{Z}	.. ..
2 ..	1.5 ..	.. .. -	.. 5.80^{Z}	50m roll
3 ..	1.5 ..	.. .. -	.. 6.70^{Z}	.. ..
2 ..	2.5..	.. .. -	.. 6.50^{Z}	.. ..
3 ..	2.5..	.. .. -	.. 7.00^{Z}	.. ..
2 .. (side-by-side)	0.75..	.. .. -	.. 4.20^{Z}	.. ..

The company have also begun to produce telephone cables (for household and industrial use). These are multi-pair cables insulated in PVC with a PVC sheath. It is planned to extend the range up to 16 pairs next year.

2.6.3. Customers

The wires are for installation in houses and industrial buildings and are in hard copper, apart from the side by side wire which is flexible for domestic use. Consequently, most of the output is sold to building firms, electrical engineers and contractors, and retailers.

2.6.4. Raw materials

The copper wire used comes direct from Latreca and is coated with imported PVC. About 15 tons of wire was used in 1967 and 12 tons in 1966.

2.6.5. Likasi Workshops

It is impossible to quantify the capacity or even the output of a workshop such as that at Likasi, and the amount of copper used bears no direct relationship to the value of repair work done. However, last year, total consumption of copper was about 45 tons. All is purchased from Latreca but only part is bought in the form of wire. The remainder comes as wire rod which is then drawn in the workshops to the precise requirements of the job in hand. This is because many electric transformers, motors and generators require special thicknesses and complex cross-sections for compact winding.

The main customers of the workshops are the electricity generating and distribution authorities, the railways, and local industries such as the cement works, sugar refinery, the mines, the textile industry etc.

3. Current and Past Demand for Copper Products

Demand for copper products in the Congo is met partly from imports and partly from local production. The local industry also has a small export trade of manufactured and semi-manufactured products. We consider first the import situation, then local production and exports.

3.1. Imports

Congolese import statistics are based on the Brussels Nomenclature system of classification. Fortunately, however, some headings are further divided into sub-categories thus giving more detailed information than is available for most other countries.

The import headings which refer to copper products fall into two sections of the import classifications. The first of these is Chapter 74 of the Brussels Nomenclature and details all imports of raw copper and semi-manufactures and manufactures made

entirely from copper. The second section is heading 8523 which covers insulated electric wire and cable. Unfortunately, both aluminium and copper insulated conductors are grouped together and even the Congo's sub-divisions do not separate them. However, the Congo does break down imports by 30 different combinations of insulation.

Table C. X shows the evolution of each category of imports since 1963. No clear trend emerges either as to the composition or total quantity of copper products imported.

3.2 Local Production

It is not possible to quantify local production of copper products in as great detail as is shown in the imports statistics. Also, to avoid double counting, production of intermediate products (wire, rod, bare wire, etc.) which are further processed by the copper fabrication and insulation industry is ignored in Table C. XI. The table, therefore, covers only sales of copper products to users outside the copper fabrication industry. Details of the production of intermediate products can be found in Section 3.

Table C. X part (i) - Imports of Copper Products 1963-1967.

Import Heading Chapter 74 - Copper and Articles Thereof	1963 Kgs	1963 Frs C	1964 Kgs	1964 Frs C	1965 Kgs	1965 Frs C	1966 Kgs	1966 Frs C	1967 (first six months) Kgs	1967 (first six months) Frs C
Rods, angles, shapes & Sections	15,372	1,453,347	257	111,600	12,629	2,739,584	32,859	7,235,746	3,633	1,166,070
Single wire (of Tombac)	250	17,901	100	23,931	–	–	–	–	–	–
Others single wire	41,115	6,043,929	33,234	6,965,344	14,906	3,733,911	5,133	1,682,628	1,314	490,646
Plates, sheet & strip over 15 mm (of Tombac)	–	–	22	8,564	1	10,250	24	14,467	–	–
Plates, sheet & strip over 15 mm (of Argentan)	–	–	1,097	139,921	–	–	–	–	–	–
Plates, sheet & strip over 15 mm (of Copper)	15,015	1,673,443	21,208	3,874,550	17,524	4,248,310	23,908	6,245,816	2,902	1,289,232
Foil up to ·15 mm thick	779	136,014	157	7,378	573	127,782	586	413,218	205	58,575
Copper powder & flakes	–	–	1	350	1	21,570	65	16,678	61	29,908
Tubes, pipes & hollow bars	40,220	5,626,610	63,958	17,526,987	61,870	19,095,946	35,870	13,437,450	14,588	6,143,131
Tube & pipe fittings (joints, elbows, flanks etc)	7,374	2,050,438	13.139	11,482,130	8,465	5,862,002	13,143	6,282,154	392	310,597
Reservoirs, vats, tanks etc. (over 300 litres capacity if not fitted with mechanical or thermal equipment)	4,671	620,441	–	–	28	26,191	25	8,934	–	–
Stranded wire cable or cordage (uninsulated)	66,612	6,898,306	46,593	8,012,576	12,348	4,527,949	3,024	1,171,864	5,584	1,689,636
Cloth of copper wire	6,207	1,032,500	14,440	4,734,374	4,335	1,557,857	9,691	4,334,991	713	386,867
Grills & fencing	1,112	187,270	145	122,406	4,369	1,395,593	500	131,874	1	133
Chains	2,533	266,069	330	208,001	532	159,897	251	148,346	84	28,957
Parts of chains	–	–	–	–	5	5,900	27	29,525	–	–
Nails, tacks & staples	1,342	217,556	52,666	2,356,864	66,056	2,849,895	1,655	304,767	258	100,223
Spikes, clamps, studs & hooks	34	22,000	1,393	335,248	3	242	137	40,049	236	140,457
Drawing pins	421	21,200	23	39,738	19	9,095	392	75,975	–	–
Nuts & bolts	2,281	507,485	1,981	798,124	2,806	1,064,851	2,633	1,576,119	247	193,422
Screws	3,255	694,725	4,532	1,473,949	4,503	1,578,084	1,494	614,024	240	178,222
Rivets & Cotterpins	2,870	689,239	4,686	1,669,658	6,226	2,039,289	3,964	1,862,002	566	243,792
Washers etc.	486	79,481	755	231,118	2,611	1,229,469	2,820	1,963,245	66	148,789
Springs	40	16,184	21	78,885	791	209,290	1,919	14,446	429	23,650
Domestic cooking & heating apparatus (not electrical)	9,404	3,419,683	3,908	1,524,732	10,967	2,601,468	4,111	1,266,825	693	171.175
Parts of domestic cooking & heating apparatus	3,187	195,517	5,358	1,355,585	–	–	4	21,417	7	14,309
Other domestic articles	103	44,686	242	358,282	123	79,903	538	275,287	484	175,527
Builders sanitary ware (for indoor use)	2,130	381,518	2,048	1,177,113	2,772	1,380,961	2,505	1,717,388	454	375,837
Pins & needles	1,375	250,765	1,340	500,870	1,318	570,460	1,519	608,188	489	414,362
Parts made of copper n.e.s.	120	17,579	121	45,551	15,878	966,056	105	45,392	150	241,160
Cast & forged articles of copper	91	21,400	2,763	611,253	20,882	4,477,986	1,406	467,816	273	407,693
Other copper articles n.e.s.	8,330	1,833,091	5,088	2,786,524	27,852	5,849,898	20,879	15,483,613	28,483	21,270,500
Total	236,729	34,418,377	267,166	68,555,606	300,393	68,419,689	171,187	67,490,239	62,552	35,692,870

Table C.X (part ii) - Imports of Copper Products 1963-1967

Import Heading		1963		1964		1965		1966		1967	
		Kgs	Frs C	Kgs	Frs C	Kgs	Frs C	Kgs	Frs C	Kgs	Frs C
With lead sheathing but not armoured with other metals	Insulated with rubber	13,429	1,242,319	66,581	15,884,787	54,700	10,740,509	34,254	6,976,632	38,990	14,417,382
	Insulated with dry paper	254	21,378	11,547	930,242	48,408	6,698,813	16,630	2,637,046	–	–
	Insulated with impregnated paper	48,237	1,990,463	47,749	6,892,739	34,852	4,864,617	57,423	7,783,037	26,500	3,323,154
	Insulated with thermo plastics	18,509	2,566,355	18,349	4,236,358	19,452	3,873,516	15,090	3,711,861	13,070	2,896,459
	Insulated with other materials	8,023	1.329,372	19,484	4,401,032	32,866	6,900,791	18,608	3,470,827	7,515	1,834,302
With lead sheathing and armoured with other metals	Insulated with rubber	204,263	10,920,626	43,678	8,344,838	73,611	13,351,865	36,348	5,112,271	68,912	11,512,899
	Insulated with dry paper	25,660	908,695	54,560	6,128,488	30,139	4,407,125	22,251	3,400,498	5,894	1,309,211
	Insulated with impregnated paper	204,927	13,710,400	193,783	29,841,730	275,035	42,979,276	201,995	28,799,473	49,851	9,057,643
	Insulated with thermo plastics	56,304	3,440,716	149,867	23,014,540	148,479	27,722,439	119,827	23,346,524	6,827	1,349,442
	Insulated with other materials	2,023	182,916	7,736	946,655	7,407	1,826,656	6,147	1,239,522	5,582	1,321,852
With rubber sheath	Insulated with rubber	297,588	27,821,384	271,146	50,327,809	247,714	48,600,369	328,541	65,096,606	41,005	11,669,488
	Insulated with other materials	9,722	594,631	23,748	3,495,938	14,346	4,017,838	17,789	5,646,941	5,266	1,912,656
With plastics sheath	Insulated with rubber	75,628	6,558,744	84,290	16,099,057	87,538	18,250,030	86,006	20,053,704	22,280	6,204,445
	Insulated with plastics	255,511	22,989,764	422,539	64,970,987	700,325	106,427,976	733,988	124,379,893	205,817	47,080,612
	Insulated with other materials	11,870	2,069,803	143,560	20,343,648	242,546	27,365,897	60,779	9,188,005	15,200	3,521,136
With sheath of other materials	Insulated with rubber	6,783	603,947	9,920	1,808,401	7,382	1,252,354	1,496	751,896	2,726	2,509,615
	Insulated with dry paper	8,417	386,797	1,247	297,659	6,027	1,343,920	632	62,741	–	–
	Insulated with impregnated paper	333	27,749	–	–	4,135	915,213	2,135	379,415	1,420	288,242
	Insulated with plastics	1,875	179,447	6,293	1,692,287	15,256	2,905,296	3,848	732,723	6,999	1,706,057
	Insulated with other materials	2,646	219,479	10,890	2,304,431	13,253	3,456,358	6,304	2,162,496	817	229,011
Without sheath	Insulated with rubber	10,645	1,348,753	5,596	1,038,171	14,378	3,042,796	3,496	1,487,991	79,999	10,758,802
	Insulated with cotton	329	46,493	416	124,841	924	327,656	1,013	194,124	110	42,500
	Insulated with silk	858	171,454	302	202,565	50	16,642	1,001	361,898	417	219,041
	Insulated with synthetic fibres	3,050	354,429	3,106	892,394	1,458	331,893	2,547	502,809	94	38,983
	Insulated with varnish	18,100	2,996,716	29,614	6,221,031	29,264	8,999,964	40,530	11,888,105	9,442	3,117,738
	Insulated with plastics	13,243	1,595,484	27,916	5,853,286	22,948	4,460,153	37,420	10,476,608	3,631	1,500,595
	Insulated with other materials	22,633	2,514,840	38,848	9,218,169	26,075	6,958,648	4,808	1,341,007	4,520	1,898,231
Wire cut to length and fitted with connectors	Insulated with rubber	2,470	993,343	3,391	2,651,111	3,581	1,533,588	3,886	2,689,233	1,060	664,375
	Insulated with thermo plastics	74	79,160	128	94,520	23,820	4,183,347	283	151,790	220	790,906
	Insulated with other materials	696	642,133	1,968	1,237,309	1,439	1,305,938	87,340	9,079,115	96	232,254
	Total	1,324,100	108,507,790	1,698,252	289,495,023	2,187,408	369,061,483	1,952,415	353,104,791	624,260	141,407,031

Table C. XI. - Sales of Finished Copper Products by the Copper Fabrication Industry.

	Metal content (tons)	Manufacturer
Type 1 - Semis	563	Latreca
of which - sheet	101	"
- shapes, rod and strip	402	"
- tubes and fittings	60	"
Type 2 - Bare Conductors	507	Latreca (+ Congacec (Likasi))
Type 3 - Other Manufactures and Castings	237	Somkat, Chanimetal, Texal
Type 4 - Insulated Copper Wire	200	Splendor, Congacec (Kinshasa)
	1, 507.	

3.3. Exports

Export figures for the Congo are known in detail for 1963, 1964 and 1965 and the first 6 months of 1967.* However, the figures for 1966 are not yet available.

In most years only small quantities of fabricated copper products have been exported, mainly to Zambia, Southern Rhodesia (before UDI) and Angola. 1965 was an exceptional year in that very large orders were received, especially for copper wire, and the orders came from more distant markets. A total of 1, 127 tons of wire was exported in that year to Libya, South Africa, Afghanistan and Pakistan. Further export orders of this size are not expected by Latreca but there clearly is a potential for exports above the level of other recent years.

All the products exported are made by Latreca, except possibly the small quantity of miscellaneous copper manufactures. Splendor, the manufacturer of insulated house-wiring, used to export to neighbouring African countries before independence. Attempts are now being made to re-enter these markets and to investigate the possibility of selling to East Africa.

3.4. Net Demand for Copper Products in the Congo

Unfortunately a complete set of import, export and home production figures is not available for any single year; since export figures are not available for 1966 and imports in 1967 cover only the first six months.

To estimate net demand we have therefore taken the average level of imports for 1964 to 1966; the average level of exports for 1964, 1965 and 1st half of 1967, and local production for 1967. The exceptional figure for wire exports in 1965 has been ignored. The considerable and uncorrelated variation in all three elements of demand from year to year mean that

* Figures for the first six months of 1967 are provisional. They are taken from the unpublished preliminary computer print out which is subject to revision, usually in an upward direction, when delayed returns are received.

Table C. XII - Exports of Copper Products 1963-1967

	1963		1964		1965		1967 *	
	Kgs	Frs C	Kgs	Frs C	Kgs	Frs C	Kgs	Frs C
Rods, Shapes & Sections	5,569	666,157	13,669	1,804,078	30,382	4,557,300	1,506	92,895
N. Rhodesia/Zambia	494	32,804	4,004	551,840	–	–	1,506	92,895
S. Rhodesia	4,321	591,650	9,362	1,202,875	–	–	–	–
Angola	555	28,273	303	49,363	–	–	–	–
Mixed destinations	199	13,430	–	–	30,382	4,557,300	–	–
Single Wire	2,163	114,209	947	105,009	1,126,739	156,543,578	–	–
N. Rhodesia/Zambia	1, 712	91,216	947	105,009	913	132,977	–	–
S. Rhodesia	451	22,993	–	–	–	–	–	–
South Africa	–	–	–	–	253,971	30,083,512	–	–
Afghanistan	–	–	–	–	200,000	27,931,330	–	–
Pakistan	–	–	–	–	23,917	3,587,550	–	–
Libya	–	–	–	–	647,938	94,808,209	–	–
Sheet, strip & plate	1,071	64,660	481	61,530	22,415	3,094,485	21	1,030
N. Rhodesia/Zambia	–	–	481	61,530	1,920	27,600	–	–
S. Rhodesia	–	–	–	–	322	51,640	–	–
Angola	1,071	64,660	–	–	–	–	–	–
France	–	–	–	–	25	2,000	–	–
Pakistan	–	–	–	–	9,060	1,350,000	–	–
Indeterminate	–	–	–	–	11,088	1,663,245	–	–
Belguim	–	–	–	–	–	–	21	1,030
Foil (up to 15mm)	10,000	2,540,536	–	–	2,210	311,136	–	–
N. Rhodesia/Zambia	–	–	–	–	2,210	311,136	–	–
Mixed destinations	10,000	2,540536	–	–	–	–	–	–
Tubes	15,257	652,697	1,991	287,900	18,264	2,945,860	7,339	3,769
Belgium	78	7,000	–	–	–	–	–	–
N. Rhodesia/Zambia	–	–	1,780	252,610	1,662	222,840	7,339	3,769
S. Rhodesia	15,139	643,903	211	35,290	12,266	2,072,605	–	–
Angola	40	1,794	–	–	4,336	650,415	–	–
Stranded wire & cable	5,789	281,291	757	96,075	4,108	647,812	822	18,095
N. Rhodesia/Zambia	–	–	–	–	4,037	609,812	822	18,095
S. Rhodesia	4,762	229,771	–	–	–	–	–	–
Rwanda	–	–	–	–	67	30,000	–	–
U.S.A.	–	–	–	–	4	8,000	–	–
Mixed destinations	1,027	51,520	757	96,075	–	–	–	–
Screws, nuts, bolts etc.	–	–	34	3,193	–	–	–	–
U.S.A.	–	–	34	3,193	–	–	–	–
Domestic Articles	–	–	–	–	2	1,000	–	–
Belgium	–	–	–	–	2	1,000	–	–
Other Articles n.e.s.	–	–	3,923	838,650	655	464,930	2,852	759,798
Spain	–	–	3,600	750,000	1	450	6	320
France	–	–	5	1,030	88	65,390	34	6,908
N. Rhodesia/Zambia	–	–	150	75,300	–	–	32	1,904
U.S.A.	–	–	148	8,200	117	27,240	59	15,980
Burundi	–	–	20	4,120	7	4,000	–	–
Belgium	–	–	–	–	147	46,700	499	57,573
Kenya	–	–	–	–	–	–	38	11,655
Tanzania	–	–	–	–	–	–	706	7,968
Indeterminate	–	–	–	–	–	–	–	–
W. Germany	–	–	–	–	148	301,800	–	–
Italy	–	–	–	–	130	1,350	–	–
Switzerland	–	–	–	–	16	17,000	–	–
Syria	–	–	–	–	4	1,000	–	–
Total Exports Of Copper Products	39,849	4,319,550	21,802	3,196,435	1,204,775	168,566,101	12,540	875,578

* First six months, provisional figures.

no year is really typical so this procedure, though imprecise, gives an acceptable indication of the magnitude and pattern of demand.

Table C.XIII - Net Local Demand for Copper Products. (tons metal content)

	(a) Imports	(b) Local production	(c) Exports	(d) Net local demand	(e) % met by local production
Type 1 — Semi-manufactures	102	563	32	633	84
Sheet	21	101	8	114	82
Shapes, rod, strip	15	402	15	402	96
Tubes and fittings	66	60	9	117	44
Type 2 — Bare Conductors	38	507	80	465	92
Type 3 — Other manufactures and castings	119	237	2	354	66
Manufactures	99	15	1	113	12
Castings	20	222	1	229	92
Type 4 — Insulated Conductors	780	200	—	980	20
TOTAL	1,039	1,507	114	2,432	57

The last column (e) in table C.XIII shows the proportion of Congolese internal demand for copper products met by the local fabrication industry. For most products the proportion is high. Exceptions are:

(i) Tubes and Fittings. This is partly because Latreca's extrusion press is too small to produce the full range of wide tubes and partly because much of this category is fittings many of which may be specialised and outside the basic range made by Latreca.

(ii) Manufactures. These include a range of miscellaneous objects made entirely from copper or alloy. None accounts for a major proportion of demand and consequently there has been little scope for local production.

(iii) Insulated wire and cables. At present only housewiring is produced within the Congo. Both firms which make it are currently working below capacity and imported housewire still takes a significant proportion of the local market. The bulk of imports are, however, more complex types such as power, mining and telephone cables.

4. Demand for Copper by Industrial Sector

4.1. Electricity Supply Industry

The electricity supply industry in the Congo is in the hands of private or mixed private and state companies. The companies obtain their concessions from the state which supervises them through the Water and Electricity Section of the Ministry of Public Works.

Historically the major part of the Congo's electricity generating capacity has been installed to meet the needs of the mining industry. Most of the mining companies produce their own power or have set up companies to do so for them. Many towns are supplied from plants built by the mining companies.

The main producing companies in the Congo are:

(i) Société Forces de Bas-Congo which runs the Zongo Hydro-electric plant.

(ii) Société Forces de L'Est which runs the Kisangani, Bukavu and Albertville hydro-electric plants (as well as Taronka in Rwanda)

(iii) Colectric which runs the Sango hydro-electric plant.

(iv) Regideso which runs Matadi hydro-electric plant and the thermal plants throughout the country.

(v) The Inga project is still in its early stages but will generate electricity from a hydro-electric plant at Inga.

Their total installed capacity is 225.6MW which accounts for only 29.4 per cent of the Congo's capacity. The remainder is operated by the following mining companies which generate electricity for their own use:

(i)	Sogefor (for Gecomin)	-	Katanga	Installed	capacity	465.0 MW
(ii)	Geomines	-	"	"	"	28.9 MW
(iii)	Sermikat	-	"	"	"	9.9. MW
(iv)	Miba	-	Kasai	"	"	8.6 MW
(v)	Forminiere	-	"	"	"	1.6 MW
(vi)	Symetain	-	Kivu	"	"	8.3. MW
(vii)	MGL	-	"	"	"	1.7 MW
(viii)	Gobelmines	-	"	"	"	6.8. MW
(ix)	Kilo-moto	-	Eastern	"	"	10.0 MW
Total	mining			"	"	540.8MW

There are, however, only three major distribution companies:

(i) Colectric which distributes from its own plant and from those of Société Forces de Bas Congo, in the town of Kinshasa.

(ii) Sogelec which distributes the electricity produced by Sogefor in the Lubumbashi and Likasi areas.

(iii) Regideso which distributes in all the other towns.

Annual production, exports and imports and consumption are shown in Table C. XIV.

Production rose over this period at an annual rate of 1.3%. This low rate is attributable to the disturbances which affected both supply and demand and reduce the rate of growth of the major users i.e. the mining firms. Also, net exports dropped by half. Hence internal consumption was rising faster than production - at a rate of 4.2% per annum. Consumption per head has only been growing at 2.2% per annum though this is perhaps a less relevant indicator in the Congo than elsewhere because most of the electricity is consumed by the mining industry which produces for the export market.

Table C.XIV - Annual Production, Exports, Imports and Consumption of Electricity from 1960-1965 (MWh)

	1960	1961	1962	1963	1964	1965
Production	2,456,000	2,444,000	2,642,000	2,370,000	2,381,000	2,618,000
of which hydro-electric	2,425,000	2,403,000	2,596,000	2,325,000	2,336,000	2,573,000
Exports to Zambia	551,000	487,000	498,000	293,000	214,000	275,000
Exports to Burundi	10,000	10,000	12,000	13,000	15,000	12,000 est.
Exports to Brazzaville	–	90	–	–	–	–
Exports from Brazzaville	300	90	–	200	50	200
Net exports	560,000	497,000	510,000	305,000	229,000	286,800
Consumption	1,874,000	1,916,000	2,098,000	2,033,000	2,122,000	2,298,000
Consumption per head kwh/head	132.0	132,0	145.0	135.0	139.0	147.0

The estimated total length of transmission and distribution lines is shown below with details of the main lines.

Table C.XV - Length of Transmission and Distribution Lines in the Congo

	Length KM	Voltage KV
Total length of transmission and distribution lines	11,469.0 (est.)	
of which High voltage lines	3,469.0	
Low " "	8,000.0 (est.)	
Sanga I - Kinshasa	71	66
Zongo I - Kinshasa	65	132
Zongo I - Kinshasa	80	70
Zongo I - Lusaka	228	70
Le Marinel - Jadotville	220	220
Jadotville - Zambia	200	220
South Katanga inter-connection	518	120
" " "	126	50
Mururu - Bujumbura	160	70
Kiyumba - Albertville	120	132
Piana - Manono	83	120
Kalima -	114	33
Namoya -	69	55
Soleniama - Kilo-Watsa	140	30
Budana - Kilo-Watsa	557	70
Total	2,962	

In 1965 there were in all 40,450 public subscribers for supplies of electrical energy.

Most of the wire and cable used by the electricity industry is, of course, used in the maintenance and extension of transmission and, more especially, distribution networks operated by the three distribution companies.

4.1.1 COLECTRIC

Details of copper products and insulated cables used by Colectric in 1967 are given below. These do not correspond exactly to purchases in that period but to the amounts of cable drawn from stock.

Colectric uses no aluminium cables. It is therefore possible, knowing the density of copper, to work out the weight of the copper content of cables used from the length and cross sections given. Total copper usage by Colectric in 1967 was 127.5 tons of copper in insulated cables plus 4.70 tons in bare copper conductors.

All the insulated cables used are imported. Colectric uses no thin plastic insulated wire of the types made by Splendor and Congacec so does not buy from these firms. All the bare copper conductors (wires, cables, flats, etc.) are purchased from Latreca through Chanic.

Colectric provided figures for the length of cable laid each year since 1963. Unfortunately these figures exclude the small low tension cables used for delivery to houses and a certain amount used for replacement purposes. In 1967 the only year for which figures are available for both the extension of the main network and the total usage of cables, the discrepancy was quite large: 160 Km in total of which only 111 Km. was used for extending the main network. We have assumed the same proportion to hold good for previous years.

Table C.XVI - COLECTRIC - Consumption of Bare and Insulated Conductors in 1967

Part (i) - Insulated Conductors

Types and Section	Quantity (metres)
6.600 V.	
3 x 10	2,620
3 x 35	5,490
3 x 50	20,632
3 x 95	14,241
3 x 120	14
	42,997
Low Tension - armoured	
2 x 1.5	530
3 x 1.5	1,473
4 x 1.5	150
2 x 2.5	3,868
3 x 2.5	4,139
4 x 2.5	2,768
4 x 4	21,545
4 x 6	25,760
3 x 16 + N	6,093
3 x 35 + N	7,611
3 x 50 + N	1,605
3 x 70 + N	7,202
3 x 95 + N	7,598
	90,342

Table C.XVI - COLECTRIC - Consumption of Bare and Insulated Conductors in 1967.
(continued)

Part (i) - Insulated Conductors

Types and Section	Quantity (metres)
Low Tension - Unarmoured	
2 x 1.5	2,887
3 x 1.5	254
2 x 2.5	4,597
3 x 2.5	3,805
4 x 2.5	4,997
4 x 4	4,368
4 x 6	4,774
4 x 16	155
1 x 95	418
1 x 185	830
	27,085
Total	160,424

Part (ii) - Uninsulated conductors.

Type	Section	Quantity (Kgs)
Bare wire	1.5 mm2	24
	3.0 mm2	373
	5.0 mm2	832
		1,229
Bare cable	25 mm2	164
Strip	15 x 3	14
	20 x 2	447
	25 x 2	47
	25 x 4	98
	30 x 2	25
	30 x 4	85
	30 x 6	882
	35 x 5	18
	40 x 4	37
	40 x 5.	97
	50 x 6	342
	50 x 8	613
	60 x 5	6
	60 x 10	85
	100 x 8	14
		2,810
Rod	10 Ø	440
Braided wire	16 mm2	58
Total		4,701

Table C.XVII - Extension of Main Network by COLECTRIC 1962 - 1967

Year	Length of cable laid * Km.	Estimated total consumption of cable Km.	Estimated length of network at 31/12 each year Km.
1962			1,028
1963	75	108	1,103
1964	136	196	1,239
1965	75	108	1,314
1966	90	130	1,404
1967	111	160	1,515

* excluding certain small distribution and replacement cables.

The amount of cable used per annum has fluctuated widely from year to year so it is not possible to deduce a trend from these figures. However, the length of the network has been increasing at the equivalent of 8 per cent per annum compound.

At present Colectric use no aluminium cables. Their reasons for this policy are as follows:

(i) The change from copper to aluminium would involve retraining their labour force in the methods of making junctions, laying cables and estimation of load capacities, etc.

(ii) The change would involve the duplication of all tools used for handling cables since tools pick up small pieces of metal which may incite electrolytic degradation if deposited on a foreign metal.

(iii) Although an all-aluminium system of high voltage transmission would be cheaper in cost of cable the problems of mixing aluminium and copper make it very expensive to change to aluminium.

(iv) Underground cables must be armoured and insulated. If they are based on an aluminium conductor the cable has to be wider so the insulation is more expensive and the cable more difficult to manipulate.

These factors of course, apply to any country except those which possess an entirely aluminium high tension grid. The reason they have been so important in the Congo is the fact the authorities are particularly short of technically trained managers at the middle level. The process of making a change would, therefore, require managerial resources which are already fully stretched in maintaining the efficiency and growth of the network.

It can, however, be envisaged that at some time in the future the situation will change. Technically competent personnel are being trained in greater number than in the past and others are gaining experience on the job. Also the backlog of more urgent tasks which have accumulated during the post-independence troubles will gradually be overcome.

The point at which it will become feasible is difficult to predict. Colectric are certain that it will not be reached for at least five years and probably much longer. We have therefore assumed that the changeover will have just begun by 1975 and that by 1980 the categories of cable for which aluminium is most suitable will be entirely in aluminium.

4.1.2. REGIDESO

The Regideso has recently been put under new management after an administrative disruption during the period of troubles. Unfortunately as a result of the previous dis-organisation no statistics of purchases of cables or copper products are available. Indeed the only available operating statistics, relevant to this survey, are contained in the year book for 1959.

These show the following length of cable then in existence:

Table C.XVIII - REGIDESO - Electricity Distribution Network 31.12.59

Aerial H.T. lines	-	85.5	Km.
" L.T. "	-	150	"
Underground H.T. lines	-	600	"
" L.T. "	-	757.5	"
" H.T. Connections	-	32	"
" L.T. "	-	450	"
		2,075	"

Since then the network has probably not shown any significant increase because destruction has roughly cancelled out any extensions.

Plans for future growth are not yet available but it is expected by the Regideso that the network will expand by about 5 per cent per annum. This is a fairly low figure when compared with growth experienced by Colectric and especially when compared with the rate of growth before independence. Between 1958 and 1959, for example, the network expanded by 242 Kms i.e. over 13 per cent in one year. However, the population growth in Kinshasa which is served by Colectric is more rapid than in the provincial towns served by Regideso so it is reasonable to except Regideso's network to grow less rapidly.

4.1.3. SOGELEC

Sogelec distributes electricity to the town of Lubumbashi and other mining towns in South Katanga as well as to the mining installations.

It is not possible to distinguish the purchases of cable by Sogelec from those made by Gecomin for its mining operations. These are dealt with in a later section of this annex on the mining industry.

Future growth of electricity industry: In ECA document, E/CM14/BP/36 - Electric Energy Survey for Africa - the future electricity situation in the Congo is projected as follows:

Table C.XIX - Projected growth of Electricity Production and Capacity 1965 - 1980

	1965	Growth Rate p.a.	1970	Growth Rate p.a.	1975	Growth Rate p.a.	1980
Production GWH	2,618	4.0%	3,150	7.0%	4,400	7.0%	6,150
Hours	3,420	-	3,500	-	3,600	-	3,700
Capacity MW	766	3.25%	900	6.25%	1,220	6.2%	1,660

The growth rates assumed in the ECA study of the Non-Ferrous Metals Industry in Central Africa* are much higher - 10.4% p.a. between 1966 and 1975 and 16.2% p.a. from 1975 to 1980. We have used the latter figures as being more relevant to this study for the following reason: Sogefor, the Gecomin subsidiary which also supplies Nippon Mining, are expecting a growth rate of production of electricity of 6.9 per cent p.a. between 1970 and 1978. Because Sogefor produce the bulk of all electricity used in the Congo they virtually set a lower limit to the growth rate. However, the growth of electricity in other sectors is likely to be extremely rapid, particularly from the development of the Inga project as a result of which a number of entirely new electricity based industries such as aluminium smelting and chemical industries are likely to be established. Thus the total growth of electricity production is likely to be well above the 7 per cent growth of the main traditional consumer.

4.2. Telecommunications

The telephone system throughout the Congo is controlled by the government owned P.T.T. Because of the shortage of foreign exchange in recent years it has been impossible to import the equipment necessary to maintain and extend the telephone service to meet the increasing demands being placed upon it. For this reason actual purchases do not reflect the real needs of the P.T.T. For example, in 1967 the service technique estimated that its bare minimum requirement for cables was 10,000 metres of each of the seven main types of cable but foreign exchange was only forthcoming for about 5,000 metres of each type.

Table C.XX - Actual purchases in 1967 shown below

Specification	Length	Price per metre	Value
	metres	Z / metres	Z
1Q 6mm^2 Ø	5,000	.234	1,170
2Q " "	"	.287	1,435
3Q " "	"	.322	1,610
7Q " "	"	.426	2,130
13Q " "	"	.582	2,910
26Q " "	"	.955	4,775
51Q " "	"	1.528	7,640
Others	-	-	3,178
	Total		24,848 (11.1 tons) Cu

The total copper content is estimated at about 11 tons.

No time series of purchases is available and because of the arbitrary constraints imposed upon purchasing policy past trends would be no guide to future purchases.

However, according to the P.T.T. there is a recurrent annual need for up to 100,000 metres of each of the major types of cable (3 quarts up to 51 quarts) and 50,000 metres of the lesser types (1 quart, 2 quarts and over 51 quarts).

This latent demand is likely to be realised if the cables are produced in the Congo and do not require foreign exchange to purchase them.

* Komorowski - 68 - 379/35

4.3. Construction Industry

The output of the construction industry industry in the Congo is given in Table C.XXI below.

Table C.XXI - Construction Industry Net Output
($m)

1959	1964	1966
39.8	21.8	29.8

Figures concerning output of the construction industry are very unreliable because of the large amount of unlicensed building carried on by small builders. However, if this figure is roughly correct, gross output (which is normally between 2 and $2\frac{1}{2}$ times net output) would be of the order of $60 - 75 m. in 1966.

In the Congo much of the installation of electrical wiring in large building projects is carried out by electrical contractors. In Kinshasa the two major firms are Entrelco and Congowatt.

Entrelco expect electrical fittings to account for on average, between 5 and 10 per cent of the total cost of a building. Roughly half of this is accounted for by the cost of installation and just under half the electrical fittings are wire and cable. The cost of wire and cable should amount, therefore, to somewhere near 1 per cent of the value of a finished building. A similar figure has been obtained from contractors and architects in a number of countries.

On the basis of the following assumptions, therefore, it is possible to estimate the total demand for building wire in the Congo:

(i) Gross output of the construction industry was $60 - 75 m. in 1966.

(ii) Only 85 per cent of that was on building, the rest being on roads and similar public works.

(iii) The proportions of the value of output accounted for by insulated wire and cables is roughly 1 per cent.

(iv) The average value of wire and cable is about $2,500 per ton of copper content. On this basis the total demand for wire and cable in construction is between 200 and 260 tons.

Other copper and brass products are also used in considerable quantities in construction because they are manufactured locally by Latreca. This is particularly true in Katanga where copper is used as a matter of pride for a variety of decorative and functional fittings. The bulk of Latreca's output of extruded shapes (e.g. window frames) and much of the tubing are used in the construction industry.

4.4 The Mining Industry

The copper mining industry in the Congo is discussed in its role as a producer of copper in Section 5 of this annex. It is also important as a major consumer of copper products, particularly insulated conductors, which are needed in large quantities to bring power and light to the mines and other installations. Other sectors of the mining industry, such as tin and manganese mining, similarly use copper products.

The principal mining companies and the products they produce are:

(i) Gecomin producing copper, cobalt, zinc, cadmium and germanium

(ii) Symetain " tin

(iii)	Géomines	producing	tin
(iv)	Cobelmines	"	tin and wolframites
(v)	Kivumines	"	tin
(vi)	MGL	"	tin, gold and wolframites
(vii)	MIBA	"	diamonds
(viii)	Forminière	"	diamonds
	EKL	"	diamonds
(ix)	Kilomoto	"	gold

The output of each mineral is shown in Table C.XXII.

Table C.XXII - Output of Congolese Mining Industry 1966

	Production tons	Value ($000)	%of value of total production
Copper	316,000	375,606	72.34
Cobalt	11,300	40,217	7.75
Zinc	114,850	33,306	6.41
Cadmium	411	1,849	0.35
Germanium	15	220	.04
Gold	4,970kgs	5,666	1.10
Tin	7,150	25,704	4.95
Diamond (Kasai)	11,480ct	61	.01
(Lubilash)	12,417,600ct	27,815	5.36
Manganese (mineral)	248,940	8,200	1.60
Wolframite	227	284	.05
Colombo-tantalite	96	202	.04
		519,130	100.00

Gecomin is the only company for which detailed figures of purchases of wire and cable have been obtained. These are reproduced in Table C.XXIII. The table covers only imported conductors which includes all its requirements for insulated wire and cable. Bare conductors are purchased from Latreca but detailed figures are not available though it is known that Gecomin purchases nearly half Latreca's output. In particular, large quantities of copper sheet are used as cathode starter plates.

Table C.XXIII - Gecomin: Purchases of Imported Conductors

	Quantity	Value ($)
Winding wire – silk covered without enamel	575 Kg	1,561
" " – insulated with polyvinyl enamel	6,539 K	13,264
Bare wire and trolley wire – 107mm	93,214 K	64,917
Bare cable – electrolytic to NBN 313	45,828 K	13,855
Drilling cable – Type CTSB – 250 volts	5,679 K	8,132
Flexible cable CSOB – Type Cordeliere	14,065 M	1,812
cable CMTB – rubber sheath 500 v	36,502 M	9,050
" CTEB – thick rubber sheath 1,000 v	24,583 M	28,014
" CGVB – supple, plastic sheath 1,000 v	2,300 M	343
" CTB – " thick rubber, 1,000 v	7,914 M	43,816
Armoured, PVC insulated cables – steel wire or tape for underground use 100 v	30,710 M	70,504
Armoured, paper " " for 10,000 v to 15,000 v no longer to be used	7,603 M	38,347
Cables VTLMB and Vinyflex – side by side, 250 v	55,944 M	4,515
Cable VOB – supple 1,000 v	65,850 M	3,413
" VFVB – PVC and armoured 1,000 v	107,629 M	51,874
" CRVB – Rubber insulated, PVC sheath 1,000 v	90,859 M	58,924
Signal cable – Rubber insulated, unarmoured with neoprene sheath	5,359 M	7,277
Telephone cable – PVC insulated, both armoured and unarmoured	67,578 M	24,329

Consumption of cable is expected to grow by 20 per cent next year and by a further 50 per cent the year after because of major investment projects. The projects immediately in view are related to the entry into production of the mine at Kamoto, the construction of additional refining capacity and the increase in hydro-electric plant.

In subsequent years demand for cables would rise more in line with the growth of output i.e. 5 per cent per annum.

4.5 Railways

The Congolese railway system is controlled by four firms:

(i) OTRACO which operates the line from Matadi to Kinshasa (the country's main route to the coast) and also controls most of the river system. There is also a line from Boma to Tshele. Total rail length is 506 kms.

(ii) BCK which operates the railway network in South Katanga linking the mines to the river system, and to rail routes to the sea through Angola and Zambia. The network has a total length of 4,880 kms.

(iii) Vicicongo which operates an isolated but extensive system in the North East of the Congo linking with the Itimbiri river (a tributory of the Congo) at Aketi. The network is 836 kms long.

(iv) CFL which operates the isolated line between Ponthierville and Kisangani cutting off the rapids on the river at that point. The length is 125 kms.

The railways are significant users of copper products since they require:

(i) brass, bronze and copper spare parts for locomotives and rolling stock. This is particularly true of steam locomotives which need large quantities of brass castings.

(ii) trolley wire for overhead electrification. This requires regular, though not frequent, renewal because of the wear it receives. The supporting cable carrying the current to the trolley wire is usually bare cadmium copper cable.

(iii) insulated cables are required for signals, telephones and power supplies associated with the railway system.

Information on their consumption of these products has been obtained from OTRACO and BCK.

Table C.XXIV - BCK: Purchases of Copper Products 1967

Insulated Wire and Cable	Quantity	
Low tension (750V) power cables	10,400	metres
Signal and telephone cable	65,000	"
Wire and cable insulated with rubber	22,600	"
Flexible cables - CTFB - CTMB	16,500	"
Insulated conductors CRVB	66,000	"
Special wires and cables	15,000	"
Other Copper and Alloy Products		
Bare conductors	13	tons
Trolley wire and supporting catenary cable	140	"
Sheet, tubes and rods of copper or brass	17	"
Tubes, jets and bushes in bronze	100	"

Total copper and alloy content was approximately 311 tons. Over half of this (about 164 tons) was due to the electrification programme for which most of the trolley wire, catenary cable and signal and telephone cable were required. When the first electrification programme is complete the demand will be substantially lower. However, should further sections of line be electrified such additional demands will recur. Demand for castings in bronze and for alloy semis is likely to decline as diesel-electric locomotives replace the old steam locomotives. The latter have a far greater number of copper and alloy parts needing frequent replacement than do diesels.

OTRACO uses far less copper and alloy products than does BCK. Their requirements in 1967 are shown in Table C.XXV.

Table C.XXV - OTRACO: Consumption of Principal Copper and Alloy Products 1967

Copper tubes	590kgs
Copper wire	3,628kgs
Copper rods and bars	30kgs
Copper sheet	72kgs
Insulated copper cables (including weight of insulant)	98,025kgs

5. Copper Mining in the Congo

5.1 Organisation and History

Copper was mined, smelted and worked in the Congo many centuries before the arrival of the European. In 1906, however, the Union Minière du Haut Katanga was created by the Société Générale de Belgique, Tanganyika Concessions Ltd. and the Comité Special du Katanga, and was entrusted with the exploitation of a vast concession for mining copper, associated metals and tin. The first smelter was commissioned in 1911 at Lubumbashi and production was nearly 1,000 metric tons that year. As production grew the UMHK gave birth to a number of subsidiary companies to supply its raw materials and energy, to engage in construction, and to exploit associated minerals such as zinc.

After the Congo obtained its independence in 1960 the UMHK continued to operate as a private company until it was nationalised on 1st January 1967 and called La Générale Congolaise des Minérais (Gecomin) and put under Congolese control. Subsequently, on 15th February 1967 a management agreement was reached with the Société Générale des Minérais des Belgique (SGM) under which the latter is responsible for production, marketing, procurement and personnel recruitment.

Until recently the UMHK/Gecomin was the only firm engaged in the extraction of copper in the Congo. However, the Nippon Mining Company has been given exploration rights in concessions adjacent to that of Gecomin (an area of 36,000 sq.km. in two concessions). Prospecting has already been carried out and mining is likely to begin at the Muroshi Mine in 1972/3 subject to ratification of an exploitation agreement with the Congolese authorities. Initial output is expected to be 42,000 tons of concentrate per annum (36.7 per cent copper) to be refined in Japan or in the Lubumbashi smelter which has some spare capacity. It is understood that a five year investment plan of U.S. $40 million has been programmed. Nippon Mining have an agreement with the Congolese government that if output exceeds 60,000 tons per annum of copper content the copper will be refined in the Congo.

5.2 Production

Copper Production in the Congo 1911-1967 and Projected to 1980

(tons of metal)

1911	598	1921	30,464	1931	120,186	1941	162,167	1951	191,959	1961	293,509
1912	2,492	1922	43,362	1932	54,064	1942	165,940	1952	205,749	1962	295,236
1913	7,407	1923	57,886	1933	66,596	1943	156,850	1953	214,116	1963	269,924
1914	10,722	1924	85,570	1934	110,085	1944	165,484	1954	223,791	1964	275,547
1915	14,042	1925	90,104	1935	107,682	1945	160,211	1955	234,673	1965	287,568
1916	22,167	1926	80,639	1936	95,667	1946	143,885	1956	247,452	1966	315,664
1917	27,462	1927	89,156	1937	150,588	1947	150,840	1957	240,280	1967	318,976
1918	20,238	1928	112,456	1938	123,943	1948	155,515	1958	235,586	1970	369,200
1919	23,019	1929	136,994	1939	122,649	1949	141,399	1959	280,403	1975	531,000
1920	18,962	1930	138,949	1940	148,804	1950	175,920	1960	300,675	1980	690,000

Copper production has risen steadily since the war at a compound rate of 4 per cent a year between 1946 and 1967. Production was disrupted during the post independence troubles but is again growing rapidly. Gecomin plans to expand output at 5 per cent per annum to attain 600, 000 tons p.a. by 1980. In addition Nippon Mining will be producing 15, 000 tons of copper or the equivalent amount of concentrate by 1972 and some 90, 000 tons by 1980 (at a conservative estimate).

The company produces both electrolytic and blister copper. Output of the various types of copper was (in 1967):

Electrolytic copper (Likasi)	160, 822 tons
Cathode copper (Kolwezi)	81, 448 ..
Unrefined (Blister) Copper (Lubumbashi)	76, 706 ..
	318, 976 ..

The blister copper is largely exported to Belgium for further refining. This last stage of refining involves the elimination of the few remaining impurities and so produces negligible loss of weight. There would, therefore, be insignificant saving in transport costs if all the refining were carried out in Katanga. In any case, Gecomin have no plans to carry it out there. This is mainly because the pattern of demand for different degrees of purity is continually changing and they would be too far from the consumer industries to programme their refining to the prevailing pattern of demand. It would also involve the duplication of refinery capacity already available in Europe. For the same reasons the company only recasts electrolytic copper into wire-bar which is the main form required by the world market. Much of the cathode is recast again in Europe to meet the requirements for billets, ingots etc.

ANNEX D

ZAMBIA

COUNTRY REPORT

1. Introduction

The Zambian economy has shown a remarkable rate of growth since Independence in 1964 notwithstanding the difficulties and deprivations arising from the Rhodesian Unilateral Declaration of Independence (UDI) in November 1965 and the consequent sanctions policy against Rhodesia. As the 1967 Bank of Zambia Report states "Before UDI, Zambia had close trade and economic ties with Rhodesia and its principal outlet to the sea ports was through Rhodesia. Since then considerable progress has been made towards disengagement from the Rhodesian economy by development of alternative trade routes and sources of supply. Admittedly, this process of disengagement has been costly, in that it has necessitated not only the expenditure of sizeable resources on contingency measures but also, to an extent, a re-ordering of priorities implicit in the First National Development Plan covering the four year period, 1966-1970." The breakdown of GDP at factor cost (current prices) in 1966 is shown in table D.I.

Table D.I. - GDP in Zambia by sector at factor cost, 1966.

	$m.	%
Agriculture, forestry and fishing	84.7	9.4
Mining and quarrying	336.1	37.3
Manufacturing	84.3	9.4
Construction	75.6	8.3
Electricity and water	10.4	1.1
Trade	109.6	12.1
Financial institutions	16.0	1.8
Real estate	21.3	2.4
Transport and communications	45.4	5.0
Government	50.0	5.5
Community and business services	48.4	5.4
Personal services	20.4	2.3
Total GDP (at Factor Cost)	902.3	100.0

It will be seen that mining is the mainstay of the economy. On average copper accounts for 95 per cent of mineral production in terms of value. The copper industry is discussed in detail in section 5. below. Other minerals of any importance are lead, zinc, cobalt, manganese and coal. During recent years the contribution of mining to GDP has fallen slightly, and, at the same time, there has been an increase in the importance of the manufacturing and construction sectors. At current prices the manufacturing sector has increased from $39.5 million in 1964 to $84.3 million in 1966, and construction by $28.0 million to $75.6 million over the same period. The Government, through the Industrial Development Corporation of Zambia (INDECO), has played a vital role in encouraging industrial expansion in the economy. The full range of INDECO projects is substantial, especially since February when INDECO was invited to purchase 51 per cent of the equity capital of several firms. Apart from these interests, INDECO has been

involved in the following ventures; cement, clay, sugar, textiles, nitrogen fertilizers, iron and steel, grain bags, copper fabrication, explosives, glass bottles, tyres etc. For the future it can be anticipated that industrial diversification will continue and that manufacturing facilities will be built up to serve the mining industry and, as a result, Zambia's current dependence on outside supplies will be reduced. Despite the relative importance of the mining industry and the growth in the manufacturing sector, 75 per cent of the population (3.9 million at 31st December, 1966) are dependent on agriculture. Total agricultural production accounts for barely 11 per cent of GDP and, of this, only one-third is marketed. Furthermore, production is mainly for domestic consumption, exports of tobacco, groundnuts and maize only accounting for about 3 per cent of total export earnings.

The general picture which emerges from this brief summary of the Zambian economy is that the country has been able to sustain a fast rate of growth despite the interruptions caused by UDI which resulted in the diversion of a sizeable part of investment to building-up mainly infrastructural facilities. A second characteristic of Zambia's economic growth is that it has been by and large self-generated in the sense that dependence on external finance has been negligible. However, if the current trend of higher imports and sluggish export earnings persists, the situation will change. Zambia has had a sizeable balance of payments surplus in recent years and this has to an extent been due to copper. Ultimately the prosperity of the Zambian economy is dependent upon the future price of copper.

2. Domestic Copper Fabrication

2.1 At present no fabrication of non-ferrous metals is carried out in Zambia. However, the possibilities of establishing copper fabrication facilities have been under discussion for some time and two plants will soon be in operation - a wire and cable mill coupled with an extrusion press, and a small wire drawing and coating plant for winding wires and heavy section copper used in transformers.

2.2 Wire and Cable Mill and Extrusion Press

Metal Fabricators of Zambia Ltd. (ZAMEFA) was formed in 1968 to produce copper and aluminium wire and cables and extruded products. The company was formed with the Government of Zambia through INDECO holding 51 per cent of the equity capital and with the following partners: Phelps Dodge - Svenska Metallwerken International Corporation (PDSMI), Zambia Anglo American Corporation Ltd., Roan Selection Trust Ltd., and Continental Ore Corporation. The plant will produce 3,000 tons of copper and 900 tons of aluminium wire and cable and is likely to start production in 1970. The total machinery costs of about $1.96 million include an extrusion press. The plant is designed to produce building wire, power cables, telephone cables and bare conductors.

2.3 Winding Wires

South Wales Electric Company of Kitwe are engaged in the rewinding and manufacture of transformers. In this connection it is understood that the company are currently contemplating the introduction of a small rolling and coating facility to fabricate wire and heavy section copper, for their own use in the first instance. It is probable that the machinery will be able to produce 230 kgs. per day (45 tons per annum - 200 days). Their current requirements are arount 23-27 tons per annum of copper. Despite the fact that this company are experiencing a substantial increase in their annual requirements, it would seem probable that there will be a balance of wire for sale to other users, either in or outside Zambia at least at first.

2.4 In addition to the above proposed plants, consideration has been given to the possibilities of the two mining groups establishing a continuous casting plant to produce

Table D.II - Imports of Copper Fabricated Products into Zambia 1964-1967 (Imports F.O.B)

		1964		1965		1966		1967	
		Tons	Value $'000	Tons	Value $'000	Tons	Value $'000	Tons	Value $'000
68271	Copper tubes	43	47	61	78	39	59	62	99
68260	Copper sheet plain or perforated	39	43	99	80	178	276	78	124
68250	Copper bar and rod	159	201	177	151	32	61	31	50
68221	Brass and bronze bar and rod	–	–	13	17	37	56	38	44
68231	Brass and bronze pipes and tubes	–	–	2	4	2	2	3	6
68240	Brass and bronze sheet	–	–	8	9	5	7	10	12
68219	Brass, bronze and phosphorous copper ingots	40	27	37	13	11	14	–	5
68222	Phosphorous bar, rods, blocks, tubing	–	–	27	32	36	50	14	20
68299	Copper and copper alloys n.e.s.	108	71	7	16	42	53	6	7
68272	Copper pipe fittings	–	–	14	32	16	34	18	41
68232	Brass and bronze pipe fittings	87	167	114	240	110	303	113	301
68283	Wire, brass	–	–	–	1	–	–	1	1
69312	Electric cable and wire, uninsulated*	547	453	457	604	1208	1176	482	410
69996	Copper manufactures n.e.s.	–	–	–	–	–	–	–	8
	TOTAL:	1023	1009	1016	1277	1716	2091	856	1128
72310	Electric cable and wire, insulated*	1075	766	5543	4286	5117	5501	5367	4962
72311	Wire and cable, copper insulated* with polythylene and polyvinyl chloride	1058	1022						
	TOTAL INSULATED WIRE AND CABLE:	2133	1788	5543	4286	5117	5501	5367	4962

Source: Annual Statements of External Trade, 1964 to 1967 (Central Statistical Office, Lusaka)

* Includes some aluminium conductors

oxygen free high conductivity copper. Due to technical problems in connection with the quality of the wire rod produced by this process, the project is unlikely to proceed until these difficulties have been overcome. It is anticipated, however, that the Government will pursue a project to produce rod for export in Zambia and in all probability a rolling mill will be established.

3. Demand for Copper Products

At present all Zambia's requirements of copper products are imported. However, the import statistics shown in table D.II provide only an approximate indication of the size of the demand since aluminium conductors are included in both SITC 72310 (insulated conductors) and 69312 (bare conductors). It is known, however, from our market study that about 95 to 98% of all insulated conductors used in recent years are of copper.

The market for insulated wire and cable reached its peak in 1965 and in the following year there was a drop, probably due to the transport difficulties which followed from UDI. Imports of uninsulated conductors were at a peak in 1966. It is known that there was a considerable requirement for aluminium conductors for the construction of the second Kariba-Kitwe 330 KV transmission line which was commissioned in October, 1966. The Zambian market for other semi-manufactured and manufactured copper and copper alloy products is small by comparison with the requirements for wire and cable. The market for pipe fittings remained reasonably static from 1965 to 1967. With the possible exception of semi- manufactured and manufactured products the import statistics provide an unsatisfactory basis for analysis since it is not possible to obtain a more detailed breakdown than that shown in Table D.II. Zambia's principal sources of wire and cable imports during the period under consideration were the U.K., Rhodesia and South Africa. Together these three countries met at least 85 per cent of Zambia's demand for such products. However, Rhodesia's share of the market in fact fell quite substantially from 47% in 1966 to 34% in 1967 for insulated wire and cable and from 46% in 1966 to 22% in 1967 in the case of bare conductors. The pattern in 1968 and future years will, however, be significantly different. As from the middle of 1968 all imports of wire and cable must enter Zambia through the port of Dar-es-Salaam in Tanzania and this therefore precludes imports of South African and Rhodesian products.

4. The Principal Industrial Sectors

The main end-users of copper and copper alloy products are the two mining companies, the electricity authorities, the municipalities, the Post Office, the construction industry and Zambia Railways. In nearly all cases detailed schedules were provided giving details of the users' consumption patterns. In cases where such information was not available, estimates have been made, and where this was necessary an indication is given in the analysis which follows.

4.1 The Mining Industry

The recorded consumption of wire and cable by the two mining companies is given in Table D.III. It is estimated that the copper content of wire and cable consumed by the Anglo-American group amounted to 106 tons in 1967 which represented a slight drop from the 1966 consumption. The decrease resulted from the fall in copper production in that year (1967). The estimated annual requirement of wire and cable by the Roan Selection Trust Group (RST) amounts to 286 tons. A direct comparison between RST's and Anglo-American's consumption pattern of cables is made difficult by the differences in the two kinds of purchasing practices currently in use. The Anglo-American figure represents what might be called recurrent consumption and therefore excludes all wire and cable used in development/capital projects. In any particular year, this latter amount can vary considerably. No recorded figures of the amount used are available, however, since

nearly all this type of work is undertaken by contractors who supply their own wire and cable requirements. The RST Group, on the other hand, supply over 95 per cent of the wire and cable needed for construction projects direct to the contractors who are employed on development work. Since Anglo-American accounts for 54 per cent of the Zambian copper production, total Anglo-American requirements have been estimated at 363 tons per annum.

Table D.III - Reported Mining Companies' Consumption of Wire and Cable

	ANGLO AMERICAN Quantity (tons)			Value ($)		R.S.T. Quantity (tons) Average for	TOTAL Quantity
	1966	1967	1968 (est)	1967	1968 (est)	1965, 66, 67	1967
PVC INSULATED	52·1	67·5	80·5	308,498	354,441	179·4	246·9
a. Single Core	7·7	7·2	9·1	19,426	25,460	25·2	32·4
b. Flat Twin	0·5	0·5	1·0	4,934	7,549	8·3	8·8
c. Multicore	1·9	2·9	2·6	19,841	16,887	3·7	6·6
d. Blasting wires	3·3	3·1	2·0	26,684	6,983	4·5	7·6
e. Bell wire (incls. telephone)	4·3	1·7	2·1	19,583	22,180	8·4	10·1
f. Armoured Cables	34·4	52·1	63·7	218,030	275,382	129·3	181·4
MINERAL INSULATED	...	...	0·05	73	650	2·8	2·8
WINDING WIRE	3·6	4·0	3·4	8,196	6,224	10·1	14·1
PAPER INSULATED	5·7	1·5	1·0	5,564	3,282	50·9	52·4
a. Armoured Cable	5·7	1·5	1·0	5,564	3,282	50·9	52·4
b. Single Core	–	–	–	–	–	–	–
RUBBER INSULATED	5·7	5·9	5·3	30,829	30,761	*	5·9
a. Armoured Cable	0·1	–	–	11	17		
b. Single Core	3·3	4·1	4·5	18,553	23,946		
c. Multicore	2·2	1·8	0·8	12,265	6,700		
CAMBRIC INSULATED	0·6	0·4	0·3	2,756	2,206	*	0·4
BARE COPPER WIRE	42·6	26·9	40·6	55,125	75,594	42·3	69·2
a. Stranded solid	31·4	18·2	29·0	42,595	61,180	5·6	23·8
b. Trolley wire	11·2	8·7	11·6	12,530	14,414	36·7	45·4
TOTAL:	110·3	106·2	131·1	411,041	473,158	285·5	391·7

* No separate breakdown given for rubber and cambric insulated cables by R.S.T.

The annual requirements of the mining industry for wire and cable are therefore as follows:-

	Aluminium Conductors	Copper Conductors (Metal content - tons)
Anglo-American	none	363
Reported consumption	"	106
Other requirements (estimated)	"	257
RST Group		300
Reported consumption	none	286
Other requirements (estimated)	"	14
	Total:	663

The total recorded purchases by RST amounted to $805, 140 in 1965 and $814, 996 in 1966. The origin of these wire and cable imports was:

	1965	1966
	$	$
Rhodesia	554, 400	736, 204
South Africa	130, 620	1, 400
United Kingdom	115, 920	76, 916
Other sources	4, 200	476
	805, 140	814, 996

These figures show the predominance of Rhodesia in meeting RST's requirements before UDI. The Rhodesian Cables plant in Salisbury, Rhodesia, produces a full range of PVC cables and bare conductors. In other words, virtually all the PVC insulated housewire range, power cables and bare conductors were fabricated in the Salisbury cable mill. The other insulated conductors, (paper, rubber, mineral etc.) were imported from the U.K. or South Africa. This dominance of Rhodesia changed dramatically in 1967 and 1968.

The value of Anglo-American (direct purchases) amounted to $411, 044 in 1967, this implies a cost of $3, 880 per ton of copper used in wire and cable. The total cost of wire and cable purchases for the mining industry must be of the order of $2, 500, 000 per annum.

It will be seen that the mining companies consumed no aluminium wire and cable. This is because the bulk of their requirement is for underground flexible cables and for this function copper is still preferred as it is less bulky, hangs better, and requires less insulation. For overhead lines copper is used because it is less susceptible to corrosion than aluminium. Furthermore, the mining companies' labour forces are trained in the handling of copper cables and they will probably continue to use it until the cost saving factor of using aluminium becomes crucial.

The two mining groups consume different proportions of PVC, mineral, paper, rubber and cambric insulated cables. Although the RST schedule does not include rubber insulated products, it is known that they do use a little, though rubber is slowly being replaced by PVC. Virtually all the paper insulated cable is both lead covered and armoured When the local wire and cable mill being established in Zambia is in production, most of the industry's PVC insulated cable and conductors will be produced in the Copperbelt. It is likely that there will then be a growth in the mining industry's consumption of PVC at the expense of rubber, cambric and paper insulated cables.

In comparison with wire and cable consumption the mining industry's requirement for copper semi-manufactures is very small indeed. Table D.IV gives details of Anglo-American's consumption.

Table D.IV - Anglo-American Consumption Of Semi-Manufactured Products

	1967 tons	1968 tons	1967 $	1968 (est.) $
Copper				
Flat strip	0.4	0.4	644	658
Round bar	0.2	0.2	512	423
Sheets (electrolytic)	0.5	0.3	944	616
Piping	1.0	0.9	4,859	4,498
	2.1	1.8	6,959	6,195
Brass				
Rod	-	-	1	-
Plates	0.2	0.2	185	162
Round rod	0.6	0.8	725	806
	0.8	1.0	911	968
TOTAL:	2.9	2.8	7,870	7,163

A small amount of aluminium semi-manufactures is used. However, the requirement of aluminium cathode sheets is significant.

The future growth of the mining industry is difficult to predict, and so the future level of its demand for wire, cable and semi-manufactures cannot be given with accuracy. However, it would seem that the growth rate should be around 4 - 5 per cent per annum. Details of the known development projects are given in section 5 of this annex.

4.2 Electricity Authorities and Municipalities

The generation, transmission and distribution of electricity is at present the responsibility of about fifteen different undertakings. The whole system is currently under review and it is anticipated that there will be a radical reorganization. Zambia is now working towards a fully inter-connected system. At present, the two 330KV circuits from Kariba to Kitwe are connected with the 220 KV transmission line from Likasi in the Katanga Province of Congo (Kinshasa) and a new 220 KV line from Livingstone will join up with this main grid at Leopards Hill (near Lusaka).

The Central African Power Corporation (CAPC) was established at the end of 1963 to take over from the Federal Power Board the ownership, operation and development of the Kariba Scheme jointly for Rhodesia and Zambia. CAPC is therefore responsible for the 705MW hydro-electric scheme at Kariba, together with the two transmission lines, the sub-stations, including the two at Leopards Hill and Kitwe, and the switching station at Kabwe. CAPC sells bulk electricity to the Central Electricity Corporation (CEC) and to the Copperbelt Power Corporation. The most recent CAPC development is the commissioning of the second 330KV transmission line in October 1966. This 431 km. line used 2,650 km. of "Bison" (54/7/.118") steel core aluminium wire with an estimated aluminium content of about 2,700 tons. Despite minor development and repair work on the existing system its annual requirements of wire and cable are negligible. For the future it is likely that a further 330KV transmission line will be constructed in the early 1970's. However, no details will be known until after a decision has been made on the Kariba North Bank development. Recent press statements indicate that the CAPC electrical consultants have been requested to update their original 1965 report on the North Bank development. If such

a line were to be built, aluminium conductors would be used for this extra high voltage line in accordance with current engineering practice.

Central Electricity Corporation (CEC) is a company owned by Government and run on a commercial basis. It is basically only responsible for transmission and distribution. However, it does operate a small thermal station which at present has a low output level to provide essential supplies under emergency conditions. CEC's licensed area is being expanded considerably and is likely to cover the Southern Province from Lusaka to Kabwe, and part of Barotse Province. At present CEC has two 88KV lines from the Leopards Hill Road sub-station (take off points for CAPC power) to Lusaka. In addition it operates an extensive 33KV, 11 KV and low voltage overhead and underground system. In 1966/67 the extensions to the Corporation's distribution system included 360 km of high and low voltage overhead line, 46 km of underground cable and 144 sub-stations at a total cost of $1,195,910. The projects on which work has already been started are:

(a) an extension of the grid by the construction of a one circuit 88KV line with a maximum load of 15MW from Leopards Hill (Lusaka) to Kabwe. This 144 km line was expected to be completed by the end of 1968;

(b) the Livingstone-Kafue single circuit 330KV line (to be operated at 220KV) linking the Victoria Falls Generating Station with the Corporation's system at Kafue is under construction and is likely to be completed early in 1969. This scheme includes an 88KV line to the Mwaambwa and Nkandabwe coalfields of the Gwembe Valley, and

(c) an 88KV line (to be operated at 33KV) might be constructed from Kafue to King Edward Mine with a further extension to Mumbwa. This project is still the subject of studies.

The expansion of the CEC has been considerable. In 1965/66 the number of units sold was 123.75 million KWH, which was a 19 per cent increase on the previous year, and a further advance of 6 per cent was recorded in 1966/67. This increase was largely due to industrial expansion in and around the Lusaka area. The CEC Annual Report for 1966/67 states that "Industry and the increasing urban population will create substantial demands for electricity and there is much truth in the contention that the rate of development of a nation can be assessed by the growth rate of electricity." The Report continues by saying that "it is estimated that the demand in the Corporation's supply area will double within the next three years and certainly the most spectacular growth will occur at Kafue where an industrial complex is in the making. The Corporation's system will require substantial reinforcement and expansion but as the loadings which are now materialising have been envisaged for some time, the basic system will prove adequate to meet the situation." In 1965/66 the estimated metal content of wire and cable used by CEC was 204 tons which was 53.5 per cent higher than in the previous year. In 1966/67 the Corporation's consumption was estimated to be 109 tons. The CEC demand far surpasses the consumption of all the other electricity authorities, and over 50 per cent in terms of copper metal content of their requirements was met by paper insulated, lead covered cable. There is now, however, a tendency to use more and more PVC cable. As with most other electricity authorities, CEC has a preference for aluminium conductors for overhead lines. At present aluminium conductors cost some 70 per cent of their equivalent in copper; also there are reduced chances of theft and aluminium is lighter to handle so there is a reduction in erection costs. Most of their aluminium conductors are presently supplied by Japanese manufacturers, whilst copper cable is imported from the U.K. or South Africa. In the field of underground cables and housewires, CEC currently use copper but there is a move towards the use of aluminium although on a very conservative basis at present. The main problem seems to be that contractors installing cables are not sufficiently accustomed to the techniques required for handling aluminium.

The financing of the CEC programmes is done by internal or external borrowing.

Copperbelt Power Company (CPC) is a wholly owned subsidiary of the two mining groups and was established to meet the mining industry's electrical requirements. CPC both generates and buys electricity in bulk from the CAPC. This is sold in turn to the mining companies, the Northern Electricity Supply Commission (NESCO) and to the seven municipalities on the Copperbelt. The whole system is complex and is centred around the Central Switching Station in Kitwe into which is fed the two 330KV CAPC transmission lines and the one 220KV line from Jadotville in Congo (Kinshasa). The latter line passes through a switching station at Luano from which 66KV lines are taken. A second 220KV line from Kitwe to Luano was recently commissioned. The whole 66KV and 11KV network revolves around these two centres. In addition to the power purchased from CAPC and the Congo, there is one direct coal-fired generator at Nchanga (built in 1948 with a 90MW installed capacity) and three generators operated on waste heat from the smelters - at Luanshya, Nkana and Mufulira. The power output of these latter generators fluctuates with the utilization of the smelters. The following table shows the maximum demands and generation of the Copperbelt electrical power system.

Table D.V - Electricity Supply in Zambia

	1962	1963	1964	1965	1966	1967
System - max demand (MW)	279	287	303	334	349	364
Annual increase (%)	7.3	2.9	5.4	10.2	4.5	4.3
KWh generated on Copperbelt (mn)	333	431	399	375	333	342
KWh imported from Congo (mn)	470	280	201	264	315	9
KWh imported from Kariba (mn)	1,167	1,410	1,670	1,832	1,873	2,369
System's gross generation (KWh) (mn)	1,970	2,121	2,270	2,471	2,521	2,720
Annual increase (%)	5.8	7.7	7.2	8.9	2.0	7.3
KWh sent out	1,947	2,087	2,239	2,442	2,492	2,692
Annual increase (%)	6.0	7.2	7.3	8.8	2.1	7.5

It will be seen that since 1962 there has been a steady increase in electricity consumption. Imports of electricity from Congo almost stopped in 1967 and the Le Marinel Agreement is currently under discussion.

To meet the electricity needs of the Copperbelt the following schemes are planned:-

(a) a 220KV line (with the possibility of a second line in the future) from Kitwe to Mariosa which will eventually replace the current 66KV lines,

(b) a 220KV line (with the possibility of a second line) from Kitwe to Mufulira is projected for sometime in the future, and

(c) two 20MW gas turbines at Luano for emergency generation have already been ordered.

The whole CPC systems utilised copper conductors until two or three years ago. There is now a tendency to use aluminium and its use is planned for the new 220KV transmission lines mentioned above. There is also a tendency to use aluminium for the 66KV lines, except in and around the mining areas where aluminium is affected by the corrosive sulphur fumes.

Despite this, since CPC is owned by the two mining groups there is a bias towards the use of copper conductors. In 1966 the CPC used 30.5 tons of copper about two-thirds of which was bare copper conductors.

Northern Electricity Supply Commission (NESCO) is basically responsible for the rural electrification programme of the Government. As such it is involved in sub-economic schemes with Government finance. Besides its small generating plants NESCO purchases electricity in bulk from CAPC. Details of its operations for 1966/67 are as follows: -

	Installed Capacity	Units sold
	KW	KWh
Mbala	750	1,751,801
Mansa	2,000	2,293,359
Chipata	930	2,034,490
Kasama	900	2,646,247
Mongu	300	771,471
Solwezi	150	-
W. Province Bulk Supplies	10,550	7,686,922
Mpika	-	-

NESCO is involved in three schemes at present:

(a) one at Musiwasi, which has a 6MW hydro generating plant (to be increased to 12MW as the load grows). From Musiwasi, there is a 66KV line to Chipata and back to Petauke. There is a proposed line from Musiwasi to Serenji and to Mkushi which was thought likely to be commissioned in 1968,

(b) at Kasama there is a mixed hydro/diesel plant with an installed capacity of 4.8MW (it can be increased to 6MW). A line from Kasama to Mbala (66KV) is likely to be commissioned in 1969/70, and

(c) the construction of a 2MW plant at Msomba Falls which could be increased by 1MW in the future.

NESCO uses steel core aluminium for all their overhead transmission lines. PVC insulated copper is used for underground circuits but as underground installations are so expensive, overhead lines are used where possible. In 1966 only 9 tons of copper cable were used as compared to 650 tons of aluminium in overhead conductors.

The long term development is difficult to forecast. To a large extent many of the rural electrification schemes have either been completed or are currently under construction. In terms of electricity consumption, NESCO has in recent years experienced substantial growth about 30 per cent in 1964/65 and 18.5 per cent in 1965/66.

Victoria Falls Electricity Board (VFEB) generates its own electricity and sells in bulk to the Livingstone Municipalities and directly to consumers in the Southern Province. It owns and operates a 33KV line to Choma and Kalomo. The installed capacity of the hydro station at present is 8MW. Two additional gorges are currently being harnessed and an additional capacity of 60MW will be provided early in 1969. A further 40MW could be made available in the future. In addition to these developments the 220KV transmission line mentioned in the section on the CEC will link the generating capacity of the VFEB to the Kariba/Kitwe grid. It is anticipated that the role of the VFEB will be confined to generating electricity so its requirement for wire and cable in the future will not be significant. Units generated increased by 17.5 per cent in 1966.

Kafue Hydro-electric Scheme is at present being administered directly by the Government. This $104m. scheme will have a 200/220 MW installed capacity by 1971.

The eventual capacity is reported to be 500MW. The project is being built and financed by Energoprojekt of Yugoslavia who will determine the source of supplies for equipment.

Copperbelt Municipalities (Kitwe, Ndola, Mufulira, Chingola, Kalulushi, Luanshya and Chililabanbwe) all purchase their electricity in bulk from the CPC and distribute directly to the consumer. The requirements of these local authorities vary considerably - see Table D. VIII. A large part of their total wire and cable requirement was accounted for by paper insulated cables.

Kabwe is supplied with its electricity from the Anglo-American lead and zinc mine (Broken Hill Development Corporation). The mine has an installed capacity of 39MW, of which only approximately 3MW is available to the town. However, with the completion of the 88KV line from Leopards Hill (near Lusaka) to Kabwe, the town will now be supplied directly by the CEC and the maximum load available will be 15MW. A large portion of this amount has already been allocated to the various projects earmarked for Kabwe - the new railway workshop, the glass bottle factory, etc.

Livingstone Municipality is supplied by the VFEB. Consumption of wire and cable fell from 1965 to 1966 and, although a large part of its requirement was for paper insulated cable, there has been a significant switch to PVC insulated. It is felt that the annual consumption of wire and cable by Livingstone will remain fairly static over the next five years or so.

Summary

The forecasts of demand and consumption for electricity in Zambia, drawn up by CAPC, are given below:

Table D. VI - Electricity Consumption and Maximum Demand Forecast

	1969		1970		1971		1972		1973	
	MW	KWh x 10^6	MW	KWh x 10^6	MW	KWh x 10^6	MW	KWh x 10^6	MW	KWh 10^6
CPC	408	3,041	429	3,193	450	3,358	472	3,521	487	3,697
CEC*	73	355	84	410	91	440	96	460	106	500
Livingstone + VFEB	10	40	11	43	13	51	14	55	15	59
TOTAL	491		524		554		582		608	

* includes Kabwe and Siankandobo

The consumption of wire and cable by all the electricity authorities and municipalities discussed above is summarised in Tables D. VII and D. VIII below. It would appear that PVC and paper insulated cables are of about equal importance. Rubber and other insulated cables can virtually be ignored as indications suggest that there is a tendency to move from rubber to PVC insulated wire. In 1967 total consumption of wire and cable amounted to 282 tons (metal content).

Table D. VII - Electricity Authorities' Annual Consumption Of Wire/Cable - tons

	CAPC 1965 and 1966	1964/65	CEC 1965/66	1966/67	NESCO 1965/66	1965	CPC 1966	1967
PVC Insulated	18·1	20·9	88·1	42·8	9·2	2·5	7·6	5·7
Telephone	0·4	–	–	–	–	0·05	0·2	0·3
Misc. cables (PVC)	......	0·8	1·5	3·7	–	......	......	0·05
Rubber Insulated	–	–	–	–	–	2·5	2·1	0·9
Paper Insulated	–	24·7	109·2	47·0	–	1·2	1·6	2·2
Copper wire (bare)	2·8	2·3	5·7	15·6	–	10·6	19·1	3·6
TOTAL	21·3	48·7	204·5	109·1	9·2	16·8	30·6	12·7

Table D. VIII - Municipalities: Annual Consumption of Wire/Cable

	Kabwe	Livingstone	Kitwe	Ndola	TOTAL	Remaining * Municipalities estimate	TOTAL
COPPER							
PVC Insulated	5·2	2·8	1·4	2·1	12·2	2·4	14·6
Rubber Insulated	–	....	–	–	....	....	....
Paper Insulated	–	1·9	30·5	77·1	109·5	20·8	130·3
Bare Wire	3·2	0·1	0·7	0·9	4·9	0·9	5·9
TOTAL:	8·4	4·8	32·6	80·1	126·6	24·1	150·8

* Mufulira, Chingola, Kalulushi, Luanshya and Chililabonbwe.

4.3 Post Office (GPO)

The main requirements of the GPO are for overhead and underground cables, indoor cables and copper coated steel wire (copperweld, copperply and copperclad steel). There is likely to be a tendency to move away from paper insulated/lead covered Armoured Star Quad to polyethylene and corrugated steel insulated cables. At present no aluminium is used and it is unlikely to be substituted for copper on any significant scale. However, in the case of busbars, a certain amount of aluminium is being used. In addition to wire and cable a small, and in most cases insignificant, amount of copper is used in instruments, earth bars, exchanges and switchboard cable. In 1967, the total metal content of the wire and cable used by the GPO (including bare conductors) was about 225 tons. However, a proportion of this was copper coated steel wire which consists primarily of steel rather than copper. Most contracts for the supply of wire and cable are of three years duration. It is expected that the growth rate of the telephone service in Zambia is likely to be up to 25 per cent per annum for the next three years after which it will, in all probability, decline to 10 per cent per annum. However, up to 1980, a 12 per cent growth rate per annum for the period as a whole would seem probable. At present there are between 50 - 60,000 telephone subscribers in the country and approximately 140,000 telephones.

4.4 Construction Industry

It is impossible to assess the copper consumption of the construction industry with any degree of accuracy. However, it is likely that the building industry in Zambia will

be a significant consumer of wire and cable over the next few years given the fairly extensive government housing programme. The Ministry of Local Government and Housing have stated that their tentative programme over the next five years will be as follows:

Government's own Civil Service Housing Programme

Low and medium density housing units	2,200
High density housing units	2,440
	4,640

Local Authorities' Housing Programme

High density units	22,500
Medium density units	500
	23,000

In a publication entitled "The Building Industry and the First National Development Plan", issued by the office of National Development and Planning in January 1967, it is stated that the whole building industry is expected to spend $98 million in 1966/67 rising to $123 million in 1969/70. Annual expenditure in 1964 was $41 million and in 1965 $64 million. This publication contains a comprehensive list of some 106 building materials and labour inputs required for the building target envisaged in the National Plan. The list of wire and cable requirements is given in Table D.IX indicates a consumption of 177 tons of copper in insulated conductors in 1966/67. To this must be added wire and cable used in industrial buildings. For housewire it would appear that copper conductors will continue to be used in the foreseeable future. No detailed information on brass fittings and other copper products was available.

4.5 Zambia Railways

The railways until June 1967 were part of the former Rhodesia Railways. Since the division of the unitary system only a small amount of the repair and maintenance on locomotives and rolling stock has in fact been undertaken in Zambia by Zambia Railways. This position will change with the commissioning of a new railway workshop in 1970 and the envisaged repair programme. Until recently all requirements have been supplied from the former unitary stocks held in Bulawayo (Rhodesia) with only buffer stocks held in Zambia. Because of this, Zambia Railways' consumption of both cables and fittings appears to be minimal at present. Furthermore, with the planned dieselisation of the railways, their future requirements will be reduced.

4.6 Miscellaneous

4.6.1 Coppercrafts Ltd. - a company owned by Zambia Anglo-American produces about 100 different copper items including trays, tables (coffee/occasional), vases, lamps, dishes, bangles, firescreens, bowls, clocks, etc. In 1967 approximately 40,000 items were produced at a total value of $224,000. The plant imports copper sheets, tubes etc. and its 1967 requirements were as follows:

	Consumption kgs.	Source of Supply	Landed factory Prices
Copper sheet (plain) 6 ft. x 3 ft.	21,112	Italy	$1,866 per ton
Copper sheet (perforated) 6 ft. x 3 ft.	4,625	U.K.	$21 to 41 per sheet
Copper strip	5,930	South Africa	$1·40 per kg.
Copper tube	234	South Africa	$2·25 per kg.
Oval extrusion	464	South Africa	$2·10 per kg.
Flat extrusion	43	South Africa	$1,70 per kg.
Copper wire — twin ripcord	10,000 metres		$3·50 per 100 metres

Table D. IX - Housing Industry - Estimated Wire & Cable Requirements 1966-1967

			Quantity '000 ft.	Copper Conductor weight lb./1,000 yds.	Copper Content lbs.
COPPER:					
1.	Earthing Wire:				
	·0045 sq. in.	7/·029"	662	54·37	11,998
	·01	7/·044		125·20	
	·0225	7/·064	535	264·90	47,241
					59,239
2.	Single wire: PVC insulated				
	·001 sq. in.	1/·036" (bell wire)	23	11·77	90
	·002	3/·029) red	5,060	23·37	39,417
	·003	3/·036) and	2,118	36·01	25,423
	·0045	7/·029) black	2,420	54·37	43,858
	·007	7/·036)	236	83·80	6,592
	·01	7/·044	602	125·20	25,123
	·0225	7/·064	474	264·90	41,854
					182,357
3.	Twin and Triplex Cables				
	2 x 40/·0076 twisted		189	41·96	2,643
	2 x 3/·036 +	1/·044 earth	19	89·60	567
	2 x 7/·029 +	3/·036 earth	40	144·75	1,930
	2 x 7/·044 +	7/·036 earth	80	334·20	8,912
	2 x 7/·064 +	7/·052 earth	224	704·60	52,610
					66,662
4.	Multicore: PVC: SWA:				
	·01 sq. in.	7/·044 2 core	124	250·40	10,350
		3 core		375·60	
	·0145	7/·052 2 core		349·60	
		3 core		524·40	
	·0225	7/·064 2 core	2	529·80	353
		3 core		794·70	
		4 core	8	1,059·60	2,825
	·04	19/·052 3 core		1,425·90	
		4 core	3	2,160·60	1,901
	·06	19/·064 3 core		1,901·20	
		4 core	14	2,880·80	13,443
	·1	19/·085 4 core	33	4,848·00	53,328
					82,200
5.	Paper Insulated: lead covered:				
	0·1	19/·083 4 core		4,848·00	
	0·15	37/·072 4 core		7,104·00	
		TOTAL:			390,458
ALUMINIUM				Aluminium conductor weight	Aluminium content lbs.
1.	Wire				
	0·25 sq. in.				
	0·50				
	0·60				
2.	Steel cored				
	0·02 sq. in.		365	100·00	12,167
	0·05		782	292·40	76,219
	0·10		781	580·50	151,123
		TOTAL:			239,509

Source: (1) The Building Industry and the First National Development Plan O.N.D.P. January 1967

(2) Additional information obtained directly from O.N.D.P.

All copper inputs are at present imported from outside the Region. When copper semi-manufactures are available locally it may be presumed that Coppercrafts will use them. A small part of the output of this company is currently being exported, principally to East Africa. It is likely that the export market for Zambian produced copper ornamental work could be expanded quite rapidly. In 1967, total consumption of copper semi-manufactured products amounted to 32 tons (metal content).

4.6.2 Non-Ferrous Metals Works Ltd. is a metal dealing merchant company with its head office in South Africa. The company does not process copper or copper alloy products since by legislation all copper scrap has to be sold directly to the copper companies. However, the plant is involved in the melting and refining of lead-based alloys specifically for the local market. It was suggested that there was at present no market for copper alloy products which would warrant the establishment of domestic facilities. The company does import copper semi-manufactured products and they felt the annual market for sheet was 55 - 75 tons, for tubes 90 tons, and for rod 15-20 tons. Apart from Coppercrafts, the main consumers are the mines.

4.6.3 South Wales Electric Company is involved in the rewinding and manufacture of transformers. The winding wires are either double paper covered or Bicalex-Alumex coated. In 1966/67 a total of 24,585 kgs. of copper was used and 1,055 kgs. in the form of busbars. This company mainly services the mines and the electricity authorities and is experiencing a 30 to 50 per cent rate of annual growth at present. As already indicated it is currently contemplating the introduction of its own drawing and coating facilities to meet its own requirements of copper wire. Consideration is also being given to the assembly and manufacture of electric motors and switchgear. At present there is only one other company involved in transformer repairs and another engaged in the repair of car generators.

4.7 Summary

The marketing of wire and cable to the Zambian market is done either directly by foreign manufacturers or through local agents. It would seem that in all probability British Insulated Callenders Cables has about 60 per cent of the market. This position will change as and when the local fabricating plant becomes operational. In the meantime a price ring is maintained by all the former members of the Cable Manufacturers' Association. In Zambia the Cable Importers' Association of Zambia recommends a price structure to its members. This Association took over from the Factory Liaison Committee and the Cable Importers' Association of Central Africa which operated until imports of wire and cable were prohibited from the Salisbury fabricating plant known as Rhodesian Cables Ltd. The Factory Liaison Committee was responsible for recommending prices to its members for all wire and cable produced in Rhodesia for sale in Zambia and Malawi whilst the Cable Importers' Association of Central Africa was concerned with those cables which could not be produced by Rhodesian Cables.

5. Copper Mining Industry

5.1 As was stated earlier, the copper industry fulfils such a vital role in the Zambian economy that the nature, characteristics and problems facing the industry have been given some prominence in this section. Although in 1967 copper accounted for 38 per cent of net domestic product at factor cost, the industry would account for a much larger proportion if all its indirect effects and linkages were taken into account. In the same year, 56 per cent of Government revenue and 95 per cent of domestic exports were accounted for by the industry. Total emoluments of employees of the copper companies for 1967 amounted to $120 million, of which $91 million represented basic wages and salaries including leave pay. The total labour force in service in 1967 was 47,000 which represented 15 per cent

of the total Zambian labour force of around 320,000.

Table D.X. - Estimated Contribution of the Zambian Copper Industry to the Net Domestic Product, Government Revenue and Domestic Exports of Zambia 1964 to 1967

	Net Domestic Product*	Copper's Contribution to Net Domestic Product		Government Revenue	Copper's Contribution to Government Revenue		Total Value of Domestic Exports (F.O.R.)	Copper and Cobalt Value of Exports	Copper and Cobalt Contribution To Exports
	$m	$m	%	$m	$m	%	$m	$m	%
1964	640	301	47	151	80	43	458	423	92
1965	806	344	43	265	188	71	525	487	93
1966	1,016	479	47	357	228	64	686	652	95
1967	1,076	414	38	375	210	56	651	616	95

* At factor cost, including subsistance output, mineral royalty and export tax.

In 1967 Zambia produced about 13 per cent of total world copper mine production, ranking third to the U.S.A. and Chile (see Table 11.II). Production has increased steadily from 384,750 tons of refined copper in 1954 to a record level of 675,100 tons in 1965. In 1966 production fell to 586,200 tons but increased to 617,000 tons in 1967. The fall from the 1965 level was caused primarily by fuel shortages and transport difficulties which occurred as a result of UDI. Shortages of coal traditionally imported from Wankie (Rhodesia), affected refining operations and led to an accumulation of ore concentrates totalling nearly 68,000 tons (roughly 22,700 tons of copper) during the year. Despite the transport difficulties all refined copper produced in Zambia since UDI has been exported. In line with Government's sanctions policy, the quantity exported through Rhodesia has been considerably reduced and alternative routes by road, rail and air have been used increasingly. Although production fell in 1966 and rose again in 1967, export receipts from copper rose by nearly 35 per cent to $652 million in 1966 and dropped to $616 million in 1967.

Table D.XI - Copper Production, 1966 and 1967 - Tons

		Blister (incl. Anodes)	Refined Copper shapes	Cathodes	Total Finished Production
Bancroft	1966	9,219	22,986	2,772	34,977
	1967	10,351	28,245	3,644	42,240
Chambishi	1966	–	3,169	10,965	14,134
	1967	–	17,107	1,677	18,784
Chibuluma	1966	–	8,312	12,148	20,460
	1967	–	19,240	3,646	22,886
Mufulira	1966	–	113,213	19,158	132,371
	1967	–	141,484	8,051	150,535
Nchanga	1966	55,728	137,626	13,674	207,028
	1967	50,431	135,972	18,637	205,040
Rhokana	1966	23,860	57,571	7,031	88,462
	1967	21,488	58,304	8,006	87,798
R.S.T.–Luanshya	1966	–	69,231	19,959	89,190
	1967	450	75,984	13,215	89,649
Copperbelt	1966	88,807	412,098	85,707	586,613
	1967	82,884	476,338	57,877	616,990

Table D.XII - Sales Of Zambian Copper To Customer Countries 1965 To 1967

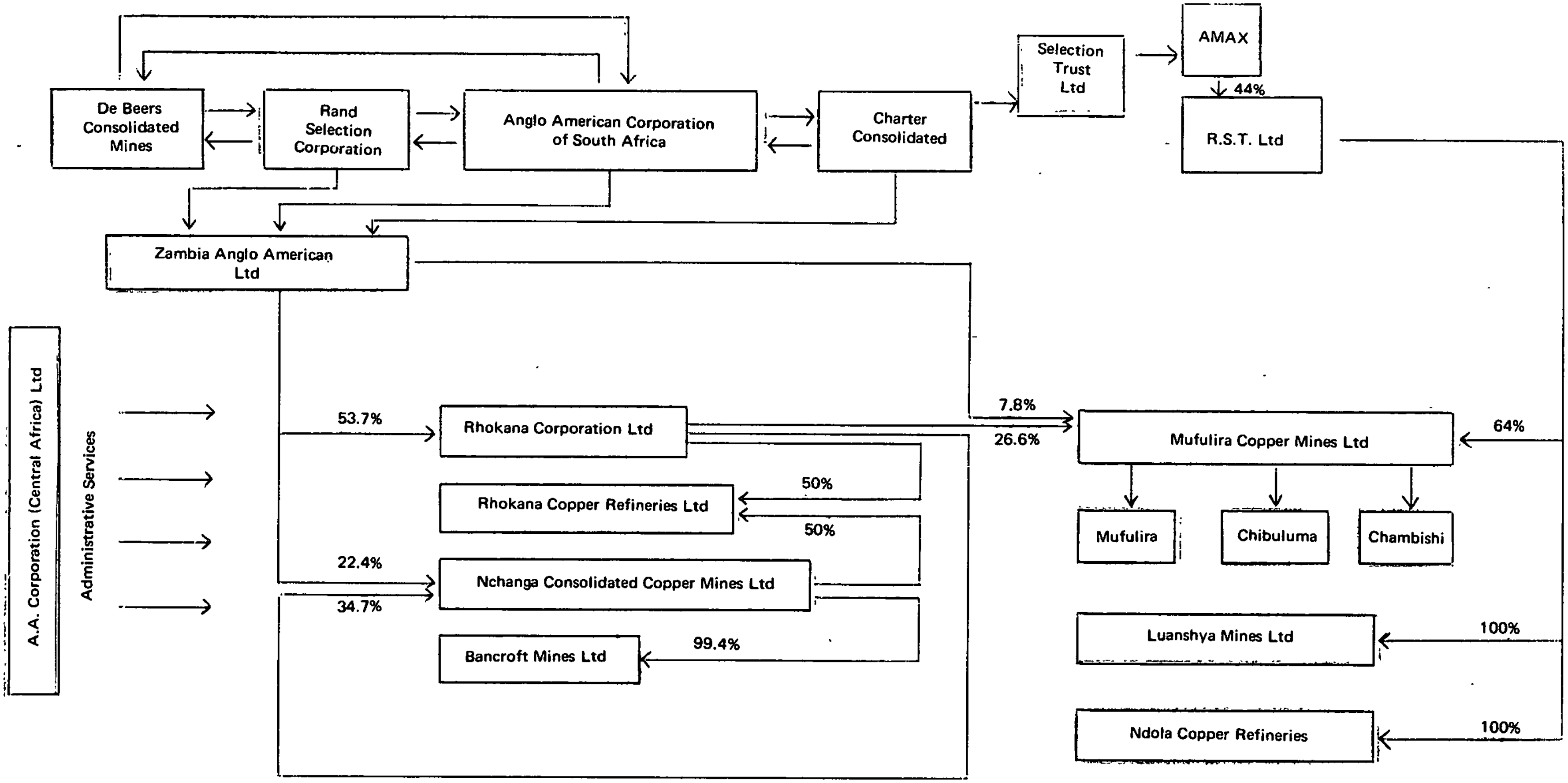
	'000 Tons		
	1965	1966	1967
France	54	50	50
Germany (West)	100	90	78
Italy	54	54	52
Japan	91	95	131
Spain	4	4	7
South Africa	27	27	22
Sweden	14	14	16
Switzerland	9	9	10
U.K.	254	209	181
U.S.A.	9	4	18
U.S.S.R.	9	4	-
Others	36	41	41
	661	601	606

The Copperbelt of Zambia - a strip of land about 160 km long and 48 km wide - constitutes the world's second largest concentration of copper after the State of Arizona (USA). Today although about 660,400 tons of copper are produced each year by the mining groups, reserves of ore are estimated to exceed 800,000,000 tons. The two mining groups are - Anglo-American and Roan Selection Trust. The Zambia Anglo-American Ltd. (ZAA) is the financial company of the Anglo-American Group and is responsible for about 54 per cent of Zambia's copper output. ZAA controls three of the principal mining companies - Bancroft Mines Ltd., Nchanga Consolidated Copper Mines Ltd., and the Rhokana Corporation Ltd. The other group, Roan Selection Trust Ltd. (RST), owns two companies, the Luanshya Mines Limited and Mufulira Copper Mines Ltd., with its three divisions - Mufulira, Chibuluma and Chambishi. The complex interrelationship of the various mining companies to their holding company is outside the scope of this study. However, for the sake of convenience a simplified diagrammatical representation of some of these links is given in Fig. D.I. ZAA's and RST's interests outside the mining sector have been excluded. Both groups co-operate very closely, especially during the past three years when considerable difficulties have been encountered as a result of UDI. The mining companies within the groups are as follows:

	Annual Production tons
ZAA Group	
Rhokana Corporation Ltd. - concentrator, smelter, cobalt plant, sulphuric acid plant, a TORCO pilot plant and the Rhokana copper refinery.	86,000
Nchanga Consolidated Copper Mines Ltd. Second largest copper mine in the world - - concentrator and leach plant - grade of ore has decreased in last three years from 5.5% to less than 4.0%.	238,000
Bancroft Mines Ltd. - encounters considerable watering problems and pumps 65m. gallons per day - concentrator	46,000
Kansanti Copper Mining Co. Ltd. - prospecting company, attempting to establish reserve of oxide ores for mining operation based on TORCO process.	-
Bwana Mkubwe Copper Mining Co. Ltd. - likely that this mine will be reopened.	-
Total:	370,000
RST Group	
Luanshya Mines Ltd. - Concentrator and smelter, anodes sent to Ndola Copper Refineries.	96,500
Mufulira Mines Ltd.	
Mufulira Division - Contractor, smelter and refinery - second largest underground mine in the world.	162,500
Chibuluma Division - concentrator	23,000
Chambishi Division - concentrator and leaching plant.	23,000
Ndola Copper Refineries Ltd. - refinery with a 120,000 long ton capacity per annum.	-
Baluba Mines Ltd. - involved in pilot mining operations.	-
Mwinilunga Mines Ltd. - the rich Kalengwa deposits are located 200 miles west of the Copperbelt. Reserves of 600,000 tons with an average of 10% copper.	-
Total:	305,000
Copperbelt Total:	675,000

Fig. D. I.

ZAMBIAN MINING GROUPS*



* Excludes all non-mining interests and companies not currently involved in production and/or refining.

Of the ZAA total approximately 300, 000 long tons or 82 per cent is produced as electrolytic copper. Likewise with the RST Group, 183, 000 tons at the Mufulira Refinery and 122, 000 tons at the Ndola Refinery represent the output of refined copper. Table D.XI shows that blister copper accounted for 13.4 per cent of total copper production.

5.2 Future Plans

As usual, the problems of forecasting future capital investment programmes are fraught with difficulties. The present capacity for the ZAA Group was given above as about 370, 000 tons/year and it was also mentioned that a massive investment will be required to offset the decrease in grade of ore in Nchanga from 5.5 per cent copper three years ago to less than 4.0 per cent today. It has been widely published that a Japanese Consortium (Mitsui and Co. Ltd. and Mitsubishi Shoji Kaisha Ltd.) has lent to ZAA U.S. $70, 000, 000 under an agreement in which the Group will supply 100, 000 tons/year of blister copper during the next ten years in return for Japanese plant and equipment. This loan will be used for developing the Nchanga mine and processing plant and its capacity of benefication will increase from 480, 000 tons/month to 810, 000 tons/month. The second project involved in the loan is the development of the ZAA patented TORCO process to treat "refractory ores". Research has been conducted on a 500 ton/day plant at the Rhokana smelter. In addition to this development programme, it can be assumed that Bancroft will soon overcome its initial problems and that its present capacity will be increased to over 50, 000 tons by 1973, and that new production will start at Kansanshi in 1970/71 of 15, 000 tons/year and at Bwana Mkubura at the same rate.

The likely developments in the RST Group are not so clearly demarcated as in ZAA. The present capacity of the group is a little over 300, 000 tons/year. Mufulira has started a project which has been under investigation for some time to increase its present capacity of production from 163, 000 tons/year to 188, 000 tons/year by intensifying the introduction of new mining methods. The plant will increase its treatment capacity by 110, 000 tons of ore per month to 725, 000 tons/month at a total estimated cost of $12.6 million (completion early in 1971). The Kalengwa project should be in production by 1969/70, producing around 15, 250 tons/year for a period of four to five years. By 1973 and 1975 the production pattern could be as follows:

	1968 (tons)	1973 (tons)	1975 (tons)
Rhokana	86, 000	86, 000	86, 000
Nchanga	239, 000	264, 000	264, 000
Bancroft	46, 000	51, 000	61, 000
Others	-	31, 000	31, 000
	371, 000	432, 000	442, 000
Luanshya	96, 000	96, 000	96, 000
Mufulira	163, 000	188, 000	188, 000
Chibuluma-Chambishi	46, 000	46, 000	46, 000
Kalengwa	-	15, 000	15, 000
	305, 000	345, 000	345, 000

On the basis of these forecasts, the present capacity of about 675, 000 tons can be expected to increase to about 770, 000 tons/year by 1973. In addition, a further 20, 000 tons can be expected from the various prospecting companies in the RST Group which would further increase the 1973 projection to 790, 000 tons. Furthermore, it is probable that the ZAA Group total could be increased with more intensive operations at Rhokana which might fall in the range of 5 per cent (some 20, 000 tons/year). In total, it would seem that a figure of 810, 000 tons for 1973 is feasible and would certainly be reached by

1975. However, these expansion programmes are dependent on the availability of capital on the supply of fuel and the manpower position.

5.3 Costs

Unlike other producing countries, a great deal of information is available on costs of production as details are given in the company annual reports.

In Chapter 9, details were given of an analysis undertaken by Sir Ronald Prain [1] in which the production costs of five leading countries were compared. It was shown that between 1962 and 1967 the biggest increases were in Zambia (86 per cent) and the Congo (K) (77 per cent). Further details for Zambia are given below:

Relative cost of Competitive Copper - $ Per Ton

	1962	1963	1964	1965	1966	1967
Zambia	452.9	453.6	499.8	553.8	922.6	842.4
World (excl. Soviet areas)	448.9	458.2	489.1	529.2	623.3	627.9
Percentage of world production above Zambian average	37%	38%	30%	27%	12%	14%

Zambia's relative position in the world industry worsened sharply from 1962 to 1967. In 1962, 37% of world production was produced at average costs in excess of Zambia, whilst by 1967 only 14 per cent of copper was produced at a higher cost. Sir Ronald Prain indicates that the Zambian cost increase of $388.7 per ton between 1963 and 1967 was accounted for by an increase of $54.6 in royalty payments, $95.2 in Export Tax payments, $22.4 in increased transport costs, $61.6 for increases in employees' emoluments, which leaves a balance of $155.

The production costs as between the various mines vary considerably. Furthermore, the combination of the three taxes puts the Zambian copper industry within the highest tax bracket by world standards.

Royalty payments were made up to the time of Independence to the British South Africa Company (BSA) which claimed the mineral rights over a large part of the then Northern Rhodesia. These royalty rights were passed to Zambia at Independence and the formula which was devised at the beginning of the century has only experienced minor alterations and is as follows:

Royalty = (13.5% of LME - $22.4) per ton

The LME price is the daily unweighted average of spot and forward quotations for the four different types of copper transacted in the Exhange. This royalty basically represents a tax on production which ignores costs and is charged whether the copper is sold or not.

Export tax was introduced in April 1966 after the producers' price had been abandoned by the Zambian companies. The purpose of the tax was to cream off excess profits above $826.2/ton. In other words, the tax amounted to 40 per cent of the excess of the LME price above $826.2/ton. As with the royalty, this export tax is also a tax on production which ignores costs.

Profits tax of 45 per cent (the first $280,000 at 37½%) on gross profits was introduced in the 1968 Budget.

1 Sir Ronald Prain "Constraints in the Zambain Mining Industry in Charles Elliott (ed): Constraint on Zambia's Economic Development (Oxford University Press forthcoming).

A recent statement by President Kaunda has indicated that the taxation system as it applies to the Mining Companies is likely to be changed and it seems that any new formula is likely to be based more on profitability.

The increase in labour costs has been the direct effect of a 22 per cent increase awarded in October 1966 following the Brown Commission. At the same time the productivity of the mines has fallen. This has been due on the one hand to work stoppages, shortages of fuel, difficulties in transport etc., and on the other to reduction in the grade of ore mined. The transport cost increases were caused by U. D. I. which resulted in the diversion of traffic away from Rhodesia Railways to alternative routes. The combination of all these adverse effects has been counter-balanced by a period of outstandingly high prices. However, these high prices have promoted massive expansion programmes around the world and Zambia's competitive position has been badly hit by the combination of factors mentioned above.

5.4 Marketing

The sales agents of the main producing-exporting countries conduct sales campaigns for each calendar year around September of the previous year. The yearly production is allocated to the (traditional) customers on a monthly basis with an indication of their preferences for qualities and shapes. The products requested are usually electrolytic wire-bars of various weights and blister copper (cakes or refined anodes). The contracts are virtually standardised amongst the various copper producer companies and include clauses on specifications, period of contract, shipment and delivery, the basis of pricing, system of pricing, payment system, premiums and discounts and force majeure. The pricing used to be based on the official LME three months electrolytic wire bar asked price. However, since 1st July 1968 this was changed to the settlement price or the official cash asked price for electrolytic wire bars. Although the price basis refers to the "tough pitch electrolytic wire-bar", there is a range of premiums and discounts for sales of other types of copper - i.e. $5.0 ton premium for scalped wire bar, a discount of $2.5 ton for cathodes, etc. However, these premiums and discounts vary considerably with conditions of the market.

Both the mining groups have sales organisations. The RST Group output is sold at the African port to RST International Metals Ltd. (RSTIM) this is a London registered wholly owned subsidiary of RST Ltd. RSTIM sells the group's copper to customers through the Ametalco Group of companies which act as sub-agents. From 1966 the sales organisation of the ZAA Group of companies is known as Anmercosa Sales Ltd. (Amerisales), which has a subsidiary LME ring dealing company.

In October 1968, the Government of Zambia announced the setting up of the Metal Marketing Company of Zambia which will be charged with supervising the marketing of Zambia's copper exports. In other words, it is Government's intention that the marketing of copper will continue to be done by the existing international marketing organisation but under the overall direction of the proposed Metal Marketing Company. ZAA and RST will have 49% of its equity. Prior to the setting up of the Company, all copper exports were subject to licensing by the relevant Ministry which also specified transport routes out of Zambia. This control by the Metal Marketing Company could have a significant effect on copper prices for local fabrication in Zambia or in the East and Central African sub-regions.

5.5 Small Mines

It has been mentioned that the present system of royalty and export tax is currently under review. The current taxation arrangements have been responsible for the virtual non-existence of small scale mining operations. This is in direct contrast to various other member nations to CIPEC. For example, Chile produces more than 150,000 tons/year of copper from small scale mines and in Peru the output from small and medium operations

has been about U.S. $100,000 per year. The Government is at present studying a small mines policy.

5.6 CIPEC

During the Lusaka Copper Conference held in June 1967, representatives of the four main copper exporting countries - Chile, Congo (K), Peru and Zambia - agreed to establish a joint international body CIPEC (International Council of Copper Exporting Countries). The objectives of CIPEC are:

(1) To co-ordinate measures designed to foster, through the expansion of the industry, dynamic and continuous growth of real earnings from copper exports, and to ensure a forecast of such earnings.

(2) To promote the harmonisation of the decisions and policies of the member countries on problems relating to the production and marketing of copper.

(3) To obtain better and more complete information, and appropriate advice on the production and marketing of copper from member countries.

(4) In general, to increase resources for economic and social development of copper producer countries, bearing in mind the interest of consumers.

It is premature to assess the importance of CIPEC. However, a great amount of work and hope has been invested by the four member countries to co-operate in the setting up of CIPEC which is expected to play an important role in the world copper industry.

5.7 Zambia's Economic Revolution (Mulungushi 19th April, 1968)

As far as the copper industry is concerned, Mulungushi specified that the companies had to re-invest 50 per cent of net profits in Zambia. In other words a maximum of 50 per cent of net profits could be remitted overseas on the assumption that this did not exceed 30 per cent of equity capital. At the same time an announcement was made that a Foreign Protection Investment Act would be introduced.

ANNEX E

REPUBLIC OF THE CONGO

COUNTRY REPORT

1. Introduction

A detailed breakdown of value added by sector for the Congolese economy is not available. An approximate breakdown is given in Table E. I below

Table E.1 - Value added by sector of GDP in 1963

	$ millions
Agriculture - subsistence	20.0
commercialised	12.0
Manufacturing Industry	21.0
Construction, Power etc.	6.8
Services	76.8
Total G. D. P.	136.6

The principal industries are the processing of timber, oil, food and drink. Several firms make simple chemical products such as paints, soaps, insecticides and perfumes. By 1965 there was a total of 65 industrial establishments.

The main centres of industrial activity are at Pointe-Noire, the principal sea port, and at Brazzaville which is at the point of transhipment for the lowest navigable point of the river Congo.

The main rail link within the Congo is the line between Pointe-Noire and the Congo. A branch line runs from Mont Bela to Mbinda on the border of Gabon. The north and east of the Congo are served by river links; the Congo and the Oubangui along the eastern border and up to the Central African Republic, and the Sangha across the north of the country to Ouesso on the border of the Cameroon.

The second Development Plan which is to succeed the interim plan for 1964-1968 has not yet been published. However, certain major projects which may be undertaken were suggested or initiated in the interim plan. The largest single project is for the establishment of a hydro-electric barrage at Kouilan. This would be the source of some 6.8 G. Wh. per annum of low cost electricity to power an entirely new electro-metallurgical industry producing aluminium, ferro-manganese, ferro-silicium and a number of other electro-siderurgical products. The investment required for this project would be $ 600 million - three times the total required for the whole of the first Five Year Plan.

A somewhat less ambitious project is the exploitation of the potash deposits at Holle which was to be initiated during the period of the interim plan. Output is planned to reach 350, 000 tons per annum and an investment of $48 million will be required.

2 Copper Fabrication Industry

There is no copper fabrication industry in the Congo (Brazzaville).

3. Demand for copper products

Detailed historical figures for imports of copper products were not available at the time of printing this report. However, the broad import breakdown shows that all imports of these categories come from France. Table E. II shows a detailed breakdown of French exports to the Congo (Brazzaville) from 1963 to 1966.

Insulated conductors include aluminium and quantities refer to the total weight of the cable not just the metal content.

There has been no consistent trend during this period though imports of most categories do appear to have declined in 1966, possibly as a result of the high stock levels in the previous year.

Table E.II - Export of Copper Products to the Congo (Brazzaville) 1963-1966

	1963	1964	1965	1966
	Tons	Tons	Tons	Tons
Copper and alloy semi-manufactures				
Copper				
Wire-single strand	18	6	4	1
Wire-stranded	28	14	23	7
Wire-rods	-	-	-	-
Rods, bars & sections	1	3	2	1
Plates, sheet & strip	1	-	-	1
Tubes	3	9	5	5
Total Copper	51	32	34	15
Alloy				
Wire	-	7	6	7
Rods, bars & sections	7	12	10	5
Plates, sheet & strip	-	-	-	1
Tubes	1	1	24	11
Total Alloy	8	20	40	24
Total semis	59	52	74	39
of which:				
total wire	46	27	33	15
Insulated conductors				
Plastic insulated	133	93	155	77
Rubber insulated	69	43	46	54
Insulated with impregnated paper	18	31	107	-

Table E.II - Export of Copper Products to the Congo (Brazzaville) 1963-1966

(Continued)

	1963 Tons	1964 Tons	1965 Tons	1966 Tons
Varnish/lacquer insulation	-	-	84	8
Other cable & wire	22	13	-	22
Power cable lead sheathed	-	-	12	12
Telecommunications lead-sheathed	-	-	11	-
Other tele-communications cables unsheathed	-	-	36	-
Total insulated:	242	180	451	173

4. Principal Industrial Sectors

The main user industries in the Congo (B) are believed to be

(i) electricity transmission and distribution

(ii) the telephone service

(iii) the construction industry and

(iv) the railways

It was only possible to obtain detailed figures of purchases from the telephone service; the electricity authority, however, provided approximate figures.

4.1. Electricity transmission and distribution

The main electricity authority in the Congo is the Energie du Congo which controls the concessions previously held by the Societe Equatoriale d'Energie Electrique at Djoue, and the Union Electrique d'outre-mer, supplying Brazzaville. In addition there is a small plant at Dolisie which has always been state owned and the power plant at Jacob which supplies, and is owned by, the Societe Industrielle et Agricole de Niani.

Because of the recent re-organisation of the old private companies under Energie du Congo no comprehensive figures of cable purchases are available.

However, it is estimated that annual purchases of naked copper wire and conductors amount to about 25 tons of copper while the total length of insulated cable purchased for transmission and distribution is of the order of 120km.

The main types of cables used are:

Bare conductors

10.8 mm^2
14.1 mm^2
22.0 mm^2
29.3 mm^2
38.0 mm^2
48.0 mm^2

Insulated conductors

PVC 1.5 mm^2 to HFG 120 mm^2.

The process of substitution of aluminium for copper has already been in progress for a number of years, and is now virtually complete. Previously virtually all cables were based on copper but in future only one third, at most, will remain so: these being primarily low tension small diameter cables. The bulk of the bare conductors will continue to be in copper.

Past Growth and Future Plans:

Table E.III - Number of Subscribers

	Brazzaville	Pointe Noire	Dolisie	Total
1960 December	4,548	3,299	205	8,052
1961 "	4,787	3,506	239	8,532
1962 "	5,349	3,587	254	9,192
1963 "	5,602	n.a.	328	n.a.
1964 "	5,564	3,469	350	9,383
1965 "	5,922	3,787	376	10,085
1968 March	7,156	4,162	408	11,726

This represents an average growth rate of 5.3 per cent per annum compound. However, in the first four years the growth rate was only 3.8 per cent whereas since 1964 it has been 7 per cent per annum. The authority expects this rate to continue in the future.

Table E. IV - Growth of Electrical Capacity (kw)

	1965	1968	1970 (est.)
Brazzaville	18,000	18,000	18,000
Pointe Noire	7,200	8,900	12,600
Dolisie	780	960	960
Jacob	4,500	4,500	4,500
Small thermal centres	500	500	500
	30,980	32,860	36,560

Table E.V - Production, imports, exports and consumption of electricity 1960-1965 (MWh)

	1960	1961	1962	1963	1964	1965
Production	28,913	32,243	36,591	41,579	43,718	42,471
of which Hydro electric production	19,329	21,405	24,196	27,194	27,836	26,680
Exported from Djoue (to Congo (K))	307	87	–	169	52	181
Imported from Sanga (from Congo (K))	–	89	–	–	–	–
Total consumption:	26,783	29,765	34,247	38,510	40,147	38,979
Consumption per head (kWh/head)	35.1	38.6	44.0	47.8	48.8	46.3

The difference between production and consumption is accounted for largely by trade and line losses. Growth in consumption has been at a rate of 7.7 per cent per annum since 1960.

According to the interim plan (1964-68), which contains forecasts extending beyond that date, it is expected that demand in 1970 will reach 156,000 MWh. Much of this enormous increase in demand would come from industrial developments notably, potash deposits at Holle (60,000 MWh), and a cement plant at Loutete (12,000 MWh). A doubling of consumption by other users at Brazzaville and Pointe Noire was also projected between 1963 and 1970 though growth in consumption has not proceeded at this rate so far.

The total length of the transmission and distribution system in 1965 was 432 km. which is divided as follows:-

	H.T.	L.T.	Total
Length in km.	169	263	432

The main lines foreseen in the plan were in order of priority:

	Length km	Voltage kv	Plan
Moukoukoulou-Le Brig-Loutete	62	90	1964-68
Le Brig-Jacob	57	90	
Loutete-Brazzaville	177	90	1969-73
Jacob-Dolisie	81	90	

This would represent a doubling of the rate of construction of major lines in the period of the second plan, compared with the first. This is equivalent to 16.7 per cent growth per annum, over five years, of requirements for transmission cables. As the distribution network has in the past been largely dominated by supplies to domestic consumers, commerce and small industry, but will in future be increasingly oriented towards large industry, growth in cable consumption would not be expected to grow in the same proportion. Moreover, the transmission lines will be predominently aluminium and not copper.

4.2 Telephone System

The telephone system of the Congo (B) is organised by the Office National des Postes et Telecommunications.

The range of types of cable and wire used is too great to show in detail. However, a summary of their requirements is shown below.

Table E. VI - O. N. P. T. Purchases of Copper Conductors 1965, 66 & 68

	1965	1966	1968
Value CFA	14,467,583	60,802,566	13,773,580
Length metres	160,000	240,841	67,450
Copper content kgs	15,839	78,320	13,660

No aluminium cables are used nor is there any likelihood of substitution in the future since copper is preferable for technical reasons despite its higher price.

Unfortunately, no indication of past or expected future expansion of the telephone service is available.

5. Mining Industry

The republic of the Congo (Brazzaville) has small deposits of copper ore at M'Passa. These are currently being exploited but production fluctuates around a very low level.

As output is so low the ore is merely concentrated and exported to European refineries. The concentrates have a copper content of about 40 per cent.

Research is being carried out to investigate the exploitation of the 'black earths' at Mindouli which are believed to contain about 25,000 tons of copper metal at a concentration of about 5-6 per cent. There are also believed to be deposits at Monts Bambas which are to be investigated.

Table E.VII - Production of concentrates 1960-1966 (tons of concentrate)

1960	1961	1962	1963	1964	1965	1966
-	334	3,277	830	-	169	250

Given the low and fluctuating level of production and the limited reserves (which do not justify a significant expansion of output) it is not possible to envisage the installation of refining capacity in the Congo.

FEDERAL REPUBLIC OF THE CAMEROON - Country Report

1. Introduction

The Cameroon is, after the Congo (K), the most economically developed country in the Central African sub-region. However, its secondary sector still accounted for only 13 per cent of total value added in 1963.

Table F.I - GDP by Contributing Sector 1963

		US$m	%
Primary sector	- Agriculture, forestry and fishing	261.6	41
Secondary sector	- Mining	-	
	Manufacturing	49.4	
	Building and construction	22.3	
	Power, water, etc.	7.7	
		79.4	13
Tertiary sector	- Transport, government, commerce, etc.	292.7	46
TOTAL GDP		633.7	100

Within the secondary sector manufacturing industry preponderates. The most important manufacturing industry is the production of aluminium from imported alumina, using the hydro-electric capacity of Edea. Apart from this, industrial activity is fairly diversified.

There are over 140 establishments ranging from saw mills and food processing plants to engineering works (the manufacture of nails, agricultural machinery, domestic utensils etc.) and chemical plants (paint, soap and matches).

Industry is mainly concentrated round the region of Douala-Edea, though other areas of concentration exist at Yaounde and in the west and north.

The GDP is expected to be double its 1963 level by 1975 according to the rates of growth predicted in the economic plan. Two of the major developments to be undertaken during this period, which will lay the foundations for further expansion, are the Trans-Cameroon railway and the proposed development of bauxite mining and the production of alumina locally.

The Trans-Cameroonian is well under way and is expected to reach Ngaoundere by May 1973. This will give an incentive to the industrial and agricultural development of the railway's hinterland. It will also be the vital link in opening up the bauxite deposits at Mini-Martrap, which have been suggested as the source of alumina for an expanded aluminium plant. In an ECA study* it was suggested than an alumina plant of 500,000 tons annual capacity feeding an aluminium smelter of 240,000 tons annual capacity should be in production by 1980. This would require some 600MW of additional electrical capacity.

2. Domestic Copper Fabrication

There is no domestic copper fabrication for the local Cameroonian market. However, there is a local aluminium industry in the Cameroon as was mentioned above. Since many of its products can be competitive with similar items made of copper, it is important to summarise its activities.

* ECA 68-379/35 Komorowski, The Aluminium Industry and demand for non-ferrous metals in Central Africa 1965-80.

Table F. II - Imports of Copper Products

	1963		1964		1965		1966		1967	
	tons	$	tons	$	tons	$	tons	$	tons	$
Raw copper and scrap	–	–	–	–	0·2	492	–	–	0·1	488
Master alloys of copper	–	–	–	–	–	–	–	–	0·1	388
Rods, sections & single wire	49·9	43,216	45·0	44,576	49·2	202,052	18·1	28,052	83·6	76,804
Copper sheet and strip	2·7	4,060	3·8	4,292	3·6	5,792	1·5	20,396	4·6	8,220
" foil (less than ·15 mm)	0·6	912	–	108	–	–	0·2	596	0·6	1,192
" powder and flakes	–	–	–	24	–	32	–	332	0·3	324
" tubes and pipes	10·3	16,432	16·2	24,408	14·5	24,200	13·4	32,932	62·8	62,376
" fittings for tubes & pipes	2·6	7,516	4·1	13,460	2·6	10,156	3·0	12,176	5·3	25,836
" containers > 300 litres	0·2	16	–	–	–	–	–	664	–	–
" wire or cable—stranded	39·1	31,528	36·7	30,584	31·4	34,400	26·3	41,200	41·6	69,256
" wire mesh or grills	–	28	0·1	216	0·4	516	–	144	–	200
" chains	0·1	520	0·2	826	–	32	–	108	0·2	3,052
" nails, hooks & pins	0·7	1,732	1·8	3,104	0·9	1,488	1·3	1,868	1·3	2,820
" nuts, bolts, screws & washers	4·0	9,640	2·0	4,624	4·3	7,716	2·9	7,196	5·1	13,180
" springs	–	–	–	36	–	–	–	60	–	–
" domestic heating apparatus	6·5	14,620	21·3	42,476	9·7	18,124	10·9	17,356	11·5	28,540
Other domestic copper ware	1·6	4,436	1·2	3,628	0·6	2,836	0·9	5,376	0·5	3,796
Other articles of copper	125·7	143,416	134·6	184,396	119·6	317,160	2·7	14,932	5·4	30,084
TOTAL	244·0	278,072	267·0	356,768	237·0	634,996	81·2	166,236	223·4	326,656
Insulated conductors (including aluminium)	317·9	353,116	285·9	334,584	532·7	586,156	435·5	495,424	550·8	740,556

Production of primary aluminium in the Cameroon began in 1954. It is carried out by ALUCAM, an offshoot of Pechiney-Ugine, which produces the aluminium from imported alumina using the cheap hydro-electric power at Edea. Most of the aluminium is exported in its primary form but a certain amount is used locally by two subsidiaries of ALUCAM: SOCATRAL which manufactures sheets and corrugated sheet for roofing; and ALUBASSA which manufactures kitchen ware and similar items from rolled aluminium.

Aluminium output in 1966 was 48,000 tons while production of sheet was 3,500 tons and kitchen utensils 350 tons. It is planned to expand the production of primary aluminium to 58,000 tons by 1971/2, which is near to the capacity of the existing plant. As mentioned earlier, it is eventually hoped to exploit the bauxite deposits near Ngaoundere and to expand the capacity of the aluminium smelter to perhaps 240,000 tons per annum. This will inevitably give a considerable incentive towards the establishment of local fabrication industries. However, no plans exist at present to extend the range of fabrication processes carried out in the Cameroon. In particular, ALUCAM do not believe it will be feasible within the foreseeable future to produce aluminium wire or cable in the Cameroon.

Consequently the only copper products which will meet with competition from Cameroonian aluminium products are those made of sheet and, possibly at a later stage, tubes and pipes.

3. The Demand for Copper Products

The demand for copper products is met entirely from imports.

3.1 Imports of Copper Products and Insulated Cables

Table F.II overleaf shows imports of copper products and insulated cables since 1963. Imports of insulated conductors have risen from 318 tons in 1963 to 551 tons in 1967. Demand for other copper products has been more or less stable during this period except in 1966 when demand fell substantially. Apart from insulated conductors the principal categories are rods, sections and single wire; stranded wire and tubes.

4. The Principal Industrial Sectors

4.1 Electricity

There are three companies in the Cameroon engaged in the production and distribution of electricity.

4.1.1 The Electricite du Cameroun (EDC) was established by the state in 1963 and the state is the majority shareholder. It took over the production and distribution installations and functions previously carried out by the 'Societe d'Energie Electrique du Cameroun', the Central Company for Electrical Distribution and several municipal authorities. It is therefore the responsible authority for the whole of the East Cameroon except Edea.

The Societe d'Energie Electrique du Cameroun (ENELCAM) operates the Edea hydro-electric plant supplying the Alucam smelter.

In the West Cameroon, the West Cameroon Electricity Corporation controls the production and distribution of electricity.

Detailed information on the consumption of wire and cables has been obtained from the first and most important of these three organisations. The figures are summarised in the table below.

Table F.III - Consumption of Wire and Cable of Copper and Aluminium in 1967/8 by Electricite du Cameroun

(i) Bare wire and cable of copper

	Section	Length	Copper Content
Wire	2.5mm^2		200 kgs
"	3.0 "		1,000 "
"	4.0 "		2,484 "
"	5.0 "		995 "
"	8.0 "		517 "
Cable	17.8 "		2,005 "
"	29.3 "		2,030 "
"	48.3 "		1,986 "
Sub total			11,217 kgs

(ii) Insulated wire and cable of copper

Low tension - U1000	R12N	1 x 6mm^2	41,880 metres	2,094kgs
" " "	"	1 x 10 "	27,100 "	1,515"
" " "	"	1 x 16 "	3,585 "	499"
" " "	"	2 x 6 "	28,816 "	2,882"
" " "	"	4 x 6 "	3,012 "	602"
" " "	"	4 x 10 "	14,571 "	3,258"
" " "	"	4 x 25 "	2,499 "	2,137"
" " Cables torsedes retylenes		2 x 10 "	45,000 "	5,031"
" " " "	"	4 x 10 "	5,000 "	1,118"
" " " "	"	4 x 25 "	8,500 "	7,269"
" " PCV armoured, underground		3 x 25 "	1,000 "	641"
" " PCV armoured, underground		4 x 6 "	500 "	100"
" " PCV armoured, underground		4 x 10 "	15,050 "	3,365"
" " PCV armoured, underground		4 x 16 "	298 "	166"
" " PCV armoured, underground		4 x 25 "	3,067 "	2,623"
" " PCV armoured, underground		3x50+1x25 "	505 "	517"
" " V500 VGV		5 x 1.5"	3,627 "	271"
" " " HG		5 x 1.5"	400 "	30"
High tension 8,700V armoured		3 x 50 "	1,509 "	1,261"
" " 15,000V "		3 x 50 "	1,503 "	1,256"
Sub total				36,635"

(iii) Bare wire and cable of aluminium

		Aluminium Content
Bare almelec cable - greased	54.6mm^2	10,804 Kgs
" " " "	93.3 "	2,104 "
Sub total		12,908 "

Table F.III (continued)

(iv) Insulated wire and cable of Aluminium

Low tension Almelec vultylene, pre-assembled	3 x 35+2 x 16+54.6	13,602 metres
Low tension Almelec vultylene, pre-assembled	3 x 50+2 x 16+54.6	32,880 "
Low tension Almelec vultylene, pre-assembled	3 x 70+2 x 16+54.6	5,020 "
Low tension U1,000 VGVFV	3 x 70+1 x 35	1,992 "
Low tension U1,000 VGVFV	3 x 120+1 x 70	3,066 "
High tension 15,000V	3 x 70	9,045
Telephone cable, self supporting	20 pairs of .9mm^2	7,922
Sub total		52,000kgs

Summary

Total copper content -	of bare wire and cable	11,217 kgs
	of insulated and cable	36,635 "
	of both bare and insulated	37,852 kgs
Total aluminium content -	of bare wire and cable	12,908 kgs
	of insulated and cable	52,000 "
	of both bare and insulated	65,000 "

Future projects under study by EDC include the installation of 90,000 volt transmission lines between Douala and Tiko (80km), Douala-Nkongsamba (150km) and Bkongsamba-Bafoussam (150km). However these projects will use steel cored aluminium of 228mm^2 and not copper.

The second plan allows for considerable investment in the electricity industry to meet the rapidly growing demand. The major projects are shown in Table F. IV.

Table F.IV - Investment Plans for the Electricity Industry ($'000)

Major Investment Plans	1st year	2nd year	3rd year	4th year	5th year	TOTAL 2nd Plan
Regulating Sanaga-Mbakuou Equiping Edea II Survey of Edea - Yaounde line	-	2,800	5,200	5,200	5,400	18,600
Development of site in centre/ south littoral	120	200	-	-	-	320
Development of capacity in West Region	-	120	-	600	1,680	2,400
Preliminary project Lagdo (North)	-	-	-	200	-	200
Development of capacity in South of W. Cameroon	160	-	240	1,200	1,600	3,200
Sougloulau Falls survey	-	-	120	120	160	400

Table F.IV (continued)

Electrification of secondary centres						
Enlargement of diesel plant, distribution network and public lighting in Douala	1,068	408	308	620	276	2,680
Strengthening Mouffou station for reserve in Yaounde and extending public lighting	300	480	640	260	180	1,860
Thermal station and beginning of distribution at Ngaoundere	-	-	480	40	92	612
Englargement of plant and distribution network in Bafoussam, Kwiti, Bafang, Eboloua	724	480	492	496	568	2,760
Total Expenditure	2,372	4,488	7,480	8,736	9,956	33,032
Increase in planned expenditure over previous year		89%	67%	17%	14%	

This represents a very rapid initial rate of growth in investment expenditure, declining to a more sustainable rate at the end of the period.

4.2 The Telephone System

It was not possible to obtain any information from the PTT on their consumption of cable and other products, nor on the extent of the telephone system and plans for its future expansion.

However, the plan indicates that considerable expansion of capacity is foreseen.

Table F.V - Investment Plans for the telephone system ($'000)

Investment Projects	1st year	2nd year	3rd year	4th year	5th year	TOTAL 2nd Plan
Extension of Yaounde exchange to 2,000 lines. Transfer those on R6 exchange to Yaounde exchange	160	-	40	-	-	200
Transfer R6 equipment to Douala increasing lines from 2,000 to 3,000	80	-	-	-	-	80
Improvement and extension of underground system of Douala	400	520	-	-	-	920

Table F.V (continued)

Installation of permanent automatic exchange at Yaounde permitting increases from 3,000 to 10,000 lines	-	-	560	-	332	892
Total Expenditure	640	520	600	-	332	2,092

4.3 The Construction Industry

The building and construction industry is expected to show the fastest rate or growth of any sector during the period of the second plan. Between 1963/4 and 1970/1 the value added annually by this sector will have risen from $22.0m to $51.6m.

A major programme of low and medium cost urban housing will play a part in this growth, State expenditure will average about $2 million per annum throughout the plan, on the preparation of about 1,800 sites and construction of houses on about 600 of them. Total private house building, including that on government prepared sites, is also expected to average $2 million per annum. The bulk of construction output is therefore likely to be on industrial, commercial and government buildings and infrastructure such as roads, railways and dams.

5. Copper Mining

At present there is no significant mining sector in the Cameroon though a certain amount of tin and a very little gold is extracted by small scale methods. Fairly extensive geological surveys have indicated some interesting copper deposits near Poli which merit further investigation.

The main mining development is likely to be the exploitation of the Bauxite deposits previously mentioned. Reserves are estimated to be at least 1,200 million tons containing about 42 per cent of alumina. It can be foreseen that the extraction would be by opencast mining, but would nonetheless require considerable and regular expenditure on insulated cables for the transmission of power and light to the site.

ANNEX G

THE UNITED REPUBLIC OF TANZANIA

COUNTRY REPORT

1. Introduction

The United Republic of Tanzania (area 362,688 square miles) consists of Tanganyika and Zanzibar. In size it is comparable to the combined areas of France, Germany and Belgium and is the largest of the three East African countries.

Over 60 per cent of the country is unsuitable for cultivation because of tsetse fly infestation and lack of water. Most of the cultivatable land is in the northern and southern highlands along the coast and in the western lake region. The majority of the population of 12.2 million live within these fertile areas.

The economy of Tanzania is to a very large extent based on agriculture as is indicated in Table G.I. Tanzania is the world's largest producer of sisal whilst cotton and coffee are the other major cash crops. Zanzibar is the largest exporter of cloves in the world. Agricultural produce is the major component of export receipts. The large agricultural sector has set the pace for the growth of the economy as a whole over the last decade.

The dominance of agriculture in the Tanzanian economy was featured by the slowdown in economic growth in 1967 as adverse weather conditions reduced and delayed harvests. The mining and manufacturing sectors accounted for only 6 per cent of G.P.D. in 1964. It is estimated in the National Plan that this will rise to 10 per cent in 1970 and 15 per cent in 1980.

Table G.I - G.D.P. at Factor Cost (current prices)

$ 000s

Industry	1960	1961	1962	1963	1964
Agriculture	315,862	319,480	347,760	388,360	393,680
Mining & Quarrying	14,560	15,316	14,364	12,348	16,360
Manufacturing	15,300	19,482	21,599	22,674	24,458
Construction	12,782	16,352	17,040	17,799	20,896
Electricity & Water	3,446	3,808	4,163	4,275	4,835
Commerce	58,606	62,269	67,827	75,390	79,486
Rent	22,472	23,455	24,528	26,210	31,127
Transport	24,455	24,038	26,174	26,322	27,988
Services	50,663	57,629	60,477	77,014	84,963
Total	518,148	541,811	584,071	650,470	684,042

Although Tanzania is a member of the East African Community she has not benefited from the Common Market arrangements to the same extent as the other member countries. However, the Transfer Tax System, introduced at the end of 1967 under the Treaty for East African Co-operation to reduce the imbalance in industrial development between the three countries, is beginning to have a favourable effect on Tanzania's industrial activity.

Only 6 per cent of the population can be considered urban. The port of Dar-es-Salaam (population 272,000) is the major centre of industrial activity and also the capital. Tanga (population 38,000), Moshi, Arusha and Mwanza are the other major centres of population.

Lack of adequate transport is a major obstacle to industrial development and mineral exploitation in certain areas of the country. The railway system in Kenya, Uganda and Tanzania is operated by East African Railways as an integrated system.

The central line traverses the breadth of the country from Dar-es-Salaam through Morogaro, Dodoma and Tabora to Kigoma on Lake Tanganyika. A branch from Tabora runs north to Mwanza on the shores of Lake Victoria. Most of the existing roads in Tanzania were built for administrative reasons with little reference to traffic flows.

Following on from the Rhodesian UDI, there has been a substantial reduction of Zambian traffic flows. In other words a large portion of Zambian traffic has been re-routed through Tanzanian ports and the effect on the communication links has been significant. In particular a large amount of money has been spent on the Great North Road which links the Zambian line of rail with the port of Dar-es-Salaam. Furthermore a joint Government transport company was established to haul goods on this road whilst an air cargo company was formed to fly copper to Dar-es-Salaam. In addition an oil pipeline has been constructed between Dar-es-Salaam and Ndola. The largest project which is under consideration is the 980 mile Tanzania-Zambia rail link. An engineering and economic feasibility study for a proposed rail link was undertaken by a joint Anglo-Canadian team in 1966. Currently a Chinese team is involved in an engineering design survey. The Anglo-Canadian study estimated that the capital cost of the line would amount to £96.3m. In addition it would be necessary to provide for locomotives and rolling stock at a cost of about £26.5m. and working capital at £3.5m.

2. Copper Fabrication

There is at present no copper fabrication industry as such in Tanzania. However, there is one aluminium fabrication plant which intends to produce products, notably cables, competitive with those of the copper fabrication industry.

Aluminium Africa Limited produces aluminium and corrugated sheets. The company which was established in 1960 has aluminium fabricating facilities located in Dar-es-Salaam. The capacity of the plant is about 5,000 tons per annum. Production in 1964 of aluminium sheet, coils and foils amounted to 3,000 tons. The company is planning to install a foundry, extrusion press and drawing machinery and will then be able to manufacture castings, extruded products and cables.

A preliminary feasibility study of a copper wire and cable factory in Tanzania was prepared in 1968 by the U.N. Industrial Studies and Development Centre. The project envisaged the production of housewire by drawing 2.6 mm. wire stranding, and insulation. The projected production was to be 30 tons per month of PVC insulated wire giving a total of 360 tons per annum. The report concluded - "The project does not appear to be viable economically for a small production of 360 tons per annum. At best it will be a marginal proposition depending very largely on highly efficient management .... for the project to be clearly viable and profitable a yearly production of 1,000/1,200 tons of electric cables in terms of copper should be established". The present small size of the domestic market seems at the moment to preclude profitable production of electric wire and cable in Tanzania.

3. Demand for Copper Fabricated Products

The market for copper fabricated products is supplied entirely by imports.

The import statistics for the years 1963-7 are given in Table G.II. Zanzibar and mainland Tanzania have until this year published separate trade statistics compiled on different bases and it has not been possible to give combined figures for the whole country. Consequently the import figures for copper fabricated products refer only to the mainland. The principal sources of imports were the U.K. followed by Italy, France, West Germany and the U.S.A., although recently, insulated housewire has been imported from East African Cables in Nairobi. The Uganda Cable Corporation also expects to export to Tanzania.

Table G.II - Tanzanian Imports of Copper Products

		1963		1964		1965		1966		1967	
		Tons	$	Tons	$	Tons	$	Tons	$	Tons	$
68210	Copper & Alloys whether or not refined	2.5	1,447	1 5	1,481	−4.0*	− 1,136*	1.4	1,887	0.9	2,234
68221	Copper & Alloys Worked, Plates, Sheet, Strip	35.0	33,146	12.0	14,201	13.0	18,768	4.0	13,932	11 1	17,388
68222	Copper wire	77.8	73,273	23.5	24,939	42.8	48,745	30.6	51,172	42.0	56,571
68229	Other Copper & Alloys of Copper Worked	15.6	19,286	27.1	34,714	44.7	66,133	70 0	111,395	79 9	91,537
69829	Articles of Copper N.E.S.	–	–	–	–	–	2,363	–	5,398	–	3,841
69729	Utensils of Copper, Brass or Bronze	–	–	–	–	2.5	4,300	3.8	7,588	1 6	4,942
	TOTAL (not incl. 72310)	130.9	127,152	64.1	75,335	99.0	139,173	109 8	191,372	135.5	176,513
72310	Insulated electric wire and cable	520	426,790	468	435,766	640	703,102	608	639,030	401	428,982

* A minus figure indicates differences in the calculation of interterritorial trade.

4. Main Industrial Sectors

Specific information on copper consumption by industries in Tanzania is sparse. However, information on the consumption of copper products by the common services organisations (such as the East African Posts & Telecommunications Service and the East African Railways and Harbours Board) are included in the Kenya Country Study (ANNEX E). The only major sector on which there is detailed information for Tanzania is the electricity industry.

4.1. Electricity Supply Industry

Tanzania at present produces no coal, oil or natural gas, consequently the energy needs for the developing economy are met primarily by electricity generation.

Total consumption of electricity grew from 33 million KWH in 1950 to 146 million KWH in 1959.

Table G.III - Electricity Sales in Millions of KWH - 1961-66

Year	Domestic	Net Exports	Total
1961	120	23	143
1962	135	21	156
1963	147	16	163
1964	162	5	167
1965	180	0+	180
1966	215*	0	215*

Source: Ministry of Economic Affairs and Development Planning

* Estimated

\+ Exports of electricity to Kenya had fallen to zero by 1965 and Kenya was disconnected from the Tanesco system.

Most of Dar-es-Salaam's electricity consumption is supplied from the Hale Hydro Electric Power Scheme (completed in 1964 at a cost of $15½ million) through a 174 mile 132 KV line. The growth of industrial sales of electricity has been concentrated at Dar-es-Salaam and Arusha. At Dar-es-Salaam the very high growth rate of nearly 39 per cent per annum has been achieved since 1963.

The average growth rates of total energy sales for the five year period 1963-67 are compared below with those for the period 1958-62.

Table G. IV - Percentage per annum.

Coastal System	1958-62	1963-67
Dar-es-Salaam	14.1.	22.7.
Tanga	4.4	0.8
Morogoro	7.8	61.6
Total:	8.7	15.3

Moshi/Arusha System

Moshi	10.1	5.9
Arusha	10.2	10.6
	10.1	8.6

Recent estimates of the rate of growth of electricity* consumption in Tanzania assume that all rates of growth will settle down at 10 per cent per annum by 1978 or earlier. The exception is Dar-es-Salaam where the prospective growth of industrial sales will be above 10 per cent until 1982. The recession in sisal will result in a reduction in the load factor at Tanga and Morogoro. It is unlikely that consumption in the two centres will remain stagnant. It should rise to the long-term growth rate of 10 per cent per annum by 1978.

In order to cater for the growth in demand, Tanesco has initiated a $8.6 million project for the construction of additional generating and distributing capacity. The International Bank for Reconstruction and Development has approved a loan of $5.2 million towards the project.

The copper requirements of Tanesco for the year 1967-68 are detailed below. The company estimates that its requirements of cable and wire are increasing at about 10 per cent per annum. By 1970-71, Tanesco is intending to substitute aluminium for copper low voltage cables. The high voltage 11 kv. cables will continue to be made of copper.

Table G.V - Tanesco: Requirements for insulated conductors 1967/8

Copper	Quantity (metres)	U.S. $ Value ($)	Unit price $ 1 metre
11kv 3 core 0.0225 sq. in. Paper insulated and armoured cable	1,709	5,965.1	3.49
11kv 3 core 0.1 sq. in. Paper insulated and armoured cable	364	3,267.6	8.975
11kv 3 core 0.2 sq. in. Paper insulated and armoured cable	258	3,399.2	13.174
Single core 7/.044 PVC	9,371	1,783	0.1903
" " 7/.064 "	9,144	3,424	0.3744
Two " 3/.029 "	6,946	2,489	0.3583
" " 3/.036 "	728	294	0.4038
" " 7/.029 "	3,829	1,789	0.4672
" " 7/.044 "	13,710	11,802	0.8608
" " 7/.064 "	1,092	1,293	1.1840
Three " 7/.044 "	521	548	1.0518
Four " 7/.044 "	1,553	2,077	1.3374
" " 7/.064 "	2,924	6,213	2.1248
" " 19/.064 "	1,242	2,671	2.1505
Aluminium 19/.083 "	4,204	12,535	2.9816

* Source: 'Supplementary Report on Market for Electricity for Tanesco' by Merz and McLennan, London, May 1968.

ANNEX H

UGANDA

COUNTRY REPORT

1. Introduction

1.1 Uganda, which became independent in 1962, has an area of 94,000 square miles nearly a fifth of which is occupied by lakes and swamps. Agriculture, as indicated in Table H.I dominates the economy and provides approximately 80 per cent of exports whilst supporting over 90 per cent of the population. Per capita income is somewhere in the region of £25 - 30 per annum. Cotton and coffee are the major crops and form the basis of the monetary agricultural sector. The major structural weakness of the Ugandan economy is its overriding dependence on the world prices of these two crops.

Table H.I - G.D.P. at Factor Cost by Industry - 1960 prices

($ Million)

Industry	1961	1962	1963	1964	1965	1966 Estimate	1967 Forecast
Monetary Economy							
Agriculture	135.2	124.6	150.3	160.7	163.8	176.6	176.1
Cotton Ginning, Coffee Ginning, Sugar M/ct	12.6	12.6	17.9	19.0	19.0	20.1	19.8
Forestry, Fishing, etc.	6.4	6.7	6.4	6.4	6.4	6.7	7.2
Mining & Quarrying	7.0	7.8	8.1	8.9	8.6	8.4	9.2
M/ct of food products	3.3	3.0	3.0	3.6	3.6	4.2	4.4
Miscell. M/ct	13.4	12.8	12.8	13.1	15 4	18.4	20.1
Electricity	5.6	5.8	6.4	6.4	7.5	8.4	9.2
Construction	9.8	10.3	9.2	8.6	11.2	10.0	11.2
Commerce	41.1	42.2	49.8	52.6	57.4	61.6	63.8
Transport & Communication	17.1	16.5	17.9	18.7	20.1	22.4	23.8
Govts. (central & local)	17.3	17.3	15.4	18.2	17.3	17.9	18.4
Miscell. Services	30.5	29.6	30.5	32.7	39.4	42.0	43.9
Rents	9.2	9.5	9.8	9.8	10.6	11.2	11 5
Total Monetary Economy	309.1	299.0	337.9	360.3	381.1	407.9	418 6
Non-Monetary Economy							
Agriculture	94.0	106.9	108.4	112.3	114.5	119.5	122.9
Forestry & Fishing	14.3	14.6	14.8	15.4	15.6	16.2	16.5
Total Non-Monetary Economy	108.3	121.5	123.2	127.7	130.2	135 5	139.4
G.D.P.	417.4	420.5	461.1	488.0	511.3	543 5	558.0

Table H.II - Value of principal Exports to destinations outside East Africa.

$ millions	1963	1964	1965	1966	Jan-Nov 1967
Coffee	76.16	99.12	85.12	97.44	87.64
Cotton	40.04	44.52	47.04	42.84	41.16
Copper	10.08	17.36	22.40	15.96	14.00
Tea	5.60	6.16	6.72	8.68	8.68
Total, All items including re-exports	152.6	185.92	178.92	184.52	166.60

One of the major obstacles to economic development is the distance of Uganda from a port (Mombasa is over 800 miles). However, this factor does give Ugandan industry a natural protection against imports which tends to foster the growth of industries supplying the local market. Uganda also suffers from lack of mineral wealth only copper is exported on any scale, although some tin, wolfram and beryl are exported in small quantities.

Uganda is a member of the East African Common Market and shares a number of common services with Kenya and Tanzania.

Under the policy of agricultural diversification tea cultivation has been encouraged since world prices seem to be more favourable and production is not restricted by the quota system which affects coffee output. Tobacco output is likewise forecast to rise from 6 million lbs. in 1966 to 18 million lbs. in 1970.

During 1967 the growth of the economy slowed down, provisional figures estimate real growth at just under 3 per cent compared with nearly 5 per cent in 1966. The slow down was due to the poor cotton and coffee crops which have a substantial impact on the G. D. P.

Much of the industrial activity is centered above the Northern shores of Lake Victoria. Kampala is the capital and also the largest city in Uganda with a population of 55, 000. The main industrial centre is Jinja (pop. 40, 000). The majority of the country's population of 8 million are rural dwellers and concentrated near the lakes in the South-East and West. The Northern region of the country is sparsely populated.

Most of Uganda's overseas trade passes through the port of Mombasa in Kenya which is some 830 miles from Uganda. The Uganda road network is probably the best in Central and East Africa. The rail system is connected with Kenya's and extends from Pakwach on the Nile South to Jinja and Kampala and then on to Kasese close to the Congo border. The railway is run as part of the East African Railways and Harbour board system. The lake steamers are also administered as part of the railways.

2. Copper Fabrication

2. 1. Activities and history. The one local copper fabrication plant is the Cable Corporation of Uganda Ltd. which was established in July, 1967. It is a subsidiary of the Mehta group. The plant produces PVC insulated housewires. There is a likelihood of the plant being expanded in the near future in order to produce low voltage underground power cables.

The present range of cables is shown in the price list Table H. III

2. 2. Output. The present turnover of the plant is $210, 000 and there are 20 employees, but it is expected that the planned expansion will double the numbers employed. At the moment the output of the plant is roughly 100 tons p. a. whilst its capacity is 150 tons.

The basis of the plant's copper fabrication process is imported 2. 6 mm. wire. The main sources for this wire are Belgium, U. K., West Germany and Japan. There is a duty of 15 per cent on the imported wire but the Ugandan Government has waived it for a temporary period of two years.

2. 3 Future. Expansion planned for 1969 is expected to increase turnover to between $840, 000 - $980, 000. The new plant which will cost $420, 000 will have a capacity to process 150 metric tons of aluminium and 400 metric tons of copper. The new fabricating plant will draw from wire rod instead of the present 2. 6 mm. wire and will produce a wider range of cables some of which will be of aluminium. As there is no local production of rod, Latreca in the Congo is being considered as a possible future source of supply of copper rod.

Zamefa in Zambia will be another potential source.

It is planned that the expanded production will meet Uganda's total needs of these types of cable and replace present imports. The Cable Corporation of Uganda Ltd. estimated that the market is growing at between 10 - 15 per cent p. a.

Table H. III - Cable Corporation of Uganda Limited.

Price list July, 1968

Electric wires and cables made to B. S. 2004/1961.

Size Single	PVC Insulated per 100 yds.	PVC Insulated & Sheathed. per 100 yds.
3/. 029	Shs. 25/=	Shs. 33/=
3/. 036	Shs. 36/=	Shs. 53/=
7/. 029	Shs. 50/=	Shs. 65/=
7/. 036	Shs. 78/=	Shs. 100/=
7/. 044	Shs. 111/=	Shs. 145/=
7/. 052	Shs. 192/=	
7/. 064	Shs. 234/=	

Size PVC Insulated and Sheathed 250/440 V. Per 100 Yds.

Size	Twin Flat	3 Core Flat	Twin Flat with ECC.
3/. 029	Shs. 61/=	Shs. 100/=	Shs. 82/=
3/. 036	Shs. 92/=	Shs. 171/=	Shs. 116/=
7/. 029	Shs. 122/=	Shs. 200/=	Shs. 170/=
7/. 036	Shs. 205/=		
7/. 044	Shs. 250/=		

P. V. C. Insulated Flexible Cords. 100 Yds. Coil.

7/. 010	PVC	Single Aerial wire		Shs. 7/25.	
14/. 0076	PVC	Twin Flat ass.	colours	Shs. 26/00.	
14/. 0076	"	Twin Twisted "	"	Shs. 28/00.	
23/. 0076	"	Twin Flat "	"	Shs. 38/00.	
23/. 0076	"	Twin Twisted "	"	Shs. 40/00.	
14/. 010	"	Single Auto Cable	"	Shs. 6/50.	100 Ft.
28/. 012	"	Single Auto Cable	"	Shs. 14/50	"
1/. 036	"	Single Bell wire	"	Shs. 26/00	100 Yds.
1/. 036	"	Twin Bell wire	"	Shs. 43/00	"

Table H.IV - Imports of Copper Products Metric Tons. U.S. Dollars. Source: Import Statistics.

	1963		1964		1965		1966		1967	
	Tons	$	Tons	$	Tons	$	Tons	$	Tons	$
Copper & Alloys whether or nor refined	1.4	1,226	20.2	15,976	30.8	27,179	3.7	4,606	16.2	22,624
Copper & Alloys of copper Worked Plates, Sheets, Strip	10.1	10,847	6.1	7,714	14.9	21,487	6.9	9,069	5.9	8,332
Copper Wire	8.4	8,878	9.0	8,531	37.9	43,122	24.7	4,118	68.3	95,202
Other Copper & Alloys of Copper Worked	44.3	60,314	66.0	82,227	71.5	108,850	123.1	215,451	73.8	129,136
Articles of Copper N.E.S.	N.A.		N.A.		–	4,583	–	2,486	–	10,306
Utensils of Brass, Copper, Bronze	N.A.		N.A.		3.0	6,633	1.85	2,948	1.5	3,872
TOTAL (not incl. Electric wire & cable insulated)	64.2	81,265	101.3	114,448	158.1	211,854	160.2	238,678	165.7	269,472
Electric wire & cable insulated	238.3	21,672	523.0	524,316	600.0	578,790	597.0	714,084	481.3	449,372

3. Demand for copper fabricated products

Demand for copper products is satisfied entirely by imports except for a limited range of housewire which is fabricated locally.

The import statistics covering the period 1963-67 are given in Table H. IV. Due to the small size of the Ugandan industrial economy the demand for imported copper products is not very complex or large in total. Bare and insulated conductors (SITC. 68222 and 72310) are the categories which have shown the greatest growth during the period for which statistics are available though fluctuations from year to year are significant.

In Uganda, there is one local plant which draws imported copper wire and produces a limited range of insulated housewiring. Some of the increase in imports of copper wire in 1967 was destined for insulation by this plant which explains the drop in imported insulated wire in that year.

4. Market Survey

Little detailed information is available concerning the consumption of copper fabricated products in Uganda. As stated above it is expected that the market is at present growing by 10 - 15 per cent. The only information on a major consumer is that detailed below concerning the Uganda Electricity Board. Information on copper consumption in the Ugandan Telecommunications Industry is given in the section relating to the East African Telephone Service in the Kenya Country Study.

4.1 Uganda Electricity Board

The Owen Falls Hydro Electric Plant has been the major element in Uganda electricity production, in order to meet expanding power needs it has been constantly extended and has now reached its capacity of 150 megawatts. The Board is entirely self-financing except for major capital investments. All of the underground cables used by the Board are copper. The Board also utilizes copper earthing rods.

The Ugandan Electricity Authorities are basing their future plans on an 8 - 10 per cent per annum growth in the market for electricity. A forecast* of Uganda's electricity production is given below:

Table H.V - Electricity production & Capacity in Uganda 1967-1980.

	MW	GWH
1967	80	455
1968	92	498
1969	104	576
1970	117	646
1971	127	701
1972	137	760
1973	149	824
1974	161	899
1975	174	958
1976	187	1,032
1977	201	1,110
1978	215	1,185
1979	233	1,265
1980	248	1,350

* Source: Report on Kenya-Uganda Co-ordinated Development - prepared for Uganda Electricity Board and East Africa Power and Lighting Co. Ltd. April 1968 by Balfour Beatty, Bow Bell House, London, E. C. 4.

Uganda's generating capacity is to some extent linked with Kenyan market growth. The maximum demand in Kenya and Uganda is estimated to increase from 175MW in 1967 to about 1,000 MW in 1986. The energy sent out from the main sub-station in the same years will go up from 1,000 GWH to about 5,300 GWH. At the moment a certain amount of the electricity produced is exported to Kenya. Uganda has plans to increase electricity production since the Owen Falls station is working at full capacity. A scheme is in the course of preparation for a Hydro-Electric plant at Murchison Falls. Planned production will be 600,000 KW or four times the maximum output of Owen Falls.

Because Kenya is developing its own Hydro-Electric capacity at Seven Forks the World Bank has refused a loan to Uganda to build an earlier Hydro Electric Power station at Bujagali Falls because of the potential duplication of generating capacity. The present transmission lines between Uganda and Kenya can be used in both directions. The World Bank suggested that Uganda should satisfy its future power requirements by importing energy surplus to Kenya's requirements. Uganda, however, seems determined to press ahead with a new power project of its own.

5. Copper Mining.

5.1. Organisation, History and Activities.

The only copper mine in Uganda is at Kilembe near the S. W. border of Uganda. The mine is operated by Kilembe Copper Cobalt who own 70% of the equity, the rest being owned by the public. Kilembe Copper Cobalt is itself owned 70% by Falconbridge, 20% by the Commonwealth Development Corporation and 10% by the Uganda Development Corporation.

Kilembe Copper Cobalt also operate a smelter at Jinja.

The initial capital of Kilembe mines was $19.8 million and since then $14.0 million additional capital has been subscribed. Capital expenditure for the last four years is outlined below.

1965	-	$2.94 million
1966	-	$2.29 "
1967	-	$1.28 "
1968	-	$1.68 "

The mine employs 5,617 people - of which 128 are European expatriates, 150 mixed races and the remainder Africans.

5.2. Capacity

Proven reserves of ore with a copper content exceeding 1.25 per cent amount to only 6½ million tons. As ore is extracted at approximately 1 million tons p.a. the life of the mine is limited unless further reserves are discovered. Field investigations into possible new ore deposits are currently being carried out and if these are found to be suitable they would greatly increase the known reserves. At present only ore over 1.25 per cent of copper is being extracted but three years ago, when production costs were lower, ores as low as 0.75 per cent were being mined.

5.3. Output

Uganda's output reached a peak in 1964 and is not expected to rise above the present level until the mine is worked out. If new reserves are not soon discovered, this would be in 1975. In 1966 output fell because unsettled political conditions led to the closure of the rail link between the Kilembe mine and the Jinja smelting plant. Production likewise fell in 1967 when the smelter was closed for a period for maintenance.

Table H.VI - Output of Blister copper 1957-1967

Smelter Output	Metric tons
1957	7,348
1958	10,714
1959	11,751
1960	14,284
1961	12,955
1962	15,091
1963	15,704
1964	17,718
1965	16,624
1966	15,672
1967	14,056

The smelter produces 99.25 per cent pure blister copper which contains 0.4 - 0.5 per cent of nickel. The monthly output of the smelter is approximately 1,300 tons. If there were to be a major expansion of copper output at the plant the present smelter capacity would have to be increased.

The Ugandan smelter copper is only 99.25 per cent purity compared with refined copper which is at least 99.9 per cent pure. The charge for refining the blister copper in the country to which it is exported is $45 per ton, though in a large refinery the refinery cost would be only $23 per ton. However, the Ugandan smelter owners do not believe it would be possible to refine locally for less than $35 per ton even if the cost of a refinery could be written off over a normal period. As it is, doubts about the likely life of the mine make the establishment of a refinery too risky given the relatively small saving and high capital cost. If the smelter was at Kilembe, profitable refining might be a possibility. At present smelting operations are at Jinja, approximately 250 miles by rail from the Kilembe mine which is situated close to Kasese in the south west corner of the country.

5.4 Costs of production

The steep rise in Ugandan production costs common to copper mining operation over the last few years is indicated below. Total costs per metric ton of copper (exclusive of capital expenditure which equals $80/ton).

1962	1963	1964	1965	1966	1967	1968
$487	$482	$497	$609	$701	$815	$823

The reason behind the rapid rise in production costs are two-fold - the difficulties of mining a partly worked out ore body and also the rise in labour costs. Falling productivity has been a feature of the mine in the last few years. The only solution to the declining productivity would be increased mechanisation but the small amount of proven reserves does not justify this. The only recent major capital investment is an electrostatic precipitator for flue gases which will cost about $700,000.

5.5 Market

The majority of the smelted copper is exported to Japan under a long-term five year contract. The selling price is based on the average monthly LME price with a deduction of $45 for refining charges. The cost of transport to Mombasa per ton of copper amounts to $14. At Mombasa wharfage charges and duties amount to $4. Shipping to Japan works out at $18. There is an export tax of 30 per cent on the selling price over $1,290. In order to stimulate mining exploration money spent on exploration is allowed to be offset against the export tax.

ANNEX I

KENYA

COUNTRY REPORT

1. Introduction

1.1 The Kenya economy is largely agrarian. In 1963 about 17.0 per cent of the GDP at factor cost was produced in the agricultural sector compared with 14.6 per cent in 1967.

Table I.I - GPD by Contributing Sector $m

	1963	1964	1965	1966	1967*
Agriculture - Monetary	146.55	147.48	132.33	163.86	163.38
Mining & Quarrying	4.52	4.14	3.86	4.68	4.68
Manufacturing	81.09	94.78	105.59	117.96	123.90
Building & Construction	18.76	18.96	19.57	26.32	33.43
Government	98.62	115.22	121.63	130.98	139.19
Subsistence sectors	224.11	235.31	226.66	263.23	277.87
G.D.P. (factor cost)	851.31	915.91	929.85	1064.48	1118.88

* provisional

Source: Republic of Kenya, Economic Survey 1968.

Despite this predominance of the agriculture sector the manufacturing sector has been growing steadily in recent years. The above GDP series shows that in 1963 9.5 per cent was accounted for by manufacturing as compared with 11.1 per cent in 1967. Over the years Kenyan industry has benefited from the East African market. The industrial groups which were the major contributors to the overall growth of 7.1 per cent per annum (1963 to 1967) were food; textiles and petroleum products. These groups apart from achieving substantial rates of growth, also have a relatively large weight in the index of manufacturing production because of their size.

The most important single enterprise currently in process of construction is a $14m fertiliser factory at Mombasa. This project will be one of the largest manufacturing establishments in Kenya when completed. Other manufacturing enterprises under construction include a plywood factory, plant for the assembly of load carriers, extensions to an existing bag and cordage factory and a new factory to manufacture jute bags. In addition the following major projects are under negotiation - two new textile mills, a paper mill at Broderick Falls, rubber tyres and a K£1m steel strip rolling mill in Mombasa. The steel will be fabricated into wire, nails, rivets, rods and angles.

Public sector participation in manufacturing enterprises is effected through the Development Finance Company of Kenya (DFCK) and the Industrial and Commercial Development Corporation (ICDC). At present Government policy seems to encourage purely private enterprise although in some cases there is limited Government participation. However, the Kenya Government will continue their priority to develop the processing industry based on local raw materials and to import substitution.

It would seem that the industrial development of Kenya could possibly proceed more rapidly now that the East African community has been inaugurated (December 1967). It is likely that the direction of industrial development will be a positive move into the domestic manufacture of capital goods, although it is difficult at this stage to identify the particular areas into which this move might go. Telecommunications equipment and motor assembly are two possible industries which may develop.

In recent years there has been an increasing deficit on the balance of trade. In 1967 total imports (including imports from Uganda and Tanzania) amounted to $336.0m and total domestic exports to $240.5m, giving an overall deficit of $95.5m as compared to $33.9m in 1963.

2. Domestic Copper Fabrication

A small wire and cable fabricating plant is situated in Nairobi. Although the company was established in 1965, it started production in June 1966 and full production early in 1967. The capital structure is as follows:

Equity capital	$252,000
Loan capital	$252,000
Working capital	$196,000
	$700,000

The company is a wholly owned subsidiary of the Delta Metal Group, which is one of the largest fabricators in the U.K. It supplies its products directly to Enfield Cables and other distributors.

The mill produces some 120 different types of cables. It has plant for wire drawing, stranding and extrusion. It produces the full range of housewires, steel wire, armoured cables, copper conductors, etc. The housewire range is from 14/.0076" to 37/.083" in 2, 3 and 4 core, to British Standard Specifications (B.S. 2004/1901, B.S. 3346/1961) and CMA Standard Specifications. The PVC Insulated, PVC Sheathed, SWA and PVC Sheathed range is from 3/.029" to 7/.064".

Wire drawing is based on imported $\frac{1}{4}$" copper rod from the parent organisation in the U.K.

Current production is running at around 200 tons per annum (copper). In 1967, production of wire and cable amounted to 150 tons. The 1968 figure represented 50-60% of the total East African market, which the company estimates at around 400 tons. Up to 31st May 1968, the import tariff was 15% in Kenya and Uganda and in Tanzania (mainland only) from 1st July, 1967. From 1st July 1968, the duty was increased to 30% and as a result, it can be anticipated that E.A. Cables will capture an increasing amount of the E.A. market. However, the Tanzanian tariff still stands at 15%. The tariff covers those copper and aluminium wires which can be produced by the factory. If the factory increases its range, then presumably the tariff will also be extended. It is understood however, that when the 15% tariff was operational, in Kenya and Uganda, non-members of the Cable Manufacturers Association were able to supply cable and wire at competitive prices to the East African market, in particular, electrical contractors, who made bulk orders from overseas from non C.M.A. Members, were able to land these in East Africa at a lower price than comparable locally fabricated products.

Of the total E.A. Cables production of 200 copper tons, it is estimated that two thirds represented insulated housewires and one third steel wire armoured cables. Bare conductors used mainly as earthing wire represented an insignificant proportion of total output. It was estimated that the break down of sales as between the three East African countries amounted to

	%
Kenya	50
Tanzania	30
Uganda	20
Overseas	0
	100

The official trade statistics for inter-territorial trade show that in 1967, Kenya exported 3,466 centals valued at $215,712 to Uganda and 3,897 centals valued at $240,030 to Tanzania and do not support the percentage breakdown given above.

There are no fiscal or other impediments to the movement of wire and cable exports to Uganda and Tanzania. Consumers of E.A. Cables have indicated that local products are not sold on reels which causes great inconvenience to the users.

The $\frac{1}{4}$" black rod is all imported from the U.K. and orders are placed through the parent company. At present, they have to finance three months stocks of wire rod - from time of order to actual use in the plant. Actual stocks held by the plant amount to one month's requirement. No duty is paid on imported rod. It was indicated that there would be no objection to purchasing the rod from Zambia and it was anticipated that there could be a cost advantage to the Nairobi based plant.

It was indicated that the selling prices for wire and cable as reflected in the Table I.II below are the same as the selling costs of comparable products in January, 1967. The plant sells directly to Enfields and Distributors and the end use is mainly for the construction industry. Enfields have been established in East Africa since 1950 and probably have at least 85% of the total market (including local products). In other words, other suppliers can to a large extent be ignored. Most of the imported Enfield products originate from the U.K., and this country's dominance as the main supplier is shown in the trade statistics.

Although E.A. Cables are currently producing only 200 tons (one shift $5\frac{1}{2}$ days week) their capacity is around 600 tons (3 shifts). As a result of the increase in the tariff, they anticipate a growing share of the total E.A. market, although their ultimate share will be dependent on the extent of local fabrication in Uganda. Their current labour force amounts to 40 plus with 4 management staff.

Table 1.II - E.A. Cables Ltd. Price List
(effective 1st July, 1968)

	PVC insulated (1 core)	PVC insulated and sheathed. (1 core)
3/.029	250/- per 1,000 yds	330/- per 1,000 yds
3/.036	360/- "	550/- "
7/.029	500/- "	650/- "
7/.036	780/- "	1,000/- "
7/.044	1,110/- "	1,450/- "
7/.052	1,920/- "	-
7/.064	2,340/- "	2,900/- "
19/.044	3,340/- "	4,000/- "
19/.052*	5,600/- "	-
19/.064*	7,500/- "	8,500/- "
19/.083*	12,400/- "	15,000/- "
37/.083*	29,900/- "	-

*prices apply only to Black, Red and Green Cables. Others 10% extra

Table 1.II - E.A. Cables Ltd. Price List (Continued)
(effective 1st July, 1968)

PVC insulated and sheathed. (250/440 volt)

3/.029	2 core	610/-	per 1,000 yds
	3 core	1,000/-	"
	2 core + earth	820/-	"
3/.036	2 core	920/-	"
	3 core	1,710/-	"
	2 core + earth	1,160/-	"
7/.029	2 core	1,220/-	"
	3 core	2,000/-	"
	2 core + earth	1,700/-	"
7/.036	2 core	2,050/-	"
	3 core	3,070/-	"
	2 core + earth	3,000/-	"
7/.044	2 core	2,500/-	"
	3 core	4,500/-	"
	2 core + earth	3,600/-	"
7/.064	2 core	5,690/-	"
	3 core	9,540/-	"
	2 core + earth	7,600/-	"

PVC insulated, PVC sheathed, SWA and PVC sheathed (250/440v)

3/.029	2 core	2,640/-	per 1,000 yds
	3 core	3,000/-	"
	4 core	3,600/-	"
3/.036	2 core	3,390/-	"
	3 core	3,720/-	"
	4 core	4,470/-	"
7/.029	2 core	3,600/-	"
	3 core	4,200/-	"
	4 core	5,100/-	"
	7 core	8,430/-	"
	12 core	14,400/-	"
	19 core	17,700/-	"
7/.036	2 core	4,620/-	"
	3 core	6,360/-	"
	4 core	8,250/-	"
7/.044	2 core	6,600/-	"
	3 core	7,980/-	"
	4 core	9,900/-	"
7/.052	2 core	8,700/-	"
	3 core	9,960/-	"
	4 core	13,800/-	"
7/.064	2 core	11,400/-	"
	3 core	15,240/-	"
	4 core	18,800/-	"

Table 1.II - E.A. Cables Ltd. Price List (Continued)
(effective 1st July, 1968)

PVC insulated flexible cords (250/440 volt.)

14/.0076	1 core	200/-	per 1,000 yds
	2 core	420/-	"
23/.0076	1 core	250/-	"
	2 core	520/-	"
40/.0076	1 core	350/-	"
Bell wires -	single	200/-	"
(1.036)	twin	400/-	"

PVC insulated and sheathed flexible cords (250/440 volt)

14/.0076	1 core	400/-	per 1,000 yds
	2 core	840/-	"
	3 core	870/-	"
23/.0076	1 core	450/-	"
	2 core	960/-	"
	3 core	1,050/-	"
	4 core	1,500/-	"
40/.0076	1 core	540/-	"
	2 core	1,200/-	"
	3 core	1,350/-	"
	4 core	1,740/-	"
70/.0076	1 core	700/-	"
	2 core	1,830/-	"
	3 core	2,070/-	"
	4 core	2,580/-	"
110/.0076	2 core	2,670/-	"
	3 core	2,940/-	"
	4 core	3,930/-	"
162/.0076	2 core	3,900/-	"
	3 core	5,160/-	"
	4 core	6,720/-	"

The value added by the local fabrication plant amounts to 35%. The rod is purchased at the LME cash plus £50 - $140.0.

Recently, E.A. Cables attempted to break through into the Ethiopian market, but came across these problems:

(a) Ethiopia was suffering from a flood of imports.

(b) High transport costs meant that the Kenya product was not competitive. Costing had been based on air freight and rail/sea/rail.

(c) The competition from a local fabrication plant.

(d) A very high duty.

(e) Ethiopia used a continental type specification which was different from the British Standards used by E.A. Cables.

The overall problems which E.A. Cables have faced is that many of the large projects are packaged deals and as such, orders for wire and cable are placed overseas. Thus for example, in recent projects undertaken by TANESCO because the project was

financed by the World Bank, all orders were placed overseas. E. A. Cables could have provided 85% of all the electrical wire and cable requirements. Similar examples could be taken from British, American and Chinese financed projects.

E. A. Cables estimated that the market will increase by 8 per cent per annum. It was suggested that this was closely tied to increases in electricity demand and thereby to growth of the construction industry. They felt that in Kenya, the current building boom would be over by the end of 1968, that the construction industry in Tanzania was picking up, and that in Uganda the recent introduction of a sales tax had dampened building activity.

3. Demand for Copper Products

The trade statistics are based on the SITC classification but do not give a fully detailed breakdown into sub-headings.

The largest category is insulated conductors which was growing until 1966. The decline in this category of imports in 1967 was due to the growing importance of the local fabricating plant. This category includes insulated aluminium conductors which are used fairly extensively by the electricity authority.

The other important heading is 68229 - Copper not elsewhere specified.

Table 1. III - Imports of Copper products into Kenya - 1965 - 1967

		1965		1966		1967	
		Tons	$	Tons	$	Tons	$
68221	Copper and alloy, plates. sheet & strip	31.1	40,958	21.0	30,632	22.3	35,842
68229	Other copper semi-manufactures	71.9	106,467	138.8	233,699	331.7	397,681
68222	Bare copper wire	176.8	197,299	163.7	241,035	199.3	159,621
69729	Domestic utensils	10.2	27,006	4.3	10,365	10.4	28,137
69892	Other copper manufactures	–	7,011	–	16,839	–	7,957
Total		290.0	378,741	327.8	532,570	563.7	729,238
72310	Insulated conductors (including aluminium)	870.0	878,550	975.0	1,153,499	794.0	956,765

4. The Principal Industrial Sectors

4.1 The Mining Industry

The mining industry is very small indeed and accounted for only $4.68m. of a total GDP (factor cost) of $ 1,118.88 in 1967.

There are in fact a few copper deposits in Kenya. The Macaulder Mine in South Nyanza was started in 1951 to produce precipated or cement copper. Ore reserves in June 1963 were estimated to consist of 142,370 short tons containing 2.70 per cent copper. Apart from the copper mineralization at Macaulder Mine several minor occurancies of copper sulphides and carbonates have been reported. Copper production in 1964 amounted to 2,044 long tons valued at $1,833,053. In 1967 however the value of copper production had fallen to $15,400.

The main mineral deposits being worked in Kenya are Soda Ash at Nagadi followed by salt and gold.

Given the present mineral knowledge of Kenya, it is unlikely that a large mining sector will be developed in the immediate future.

4.2 Electricity

There are three associated but separate companies engaged in the electricity industry in Kenya.

East African Power and Lighting Company (EAPL) is the oldest of the power companies and was established in 1922. It is a public limited liability company. Although its essential role is that of a distributor of electricity to the consumer, it owns thermal generating plants. During the last ten years EAPL has undertaken capital expenditure on the development of the electricity industry at an average rate of $2,297,405 p.a. The company is pursuing a policy of widespread expansion of its distribution network to the consumer in rural areas and urban housing estates.

The Kenya Power Company (KPC) was established in 1954 and is owned one-third by the Kenya Government, EAPL and Power Securities Corporation Ltd. KPC's role is twofold. Firstly KPC purchases a bulk supply of up to 45MW of electricity from the Uganda Electricity Board and transmits this power to Nairobi. Secondly the company generates electricity at its stations on the Upper Tona and Maragua rivers and sells electricity to the EAPL.

The Tona River Development Company Ltd. (TRDC) was established in 1964 to develop the hydro electric power resources of the Tona River at Seven Forks and downstream thereof. The inital stage is the Kindanuma Hydro-Electric Power Station with an initial installed capacity of 40MW. As demand for electricity grows successive stages of the Seven Forks Scheme will be developed giving an ultimate installed capacity of 340MW at an estimated cost of some $98m. Subsequent development of the river's resources downstream of Seven Forks could add a further estimated 700MW to Kenya's power resources. TRDC is a private limited company owned by the Kenya Government, Commonwealth Development Corporation, EAPL and Power Securities Ltd. in equal shares.

The EAPL runs both KPC and TPDC on an agency basis. The main 132 KV line from Uganda to Nairobi covers a distance of 252 miles and it is from this line that the bulk of the electricity is distributed. In addition the EAPL is supplied with electricity from KPC, TRDC and from their own diesel stations. However, the latter are being phased out as the inter-connected grid network is developed. The other transmission lines are a 132 KV line from Kindanuma on the Seven Forks Project to Nairobi, a 66KV line from Tana to Nairobi and about 348 miles to 33KV, and 1,530 miles to 11KV cables at 31st December 1966. The following table gives details on the consumption of electricity from 1964 to 1967.

'000kwh	1964	1965	1966	1967
Domestically generated	323,179	327,503	346,800	339,365
Imported	183,286	190,484	203,000	241,982
Total Available	506,465	517,987	549,800	581,347
Power station use + transmission/distribution losses	80,780	83,969	84,800	95,784
Net Sales	425,685	434,018	465,000	485,563

The above figures show that over the period as a whole there has been a 14 per cent increase in units sold. The total installed capacity in Kenya is 135MW (excluding Kindanuma) as the basis of the 20 year Development Programme drawn up by Balfour, Beatty and Company Limited of London (dated May 1967) which included a detailed study of the electrical

demands and the KWL requirements for Kenya up to 1980. The following power development plan was drawn up:

	Additional	Total installed capacity	Estimated capital cost
1967 Existing	-	135MW	
1968 Kindanuma - Seven Forks	40	175MW	completed
1970 Nairobi	15	190MW	$ 1.4m
1971 Kipevu (Mombasa)	30	220MW	$ 4.5m
1973 " "	30	250MW	$ 4.5m
1974 " "	15	265MW	$ 1.1m
1975 Kindanuma - Seven Forks	20	285MW	$ 1.4m
1976 Kambura - " "	14	299MW	$ 1.1m
1976 Gtaru - " "	80	379MW	$28.6m
1977 Kipevu (Mombasa)	15	394MW	$ 1.1m
1978 Kambura - Seven Forks	20	414MW	$ 1.4m
1979 Gtaru - " "	40	454MW	$ 2.5m
1979 Upper Reservior " "	40	498MW	$29.7m

This expansion programme has been based on an assumed 10 per cent per annum load growth. However it is felt that this is on the high side and that a more realistic figure is 8 per cent growth per annum. Although the Uganda and Kenya systems are inter-connected, Kenya should be self-sufficient for power in 1976 and will then be in a position to export electricity to Uganda.

The development programme for transmission lines include the following projects:

(a) 132KV (or possibly 275KV) double circuit line from Nairobi to Mombasa. This 300 mile line will be completed in 1970. Initially power will be transmitted to Mombasa but when the 30MW steam turbine and 15MW gas turbine plants are completed, Mombasa will be exporting power to Nairobi.

(b) An additional 132KV line from Kindanuma to Nairobi.

(c) Two additional lines (66KV) to Nairobi when the Seven Forks scheme is completed.

(d) A double circuit from Owen Falls in Uganda to Nairobi.

Other than these schemes EAPL are currently engaged on "amenity" projects which tend to be sub-economic. However the budget for these is limited to 1 per cent of gross revenue (between $140,000 - $280,000 per annum). These non-profit schemes will continue in the future. Normal capital expenditure amounts to around $1,400,000 per annum. However during the next ten years annual expenditure will be in the region of $18.20m per annum due to the construction of the Mombasa circuit. This line is being financed by CDC and ECGD.

All the overhead transmission lines are aluminium which will be used for all the new projects. Underground cables for mains distribution are still copper. At the end of 1966 this amounted to 68 miles. However there is increasing use of solidal aluminium and this tendency is likely to continue. Whilst all the service lines are aluminium, home wiring which the EAPL does not use, is copper. For earthing wire preference is given to the use of copper although some aluminium is used. However, in the coastal areas aluminium cannot be used due to high humidity, salt and high temperature.

The EAPL currently use no copper to meet their annual requirements of wire and cable (see Table I.IV). The total cost of the conductors listed in Table I.IV, which represents the annual requirements of EAPL is $317,315 per annum. However in addition to wire and cable EAPL purchases about $636 copper busbars per annum and $13,613 copper earthing rods per annum.

The electrical code currently in use in Kenya is based on that published by the Institute of Electrical Engineers in the U. K. However, the Kenya National Rules are in the process of being revised in order to simplify further the IEE rules to adapt them more to local conditions and at the same time to reduce the cost of some of the installations whilst increasing safety. It is these IEE regulations which virtually secure copper wire and cable for use in housewiring. It must therefore be assumed that unless these are changed copper conductors will continue to be used in housewiring, that there will be no copper used for overhead transmission lines, that copper will continue to be used to a certain extent in underground mains distribution and as earth wires. Given this picture it is unlikely that copper will ever regain a substantial foothold in those areas where the change has already come about.

Table I.IV - EAPL's Annual Consumption of Wire and Cable in 1967

ALUMINIUM CONDUCTORS	
PAPER INSULATED	
11 KV Paper Insulated/Lead Covered/SWA	
.06 sq. in.	1,000 yds.
.15 ..	500 yds.
.3 ..	500 yds.
PVC INSULATED	
L.V. Aluminium solidal/unarmoured	
0.6 sq. in. single core	500 yds.
1.0 ..	200 yds.
L.V. Aluminium Solidal/concentric neutral armoured	
.0225 sq. in. single core	15,000 yds.
.04	13,000 yds.
.06	8,000 yds.

Table I.IV - EAPL's Annual Consumption of Wire and Cable in 1967 (Continued)

L.V. Aluminium solidal/armoured

.04 sq. in. 4 core	2,000 yds.
.06	8,000 yds.
.15	5,000 yds.
.20	3,000 yds.
.30	1,000 yds.
.50	1,000 yds.

S.C.A. Conductors

.025 sq. in. (copper equiv.)	(6 x .093 alum + 1 x .093 steel core)	20,000 yds
.05 ..	(6 x .132 alum + 1 x .132 .. ..)	8,000 yds
.10 ..	(6 x .186 alum + 7/.062	1,000 yds

BARE CONDUCTORS

Hard Drawn Aluminium

7/.056 PVC insulated S/C conductors (single core)		5,000 yds
7/.081	..	100,000
7/.122	..	30,000
7/.173	..	1,000
7/.056 PVC insulated/sheathed S/C conductor (single core)		2,000
7/.081	..	30,000
7/.122	..	12,000
7/.173	..	8,000
7/.056 PVC insulated/sheathed flat pairs		1,000
7/.081		10,000

Bare aluminium conductors

.022 sq. in. copper equiv.		7/.081	200 miles
.05 ..	..	7/.122	150 miles
.1 ..	..	7/.173	20 miles

Steel Cored Aluminium

.025	6/.093 + 1/.093	480 miles
.05	6/.132 + 1/.132	150 miles
.1	6/.186 + 1/.062	70 miles

4.3 General Post Office

The East African Posts and Telecommunications Administration is one of several common services covering Kenya, Uganda and Tanzania and for the sake of convenience is included in this section on Kenya. The growth in the number of telephones in East Africa is given below:

	1964	1965	1966	1967	('000s)
Kenya	50.6	53.6	56.9	60.7	
Uganda	17.7	19.3	21.3	23.4	
Tanzania (mainland)	20.9	22.5	25.0	26.9	
	89.3	95.4	103.2	110.9	
Increase %		6.8	8.2	7.5	

About 75 per cent of the network is concentrated in Nairobi, Kampala and Dar-es-Salaam. The long term forecast suggests that an 8 per cent per annum growth rate would seem reasonable.

The annual requirements of wire and cable are as follows:

External Cables	4 lb/m	6½ lb/m	10 lb/m	20 lb/m	40 lb/m
Plain Lead U/G Cable miles	1,360	26,444	5,336	496	74
copper weight (sh. tons)	2.7	85.9	26.7	5.0	1.5
Armoured U/G Cable miles		6,708	1,568	235	54
copper weight (sh. tons)		21.8	7.8	2.4	1.1
Aerial Cable miles		3,478	800	2,105	–
copper weight (sh. tons)		11.3	4.0	21.1	–
Total Copper weight (201.3 sh. tons) (182.6 sh. tons)	2.7	119.0	38.5	28.5	2.6

Overhead Wire		Wire/Miles	Metal content
Cadnium Copper	40 lbs/mile	550	11.0 tons
	70 lbs/mile	120	4.2
Copper Hard Drawn	100 lbs/mile	100	5.0
	200 lbs/mile	230	23.0
Copper Covered Steel	0.80 ins.	1,350	67.2
	0.104 ins.	1,400	112.0
Drop Wire PVC No.1 Cadnium Copper	20 lbs/mile	2,400	24.0
Rural Distribution - copper	20 lbs/mile	680	6.8
		–	253.2

Internal Wire			
Annealed copper wire	6½ lbs/mile	1,600	5.2
	12½ lbs/mile	200	1.3
	20 lbs/mile	60	0.6
			7.1

All specifications are based on British GPO standards. For telecommunications copper is regarded as the best conductor and that the substitution price limit is around £700. In other words the Post Office has no interest in aluminium although the latter is being used for certain types of busbars (breakeven point is around £400-£450).

The copper content of telephone instruments and exchanges is small and in the case of the former there is greater usage of printed circuits. In the East African context the large exchanges are delivered as package deals. The GPO is self financing. The current World Bank loan of $13m is estimated to meet half its own requirements up to 1970. As a result of various Bank loans the GPO is required to go out to tender. However, cables tend to be purchased in bulk from UK producers whilst indoor cables are purchased locally from Japanese, Italian, UK or French sources.

4.4 Construction Industry

The building and construction industry has experienced a rapid rate of growth over the period from 1963 to 1967 which reflects the overall growth in the economy. The usual problems are encountered in estimating the copper content of products used in the industry. It is suggested that approximately 6 per cent of total contract in the building industry represents on average the value of electrical installations. Of this two thirds constitutes electrical materials and probably one sixth of the total electrical installations is accounted for by wire and cable. In other words probably 1 per cent of the total contract is in fact represented by wire and cable. Clearly this percentage changes with the nature of the building and the range of cable and wire is probably between 1 to 2 per cent. However, in any one year the building programme consists of a large variation of schools, hospitals, houses, government offices etc. and the private sector is involved in industrial buildings, office blocks etc. and as a result a 1 per cent figure representing the wire and cable content has been taken. The total value of contracts in the building industry are not available. However, in 1967, the Nairobi City Council approved $30.5m worth of plans and in the same year the Capital Formation estimates give a figure of $37.69 for non-residential buildings and dwellings (excl. the non-monetary sector). A figure of $28.0m has been taken as representing the total contract value of which $280.000 is assumed to represent wire and cable, nearly all of which would be copper.

By and large copper is extensively employed for housewiring and the British Code of Practice is used for electrical wiring in Kenya. In general as soon as standards are found to be acceptable in the UK the practice concerned is likely to be introduced into Kenya.

By and large the Kenya Government is not as extensively involved in house building programmes as are other Governments. However, during the last few years the Ministry of Works has been involved in a large number of major projects - IDA School programme, Government offices etc.

Very little copper is used in plumbing except for jointing purposes. However, chrome plated brass is widely used for taps and fittings. In addition a certain amount of copper foil is used with bitumised felt as a roofing material.

4.5 Railways

The East African Railways and Harbour Board operates the railways in all three countries of the East African Common Market. Purchases of copper products are shown in Table I.V for the years 1964 to 1967. Considerable quantities of a wide range of products were used though the pattern of usage is changing. PVC cables are accounting for a higher proportion of cables used and less rubber and CTS - CMA are being purchased. There has also been a decline in the quantity of copper ingots purchased - these are used for casting spare parts especially for steam engines; newer locomotives have fewer bronze, brass or copper spare parts. The railway has its own foundry to cast these spares.

Table I.V - East African Railways and Harbour Board: Consumption of Copper Products

Description	1964–6 (Average) Weight kgs	1964–6 (Average) Value $	1967 Weight kgs	1967 Value $
Cable.				
P.V.C. Insulated				
Single Core	5,920	16,963	7,671	21,484
Multi-Core	1,100	3,727	1,109	4,196
CTS Grade				
Single Core	51	96	2	7
Multi-Core	1,367	4,478	703	2,426
Rubber Insulated Cables	44	246	2	17
Misc. Insulated Cables	75	650	78	207
Insulated Wire	1,399	3,445	864	3,108
Total Insulated Wire & Cable	9,956	29,607	10,429	31,446
Bare Wire	1,218	2,250	1,971	3,704
Copper Flat	34	75	12	17
Copper Round	2,547	3,859	2,746	4,132
Copper Sheet	1,424	2,239	2,047	3,183
Copper Tubes	6,530	15,611	8,619	21,856
Copper Ingots	51,981	61,207	45,145	53,158
Total	73,690	114,848	70,969	117,496

MALAWI - COUNTRY STUDY

1. Introduction

1.1 The predominance of the agricultural sector in the economy is illustrated by the following table:

Table J.I. - GDP at factor cost ($m at current prices)

	1964	1965	1966	1967
Agriculture: African rural sector	14.28	21. 0	23.24	24.36
Other	8.12	8.40	9.52	9.24
Mining and quarrying	-	-	.28	.28
Manufacturing	9.52	12.04	15.40	21.00
Building and construction	4.76	7.00	8.96	8.96
Electricity, water and sanitation	1.68	1.96	2.52	3.36
Distribution	15.68	20.72	25.20	25.20
Banking, insurance and finance	.28	.28	.28	.28
Real Estate	.84	.84	1.12	1.40
Ownership of dwellings	1.40	1.40	1.68	1.96
Transport and communications	7.00	9.80	15.68	17.08
Public administration and defence	10.36	10.92	12.04	12.32
Education	3.92	4.48	5.32	6.44
Health	1.68	1.96	2.24	2.24
Domestic services	2.24	2.52	3.36	3.64
Other services	3.64	4.20	5.60	6.16
Monetary GDP at factor cost	84.84	107.52	132.44	143.92
Subsistence Production	64.40	69.72	71.96	75.04
GDP (factor cost)	149.24	177.24	204.40	218.96

Source: Economic Report 1967

It will be seen that agriculture accounted for 15.3% of the total GDP in 1967. The Economic Report for 1967 suggests that real output has "moved to the extent indicated by changes in the current-priced series" (p. 7). Given this the manufacturing sector share of Monetary GDP was 9.6% in 1967 as compared to 6.4% in 1964. There has been a "great surge in industrial activity" since the break-up of the Federation of Rhodesia and Nyasaland at the end of 1963. However, the 1967 Economic Report indicates that "the end of 1967 (has seen) most of the obvious opportunities for industrial development already exploited..... This decline in the rate at which new industries are established was for-seen long before it came about and is not a matter for concern." (p. 28). In 1967 a textile factory, a factory producing agricultural hoes, a distillery and a firm manufacturing aluminium and enamelled hollow-ware all came into production. In addition widespread interest has been shown in the manufacture of paper products in Malawi and a brewery is

under construction. For the future Malawi will be placing maximum emphasis on the development of agricultural processing industries (the bulk of net value of the manufacturing is already accounted for by tea and tobacco processing). To a large extent therefore the economy will be dependent on the main agricultural export products Tobacco, Tea, Groundnuts and Cotton. In 1966 the Sugar Corporation of Malawi (SUCOMA) started full production. The $8.4m capital involved represents the largest single private investment ever undertaken in Malawi.

Although domestic exports have risen over the period 1964-1967, imports have increased at a faster rate despite their fall in 1967. After taking account of invisible service items, net factor income and transfer receipts, the balance of payments deficit on current account was $20.72m in 1966, the first year for which official estimates are available.

Table J.II - Basic data on Malawi

Area	45,000 square miles (8,000 square miles under water)				
Population	about 4 million				
	1964	1965	1966	1967	$m.
GDP at factor cost	149.24	177.52	204.40	221.20	
External Trade					
Exports (f.o.b.)	35.00	40.04	48.72	52.08	(forecast)
Imports (f.o.b.)	-40.04	-57.12	-76.44	-75.60	
Trade deficit	- 5.04	-17.08	-27.72	-23.52	

2. Copper fabricating industry

Besides the small brass foundry there are no facilities for fabricating copper and copper alloy products in Malawi. The brass foundry is operated by Malawi Railways to meet its own requirements and has not been analysed in this study.

3. Market for copper products

The demand for copper products in Malawi is met entirely by imports. The market for copper products as shown by the Import Statistics (see Table J.III) is relatively very small. This reflects the extent of industrial activity in the manufacturing sector and the fact that there is no mining industry. Most of the wire and cable supplies originated from South Africa and Rhodesia. The requirements for semi-manufactured and manufactured products is extremely limited. Demand for insulated cables has increased most rapidly in recent years.

4. Main industrial sectors

4.1 Electricity Authority

The Electricity Supply Commission of Malawi (ESCOM) is the only authority involved in generation, transmission and distribution of electricity. The largest hydro scheme is at Nkula in the Southern Province which has an installed capacity of 24 MW. From here there are two 66 KV transmission lines to Blantyre where there is a steam/diesel plant with a 10 MW installed capacity. One of these 66 KV terminates at the Sucma Sugar Estate. Additional small generation plants are situated at Zomba (1.4 MW), Lilongwe (2.7 MW), Mzuzu (0.4 MW) and Fort Johnson (0.1 MW) and there is a network of 33 KV lines joining Zomba, Chola, Mlanje and Chileko with Blantyre. The major projects for ESCOM are:

Table J.III - Imports of Copper Products into Malawi 1964-66

		1964		1965		1966	
		tons	$	tons	$	tons	$
68271	Copper tubes	2.6	3,203	2.0	2,503	30.0	17,368
68260	Copper sheet	4.2	3,657	1.2	1,165	1.6	3,648
68250	Copper bar or rod	.1	280	.1	319	1.4	1,870
68221	Brass or bronze bar or rod	1.1	974	1.9	1,613	7.0	8,226
68231	Brass or bronze pipes and tubes	.1	112	1.2	1,529	1.1	1,848
68244	Brass or bronze sheet	.7	837	.5	823	1.3	1,803
68222	Phosphor bronze bar, rod and tubing	.2	272	.1	106	1.8	2,906
68219	Phosphor bronze rough cuts	2.0	1,884	1.3	1,509	.3	568
68299	Copper and copper alloys n.e.s.	6.5	5,589	.2	412	.5	994
68272	Copper pipe fittings	.5	840	5.6	6,726	5.0	5,975
68232	Brass and bronze pipe fittings	1.1	2,654	3.5	8,033	3.4	6,538
69996	Copper manufactures n.e.s.	–	10,212	–	1,386	–	1,078
6828	Single wire (bare)	7.0	3,049	46.0	34,922	54.7	n.a.
69312	Stranded wire (bare)	17.0	16,817	1.4	1,299	4.9	8,383
	TOTAL	43.1	50,380	65.0	62,345	113.0	61,205
72310	Insulated conductors*	156.0	124,662	416.0	232,103	524.6	521,606

*Includes aluminium and weight of insulant

(a) 66 KV lines from Nkula to Tedsoni, from Blantyre to Tedsoni and from Blantyre to Lilongwe.

(b) The Ranking Report (completed in January 1967) recommended that an additional hydro-electric station should be constructed at Tedsoni Falls. It was further recommended that the first stage should consist of 2 x 8MW generators at an estimated cost of $5,787,600. ESCOM's development at the Tedsoni Falls is scheduled as follows:-

	Installed	Total Capacity
2 x 8 MW	16MW	16MW by end 1971
plus 2 x 8MW	16MW	32MW by end 1971
1 x 8MW	8MW	40MW by end 1974
1 x 8MW	8MW	48MW by end 1977
(2 x 16MW plus (increasing 8MW to 9MW	32MW	80MW) 86MW) 1979/80

These developments are based on the assumption that the Malanje bauxite deposits will not be developed. However, in this eventuality the Tedsoni Falls scheme will be stepped up and/or other potential hydro sites will be developed. Malawi has a substantial hydro electric potential.

The finance for all the major capital projects is obtained from outside sources. During the current 3 year period (1969-71) the IDA has provided the capital for the Tedsoni development and the Blantyre-Lilongwe transmission line.

ESCOM has been using overhead aluminium conductors for the past 8/9 years. At present there is some 102 miles of 66KV, 169 miles of 33KV and 236 miles of 11/33KV overhead line. Copper is used for low reticulation overhead cables but the annual requirements are fairly small (about 150 miles installed). In addition copper is used in underground cables but again the annual requirements are very small (about 15 miles installed).

Since ESCOM was formed in 1957 there has been a considerable growth in the amount of units sold from 15.76mn KWH in 1957 to 73.45mn KWH in 1967. In 1966 there was a 35.5 per cent increase on the previous year and in 1967 a 26.8 per cent increase on 1966. It is anticipated that this growth will continue like that for the period up to 1980 - a 10 per cent increase would seem reasonable.

4.2 Malawi Railways

The railways will have completed their plans for dieselisation by the end of 1968 which will reduce their requirements of copper and copper alloy products quite considerably. The steam locos did use a certain amount of copper piping and copper fire boxes and after dieselisation has been completed, the use of brass will be mainly confined to axle box bearings for wagons. The Railways do have a small foundry for castings. However this is used entirely for their own purposes.

There are no plans for electrification at present, although a rail link is under construction - from Nova Fresa in Mocambique (railhead to Nakala) to the Malawi border, a distance of 109 miles, 63 miles of which are in Malawi. This project which is scheduled to be commissioned by November 1970 is being financed by South Africa. In addition a further rail link to run from the Malawi line of rail to Tete in Mocambique to join up with the existing system (100 miles to the Portuguese border) is under active consideration. These developments together with the Cora-Balassa dam scheme could have interesting developments so far as Malawi is concerned. In particular, the improved transport links

to the coast could affect the economic position of the bauxite deposits on Mount Mlanje. A further railway development could be a link to Lilongwe - the new capital of Malawi currently under construction.

4.3 Post Office

The Post Office has experienced a 12 per cent per annum growth in telephones between 1964 and 1967 and it is anticipated that this will be maintained up to 1972. However, it has been suggested that an 8/9 per cent growth rate should be assumed for the period up to 1980. The 1968 consumption of wire and cable is as follows:

Overhead (truck line) - all copperply	
0.104"	27 tons
0.080"	31 tons
0.064"	7 tons
Underground Cables - all Paper Insulated/Lead covered	
10/10 lbs	113 pair miles
14/10 lbs	37 "
20/10 lbs	61 "
38/10	130 "
54/10	165 "
74/10	604
100/10	214
150/10	151
200/10	79
Drop Wire	
No. 2 31 lbs cadmium/copper twin 10,000 yards	
No. 3 .028" copper wire 150 to 200,000 yards	
(No. 2 drop wire is being replaced by .045" copperply)	

All these specifications are to British Post Office Standards.

4.4 Construction Industry

Estimates of copper consumption in the construction industry are difficult to obtain. The Malawi Housing Corporation, a statutory body established in 1964, for purposes of building, administering and maintaining houses in Malawi, owns some 4,500 houses nearly all of which are low-cost. During the current five year period 1968-71, the corporation intends to construct 2,000 to 2,500 houses or 500 houses per annum. All these housing units are standardised and their annual copper wiring requirements (for 500 houses) are:

.002"	3/.029 1 core	20,625 yards
.0045"	7/.029 "	32,450 yards
.0225"	7/.064 1 core	3,810 yards

It would seem that copper wire and cable is used for the full range of housewires. Moreover it appears that the Corporation accounts for a significant part of building activity.

The annual expenditure on buildings in 1968 is estimated to be $3.92mn. This figure is anticipated to increase to $7.0m in 1969 as a result of the heavy IDA school programme which will run from 1969 to 1971.

Although the detailed plans of the Lilongwe developments are not available, it is known that the new capital will be built in four phases. The first is being covered by a loan of R. 8 million from South Africa and will involve the construction of 700 to 800 houses. Ministerial offices for two complexes, infrastructures etc. It is understood that the new capital will be completed within 10 years (1969/79).

5. Copper mining and aluminium production

No reserves of copper ore are known or indicated in Malawi. However, there are considerable reserves of bauxite which have been considered as the basis of a future aluminium industry. Since aluminium, if produced, would be competitive with copper the possibility of this happening is considered in this section.

At present there is no mining industry as such although there are some very small mining operations. The Geological Survey Department is, however, involved in a large scale geological study which includes geo-chemical sampling. It is well known that Malawi does have a substantial deposit of Bauxite which at present has not been exploited. The deposits have been extensively explored and analysed. On the basis of these investigations the reserves are estimated to be between 50 and 60 million tons (mainly trihydrate ore). The ECA Report entitled "East Africa and the Aluminium Industry - a Pre-feasibility Study" (dated 12th October, 1965 E/CN 14/INR/100) states that "these investigations.... indicate that the Malawi bauxite in its natural condition is at least as good in respect of alumina and reactive silica as the bauxites used to produce alumina in Guinea at Fria, and if concentrated by simple treatment to remove quartz, would be comparable with Ghana's exported bauxite and other ores now used for aluminium production at an alumina level of 50 per cent or more, for a silica level less than 4 per cent ... The ore would be mined economically by open-cast methods, after removing an overburden averaging 1-2 feet. The principal problem of the Malawi bauxite is the location on the Licherye plateau near Mlange mountain, two miles long and a mile wide, about 6,000 feet above sea level, and separated by precipices 3,000 feet above the accessible lower elevations. This location is 12 to 20 miles from the rail station at Luchenza and 322 miles by rail from the Port of Beira. This potential transport problem will be reduced when the new railway line from Nova Fresa to the Malawi railroad above Blantyre is commissioned. This railway will give Malawian traffic access to the port of Nacala in Mocambique. The ECA study referred to above considered the possibilities of Malawi exporting bauxite or alumina or aluminium. The former possibility was excluded due to the high transport cost. Likewise it was suggested that the manufacture of alumina with a plant capacity of 200,000 metric tons would not be possible under competitive conditions even if favourable freight rates could be obtained. Finally the ECA Report indicated that "the manufacture of aluminium at a 100,000 ton smelter adjacent to the 200,000 tons alumina plant and near the bauxite deposits, would be profitable to serve both East Africa and foreign markets provided that the East African market were a common unit with protection of the published world price against dumping." (p. 103). This conclusion assumes the availability of an adequate low-cost power supply. However, now that the new Nacala rail link is under construction and the Zambezi hydro electric potential is going to be harnessed at Mocambique the economic possibilities of exploiting the bauxite deposits could be changed. However, it should be pointed out in this connection that low cost power could be made available from the various Shire River projects. If the bauxite were ever exploited then this development could have a significant effect on Malawi's requirements of copper products. In particular if a smelter were established a large amount of electricity would be required. The ECA report indicated that with a 100,000 metric ton capacity alumina smelter, 200 MW of power would be required for the smelter in addition to the 10 MW of power required for the alumina plant.

Current indications suggest that despite the new transport link (s) and power developments, the bauxite question has not been reconsidered. However, it is possible that South African interests might re-explore the possibilities of mining and exporting the bauxite to Port Richards (south of Durban) where the newly established smelter is currently processing Australian bauxite. For the purposes of this study it has been assumed that, although a bauxite mining operation might be started, neither an alumina plant nor a smelter will be established in Malawi during the period under consideration.

ANNEX K

ETHIOPIA

Country Report

1. Introduction

Agriculture dominates the Ethiopian economy employing 90 per cent of the population and contributing about 60 per cent of the gross domestic product, compared with only 3 per cent for manufacturing industry. However, the industrial sector, although of minor importance is growing rapidly. During the second five year plan (1962-1967) the annual rate of growth of the economy was estimated at 4.3 per cent, but if population increase is taken into account, the rate of growth per head was about 3 per cent per annum. In the period of the third five year plan the rate of growth of GNP is expected to increase to 6 per cent per annum.

Table K.I. - 3rd 5 Year Plan (1968-1973)

Production Targets for the Major Sectors of GDP at factor cost

	1967/68		1972/73		Growth p.a.
	$'000	%	$'000	%	%
Agriculture	843	59.0	974	51.0	2.9
Industry (i)	179	12.5	302	15.8	11.1
Transport and Communications	188	13.1	315	16.5	10.9
Education, Health and Housing	90	6.3	133	7.0	8.1
Other Services	130	9.1	188	9.7	7.6
	1,430	100.0	1,912	100.0	6.0

(i) Includes mining, manufacturing, handicrafts, small scale industry, building, construction and power.

As can be seen from the table above, the planned rate of growth of the industrial sector during the period of the 3rd Plan is 11.1 per cent. In fact, during the first three years of the 2nd Plan the average annual rate of growth of the industrial sector was 25 per cent. In particular the availability of raw materials has encouraged the growth of food, tobacco and leather goods industries. Recent major developments include a textile mill, an oil refinery, a sugar plantation and mill, and a tyre manufacturing plant. Cement and footwear factories are also in operation and a chemical industry is to be established.

Table K.II - 3rd 5 Year Plan (1968-1973)

Planned Gross Fixed Monetary Investment $ mill

	Public	Private	Total
Agriculture, Forestry and Fishing	82.6	42.2	124.8
Manufacturing and Handicrafts	126.6	99.4	226.0
Transport and Communications	179.6	70.0	249.6
Mining	7.9	63.9	71.8
Electrical power	43.0	5.0	48.0

Table K.II (continued)

Education	39.0	4.4	43.4
Health	8.5	7.9	16.4
Housing	7.6	202.2	209.8

1.1 Transport Network.

The national railways are composed of two independent systems. The first links the port of Djiboute in the French territory of the Afars and Issas to Addis Ababa and is now being extended from near Addis Ababa to Sidamo province in the south, the main coffee growing region which provides Ethiopia's principal export. The second, in the northern province of Eritrea connects the port of Massawa on the Red Sea to Asmara and Agordat. The port of Assab in southern Eritrea has recently been greatly enlarged and is linked by road with the capital from which most major highways radiate. Air transport is of greater importance than in countries with more developed road and rail systems and 32 towns and cities are served by domestic air services.

2. The Copper Fabricating Industry

The only copper fabrication carried out in Ethiopia is the manufacture of housewire. This is carried out by Ethioplastic S.P.A. at Addis Ababa. This company commenced production in 1960 and is principally a producer of plastic products, but since 1963 has also engaged in wire drawing and insulating and now produces wire and cable up to a diameter of 80 square mm. In 1968 it was producing about 1,000 tons of PVC with a capacity of 2,000 tons of PVC mostly for plastic products. It was also utilising about 200 tons of copper for housewire annually although the capacity of the plant is 600 tons of metal p.a. The copper is imported mainly as wire rod and is drawn down to wire of a diameter of 0.020 mm. At present the share capital of the company is $560,000 and about 100 workers are employed including 3 Europeans.

3. Demand for Copper Products

The demand for copper semis and insulated wire and cable in Ethiopia has fluctuated in recent years although the trend has been steadily upwards. We estimate that the total demand for the years 1964-66 has averaged 655 tons of metal equivalent. This estimate is based on the import statistics of Ethiopia, the export statistics of the manufacturing countries, plus information derived from large users such as the electricity and communication authorities.

The extent of the fluctuation can be observed from the following table which gives the breakdowns of Ethiopian imports.

Table K.III - Imports of Copper, Copper Alloy and Insulated Cable

	1966		1967	
	Kg.	$	Kg.	$
Bars and Rods	16,564	5,400	122,195	30,908
Plates and Sheets	5,233	8,414	25,993	7,685
Tubes and Pipes	20,930	7.152	60,446	19,327
Uninsulated Wire	82,527	95.658	62,991	129,396
Insulated Wire and Cable	140,987	227,990	233,616	216,649

The import statistics do not show separate figures for manufactures of copper and estimates have been made on the basis of export statistics of developed countries.

4. Demand by Sectors

4.1 Construction

The construction industry, principally because of its requirement for housewiring, accounts for the largest share of demand. In recent years there has been a large construction effort, particularly in Addis Ababa, and the planned gross investment figures in the 3rd Plan indicate that this rate of construction is expected to continue.

Table K.IV - Building Permits for New Construction in Addis Ababa 1965/6

	$000s	Floor Area (sq. metres)
Villas	4,262	80,862
Multi-storey buildings	14,472	103,394
Commercial buildings	283	8,823
Petrol Stations	22	223
Industrial building	843	11,052
Schools	76	1,591
Maintenance	735	1,860
Wereda permits	3,508	91,070
	24,201	298,875

4.2 Electricity

The electricity supply industry in Ethiopia has experienced a high rate of growth in recent years. The UNECA document "Electric Energy Survey for Africa"* prepared by Dr. Rupnik records a growth in production of 18.6% p.a. between 1960 and 1965. In the same report Dr. Rupnik predicts that growth will remain rapid though the rate of growth will be somewhat slower than in the past.

Table K.V - Estimated Electricity Supply Expansion 1965-1980

	1965	Growth rate %	1970	Growth rate %	1975	Growth rate %	1980
Gwh	238	14.9	477	12.7	890	10.0	1,430
Hours	2,000	-	2,200	-	2,400	-	2,600
MW	119	12.8	217	11.2	370	8.2	550

The above table, taken from Dr. Rupnik's report is borne out by the expansion plans of the Ethiopian Electric Light and Power Authority (ELPA) who expect their electricity production to increase from 272 Gwh in 1968 to 1,296 Gwh in 1980 and these figures do not take account of the Sedao Company and other expansion plans.

In the past ELPA has used copper wire and cable for all its requirements. However, aluminium is already replacing copper for high voltage bare conductors (i.e. 15KV lines with cross sections of 16 and 25mm^2) and will ultimately be used for low voltage lines as well. The use of copper for bare conductors with 6 and 10mm^2 cross sections will, however, continue for some while. This means that about 50 tons of copper will be consumed annually regardless of price. In the case of insulated conductors aluminium is to be introduced gradually over the next 2 or 3 years the limiting factor being the training of personnel in preparation for the changeover.

A breakdown of ELPA's consumption of copper and aluminium conductors is shown in table K.VI.

* UNECA Document E/CM14/EP/36Dr. Rupnik, June 1968.

Table K.VI - ELPA; Consumption of Copper and Aluminium Conductors in 1968

Insulated Wire	km	kg	Price/$km
1.5mm²	20	267	32
2.5 "	200	4,450	36
4 "	200	7,120	52
6 "	10	534	80
10 "	6	534	152
16 "	8	1,139	188
35 "	8	2,492	392
70 "	8	5,488	744
185 "	4	6,586	2,496
Insulated Cables			
2 x 1.5mm²	10	267	80
2 x 2.5 "	30	1,335	156
2 x 4 "	30	2,136	200
2 x 6 "	4	427	272
4 x 6 "	4	854	440
4 x 10 "	2	712	664
4 x 16 "	4	2,278	980
Underground Cables			
3 x 6/6mm²	8	214	520
3 x 16/16 "	5	50	1,168
3 x 35/16 "	5	294	2,000
3 x 70/35 "	5	267	3,016
Bare Copper Conductors			$ton
6mm²		10,000	1,000
10 "		30,000	"
16 "		40,000	"
25 "		40,000	"
35 "		30,000	"
70 "		20,000	"
Aluminium Cables, Steel Reinforced			$/km
16mm² (Nominal copper area)	300	-	76
25 " (" " ")	40	-	120
70 " (" " ")	4	-	330

4.3 Telecommunications

The operations of the Ethiopian Telecommunications Board have been expanding very rapidly in recent years. In the period 1963-66 the number of telephones has increased from 18,865 to 26,811 and during the same period capital expenditure has more than doubled from $1,450,000 to $3,400,000.

Table K.VII - Operations of Ethiopian Telecommunications Board

	1963	1964	1965	1966
No. of telephones	18,865	21,404	24,791	26,811
Capital Expenditure (E$000)	1,450	2,440	3,540	3,400

The growth of the urban network is increasing at a compound rate of 20 per cent per annum. In the five year period 1968-73, it is planned to spend $4.4 million on the urban network and about $3 million of this amount will be spent on materials, mainly cable. The copper cable and wire requirements of the Telecommunications Board have increased rapidly in recent years. For example, the Board imported 35,000 Kg of copper wire of 1-3mm in 1966, 63,000 Kg in 1967 and 38,000 Kg in the first six months of 1968.

4.4 Industrial Demand

In 1965-6 manufacturing industry in Ethiopia was concentrated in the food, beverage and tobacco sector, which accounted for 47.4 per cent of employment in manufacturing and the textile industry that represented 31.1 per cent of the total. The steel, metal and electrical engineering sector only employed 930 persons or less than 2 per cent of the total. At present the demand for copper products by Ethiopian industry is therefore small.

Table K.VIII - Employment in Manufacturing Industry in Ethiopia

	1964/5 No. of employees	%	1965/6 No. of Employees	%
Food	18,596	39.0	22,112	40.3
Beverages	2,136	4.5	2,473	4.5
Tobacco	451	0.9	1,095	2.6
Textile	15,802	33.2	17,040	31.1
Leather and Shoe	1,892	4.0	2,298	4.2
Wood	2,251	4.7	2,147	3.9
Building and non-metallic	3,102	6.5	3,684	6.7
Printing and publishing	1,141	2.4	1,403	2.6
Chemical	1,400	3.0	1,618	3.0
Sheet, metal and elec.	926	1.9	930	1.7
TOTAL	47,696	100.0	54,800	100.0

Source: Annual Industrial Survey

The manufacturing sector has a target rate of growth of around 11 per cent in the 3rd Five Year Plan. The emphasis will remain on import substitution as with the possible exception of textiles and meat canning (which has had a mixed history) there are not many fields of manufactured industry in which Ethiopian industry is likely to enjoy a comparative advantage. In recent years the largest single imported items have been machinery, motor vehicles and parts, metal and metal manufactures and electrical machinery.

Table K.IX - Manufactured Imports into Ethiopia ($000s)

	1966	1967
Machinery (inc. aircraft)	37.180	23,950
Motor vehicles and parts	17,050	16,810
Metal and metal manufactures	14,360	13,840
Electrical machinery	8,400	9,880

Although there is a limit to the extent to which machinery manufacture is likely to be established in Ethiopia, nevertheless it seems likely that some items, at present imported, will be assembled in Ethiopia and the less complicated parts manufactured there.

4.4 Mining

Mineral production in Ethiopia is at present small and limited to gold, potash and salt. Potash is extracted and reserves are believed to exceed 60 million tons in Tigre province. Substantial deposits of iron ore and copper have been discovered and smaller deposits of other minerals including lignite, lead, platinum, chromium, cobalt, manganese, graphite and asbestos. Some petroleum has also been discovered but it is not yet known whether it exists in commercial quantities. The government has recently set up a para statal corporation to develop the Adola Gold Mines which is indicative of the Ministry of Mines determination to exploit the mineral resources of the country. However, apart from gold, potash and salt, it is not possible to determine the likely developments in this sector until further information is available about the commercial viability of other mineral production.

MALAGASY

Country Report

1. Introduction

The Malagasy Republic, the former French dependency of Madagascar is the fourth largest island in the world and has a population of $6\frac{1}{2}$ million. The population is predominantly rural and only about 10 per cent are wage earners. Industrial development is small on account of the inadequacies of the transport system and the limitations of the domestic market and has consequently been concentrated on the processing of agricultural products. However, there are now chemical, metal-working factories, and assembly plants for vehicles and electrical appliances in operation; recently an oil refinery, a match factory, a paper mill and a milk pasteurisation plant have also been established.

The five year development programme of the Malagasy Republic (1964-8) provides for a $5\frac{1}{2}$ per cent rate of growth. Emphasis was placed initially on increased food crop cultivation, the starting up of small and medium sized industries, educational advance and improvement in the transport network. Under the expenditure programme, 51 per cent is allocated to infrastructure (including transport) 23 per cent to agriculture, 17 per cent to industry and 9 per cent to various social projects. A special development plan for 1968/9 has been announced and among the industrial projects to be implemented are a textile factory at Majunga, a shoe factory at Tamatave and a soap factory at Tananarive.

2. Copper Fabrication Industry

There is, at present, no copper fabrication industry in Malagasy.

3. Demand for Copper Products

All copper fabricated products are imported. Annual imports of copper and copper alloy products in the period 1965-67 have averaged 238 tons of manufactures, 87 tons of wire, 22 tons of tubes and fittings, 16 tons of castings and 6 tons of other semis. During the same period the average annual import of all insulated cable, including copper and aluminium has been 529 tons.

Table L.I - Imports of Copper Products into Madagascar 1965-67

tons

	1965	1966	1967
Wire	116.8	58.7	85.9
Semis	5.3	3.9	7.3
Tubes and Fittings	20.5	22.9	23.2
Castings	28.9	8.7	11.3
Other Manufactures of copper	292.5	173.2	247.7
Insulated wire and cable (including aluminium)	364.9	757.7	463.5

The comparatively large import of copper manufactures into Madagascar (at least in comparison to the English speaking East African countries) partly arises from the more detailed breakdown of the trade statistics which permits the identification of manufactures of copper which in some countries is not possible. Unfortunately, it is not possible to differentiate between the import of copper and aluminium insulated wire and cable which is

the largest item imported both by weight and value.

4. Demand by Sectors

4.1 Construction

The largest demand for copper products is generated by the construction industry. Using the period 1961-63 as a base, some indication can be obtained about the rate of expansion of this sector from current plans.

Table L.II - Construction Activity in Madagascar Average 1961-63

	Surface Area	Value $ million
URBAN		
Housing	160,000m^2	9.2
Industrial Building	12,000m^2	0.8
Commercial Building	13,000m^2	1.0
Other	35,000m^2	2.2
Total	220,000m^2	13.2
INTER-URBAN		5.6
RURAL		
Housing		2.4
Other		1.6
Maintenance		2.0
	TOTAL	24.8

Table L.III - Growth of Construction Industry $mn.

	1963	1968	1973
Total spending for urban housing	14.0	14.4	16.8
Activity of construction companies	16.0	23.2	26.0
	30.0	37.6	42.8

Construction in 1963 in urban housing totalled about $14 million and this sector accounted for about half of total construction which altogether amounted to $30 million. By 1968 total construction activity is expected to reach $37.6 million and by 1973 a total of $42.8 million. On this basis we estimate that the construction industry for the base year of this study (1966) was consuming between 175-180 tons of copper equivalent.

4.2 Transport

The transportation sector is also likely to continue to be a considerable source of demand for copper products. At present there are two railway lines, Antsirave-Tananarive-Tamatave and Fianarantsoa-Manakara, harbours at Majunga, Tulear, Diego-Suarez and Tamatave, and an embryonic trunk road system. As has already been pointed out the 5 Year Plan has given considerable emphasis to the need to improve the transportation sector which at present limits the growth of the Malagasy economy.

4.3 Electricity Supply

The electricity supply industry is also an important user of copper fabricated products. Between 1960-65 the electricity supply industry expanded at a rate of 7.25 per cent per annum. According to the ECA Rupnik report* this growth rate will accelerate to 12 per cent in the years 1965-70. Between 1970-75, a rate of 11 per cent per annum is expected declining slightly to 10 per cent between 1975-80.

Evidence in support of an increased rate of growth can be obtained from the 5 Year Plan where it was proposed that electricity production should be increased from 140 to 195 million Kwh between 1965 and 1968. Electricity consumption has also been increasing rapidly. During the first half of 1967 compared with 1966, consumption of electricity has increased by over 10 per cent.

Table L.IV - Electricity Consumption 000s Kwh

	1966 (1st half)	1967 (1st half)
Food Industries	2,342.9	2,631.0
Rice	287.7	438.1
Cotton	5,152.0	6,926.4
Leather	279.1	298.6
Chemicals	695.8	510.6
Other industries	799.2	988.0
TOTAL	9,556.7	11,792.7

4.4 Mining

Madagascar has great hydro-electric potential. According to the Rupnik report, the hydro-electric potential of the Malagasy republic (estimated at 114 TWH/a) is about one third of the whole East African sub-region. Evidence of bauxite deposits has also been established but their extent has yet to be fully surveyed and it is not known whether there is a basis for an aluminium industry or not.

The development of an aluminium industry in Malagasy if followed by the development of an aluminium fabrication industry would give a strong incentive towards the substitution of aluminium for cable and possibly also for housewiring in the island. Already the electricity authority is using aluminium cable for all main lines (except underground cable) so there is a limit to the extent of further substitution. Until further information is available about the commercial viability of a Malagasy aluminium industry it is not possible to comment further on this point. Other minerals are present but with the exception of coal, graphite, mica and chromite, the island seems to offer only small quantities of minerals rather than large deposits.

4.5 Telecommunications

Telecommunications provide another source of demand for copper products. But the rate of growth allowed for in the third report on the 5 Year Plan does not seem to envisage a very rapid rate of expansion as receipts from telephones are only expected to increase from $3,670,000 FMG in 1967 to $4,460,000 in 1971.

Receipts from Telephones

	1967	1968	1969	1970	1971
$000's	3,670	3,860	4,050	4,250	4,460

* UNECA - E/CM14/EP/36 "Electric Energy Survey for Africa" Rupnik June 1968

4.6 Industrial Demand

The principal demand, apart from the construction and transport sectors seems likely to come from the small but developing industrial sector. At present industries are mainly confined to the processing of agricultural products including rice-milling, sugar refining, distilling, oil-seed crushing, meat canning, cigarette and chewing tobacco production. An important development here could be the signing of an agreement with a Senegalese company for the exploitation of forests and the setting up of a forestry based industry on the north-east coast. Plants for vehicle and bicycle assembly have been established and recently an oil refinery has been built at Tamatave and a chemical plant based on coal tar derivatives at La Sakoa. These developments and the other industrial projects already mentioned are the beginnings of an industrial sector, which once established will generate a continuing demand for copper products.

MAURITIUS

Country Report

1. Introduction

Mauritius is still overwhelmingly a one crop economy - sugar - although a beginning has been made in a programme of industrialisation. The most recent statistics show that in 1968 there were 7,675 people employed in manufacturing industry compared with 56,342 in agriculture and fishing.

Table M.I - Employment by Major Industrial Groups, 1968

Industrial Group	Total number of persons employed
Agriculture and fishing	56,342
Mining and quarrying	179
Manufacturing	7,675
Construction	2,327
Electricity	1,281
Commerce	3,240
Transport, storage and communication	4,421
Services	49,083
	124,548

Source: Survey of Employment and Earnings in large establishments, Central Statistical Office, March 1968.

Employment in manufacturing has been growing at a rate of 7 per cent per annum as several new projects, such as soap and toothpaste factories, have been started as a means of achieving import substitution. This programme will continue and possible new industries include radio and TV assembly and motor car assembly which should provide a growing demand for copper fabricated products. On the other hand, an industrial programme of this kind may well be matched by a run down of the sugar industry which has been a large consumer of electric power. However, the service sector, especially the tourist industry, is likely to provide an increasing demand for electrical consumption, telephones and house-wiring, as international air fares are reduced, and Mauritius becomes an option in the package tour holiday market.

2. Copper Fabrication Industry

There is, at present, no copper fabrication industry in Mauritius.

3. Demand for Copper Products

Demand for copper products is met entirely by imports.

The existing demand for copper and brass semi-manufactures is small in the absence of a sizeable manufacturing sector. The demand has also been liable to fluctuations depending on the Mauritian balance of payments. There is a considerable import of insulated wire and cable, however, reflecting the relatively high standard of living in Mauritius, where the whole population is regarded as being in the monetary economy, in contrast to other countries in this survey. Unfortunately, the trade statistics do not provide a breakdown of the copper content of the imported cable and wire but estimates have been prepared based on the demand by sectors.

Table M.II - Imports of Copper Products into Mauritius 1965-67

	1965		1966		1967	
	Tons	$000's	Tons	$000's	Tons	$000's
Bars, rods, plates sheets, wire, pipes and tubes						
- of copper	31.9	34.9	25.0	41.9	7.8	13.7
- of brass and other alloys	48.0	54.2	18.9	22.5	18.5	24.3
Castings and forgings copper and alloys	2.8	2.7	1.0	1.3	-	-
Wire netting, fencing grills or expanded metal	4.9	2.5	2.6	4.3	3.5	3.6
Nails, bolts, nuts etc. of brass and other alloys of copper	6.4	10.8	6.0	14.9	7.1	11.9
Other manufactures of copper and brass	9.5	22.9	7.8	19.8	8.6	21.4
Insulated cables of wire for elec.	446.0	374.2	310.8	256.0	447.7	450.5

4. Demand by Sectors

4.1 We estimate that the construction industry is the largest user of copper products in Mauritius. The importance of construction can be assessed from the following table of gross fixed domestic capital formation.

Table M.III - Gross Fixed Domestic Capital Formation $000's

	1962	1963	1964	1965	1966
Land	.4	.4	.5	.4	.4
Dwellings	7.6	8.1	7.9	6.7	5.2
Non-residential building	2.5	2.5	4.0	4.5	3.8
Other construction	6.7	6.8	5.8	5.6	5.0
Total construction	16.7	17.5	17.7	16.8	14.0
Transport equipment	2.9	2.9	4.3	3.2	4.7
Machinery and other equipment	5.4	7.7	9.5	7.6	4.9
TOTAL	25.4	28.4	32.0	28.0	24.0

The proportion of construction in gross fixed domestic capital formation remains high at almost 60 per cent of gross fixed domestic capital formation, although there has been a decline from the very high level of dwelling construction in 1962.

The very high rate of construction in recent years reflects the 30 per cent population increase in the last decade. According to the 1966 report, at the time of the last census, mid-1962, there was 681,619 inhabitants of Mauritius; by the end of 1966 there were 768,692. However, a co-ordinated family planning programme launched in 1966 and doubts

about the island's future development, which have increased emigration, have brought the rate of population growth down from 2.71 per cent per annum in 1962-66 to an estimated 2 per cent in the years 1966-68. Nevertheless, it seems likely in view of the fact that population growth will stablise at just over 2 per cent and given a hotel building and factory building programme in the years up to 1980, that the construction sector will remain the largest consumer of copper wire and fabricated products.

4.2 Electricity Supply Industry

The production of electric energy in Mauritius by public and private enterprises has grown at a rate of 5½ per cent per annum in the period 1960-65 compared with 8½ per cent in the East African sub-region. According to the ECA Rupnik report "Electric Energy Survey for Africa"* the growth rate-of electricity production will increase to 6.2 per cent in the years 1965-1975 and then fall slightly to 6 per cent per annum in the period 1975-80.

The Central Electricity Board's copper requirements are estimated at about 30-35 tons per annum; the largest demand is insulated conductors for service lines, probably about 20 tons and the remainder underground cables, bus bars for switchgear panels, transformers etc. Apart from underground cables the Board is using aluminium for its main line cables.

4.3 Other Sectors

Among the other sectors the largest demand for copper products comes from the telephone service. The rate of growth of telecommunications in Mauritius has not been as high in recent years as some other countries in the region because of the fact that the number of installations was already comparitively quite high five years ago.

Growth of Mauritius Telephone Service

	1963	1964	1965	1966	1967
Main exchanges	18	18	19	20	22
Individual installations	11,185	12,504	13,634	14,399	15,328

The growth of tele-communications in Mauritius in the future will probably average 3-4 per cent per annum up to 1980. The copper content of the wire consumed is estimated at 11 tons and the cable at around 23 tons in 1967/8.

The other main source of demand is the small but growing machinery repair and transport equipment industry. The size of this sector can be judged by the number employed.

Number Employed in Metal-using Industries, 1968

Metal products	330
Repair of non-electrical machinery	608
Repair of electrical machinery	157
Transport equipment - building of transport equipment	594
Repairs of motor vehicles	491
	2,180

Source: Survey of Employment and Earnings Central Statistical Office March 1968.

Although this sector is very small at present it could grow quite rapidly if current plans for a vehicle assembly industry are implemented.

* Prepared for an IAEA panel on "Small and Medium Sized Power Reactors" in Vienna, June 1968 (E/CM14/EP/36).

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Malagasy

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Institute Nationale de la Statistique
La Service des Postes et Telecommunications
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Ministere de l'Industrie et des Mines

Malawi

Economic Planning Division, Ministry of Economic Affairs

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Geological Survey
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