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Date 15th December 1988 Ext no 2441

S Morosov Esq
Chief
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UNIDO
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Dear Sir

Project Title: Assistance in Establishment of Copper Fabrication Plant in Zambia
Project No: SI/ZAM/88/801
Contract No: 88/38

I have pleasure in submitting our Final Report on the feasibility of manufacturing copper semis in Zambia.

The objectives of the study were to:

* evaluate the opportunities for manufacturing copper semis in Zambia

* carry out a technical, financial and economic evaluation of the proposed joint venture with Romania, and possible alternatives.

The market research led to the conclusion that the best opportunities for Zambia lie in the manufacture of copper sheet and strip. It will be noted, therefore, that the technical, financial and economic evaluation focuses on rolled products. This is consistant with the conclusions of the study carried out by the Cooperation Centre of Tilburg and Eindhoven Universities, and with the Romanian joint venture proposal.

It should also be recognised that the financial evaluation of the Romanian proposal is based on information and assumptions drawn from our meetings with the Romanian delegation in Lusaka in June 1988, rather than a formal document. The Romanians were unable to prepare a full and final commercial offer, as agreed, by the deadline specified. The assumptions used in the financial evaluation, therefore, may be subject to revision. However, as agreed with UNIDO (telex from Behrens 2/8/88) and INDECO (telex from Yamba 8/8/88), we have completed the evaluation on this basis.

In preparing the Final Report we have taken into consideration the comments and suggestions set out in your letter of 9th November 1988. We have addressed the key comments on the market and financial aspects of the project in the manner described in our telex (23/11/88), to which you agreed (your telex 5/12/88).

We have responded to each comment made in your letter as follows:

Technical Comments

1(1): discussed further on p.94.

1(2): discussed further on pp. 96-97.

2(1): discussed on pp. 105-106.

2(2): this is a very useful suggestion, which we have addressed on p. 106. The cost implications of this technology are dealt with on p. 109, and this is carried forward to the sensitivity analysis on p. 190 (and summarised on p.28).

Market/Finance Comments:

2(a) the multiplier of 2.0 was derived from the market research results, and is explained in full on p. 53. A note has also been added to the summary on p.4.

2(b) further discussed on p. 57, and added to sensitivity analysis on pp. 187-189 (also p. 28).

2(c) competition from Radiator & Tinning is discussed further on p. 54, and this has been added to the sensitivity analysis on p. 189 (also p. 28). The rate of growth in demand within the PTA market is discussed further on p. 62, and considered in the sensitivity analysis on p. 189 (also p. 28).

2(d) the spurious figures in Table 3.8 were drawn from the Central Statistical Office in Lusaka, which was unable to check their accuracy. The estimated demand for plate, sheet and strip in Zambia shown in Table 3.9 is therefore built largely from market research results.

2(e) to achieve full capacity production, the Romanian buyback would have to be 97% of capacity in Year 1, declining to 85% in Year 15. It was not considered realistic to assume a variable buyback ratio with a view to achieving full capacity production after the start-up period. Rather we have assumed that the buyback will be a constant 80% of full capacity. This makes easier the analysis of the effects of raising or lowering the buyback volume.

2(f) deleted as requested.

2(g) most of the financial tables in the draft report show only to Year 2003 for convenience, although analyses were carried out over the full project period. These tables have not been altered as agreed in your telex.

We trust that these amendments are satisfactory, and we look forward to your confirmation that the Final Report satisfies the terms of our contract in full.

Yours faithfully
for and on behalf of
WS ATKINS MANAGEMENT CONSULTANTS

R A F Collins
Director

17238

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

ASSISTANCE IN ESTABLISHMENT OF COPPER FABRICATION PLANT IN ZAMBIA

Project No: SI/ZAM/88/801

Final Report

WS ATKINS INTERNATIONAL
Woodcote Grove - Ashley Road
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DECEMBER 1988

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1. EXECUTIVE SUMMARY

1.1 Project Background

Although Zambia is a major producer of copper cathodes, it imports most of its requirements for copper semis. These imports constitute a serious drain on Zambia's scarce forex reserves. Since copper, the main component of production costs, is available locally, import substitution would seem a logical development.

The viability of manufacturing copper semis in Zambia is by no means certain, however. Despite the advantageous positioning close to the raw material, operating costs in Zambia are likely to be higher than competitive installations in the West, principally because of relative scales of production, the scarcity of scrap as a feed material, and the need to import expensive spares.

A previous study, carried out by the Cooperation Centre of Tilburg and Eindhoven Universities between 1985 and 1987, concluded that a Zambian manufacturer would be primarily dependent on the PTA regional market, and that the most promising opportunities lay in the manufacture of copper sheet and strip. However, a financial and economic evaluation of a small scale rolling mill with a capacity of 1,000 t/pa indicated that the project would not be feasible.

More recently, the Romanian organisation Uzinexportimport has presented a proposal concerning the establishment of a rolling mill in Zambia with a capacity of 10,000 t/pa. Romanian credits will be available to finance the purchase of Romanian plant and equipment, and repayment of the loan could be made in copper products.

This proposal is the main subject of the feasibility study presented in the present report. It is important to note, however, that the Romanians have failed to provide, as promised, full details of their commercial offer by the deadline agreed. For this reason, we have proceeded on the basis of assumptions drawn from our discussions with the Romanian delegation in Lusaka in June 1988. Inevitably, several important aspects remain unclear. The most important is the proportion of the plant's output which can be sold to Romania. We have assumed that the Romanians will accept a fixed percentage of production, rather than the volume necessary to pay back the loan for plant and equipment, and continue to do so after the loan has been paid off.

The report also compares the Romanian project with possible alternatives. This involved a re-examination of market opportunities in sectors other than sheet and strip, and an evaluation of a different type of plant. The plant selected for this exercise was a rolling mill of 2,250 t/pa maximum capacity, oriented to the PTA regional market.

1.2 Market and Plant Capacity

1.2.1 PTA region

Estimates of demand within the PTA region (Table 3.10) indicate some significant developments since the Dutch consultants' study, largely due to expansion among the region's major manufacturers.

For the product sectors specified in the TOR, the key conclusions may be summarised as follows:

* tubes: Almin (Zimbabwe) has entered successfully this market, and could supply a large percentage of demand within the PTA. Since Zamefa (Zambia) and Booth Manufacturers (Kenya) also have the capacity to produce tubes, investment in another plant in Zambia cannot be recommended

* copper and brass bars, shapes and sections: this is a promising market, but there are three producers in both Zambia and Zimbabwe, and one in Kenya. Further investment does not appear to be justified, although there is scope to develop secondary manufacturing industries using copper and brass feed

* copper and brass sheet, strip and foil: there is still no major manufacturer of these products in the PTA region surrounding Zambia. Limited local competition is provided by Radiator & Tinning (Zimbabwe) and GECA mines (Zaire).

The market research demonstrates that the only significant "gap" within the immediate PTA market for a Zambian manufacturer lies in the sheet, strip and foil sector. This is consistent with the conclusion reached in the Dutch consultants' report, and with the Romanian joint venture proposal (Section 3.1.1).

1.2.2 Sales outside the PTA

Although there has been considerable rationalisation of production in the major world markets, there is still ample capacity for rolled products, and declining markets have led to significant improvements in efficiency among the surviving producers.

A Zambian manufacturer is at a competitive disadvantage in these markets, primarily because market requirements are so varied and different to the PTA, because customers demand just-in-time delivery, and because foreign producers, using scrap, have lower raw material costs.

Zambia is unlikely to achieve any significant sales in Europe or other hard currency markets. This is consistent with the conclusions of the market research carried out by the Dutch team. The most sensible approach is to assume that a Zambian manufacturer will concentrate on the PTA market, where high tariff barriers provide effective protection against European imports. Sales to Romania as part of the joint venture proposal are treated as a separate and unique item (Section 3.1.2).

1.2.3 Demand

The current consumption of copper sheet, strip and foil in the PTA market is estimated at 835 t/pa.

A multiplier of 2.0 can be applied where copper products can be purchased in local currencies. This is based on end-users' estimates of the effect of forex restrictions on local demand. On the basis of discussions with the PTA, an assumption that 20% of export sales throughout the PTA will be paid in local currencies has been derived.

Applying the multiplier, and allowing for competition from Radiator & Tinning and GECA mines, the current market available to a Zambian manufacturer of rolled products has been estimated at 1,080 t/pa (Table 3.12).

In the case of the Romanian mill, the off-take for the Romanian market has been set at 80% of maximum capacity, which is 8,000 t/pa (Section 3.1.3).

1.2.4 Prices

Ex-works prices are used in the calculation of revenues.

Zambian sales prices are set at a 5% discount with respect to the landed price of European imports in the various PTA markets. Ex-works prices are calculated by subtracting the relevant duties, tariffs and transport costs (Table 3.13 and Section 3.1.4).

Ex-works prices of products sold to Romania are derived by subtracting transport costs from indicative international prices.

1.2.5 Product mix

For the purposes of building a revenue stream for a rolling mill supplying the PTA market (the small mill option), the following product mix has been assumed: sheet (65%), strip (15%), and foil (20%).

For the Romanian mill, the mix is composed of 80% sheet and 20% strip (for the PTA market), and 50% sheet and strip (for the Romanian market). Foil, for radiator applications, is not produced (Section 3.1.5).

1.2.6 Plant capacity and production programme

Sales forecasts in the PTA region have been built by inflating the potential demand (Table 3.12) by 3% pa.

This suggests that the PTA market for rolled product will be about 1,600 t/pa after 15 years. For this reason, the small mill option has been designed with a capacity of 750 t/pa with one shift working and 1,500 t/pa with two shift working. The mill moves to two shifts in Year 4 (1995). Capacity utilisation increases steadily over the project life, reaching 100% in Years 14 and 15. Sales as a percentage of demand reaches a peak of 85%.

The Romanian mill has been designed to operate with three shifts, and a full capacity of 10,000 t/pa. In Year 3, sales to the Romanian market are stabilised at 8,000 t/pa. Sales to the PTA market rise to 1,500 t/pa in Year 15, comparable to the small mill.

Demand, sales/production, capacity and revenue figures are summarised in Table 1.1.

It needs to be recognised that both mills are small by Western European standards. The capacities chosen have been dictated, in the case of the Romanian mill, by the terms of the Romanian

TABLE 1.1 - SUMMARY OF DEMAND, PRODUCTION/SALES, CAPACITY AND REVENUE FIGURES

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Potential demand	1081	1113	1147	1181	1217	1253	1291	1330	1369	1410	1453	1496	1541	1587	1635	1684	1735	1787	1840	1896
Small mill																				
Capacity	-	-	-	-	750	750	750	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	-
Production/Sales					225	525	675	1125	1159	1194	1229	1266	1304	1343	1384	1425	1468	1500	1500	-
Capacity utilisation (%)	-	-	-	-	30	70	90	75	77	80	82	84	87	90	92	95	98	100	100	-
Sales as % of demand	-	-	-	-	18	42	52	85	85	85	85	85	85	85	85	85	85	84	82	-
Revenue ($'000s) (Constant mid 1988 prices)	-	-	-	-	1064	2482	3191	5318	5478	5642	5811	5986	6165	6350	6541	6737	6393	7091	7091	-
Romanian mill																				
Capacity	-	-	-	-	-	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
Production/Sales:																				
- Romanian market	-	-	-	-	-	2700	5000	8000	8000	8000	8000	8000	8000	8000	8000	8000	8000	8000	8000	8000
- PTA market	-	-	-	-	-	300	500	800	900	1000	1050	1100	1150	1200	1250	1300	1350	1400	1450	1500
Capacity utilisation (%)						30	55	88	89	90	90.5	91	91.5	92	92.5	93	93.5	94	94.5	95
Sales as % of demand (PTA market)						24	39	60	66	71	72	74	75	76	76	77	78	70	79	79
Revenue ($'000s) (Constant mid 1988 prices)	-	-	-	-	-	11936	21848	34956	35417	35877	36107	36338	36568	36798	37028	37259	37489	37719	37949	30180

Source: WS Atkins

technical proposal, and, in the case of the small mill, by the size of the regional market and the need to operate at an efficient production level relative to capacity (Sections 3.2 to 3.4).

1.3 Materials and Inputs

The main raw material is copper cathode, which will be provided by ZCCM on equivalent terms to those enjoyed by Zamefa; i.e incorporating a rebate on the LME price related to transport costs ($ 104/tonne), and a quality related discount ($ 30/tonne) to compensate the user for having to use Grade A cathode.

Zinc will also be provided by ZCCM at a discount of $50/tonne over the LME price. This is used only by the small mill for the production of brass foil, which is 10% of output.

Phosphor copper, which is required for deoxidisation purposes, will be imported.

The main auxiliary materials are industrial gases. A nitrogen/hydrogen mixture is required for annealing, and can be supplied by Zamox in Ndola. Methane is also specified in the case of the Romanian mill for preheating in advance of hot rolling. Since methane is not available locally in Zambia, this is replaced by LPG.

The other major costs are related to spares and maintenance. Spares for plant and equipment are estimated at 3% of initial capital costs, after two years. Spares for the buildings and works area are estimated at 1.5% of initial capital costs.

The main inputs are listed in Table 1.2, together with summarised information on consumption and costs (Section 4).

TABLE 1.2 - MATERIALS AND INPUTS

Item	Consumption/tonne of output	Costs ($/tonne) mid-1988 prices
Copper Cathode	1.05 tonne	2,012
Phosphor Copper	Romanian mill: 2.2 kg Small mill : 2.4 kg	3,994 4,345
Zinc	Small mill : 0.033 tonne	1,179
Nitrogen/hydrogen	100 Nm^3	261
LPG	40 Nm^3	120
Industrial materials	-	35
Spares & Maintenance		
* plant & equipment	-	3% capital costs after 2 years
* buildings	-	1.5% capital costs
Electricity	Romanian mill:2,500-3,000kwh Small mill: 2,500kwh	(Fixed charge $118,600)/variable charge 13.5 (Fixed charge $41,700)/variable charge 18.64
Water	Romanian mill: 15,000 litres Small mill: 7,000 litres	2.19 0.89

Source: WS Atkins

1.4 Location and Site

Kitwe has been selected as the location for the mill. Kitwe is located close to the copper refineries, and is also well placed with respect to the domestic market. It is served by the railway line, and there is a good supply of industrial land, labour and industrial services. Indeco has accepted Kitwe as a suitable location (Section 5.1).

For the Romanian mill, a greenfield site has been selected in an area set aside for industrial development in north-west Kitwe. Following discussions with Indeco, an existing Indeco industrial site was selected for the small mill option, although the development of a greenfield site would not involve significantly greater costs (Section 5.2).

1.5 Project Engineering

1.5.1 Layout

The Romanian technical proposal did not contain information on project layout. The layout of the factory, shown in Figure 6.1, is based on Atkins' interpretation of the information relating to technology and machinery set out in the proposal. The suggested design of the works area (Figure 6.2) has been prepared by Arup (Zambia). The more compact layout for the small mill is shown in Figure 6.3 (Section 6.1).

1.5.2 Technology

The Romanian mill is designed as a single product plant, producing 1,000 mm copper strip with a thickness range 0.5 to 3.0 mm, which can be marketed either as 1,000 mm x 2,000 mm sheet or in coil slit to the width required by the customer. The capacity is 10,000 t/pa.

The mill follows conventional practice for the manufacture of copper sheet and strip, involving both hot and cold rolling (see Figure 6.4 for the process flow diagram). The novel feature of the proposal is that a single mill will be used for both hot and cold rolling, in order to minimise the cost of equipment. In principle, there is no reason why this procedure cannot be used, but there are disadvantages. The first is the wasted production time in making the roll change (estimated, and probably underestimated, as 1 shift per month). The second is the difficulty of cleaning properly the mill and its ancillary runout tables, to prevent oxide particles being rolled into the strip. The third disadvantage is the delay imposed on the production process. Stock is tied up for about 12 days before cold rolling can begin. For this reason, work in progress has been set at a relatively high 3 weeks. A further problem is that the mill is not designed to produce strip thin enough for radiator applications, for which there is considerable demand within the PTA market (Section 6.2.1).

The small mill is conceived as a flexible unit capable of producing both sheet and strip in copper, and strip in brass. It would have a capacity of 2,250 t/pa, depending on the mix of sheet and strip, with three shift working, 5 days per week. However, the melting and casting unit is designed for intermittent operation, and it is recommended that a start be made with single shift working (capacity 750 t/pa). The process specified involves static casting of slabs, and processing by cold rolling only (see Figure 6.5 for the process flow diagram).

The suggested technology follows practices which are now largely outdated. It is proposed only as a possible means for satisfying the regional market, with minimal capital investment. The most serious problem is that low volume producers of copper alloy strip have adopted increasingly continuous strip casting since this avoids much laborious rolling of thick sectioned castings. Unfortunately, this is not a practical proposition for phosphorus deoxidised copper, which is necessary if strip is to be brazed. For this reason, it is proposed that rolling slabs should be produced by static casting, and then processed entirely by cold rolling. This is an unconventional method for manufacturing copper sheet and strip, which is normally hot rolled from somewhat larger slabs, as in the Romanian mill. However, the capital cost of hot rolling mills and the associated preheating furnace is too high for this process to be considered for small volume production.

A further problem with the small mill is that sheet up to 1 metre wide is most efficiently produced with a wide rolling mill. However, since the cost of rolling mills tends to increase exponentially with width, cross rolling is recommended, which is relatively inefficient. With the same aim of minimising the capital cost of equipment, it is proposed to carry out reduction only with a 2-high mill. Although it is possible to roll down to guages below 0.1 mm in this way, several passes are necessary, which is also inefficient.

It is possible to reduce capital costs by using a single mill for both rough rolling and finishing, although this process would lower productivity (Section 6.2.2).

1.5.3 Equipment

The main items of equipment for the Romanian mill are listed in Uzinexportimport's technical proposal, and reproduced in Appendix 1. The capital cost is based on a verbal estimate provided by the Romanian delegation (Section 6.3.1). Plant and equipment is priced at $ 20 million, and installation and commissioning at $ 10 million, excluding contingencies.

The list of equipment required for the small mill option is set out in Table 6.1. The main items are the mill, melting furnace and annealing furnace. Prices are based on quotations provided by UK suppliers. Capital costs are reduced by about 25% if second hand plant and equipment is used. Since such plant is in good supply, the small mill option has been evaluated both on the basis of using new and second hand equipment (Section 6.3.2). Plant and equipment is expected to cost $ 6.38 million (or $ 4.68 million if second hand), with installation and commissioning priced at $1.7 million. Costs could be reduced to $5.38 million if the single mill concept is used ($3.93 million if second hand), with installation and commissioning priced at $1.5 million. All equipment will be imported.

1.5.4 Civil engineering works

The Romanian mill requires a main factory of 8,350 m^2, plus a number of ancillary buildings, including offices, changing room, kitchen, workshops, fuel storage and guard house. The civil and external works includes site levelling, connection to main services, and the construction of two boreholes. Costs are estimated in Table 6.2, and total $ 11.69 million.

It is also necessary to construct a housing complex for managment, technicians and some skilled labour to compensate for the shortage of good housing in Kitwe. The number of units required is estimated to be 89, and costed at $ 1.18 million (Table 6.3).

The small mill requires a factory of 900 m^2, plus a changing room, canteen, workshop and fuel storage. Civil and external works include site levelling, connection to main services, and the contruction of one borehole. Costs are estimated in Table 6.4, and total $ 1.96 million.

The housing complex associated with the factory includes 49 units, at an estimated cost of $ 0.65 million.

Capital costs for all three projects are summarised in Table 6.6. The import content for civil engineering is estimated at 55%, while that for housing is estimated at 25%. Contingencies are 10% for buildings and works, and 15% for plant and equipment.

1.6 Plant Organisation and Overhead Costs

Overhead costs for both the Romanian and small mill options are estimated in Table 7.1.

Distribution costs include only the costs of packaging. Freight charges are treated as external to the project, since revenues are calculated with reference to ex-works prices.

The depreciation schedule is based on information provided by Indeco. Charges are calculated on a declining balance, rather than a straight line basis.

1.7 Manpower

The manpower requirements for the Romanian mill are set out in Table 1.3. The table shows the breakdown between Zambians and expatriates, between skill categories, and between direct (production) and indirect (overhead) labour. These figures are based on an appraisal of the Romanian's technical proposal, but the Zambian manpower requirement, which is calculated to be 200, is identical to the verbal estimate provided by the Romanian delegation. The number of expatriates is projected to decline throughout the life of the project from 14 in Year 1, to 12 in Year 3, and 3 in Year 10 onwards. A high expatriate presence is considered necessary, although the duplication of tasks with Zambian counterparts introduces a degree of inefficiency. Manpower costs are estimated in Table 8.4 (Section 8.1). Remuneration rates for Zambian labour are based on figure provided by Indeco.

The manpower requirements for the small mill (both options) are set out in Table 1.4. A complication is introduced by the transition from one shift working to two shift working in the 4th year of production. The number of expatriates is projected to decline over the life of the project, from 8 in Year 1, to 7 in Year 3, 3 in Year 5, and 1 in Year 10 onwards. Manpower costs are estimated in Table 8.8 (Section 8.2).

TABLE 1.3 - MANPOWER REQUIREMENTS
(Romanian Mill)

	Zambians		Expatriates at project outset	
	Direct	Indirect	Direct	Indirect
Upper management	-	5	-	4
Lower management	-	5	-	3
Technicians/foremen	29	1	7	-
Skilled labour	41	35	-	-
Unskilled labour	84	-	-	-
Totals	154	46	7	7

Source: WS Atkins

1.8 Implementation

The main features associated with the implementation of the Romanian mill are set out in Table 1.5. The decision to proceed is made in 1989. The plant and equipment takes 24 months to manufacture and a further 12 months to deliver, erect and instal. Commissioning, estimated to take between 6 and 9 months, therefore takes place in 1993 (Year 5). Construction of the factory and housing colony commences in 1990, and reaches completion after 30 months in 1992. Production begins in 1993, and builds up from 20% of full capacity production in that year, to 55% in 1994, and to 88% in 1995 (Section 9.1).

The implementation schedule of the small mill is summarised in Table 1.6. The decision to proceed is made in 1989. The plant and equipment is ordered in end 1989/beginning of 1990. It takes 12 to 18 months to manufacture and procure, and a further 6 months to deliver, erect and instal. Commissioning, estimated to take between 6 and 9 months, therefore takes place in 1992 (Year 4). Construction of the factory and housing complex commences in 1990, and reaches completion after 12 months in 1991. Production begins in 1992, and builds up from 30% of full capacity production with one shift working in 1992, to 70% in 1993, and to 90% in 1994. The factory moves to two shift working in 1995 (Section 9.2).

TABLE 1.4 - MANPOWER REQUIREMENTS (Small Mill)

	One shift working				Two shift working			
	Zambians		Expatriates at project outset		Zambians		Expatriates at project outset	
	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect
Upper management	-	4	-	3	-	5	-	3
Lower management	-	1	-	-	-	1	-	-
Technicians/foremen	9	-	5	-	18	-	5	-
Skilled labour	7	14	-	-	14	19	-	-
Unskilled labour	26	-	-	-	52	-	-	-
Totals	42	19	5	3	84	25	5	3

Source: WS Atkins

TABLE 1.5 - IMPLEMENTATION SUMMARY
(Romanian Mill)

Year	Year No.	Events
1989	1	Decision to proceed Order plant and equipment (completion in 24 months)
1990	2	Commence construction (completion in 30 months)
1991	3	- -
1992	4	Construction complete Delivery of plant and equipment (30 months from order) Erection and installation of plant and equipment (36 months from order)
1993	5	Commissioning (6 to 9 months) 20% of full capacity production
1994	6	50-60% of full capacity production
1995	7	88% of full capacity production

Source: WS Atkins

TABLE 1.6 - IMPLEMENTATION SUMMARY
(Small Mill)

Year	Year No.	Events
1989	1	Decision to proceed
1990	2	Commence construction (completion in 12 months) Order plant and equipment (completion in 12 to 18 months)
1991	3	Construction complete Delivery of plant and equipment (15 to 21 months from order) Erection and installation of plant and equipment (18 to 24 months from order)
1992	4	Commissioning (6 to 9 months) 30% to full capacity production (one shift)
1993	5	70% of full capacity production (one shift)
1994	6	90% of full capacity production (one shift)
1995	7	2-shift production 100% capacity shift one 50% capacity shift two

Source: WS Atkins

1.9 Financial and Economic Evaluation

1.9.1 Investment costs

Investment costs for the three projects are summarised in Tables 1.7 to 1.9. The costs are expressed in US Dollars in both foreign and local currency, and in constant mi.. 1988 prices. Investment is broken down between pre-production expenses, civil works and structures, plant and equipment, and working capital, and include contingencies. The expected phasing of expenditure on pre-production costs and fixed assets is also shown in the tables. The figures are drawn from Tables 10.1 to 10.6, and Tables 10.10 to 10.12 (Sections 10.1, 10.2 and 10.4).

1.9.2 Production costs

Production costs for the three projects are outlined in Tables 1.10 to 1.12. These costs are expressed in US Dollars, and in current prices. The costs are broken down between direct costs, administrative overheads, financial costs and depreciation. It will be noted that the small mill with second hand plant and equipment has significantly lower financial costs. These figures are drawn from Tables 10.16 to 10.18, and 10.34 to 10.36 (Sections 10.3, 10.6 and 10.10).

TABLE 1.7 - TOTAL INVESTMENT COSTS
(Romanian Mill)

All Values in $'000s (Constant Prices)

Item	Total	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Pre-Production Costs	720	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
* foreign currency	-	42	56	28	164	-	-	-	-	-	-	-	-	-	-	-
* local currency	-	119	100	86	125	-	-	-	-	-	-	-	-	-	-	-
Civil Works & Structures	13086	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
* foreign currency	-	649	3766	1600	454	340	-	-	-	-	-	-	-	-	-	-
* local currency	-	531	3152	1627	653	314	-	-	-	-	-	-	-	-	-	-
Plant & Equipment	34500	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
* foreign currency		2300	9200	9200	6325	6900	575	-	-	-	-	-	-	-	-	-
* local currency	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Working Capital	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
* foreign currency	-	-	-	-	-	551	424	847	19	19	10	10	10	10	10	9
* local currency	-	-	-	-	-	1030	760	1118	31	31	15	15	15	15	15	0
Total		3641	16274	12541	7721	9135	1759	1965	50	50	25	25	25	25	25	9
* foreign currency		2991	13022	10828	6943	7791	999	847	19	19	10	10	10	10	10	9
* local currency		650	3252	1713	778	1344	760	1110	31	31	15	15	15	15	15	0

Source: WS Atkins

TABLE 1.8 - TOTAL INVESTMENT COSTS
(Small Mill with New Plant & Equipment)

All Values in $'000s (Constant Prices)

Item	Total	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Pre-Production Costs	505	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
* foreign currency	-	30	45	130	5	-	-	-	-	-	-	-	-	-	-	-
* local currency	-	80	100	108	8	-	-	-	-	-	-	-	-	-	-	-
Civil Works & Structures	2698	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
* foreign currency	-	127	512	576	55	-	-	-	-	-	-	-	-	-	-	-
* local currency	-	143	654	589	45	-	-	-	-	-	-	-	-	-	-	-
Plant & Equipment	9292	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
* foreign currency	-	734	4402	3765	293	98	-	-	-	-	-	-	-	-	-	-
* local currency	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Working Capital	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
* foreign currency	-	-	-	-	38	34	94	52	3	4	4	4	4	4	5	5
* local currency	-	-	-	-	92	83	60	130	4	10	10	10	11	8	11	12
Total	-	1114	5713	5168	536	215	154	182	7	14	14	14	15	12	16	17
* foreign currency	-	891	4959	4471	391	132	94	52	3	4	4	4	4	4	5	5
* local currency	-	223	754	697	145	83	60	130	4	10	10	10	11	8	11	12

Source: WS Atkins

TABLE 1.9 - TOTAL INVESTMENT COSTS
(Small Mill with Second Hand Plant & Equipment)

All Values in $'000s (Constant Prices)

Item	Total	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Pre-Production Costs	505	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
* foreign currency	-	30	45	130	5	-	-	-	-	-	-	-	-	-	-	-
* local currency	-	80	100	108	8	-	-	-	-	-	-	-	-	-	-	-
Civil Works & Structures	2698	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
* foreign currency	-	127	512	576	55	-	-	-	-	-	-	-	-	-	-	-
* local currency	-	143	654	589	45	-	-	-	-	-	-	-	-	-	-	-
Plant & Equipment	7337	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
* foreign currency	-	538	3229	3179	293	98	-	-	-	-	-	-	-	-	-	-
* local currency	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Working Capital	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
* foreign currency	-	-	-	-	37	34	78	51	3	4	4	4	4	4	5	5
* local currency	-	-	-	-	92	84	56	131	3	10	10	11	8	11	12	12
Total	-	918	4540	4582	535	216	134	182	6	14	14	15	12	15	17	17
* foreign currency	-	695	3786	3885	390	132	78	51	3	4	4	4	4	4	5	5
* local currency	-	223	754	697	145	84	56	131	3	10	10	11	8	11	12	12

Source: WS Atkins

TABLE 1.10 - PRODUCTION COSTS
(Romanian Mill)

All Values in $'000s (Current Prices)

Item	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Factory Costs	-	11408	20960	35985	38180	40505	42749	45115	47612	50245	53023	55671	58642	61881	65298	68901
Administrative Overheads	-	1608	1676	1591	1671	1754	1841	1934	2030	2132	2238	2208	2319	2436	2556	2605
Operating Costs	-	13016	22636	37576	39851	42259	44590	47049	49642	52377	55261	57779	60961	64316	67854	71506
Financial Costs	-	6227	7362	6662	6564	6063	5401	4566	4650	3974	3148	2441	1086	-359	-1726	-3246
Depreciation	-	6859	2670	2468	2352	2243	1974	1076	1782	1693	1608	1528	1451	1379	1310	1244
Total Production Costs (less tax)	-	26152	32668	46706	48767	50565	51965	53491	56074	58044	60017	61748	63498	65336	67438	69504

Source: WS Atkins

TABLE 1.11 - PRODUCTION COSTS
(Small Mill with New Plant & Equipment)

All Values in $'000s (Current Prices)

Item	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Factory Costs	1172	2199	3209	5126	5323	5725	6159	6626	7130	7516	8092	8716	9386	10042	10544
Administrative Overheads	586	613	541	604	540	567	595	625	657	689	724	760	799	838	880
Operating Costs	1758	2812	3750	5729	5863	6292	6754	7251	7787	8204	8816	9475	10185	10880	11424
Financial Costs	2717	2717	3021	2803	2905	2938	2949	2933	3428	3467	3456	3401	3308	3175	3001
Depreciation	1816	715	673	645	618	480	456	433	411	391	371	353	335	318	302
Total Production Costs (less tax)	6291	6244	7444	9177	9386	9710	10159	10617	11626	12062	12642	13229	13828	14373	14727

Source: WS Atkins

TABLE 1.12 - PRODUCTION COSTS
(Small Mill with Second Hand Plant & Equipment)

All Values in $'000s (Current Prices)

Item	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Factory Costs	1172	2199	3127	5040	5230	5629	6058	6521	7019	7398	7970	8507	9252	9901	10396
Administrative Overheads	551	577	506	567	504	528	554	581	611	641	673	706	742	779	818
Operating Costs	1723	2775	3633	5607	5734	6157	6612	7102	7630	8039	8643	9293	9994	10680	11214
Financial Costs	2188	2188	2327	2231	2265	2221	2147	2034	2328	2252	2112	1937	1719	1449	1126
Depreciation	1489	623	585	561	539	404	384	365	347	329	313	297	283	268	255
Total Production Costs (less tax)	5400	5586	6645	8399	8538	8782	9143	9501	10305	10620	11068	11527	11996	12397	12595

Source: WS Atkins

1.9.3 Internal rate of return and net present value

The cash flows before financing, presented in Tables 10.13 to 10.15, give the following results:

	Internal Rate of Return (%)	NPV at 12% (Millions $)
Romanian Mill	10.61	-3.65
Small Mill with New Plant & Equipment	6.27	-3.99
Small Mill with Second Hand Plant & Equipment	8.59	-2.13

All of the projects generate IRR's lower than 12%, which is the cut-off point specified by Indeco (Section 10.5). The Romanian mill does generate significant forex earnings, however. These revenues total $ 471.5 million (in real terms) over the project life, but they depend on the assumption that 80% of the mill's capacity is sold to Romania, and that payments are made in hard currency.

1.9.4 Financing

The Romanian mill is to be partly financed by a credit from Uzinexportimport, covering the purchase of plant and equipment. The Romanians are not proposing to contribute equity.

Under guidance from Indeco, local equity has been set with a ceiling of 33.3% of investment costs in local currency. Since local currency costs are around 10 to 15% of total investment costs, equity covers all local costs. This leads to very high debt:equity ratios.

The balance of costs is financed by long terms loans from the Development Bank of Zambia at relatively high rates of interest. It is unrealistic to build in any soft term financing for the projects, since Zambia's credit rating is, unfortunately, so low. It is equally unrealistic to assume foreign equity participation in the case of the small mill options (Section 10.7).

1.9.5 Financial statements

All projects show high debt: equity ratios and very poor current and liquidity ratios. The Romanian mill, however, does generate higher profit margins and returns on capital employed. Profit after tax and retained earnings also become positive much earlier in the project. The financial statements show clearly, therefore, that, of the three projects, the Romanian mill is the preferred option, although its viability must be considered marginal. The small mills are obviously not acceptable to investors (Section 10.8).

1.9.6 Payback, simple rate of return, IRR (with financing) and break even analysis

The calculations regarding payback period, simple rate of return, break even, and IRR with financing are presented in Tables 10.31 to 10.36. The relevant figures are reproduced in Table 1.13.

The figures are consistent with the IRR and NPV figures above. They also show clearly that the Romanian mill is the most attractive option (with the commercial terms assumed), and that the small mills are not viable (Sections 10.9 and 10.10).

1.9.7 Sensitivity

The sensitivity of the projects to changes in prices, operating costs, the price of copper, expenditure on fixed assets, and sales has been examined. The results are presented in Table 10.37. The impact of sales increases has not been examined, since each mill is operating very close to capacity in most years.

TABLE 1.13 - PAYBACK PERIOD, SIMPLE RATE OF RETURN, BREAK EVEN ANALYSIS, AND IRR (WITH FINANCING)

	Payback period (years from 1989)	Simple rate of return on total investment costs (%)	Simple rate of return on equity capital (%)	Production year in which project breaks even (years from 1989)	IRR with financing (%)	IRR with financing in real terms (%)
Romanian Mill	11	16.3	34.5	7	12.9	7.5
Small Mill with New Plant and Equipment	13	7.9	-58.5	14	-16.8	-20.8
Small Mill with Second Hand Plant and Equipment	12	11.1	-32.0	10	-1.5	-6.2

Source: WS Atkins

In general, the projects are more sensitive to changes in prices and operating costs, than expenditure on fixed assets. The small mill options produce an IRR in excess of 12% in only one case. A few cases produce IRR's over 12% in the case of the Romanian mill, but the validity of these scenarios is questionable, since the price of copper sheet and copper cathode are not independent, but move in sympathy. A rise or fall in one will be preceded or followed by a rise or fall in the other.

Although acceptable rates of return for the small mill are generated by setting PTA prices at a premium of 5 to 15% relative to European imports, such gains would be partly offset by increased import penetration. It is considered more realistic to proceed on the basis of prices set lower with respect to imports.

An IRR of 11.9%, with a decrease of expenditure on fixed assets, is encouraging for the Romanian project, but the price for the equipment used in the base case may turn out to be an underestimate. Even with a change in design of the small mill (to incorporate only one rolling mill), reducing costs by 15%, the second hand mill still does not generate an acceptable rate of return.

All options are very sensitive to variations in sales. This is a particularly important observation with respect to the Romanian mill, where sales well in excess of that needed to pay off the Romanian credit have been assumed. The small mill project also appears to be very vulnerable to a reduction in sales, either through increased competition from Radiator and Tinning, or a lower rate of growth in demand throughout the PTA (Section 10.11).

1.9.8 Economic evaluation

The forecast cash flows in economic prices for the three projects are set out in Tables 11.2 to 11.4. The results of the DCF analyses are summarised in Table 11.5.

Gross value added by the Romanian project increases from $ 2.8 million (in constant prices) in 1993, the first year of operation, to $ 10.5 million by the end of the project period (Section 11.4).

The internal rate of return for each of the options is below the minimum Indeco economic opportunity cost of capital requirement of 12%. The rates of return for the smaller mill options, at 4.8% for the new mill, and 7.0% for the mill with second hand plant and equipment, are such that these cannot be considered to be viable projects in economic terms. On the other hand, the rate of return on the Romanian mill of 11.1% is sufficiently close to the cut-off rate to warrant further consideration (Section 11.4).

The preferred option, the Romanian mill, would have two important benefits for the Zambian economy:

* direct net foreign exchange earnings amounting to some $ 30 million pa at mid 1988 prices in 1995

* an annual import substitution of copper sheet and strip totalling approximately $ 1.5 million at mid 1988 prices by 1995.

The foreign exchange cash flow for the Romanian mill (excluding the forex benefits of import substitution) produces an IRR of 38%. It is therefore clear that the project would generate substantial net foreign exchange benefits for the Zambian economy (Section 11.5). From the point of view of the copper refineries, of course, the project results in foreign exchange losses of about $ 18 million pa (in 1988 prices).

While the impact of the project on employment outside the works is difficult to quantify, it is nevertheless potentially very significant. Employment opportunities likely to arise within linked industries and induced elsewhere in the economy are estimated at 875, compared to a total of 214 jobs within the mill (Section 11.6).

1.10 Conclusions and Recommendations

The market research demonstrates that the feasibility of manufacturing rolled products in Zambia merits further consideration.

A Zambian manufacturer of rolled products will be heavily dependent on the PTA market, were high tariff barriers provide protection against third country imports. In major world markets, it will be at a competitive disadvantage.

The small mill options produce poor internal rates of return. Other measures of commercial profitability are also very poor. The projects are clearly not acceptable financially, and can be rejected. The break even analysis demonstrates that, while the mills are not uneconomically small from a production point of view, they are too small for the proposed financing scenario.

The Romanian mill produces better figures, particularly from an economic point of view, but will still look vulnerable to investors and creditors. The main problem is that all indications of profitability are very sensitive to sales. If sales are significantly less than those assumed, the project will be unprofitable. The project also suffers from a financing scenario which assumes no foreign equity participation, and no soft term loans except for the Romanian credit for plant and equipment.

The Romanian mill does not meet the financial and economic criteria set by Indeco, but is worthy of further investigation. However, a final decision cannot be made until the full details of the Romanians' commercial offer are known. The key is the volume of sales which the Romanians will accept (either as direct imports to Romania, or re-exports). Anything significantly lower than 80% of the plant's output will render the project unprofitable. It will also be important to clarify the terms of the Romanian credit, and obtain a firm quotation for the plant and equipment.

Indeco should seek matching equity participation from the Romanians. This would improve significantly the project's acceptability from a financial point of view, and its attractiveness to creditors.

Further attention should be directed towards secondary industries. A good example is the manufacture of copper and brass components (plumbing fittings, electrical contacts, nuts and bolts). Unlike copper semis manufacture, this type of industry requires comparatively little capital investment. With the recent expansion at Zamefa, the main raw material, copper and brass bars, can be sourced locally. Industries established in Kenya or Zimbabwe would have similar advantages, however, so a Zambian manufacturer could face significant competition within the PTA market. Nonetheless, the feasibility of such a project is well worth testing (Section 12).

2. PROJECT BACKGROUND

Although Zambia is a major producer of copper cathodes, it imports most of its requirements for copper semis, principally from Europe. Zamefa is the only domestic manufacturer of copper semis, producing cable and wire rod and expanding into shapes and sections. There is at present no local manufacturer of tubes or sheet and strip.

These imports constitute a serious drain on Zambia's forex reserves. Import substitution would seem a logical development since copper, the main cost component, is available locally. A further attraction is the likely multiplier effect of local manufacture on downstream industries. End-users of copper semis report that production is seriously constrained by the scarcity of foreign exchange and erratic supply. The local availability of key raw materials would have a significant effect on capacity utilisation, and the development of new industries.

The viability of manufacturing copper semis in Zambia is by no means certain, however. The potential market needs careful examination, for example. Operating costs are likely to be higher than competitive installations in Europe, principally because of relative scales of production, the unavailability of local scrap as a feed material and the need to import expensive spares. Technology is also a key aspect of the problem since this can have a major effect on capital and operating costs.

A previous study on the feasibility of manufacturing copper semis in Zambia was carried out by the Cooperation Centre of Tilburg and Eindhoven Universities in the Netherlands. The study commenced in 1985 and reported in 1987. A thorough market survey was carried out, focusing on the Preferential Trade Area (PTA), Europe and other Middle East and Asian markets. Taking into account transport costs and the impact of customs tariffs and sales tax, the study concluded that a Zambian manufacturer would be competitive within the PTA, only marginally competitive in Middle East and Asian markets (particularly for high-valued added products like strip), and not competitive at all in European markets.

The results indicated that a Zambian manufacturer would be primarily dependent on the PTA market, where preferential tariffs and sales tax rates provide effective protection against European imports. Within this market, it was concluded that the most promising opportunities lay in the manufacture of copper sheet, strip and foil, mainly because in this sector there is very little competition within the PTA. Accordingly, the project team carried out a financial and economic evaluation of a small scale rolling mill, with a capacity of 1,000 t/pa.

The financial analysis generated a negative npv at 12%, which is the cut-off rate specified by Indeco, the Zambian industrial development parastatal. Three variations to the base case (reduction of capital costs by 30%, increase of sales price by 20%, and a production increase of 50%) failed to provide a satisfactory IRR. The most promising was the reduction in capital costs which produced an IRR of 5.3%, corresponding to the use of second hand plant and equipment. The economic analysis also generated a negative npv on the base case, discounted at 12%. The IRR approached 10% only when capital costs were reduced by 30%.

A variation on the base case, assuming both reduced capital costs and a 20% improvement in sales price produced a positive npv at 12%. However, the central conclusion of the study was that a small scale rolling mill, serving the PTA market, would not be profitable, either on a financial or economic basis.

Subsequent to the Dutch study, the Governments of Zambia and Romania signed a protocol to conduct negotiations on the establishment of a copper fabrication plant in Zambia. The Romanian organisation Uzinexportimport and Indeco agreed a set or principles covering the negotiations. These were that:

* Romanian credits could be available to finance the purchase of Romanian plant and equipment

* repayment of the loan could be made in copper products, transfer prices being based on international prices

* Uzinexportimport could undertake marketing both regionally and internationally in return for a commission

* the joint venture would be subject to an independent feasibility study.

WS Atkins was commissioned by Indeco and UNIDO to carry out the feasibility study. Discussions were held with Romanian representatives in Lusaka in June 1988. At these meetings, Romanian technical proposal was presented and evaluated by Atkins' copper technologist. This was based on a fairly conventional rolling mill of 10,000 t/pa capacity producing sheet and strip. However, the commercial offer was discussed only in broad terms. It was agreed that a full commercial offer would be prepared by early August, but the Romanians subsequently requested a delay of several months. In order to comply with the timescale for completion specified in UNIDO's contract with Atkins, it has been agreed to prepare the analysis on the basis of provisional figures and terms provided by the Romanians, which can be revised when the full commercial offer is presented.

It is essential to note that several important aspects of the Romanian proposal are still unclear. The first is the proportion of the plant's output which can be sold to the Romanians. It is possible that the Romanians will only agree to accept the tonnage of copper products needed to pay off the loan for plant and equipment, which would be conventional for a buy-back agreement. On the other hand, they could agree to absorb a fixed proportion of production. The Romanian position is that the terms are negotiable, but the latter procedure appeared to be favoured. Atkins has therefore assumed the fixed percentage option in the financial and economic analyses that follow. The second question is whether the Romanians will continue to buy products once the loan is paid off. The Romanians appear to be flexible on this issue. Atkins has assumed that the Romanians will absorb a fixed percentage of output throughout the 15 years of production.

The terms of reference for the feasibility study call for a comparison of the Romanian proposal with possible alternatives. This required an examination of market opportunities in sectors other than sheet and strip, specifically tubes and pipes and copper alloy products (shapes and sections). For this reason, the market data presented in the Dutch consultants' report was reassessed. It also required evaluation of an alternative type of plant to the Romanian offer. Accordingly, a much smaller rolling mill, oriented to the PTA market only, was costed and evaluated.

3. MARKET AND PLANT CAPACITY

3.1 Demand and Market Study

3.1.1 Market situation (PTA Region)

In reviewing the market data presented in the Dutch consultants' study, Atkins has focused attention on Kenya, Zimbabwe and Zambia. These countries together account for over 80% of the PTA market for copper semis, and over 80% of production. The research was carried out by means of field visits and telephone calls to both manufacturers and end users, and analysis of the latest import/export data. Comparison was also made with the results of a (1986) survey of copper and aluminium fabricating facilities in the PTA region carried out by the United Nations Economic Commission for Africa.

Kenya

A comparison of production and consumption figures for selected manufacturers and end-users in Kenya is presented in Table 3.1. These show a reasonable fit with the figures reported by the Dutch consultants, allowing for annual variations. Import data are updated in Table 3.2 (there are virtually no exports, other than re-exports). These data lead to the market size estimates presented in Table 3.3.

TABLE 3.1 - MARKET SITUATION (KENYA)

Company	Products	Raw material	Consumption (t/pa)		
			Atkins (1988)	Dutch (1986)	UN (1986)
East African Cables	Power cables & conductors	wire-rod	400	400	900(1)
Ken West Fab	Power cables	wire-rod	240-300	200	-
Coast Cables	Winding wire	wire	60	50	-
Burns & Blane	Radiators	strip, foil	90	90	-
City Radiators	Radiators	strip, foil	75	50	-
Booth Manufacturers	Copper & brass extrusions	billets	40-60	5	1000(2)
APV-Hall	Stockists	tubes	5	5	-
Ram Co	Stockists	tubes	10-15	10	-

Sources: WS Atkins
F Meijer & B van Manen, Export Oriented Production of Copper Semi-Products in Zambia: An Economic Analysis, pp 76-78
United Nations Economic Commission for Africa, Regional Survey of Copper and Aluminium Fabricating Facilities and Marketing Prospects for Copper and Aluminium Based Products in Africa, Kampala, June 1988, pp 5-8

(1) This figure probably refers to the weight of the product, not the weight of the copper

(2) This figure is clearly spurious

TABLE 3.2 - IMPORT DATA (KENYA)

Product group	Imports (t/pa)	
	1985	1986
Bars, rods, wire-rod	719	957
Wire	80	88
Tubes, pipes	33	85
Plate, sheet, strip, foil	204	113*
Stranded wire	47	6
Insulated cable	860	760
Winding wire	40	40

Source: Kenya Annual Trade Report, 1986-1987

* this figure is contradicted by import data supplied by manufacturers

TABLE 3.3 - MARKET PROFILE (KENYA)
(Domestic consumption)

Product group	Atkins estimate (t/pa)	Dutch estimate (t/pa)
Bars, sections, shapes	100	50
Wire, wire rod	875	750
Tubes, pipes	85	40
Plate, sheet, strip, foil	225	200
Insulated cables	1,500	1,150
Winding wire	20	20

Sources: WS Atkins
Meijer & van Manen, op cit, pp 142-146

The figures suggest a significant increase in demand between 1986 and 1988, perhaps exceeding 10% pa. This is consistent with improved performance in metal and engineering sectors, which have grown at an average 7% pa since 1983. It is also important to note that Booth Manufacturers (Thika) has, since 1986, moved into the manufacture of copper and brass shapes and sections, mostly for electrical applications at present. There is considerable demand for machined brass components (e.g. nuts and bolts), which Booth intends to supply. This development limits seriously the Kenyan market for Zambian manufacturers of these products. Booth also has the capability of producing copper tubes and pipes, and plans to move into this line soon. At present, there is no local manufacturer.

Zimbabwe

A comparison of production and consumption figures for selected manufacturers, stockists and end users in Zimbabwe is presented in Table 3.4. Import/export data are updated in Table 3.5. Market size estimates are compiled in Table 3.6.

The results show some very significant developments since the Dutch consultants' study in 1986. The first of these is increasing self sufficiency. Imports as a percentage of domestic consumption is now about 10% (bars, sections, shapes), 0.3% (wire and wire-rod), 5% (tubes and pipes), 20% (cable) and 2% (stranded wire). Significant improvements have been made in all areas, except plate, sheet, strip and foil where imports account for about 95% of domestic consumption.

The second important development is increased production of tubes and pipes. Almin (Harare) started manufacturing copper tubes in 1987, and is now producing 600 t/pa entirely for the domestic market. Expansion into the export market is planned. A target of 200 t/pa exports has been set to provide the means for financing the recent purchase of equipment in hard currencies. The press has a capacity of 3,400 t/pa. End users report that quality is excellent,

TABLE 3.4 - MARKET SITUATION (ZIMBABWE)

Company	Products	Raw material	Production/consumption (t/pa)		
			Atkins (1988)	Dutch (1986)	UN (1986)
Radiator & Tinning	Bars, sections Tubes Strip Foil	billets, wire	500 180 10-15 0.5 (prod) 55-60 (imp)	500 100 25 0 (prod) 120 (imp)	370 (exp) 36 (exp)
Aluminium Industries (Almin)	Tubes Bars, sections	billets	600 5	500 (1) 500	
Central African Cables (Cafca)	Cable Wire rod	billets	2,690 1,000	5,100 (2) 500	) 2,360)
McKechnie	Stockists of: Rod, bar Sheet	-	Closed down	 40 122	 - -
Non-Ferrous Metal Manufacturers	Stockists of: Tubes Sheet	-	 0 60	 20 60	 - -
Enfield Cables	Stockists of: Tubes Sheet	-	 0 10	 3 14	 - -
Air Cool	Air conditioning units	Tubes	10-20	6	-
Cool Air	Air conditioning units	Tubes	10	5	-
Royal Refrigeration	Refrigeration units	Tubes	60	)	
Imperial Refrigeration	Refrigeration units	Tubes	40	) 50	-
McIntosh	Geysers	Sheet, strip	36-40	30	-
Treger Industries	Geysers	Sheet, strip	80	28.5	-
Copperwares	Copperwares	Sheet, strip	8	-	
Kariba Copper Products	Copperwares	Sheet, strip	-	-	12
Industry total (copperwares)	Copperwares	Sheet, strip	-	20	-

Sources: WS Atkins
Meijer & van Manen, op cit, pp 90-95
United Nations Economic Commission for Africa, op cit, pp 30-37

Notes: (1) planned production
(2) this figure must refer to the weight of the final product, not the weight of the copper

TABLE 3.5 - IMPORT/EXPORT DATA (ZIMBABWE)

Product group	Imports (t/pa)			Exports (t/pa)		
	1984	1986	1987	1984	1986	1987
Bars, rods	97	87	47	212	0	110
Tubes, pipes	78	62	46	3	0.1	2.5
Plate, sheet, strip, foil	178	175	232	0	1.2	3
Stranded wire	339	8	3	1	2.6	12.3
Cable	1,767	1,383	607	707	946	1,750

Source: Central Statistical Office, Import/Export Statistics, Zimbabwe

Note: Figures for 1987 have been estimated on the basis of data up to November 1987.

so that the products are suitable for both plumbing and refrigeration applications. Radiator & Tinning (Bulawayo) has also increased production of copper and brass tubes to 180 t/pa, although the products are said to be suitable only for plumbing applications. A small export market (of 4 t/pa) has been developed. Capacity is reported to be between 1,000 and 2,000 t/pa, and a steady expansion programme is planned. As a result of these developments, import licences are no longer being issued for tubes now being manufactured in Zimbabwe.

TABLE 3.6 - MARKET PROFILE (ZIMBABWE)
(Domestic consumption)

Product group	Atkins estimate (t/pa)	Dutch estimate (t/pa)
Bars, sections, shapes	450	400
Wire, wire-rod	3,450	3,000
Tubes, pipes	780	190
Plate, sheet, strip, foil	230	350
Insulated cables	3,000	2,800

Sources: WS Atkins
Meijer & van Manen, op cit, pp 142-146

A third development is the installation of further capacity for copper and brass bars, shapes and sections. Radiator & Tinning, which produces about 500 t/pa of machining brass, borehole liners and earthing strip, is the largest manufacturer at present. It has capacity for 5,000 to 10,000 t/pa. Almin, however, has the capability of doubling Zimbabwean production of these products within a few years. It is concentrating, for the present, on the manufacture of tubes since domestic demand has risen so rapidly, but it intends to increase production of shapes mainly for bus bars, the local market for which is estimated at 320 t/pa. Cafca (Harare) is also capable of producing copper and brass bars and sections. At present, Cafca is producing cable, wire and rod at near full capacity (3,600 t/pa against 4,000 t/pa capacity), but it intends expanding capacity to nearer 6,000 t/pa. This will allow it to diversify into 11 kV cable (800 t/pa planned) and expand telephone cable production (from 100 t/pa to around 500 or 600 t/pa). This will leave a capacity of around 1,000 t/pa for the manufacture of shapes and sections.

Local consumption of copper sheet and strip appears to have been over-estimated in the Dutch report, possibly through double-counting direct and indirect imports. We estimate consumption at 230 t/pa against a reported 350 t/pa. Radiator & Tinning, for example, is manufacturing only 10 to 15 t/pa of sheet and strip (against a reported 25 t/pa), and importing only 55 t/pa of radiator foil (against a reported 100 t/pa). The company's sheet, being only 200mm maximum width, is unsuitable for geyser manufacture (a market of about 120 t/pa), and the quality of its other products is considered poor by end-users. Radiator & Tinning claims to have recently produced a small quantity (0.5 tonnes) of satisfactory foil (rolled down to 0.13mm), and expects to satisfy its own requirements within a couple of years.

The prospects for a Zambian manufacturer in the Zimbabwean market appear poor in every major product group, with the exception of sheet, strip and foil. Cables, wire and tubes are dominated by Cafca and Almin respectively, while current opportunities in copper and brass shapes and sections will disappear with expansion at Almin and Cafca. In sheet, strip and foil, however, Radiator & Tinning is considered unlikely to make a significant impression on the market since the quality and specifications of its equipment limit the appeal of its products.

Zambia

A comparison of production and consumption statistics for selected manufacturers and end-users in Zambia is presented in Table 3.7. Import data are updated in Table 3.8. Estimates of the size of the Zambian market are set out in Table 3.9.

TABLE 3.7 - MARKET SITUATION (ZAMBIA)

Company	Products	Raw material	Production/consumption (t/pa)		
			Atkins (1988)	Dutch (1986)	UN (1986)
Zamefa	Wire-rod	Cathodes	7,224	6,800	
	Power cables		1,884	600	)
	Tel cables		847	200	) 1,500
	Copper & brass billets, shapes		1,609	100	)
Non-Ferrous Metal Works	Copperwares	Sheet, foil	8	9.5	-
	Brass & bronze rods	Scrap	10	10	-
Monarch	Geysers	Sheet, strip	150	60	-
Automotive Radiators	Radiators	Strip, foil	16-20	)	
				) 10	-
Kitwe Radiators	Radiators	Strip, foil	3-5	)	
Delta Engineering	Switchgear	Strip	1	-	-
	Busbars	Wire	0.5	-	-
NEI	Electrical goods	Strip	0.5	-	-
		Bar	2	-	-

Sources: WS Atkins
Meijer & van Manen, op cit, pp 114-116
United Nations Economic Commission for Africa, op cit, pp 18-23

TABLE 3.8 - IMPORT DATA (ZAMBIA)

Product group	Imports (t/pa)		
	1984	1985	1986
Bars, rods, sections	-	50	1
Wire	3	22.5	45.6
Tubes, pipes	10	9	52
Plate, sheet, strip, foil	39	3,243(1)	6,903(1)

Source: Central Statistical Office, Import/Export Statistics, Zambia

(1) these figures are clearly spurious. They may be 32t and 69t respectively, or even 3.2t and 6.9t.

Note: the only export is of about 7,000 t/pa of wire rod by Zamefa

TABLE 3.9 - MARKET PROFILE (ZAMBIA)
(Domestic consumption)

Product group	Atkins estimate (t/pa)	Dutch estimate (t/pa)
Bars, sections, shapes	1,650	150
Wire, wire-rod	1,400	1,200
Tubes, pipes	50	30
Plate, sheet, strip, foil	230	150
Insulated cables	2,750	1,000

Sources: WS Atkins
Meijer & van Manen, op cit, pp 142-146
Zamefa

The figures reveal some important developments since the Dutch consultants' study. These are mainly the product of recent expansion at Zamefa, which has increased the capacity of its Outokumpu continuous caster (by increasing the thickness of wire-rod drawn by the machine) from 9,000 t/pa to 12,000 t/pa. This will enable Zamefa to triple production of telephone cable (to 850 t/pa), and diversify into the manufacture of 11kV cable (like Cafca in Zimbabwe. In addition, the company's Schloeman press is to be exploited more fully to produce a range of copper and brass shapes and hollow bars (bus bars, for example). Production is budgeted at 1,600 tonnes for 1988/89, compared to 100 t/pa at the time of the Dutch consultants' visit. This market is also being supplied by Non-Ferrous Metal Works (Kitwe) and Zambia Aluminium (Lusaka).

Zamefa has also considered manufacturing tubes, primarily for the refrigeration and air conditioning markets. This is well within the capabilities of the existing plant, and is a logical diversification of activities.

The Zambian market for sheet and strip, estimated at 150 t/pa in the Dutch consultants' report, needs to be revised upwards. A figure nearer 230 t/pa may be more accurate. Demand in this sector, particularly for geyser and radiator applications, appears to be buoyant. Zamefa has in fact considered diversification into rolling strip, but decided that the project was not feasible, although this conclusion appears to have been based on an underestimate of market size.

Other Countries

The other countries within the immediate PTA region (Tanzania, Angola, Mozambique, Malawi and BLS) have not been researched first hand. International trade statistics have been used where possible. Elsewhere the consumption of copper semis has been estimated by comparing levels of manufacturing activity (this being used as a proxy). Published country reports, trade journals and regional journals have been used to check for production figures. From this it would appear that the Dutch consultants' estimates are not unreasonable. Table 3.10 sets out our estimates of the regional market by product group.

It is clear that the regional market has altered significantly in all product areas, with the exception of plate, sheet, strip and foil. This is largely due to developments taking place among the region's major manufacturers: Zamefa, Cafca, Almin, and Radiator & Tinning.

TABLE 3.10 - PROFILE OF THE REGIONAL MARKET
(Domestic consumption t/pa)

Product group	Kenya		Zimbabwe		Zambia		Others		Total	
	Atkins (est)	Dutch (est)	Atkins (est)	Dutch (est)	Atkins (est)	Dutch (est)	Atkins (est)	Dutch (est)	Atkins (est)	Dutch (est)
Bars, sections, shapes	100	50	450	400	1,650	150	100	105	2,300	705
Wire, wire-rod	875	750	3,450	3,000	1,400	1,200	1,200	1,105	6,925	6,055
Tubes, pipes	85	40	780	190	50	30	100	85	1,015	345
Plate, sheet, strip, foil	225	200	230	350	230	150	150	135	835	835
Insulated cables	1,500	1,150	3,000	2,800	2,750	1,000	2,000	1,870	9,250	6,820

Sources: WS Atkins
Meijer & van Manen, op cit, pp 142-146

Discussion

The market research leads to the following conclusions regarding the regional market for the product sectors Atkins was commissioned to study:

* tubes: Almin (Zimbabwe) has entered successfully this market, and could clearly supply a large percentage of demand within the PTA. Since Zamefa (Zambia) and Booth Manufacturers (Kenya) also have the capacity to produce tubes, investment in another plant in Zambia would not appear to be a sensible option

* copper and brass bars, shapes and sections: this is a promising market given the diversity of shapes that can be produced, and range of products that can be machined from these materials. There are, however, three producers in both Zambia and Zimbabwe, and one in Kenya. Further investment does not appear to be justified, although there must be scope to develop secondary manufacturing industries using copper and brass feed (e.g. brass nuts and bolts)

* copper and brass sheet, strip and foil: there is still no major manufacturer of these products within the PTA region surrounding Zambia. Radiator & Tinning (Zimbabwe), the only producer, has a rolling mill with a reported capacity of 3,500 t/pa (well in excess of present consumption within the region), but its claims regarding future production levels are considered far fetched. The company has a long history of poor quality and unreliability. Nevertheless, it is probable that Radiator & Tinning will supply around 20% of the Zimbabwean market, and around 15% of PTA markets in respect of which Zimbabwe has locational advantages over Zambia (notably BLS and Mozambique). Local competition is also provided by the Zairean manufacturer, GECA mines, which is already supplying Monarch (Zambia) with sheet for geysers. It

supplants European imports because of lower transport costs and lower prices related to poorer quality. The surface finish of the sheet is poor, and unsuitable for applications other than geysers. GECA is not believed capable of producing satisfactory radiator foil.

The market research demonstrates that the only significant "gap" within the immediate PTA market for a Zambian manufacturer lies in the sheet, strip and foil sector. This is consistent with the conclusion reached in the Dutch consultants' report, and with the Romanian joint venture proposal.

It was logical, therefore, to limit the investigation at this juncture to sheet, strip and foil.

3.1.2 Sales outside the PTA

Prospects for exporting sheet and strip outside the PTA region appear poor. Although there has been considerable rationalisation of production both in Western Europe and in the USA, there is still ample capacity for rolled products, and declining markets have led to significant improvements in efficiency among the surviving producers.

The Western European market would be particularly difficult to penetrate. It is dominated by West Germany (which accounts for 118,000 t/pa out of an EEC total production of 287,000 t/pa), which possesses very modern mills. The US market, valued at about 143,000 t/pa (1987), has a relatively high level of import penetration (25%), but European manufacturers are well established in this area. Markets in the Far East are dominated by Japan, which has by far the highest level of production in the world (182,000 t/pa), and perhaps the most efficient mills. There may be markets in Eastern Europe, but these countries are outside the hard currency areas, and little is known about consumption and import patterns.

It is sometimes assumed that a Zambian manufacturer of copper semis will achieve lower production costs/tonne by virtue of the discount it will receive on the LME price of copper cathodes related to transport costs to Europe. This amounts to about $ 100/tonne in the case of Zamefa. However, European manufacturers are producing copper strip primarily from fairly low grade scrap, which is itself some $ 150/tonne cheaper than the LME price for Grade A cathode. The unavailability of scrap in Zambia cancels effectively any advantage that a Zambian manufacturer might obtain on raw material costs. A Zambian manufacturer will also be at a disadvantage with respect to the costs of spares and materials, which will be imported, both from the point of view of prices (because of freight costs and customs tariffs) and stock levels (because of erratic transhipment times and approvals for forex). Potential advantages over European manufacturers with respect to labour costs will be balanced by higher manning levels, higher training costs, poorer productivity, and the cost of technical support from expatriate management.

Another problem is that that the market for copper strip in advanced industrial economies is quite different to that of the PTA. European requirements are mainly for thin strip for electrical applications, while the PTA market is presently dominated by sheet (for geysers), and to a lesser extent foil (for radiator applications). A manufacturer selling to both the PTA and Europe would therefore need to develop a quite complex and diversified production programme, which may be comparably inefficient.

The marketing of Zambian products to Europe would also be exceedingly difficult. There are a few large users of sheet such as manufacturers of copper hot water cylinders, but generally the market is divided between numerous engineering firms using sheet or strip for drawing or pressing components forming part of a finished product. These concerns deal mainly directly with the mills. They require prompt (often daily) and reliable delivery in order to minimise stocks and financing charges. Some have special requirements in terms of hardness and grain size range. Uniform, high quality is demanded, since highly automated machinery will only operate efficiently with a standardised feed. Servicing this kind of market is obviously very different from the supply of cathode in bulk to a few large users. It would be necessary to stockpile products in European depots. This would entail relatively minor warehousing and handling charges in the range 10 to $15/tonne, but significant financing charges given a delay of perhaps 3 months between ex-works shipment and receipt of payment, and the need to hold substantial stocks. It would also be necessary to protect against losses arising from a fall in the LME price of copper between paying for cathodes from the refinery and receiving payment for finished products several months later (the prices of rolled products rise and fall in sympathy with the LME price of copper).

It is possible that arrangements could be made with smaller re-rollers in European markets to take strip at an intermediate stage of production, and finish it to the requirements of final customers. Further research could be undertaken to establish the size of this market, but it is a less attractive proposition because the value-added of partly rolled strip would be significantly less than that of finished products.

For these reasons, we have proceeded on the assumption that a Zambian manufacturer will not achieve any sales to Europe, or other hard currency markets. This is consistent with the conclusions of the market research carried out by the Dutch consultants. The most sensible approach is to assume that a Zambian manufacturer will concentrate on the PTA market, where high tariff barriers provide effective protection against European imports. Sales to Romania as part of the joint venture proposal must be treated as a separate and unique item.

3.1.3 Calculation of demand

PTA region

The calculation of demand assumes that sales from a Zambian manufacturer displace European imports. Prices are adjusted to effect this displacement, taking into account differentials in transport costs, customs tariffs, and sales tax rates (see Section 3.1.4).

The calculation also takes into account the impact on demand of local manufacture. The market research has demonstrated that consumption by end-users is seriously constrained both by restrictions on forex for imports, erratic supply due to transhipment inefficiency, and the high price of imports because of tariffs. Low capacity utilisation (figures average between 40% and 50% within the region according to Table 3.11) is blamed largely on the problems of securing forex.

TABLE 3.11 - CAPACITY UTILISATION AMONG SELECTED USERS OF COPPER SEMIS

End-user	Capacity utilisation (%) (1988)
East African Cables (Kenya)	50-60
Kenwest Fab (Kenya)	50
Kenby Cables (Kenya)	75
Booth Manufacturers (Kenya)	70
Burns and Blane (Kenya)	30
City Radiators (Kenya)	40
Radiator and Tinning (Zimbabwe)	10-20
Almin (Zimbabwe)	50
Cafca (Zimbabwe)	90
Treger (Zimbabwe)	80
Non-Ferrous Metal Manufacturers (Zimbabwe)	50
Copperwares (Zimbabwe)	40
McIntosh (Zimbabwe)	30
Enfield Cables (Zimbabwe)	30
Zamefa (Zambia)	80-90
Monarch (Zambia)	50
Automotive Radiators (Zambia)	50-70
Kitwe Radiators (Zambia)	50
Non-Ferrous Metal Works (Zambia)	40

Source: WS Atkins

According to most respondents, consumption of copper semis would probably double if materials could be purchased locally, or at least with local currency. Almin, for example, estimated the Zimbabwean market for copper tubes at 300 t/pa, but now finds that 600 t/pa is insufficient to satisfy demand. Similarly, Monarch (Zambia) which purchases copper sheet in hard currency from Zaire and Europe, estimates its own demand at 300 t/pa, against the 150 t/pa it consumes at present. Manufacturers also report that the irregularity of forex allocations and thus import licences forces them to maintain uneconomic stock levels, placing further downward pressure on production. Burns and Blane (Kenya), for example, reports that with import licences taking 6 months to be granted on average, deliveries (from Europe) are spread at least 9 months apart. For this reason, the company maintains 12 months stock.

It seems reasonable to assume, therefore, that a multiplier of 2.0 can be applied where copper products can be purchased in soft currencies.

This does not mean that our estimate of 835 t/pa (see Table 3.10) for the regional market for sheet and strip can be revised to nearer 1,700 t/pa. The multiplier can be applied to domestic sales, but it is unlikely that the PTA clearing system will develop sufficiently in the near future to allow PTA members outside Zambia to purchase copper semis entirely in soft currencies. Trade between PTA members is presently weak and often unbalanced. On the basis of our discussions with the PTA, an assumption that 20% of export sales to PTA markets will be paid in soft currencies has been derived. In any event, a Zambian manufacturer will need hard currency to finance capital costs and imports of spares.

It is also important to allow for competition from Radiator & Tinning, and also GECA mines. It has been assumed that Radiator & Tinning will supply 20% of the Zimbabwean market (see Section 3.1.1), and perhaps 15% of the more adjacent markets in the PTA (notably BLS, Mozambique), while GECA mines will capture 5% of markets outside Zambia, which will be protected from competition by import licence practices. A further assumption is that PTA members, particularly Zimbabwe, Mozambique and BLS will not displace European with South African imports.

The assumption regarding competition from Radiator & Tinning may be invalidated by improvements in quality and productivity at its plant. For this reason, we have included in the sensitivity analysis (Section 10.11), an analysis of the effects of greater competition from this source under two scenarios.

These calculations are presented in Table 3.12. They show that a Zambian manufacturer of sheet and strip has a realisable market of about 1,080 t/pa initially. One will note that this figure depends on total dominance of the Zambian market, and high import penetration of the surrounding PTA countries.

Romania

Sales to Romania depend on the precise terms of the agreement reached with UZINEXPORTIMPORT. It is as yet uncertain whether the volume of annual sales will be fixed against repayments of the loan for plant and equipment, as is customary in buy-back arrangements, or whether the off-take will be a fixed percentage of output.

It has been assumed for the purposes of establishing a base case that the latter will be implemented. In the initial analysis, the off-take has been set at 80% of maximum capacity (i.e 8,000 t/pa). This allows the spare capacity to be used for serving the regional market (see Section 3.3.2).

3.1.4 Derivation of prices

In order to satisfy the assumption that a Zambian manufacturer will displace European imports from the PTA markets under review, it is necessary to set sales prices with reference to the landed prices of European sheet and strip. Landed prices are derived by adding

TABLE 3.12 - CALCULATION OF DEMAND FOR COPPER SHEET, STRIP AND FOIL IN THE PTA REGIONAL MARKET
(Figures in t/pa)

Country	Potential market (1)	Adjust for multiplier for payments in local currency (2)	Competition from Radiator & Tinning (3)	Competition from GECA Mines (4)	Total demand (2)-(3)-(4)	Assumed penetration of market (%)	Share of total demand (%)
Kenya	225	270	-	11	259	96	24
Zimbabwe	230	276	55	12	209	76	19
Zambia	230	460	-	-	460	100	43
Tanzania	60	72	-	7	65	90	6
Others	90	108	16	4	88	81	8
Totals	835	1,186	71	34	1,081		

Source: WS Atkins

Notes:
(1) From Table 3.10. Breakdown between Tanzania and 'Others' is based on Meijer & Van Manen, op cit, p. 145
(2) Multiplier is 2.0 in the case of Zambia, and 1.2 elsewhere, since only 20% of sales in these markets will be payable in local currencies
(3) Based on 20% of Zimbabwean market and 15% of 'Others'
(4) Based on 4% of markets with the exception of Zambia (0%), which will be free of imports, and Tanzania (10%), where transport advantages may allow a higher import penetration

TABLE 3.13 - DERIVATION OF EX-WORKS PRICES FOR A ZAMBIAN MANUFACTURER OF SHEET, STRIP AND FOIL

	Transport costs from Europe ($/tonne)	Tariff rates against third countries (%)	Sales tax rates for third country imports (%)	Effective rates against third country imports (%)	Landed prices ($/tonne)		
					Sheet	Strip	Foil
Europe	0	0	0	0	3,937	4,121	4,520
Zambia	120	15	15	33.25	5,365(b)	5,609	6,136
Kenya	70	30	17	52.10	6,095	6,375	6,981
Zimbabwe	120	0	20	20.00	4,868	5,089	5,568
Tanzania	70	25	25	56.25	6,261	6,548	7,172
Others	100	20	20	44.00	5,813	6,078	6,653

	Transport costs from Zambia ($/tonne)	Tariff rates against PTA members (%)	Sales tax rates for PTA country imports (%)	Effective rates against PTA country imports (%)	Ex-works prices Zambia ($/tonne)		
					Sheet	Strip	Foil
Zambia	0 (d)	0	15	15.00(c)	4,432(a)	4,633	5,069
Kenya	80	10	5	15.50	4,933	5,163	5,662
Zimbabwe	40	0	7	7.00	4,282	4,478	4,903
Tanzania	50	8.75	8.75	18.27	4,979	5,210	5,711
Others	50	10	10	21.00	4,514	4,722	5,173

Source: WS Atkins

Notes:
(1) European prices from Metal Bulletin, July 1988
(2) Tariffs and Sales tax rates from Meijer & van Manen, op cit, pp 63-66 (confirmed by PTA)
(3) Example of calculation: sheet price ex-works Zambia = (a) = (b - 5%) ÷ c) - d; (5,365 - 5%) ÷ 1.15) - 0

transport charges (freight, handling, wharfage, and insurance) to European prices, and then multiplying through by the relevant customs tariffs and sales tax rates (see Table 3.13). Indicative European prices for sheet, strip and foil for mid-1988 have been drawn from Metal Bulletin. Note that the prices for the three types of rolled product are significantly different, corresponding to different levels of value-added. The landed prices derived in this way are consistent with quoted prices among selected end-users in Kenya, Zimbabwe and Zambia.

The sales prices for each product group in each PTA market are set 5% lower than the European landed prices to give a competitive edge.

It can be argued of course that a Zambian producer could set prices at a premium with respect to European imports, since this would be offset by the ease of selling products in local currency. However, it would be unacceptable in our view to proceed on such an assumption since:

* users of copper semis in the region appear to be price sensitive. Several consumers of copper rod, for example, indicated that they have continued to import supplies when the local supplier has been uncompetitive on price, despite the difficulties of obtaining forex

* most purchases of sheet and strip by PTA consumers outside Zambia will continue to be made in hard currency for the foreseeable future (80% in our model)

* there are likely to be quality differences between locally produced and imported products.

In our view, a 5% price advantage will be sufficient to compensate for quality deficiencies, transport inefficiencies, overcome established distribution networks for European products, and to displace imports, given the added advantage that some payments may be made with local currencies.

However, this is only an estimate. The sensitivity of the project to variations in this discount rate is therefore assessed in Section 10.11.

From these sales prices, cif prices are derived by deducting tariff and sales tax charges. Ex-works prices are then calculated by deducting transport costs (see Table 3.13). These ex-works prices are used in the financial and economic evaluations set out in Sections 10 and 11. This means that distribution costs, other than packaging, are included in neither the revenues nor the operating costs. Transport costs associated with selling the products are treated as external to the project.

The prices of products sold to Romania are made comparable to international prices, as defined by Metal Bulletin. Ex-works prices in Zambia are derived by subtracting transport costs at $ 100/tonne.

The ex-works prices derived in this way are specific to particular markets, because of variations in customs tariffs and sales tax rates for PTA and third country imports. The tariff structure within the PTA gives a manufacturer located in the region an advantage which varies between 10% and 20% over third countries. Sales tax differentials provide an advantage varying between 0% and 15%. These differentials provide a significant degree of protection.

It would appear, however, that the advantages accorded a Zambian manufacturer through transport differentials have been over-estimated in the Dutch consultants' report. According to data provided by Zamcargo, a Zambian manufacturer has, for example, only a $ 20/tonne transport advantage over a European competitor to Dar-es-Salaam, compared to the $102/tonne claimed. It is not immediately clear why transport cost differentials for plate, sheet and strip should be significantly higher than for products like wire-rod, as reported in the Dutch study (Meijer & van Manen, op cit, p.46). Sheet and strip has a near identical volume/weight ratio when freighted as other copper semis, and the higher value of these products is reflected only in higher insurance costs. The transport cost differentials calculated for wire-rod, which vary from around $40/tonne (Dar-es-Salaam/Beira) to $90/tonne (Harare/Bulawayo), appear to be more realistic.

It is also noteworthy that several Kenyan end-users continue to import wire-rod and billets from Europe, although these products are available from Zambia. This is partly due to the problems experienced by Kenyan manufacturers in importing from Zambia. Truck haulage is impractical and uneconomic since contractors cannot find return loads of 20 to 25 tonnes from Kenya to Zambia. Air transport costs work out at over $1,300/tonne. Haulage via rail and Dar-es-Salaam port is slow and unrealiable. According to figures provided by Zamcargo, travel times from the Zambian Copperbelt to Nairobi will be a minimim of 35 days, and probably much longer. European deliveries are said to take about half the time.

In our view, a Zambian manufacturer is only likely to obtain a significant transport cost advantage over European producers in the landlocked markets, notably Zimbabwe, Zambia and Malawi. The main advantage lies in tariff barriers against third countries.

3.1.5 Product specifications

The regional market for copper and brass sheet, strip and foil may be segmented by end-user within the PTA region as follows:

* geyser manufacture (sheet): 60-70%
* radiator manufacture (foil): 20%
* copperwares (some sheet, strip): 10%
* electrical and other uses (strip): 2-3%

Most of the demand is for copper sheet up to 1 metre wide and in thicknesses up to 1.6mm. This would be provided in coils, or cut to specified lengths. Brass accounts for only 10% of the total market (about 50% of the radiator sub-sector). This is in sharp contrast to the situation in European and North American markets where brass strip predominates, primarily because of its use in the electrical industry. Possibly, brass consumption in the PTA will increase with the growth of consumer industries. There could also be a demand for bronze strip which has superior spring properties for contacts etc.

On the basis of information supplied by end-users, a Zambian rolling mill, supplying the regional market, would need to manufacture in accordance with the product specifications and production profile set out in Table 3.14.

TABLE 3.14 - PRODUCTION PROFILE AND PRODUCT SPECIFICATIONS

Product	% of Production (est.)	Specifications		
		End-user	Guages (mm)	Widths (mm)
Sheet	60-70	Treger (Zimbabwe)	0.46-1.6	500-900
		Monarch (Zambia)	0.71-1.6	600-920
Strip	10-15	Non-Ferrous Metal Works (Zambia)	0.46	150
Foil	20			
* copper		Burns and Blane (Kenya)	0.08	32-73
		Kitwe Radiators (Zambia)	0.08	26-109
		Automotive Radiators (Zambia)	0.08	35-85
* brass		Burns and Blane (Kenya)	0.14	32-73
		Kitwe Radiators (Zambia)	0.14	32.5
		Automotive Radiators (Zambia)	0.14	35

Source: WS Atkins

To supply fully the PTA market, a manufacturer would therefore need to:

* roll copper thinner than 0.1mm

* supply sheets in widths up to 1 metre.

For the purposes of building a revenue stream for a rolling mill supplying the PTA market (the small mill option), we have assumed the following product mix:

* sheet: 65%

* strip: 15%

* foil: 20%

The product mix must be revised for the Romanian mill since this mill is not designed to produce radiator foil, nor are we clear on requirements for the Romanian market. The following product breakdown has been assumed:

	PTA Market	Romanian Market
* sheet	80%	50%
* strip	20%	50%
* foil	0%	0%

A higher percentage of strip has been assumed for the Romanian market, since demand in electrical industries will be stronger.

3.2 Sales Forecasts

Market trends are notoriously difficult to assess. Growth rates in manufacturing and industrial activity, which are usually valid indicators of demand for metal fabrications, are variable across countries and unpredictable. Manufacturing output in Kenya rose 7% between 1987 and 1988, while the consumption of copper semis increased sympathetically by around 9 to 10%. In contrast, manufacturing in Zimbabwe recorded a modest 1% growth in 1987/88, following a 2.2% decline in 1985/86. Manufacturing output in Tanzania has declined in recent years up to 2% pa.

The performance of end-users and manufacturers of copper semis in the region provides some indication of likely sales trends. The data suggest that a growth rate in demand between 2 to 5% pa is not unreasonable. The balance of opinion among manufacturers is that an average growth in demand of around 3% pa in the PTA would be a valid assumption.

Taking all the data together, it would seem reasonable to build sales forecasts by inflating the potential demand (Table 3.12) by 3% pa. It must be assumed that European imports are reduced to zero, and that no further manufacturing facilities are established in the region.

The 3% pa rate of growth is of course only a "best estimate", based on published sources and market research results which are sometimes contradictory. For this reason, it is prudent to test the sensitivity of the project to variations in demand forecasts (Section 10.11). Two scenarios - 1% pa and 5% pa growth - have been used.

Sales to Romania are assumed to be a fixed percentage of project output throughout the life of the project.

3.3 Plant Capacity and Production Programme

3.3.1 Small mill

The small mill option, which has been designed as a possible alternative to the Romanian proposal, is oriented to the PTA market. This market is likely to be around 1,600 t/pa after 15 years. For this reason, the plant has been designed with a capacity of 750 t/pa with one shift, and 1,500 t/pa with two shifts.

Table 3.15 shows that production begins in 1992 (see Section 9 on implementation), with one shift at 30% capacity. This builds up in Year 2 (1993) and Year 3 (1994) to 70% and 90% respectively of one shift. The mill moves onto two shifts in Year 4 (1995), with 100% production on shift one, and 50% production on shift two (an average capacity utilisation of 75%). Thereafter, capacity utilisation has been designed to increase in sympathy with the growth in demand, eventually reaching full capacity in Years 14 (2005) and 15 (2006). Assuming that all production is converted to sales (which is reasonable since rolled copper products are normally manufactured to order), sales as a percentage of demand reaches a peak of around 85%.

3.3.2 Romanian mill

The Romanian mill has been designed to operate with three shifts and a full capacity of 10,000 t/pa. Table 3.15 shows that production begins in 1993 (Year 1), at 30% capacity utilisation. Production builds up to 55% of capacity in Year 2 (1994) and to 88% in Year 3 (1995). In Year 3, sales to the Romanian market are stabilised at 8,000 t/pa. This corresponds with our assumption that 80% of output will be absorbed by Romania. Sales to the PTA market are then inflated by annual increments to generate a total of 1,500 t/pa in Year 15 (comparable to the small mill). It should be noted that the Romanian mill will not be producing foil, so the potential demand

TABLE 3.15 - PLANT CAPACITY AND PRODUCTION PROGRAMME

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Potential demand	1081	1113	1147	1181	1217	1253	1291	1330	1369	1410	1453	1496	1541	1587	1635	1684	1735	1787	1840	1896
Small mill																				
Capacity	-	-	-	-	750	750	750	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	-
Production/Sales					225	525	675	1125	1159	1194	1229	1266	1304	1343	1384	1425	1468	1500	1500	-
Capacity utilisation (%)	-	-	-	-	30	70	90	75	77	80	82	84	87	90	92	95	98	100	100	-
Sales as % of demand	-	-	-	-	18	42	52	85	85	85	85	85	85	85	85	85	85	84	82	-
Romanian mill																				
Capacity	-	-	-	-	-	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
Production/Sales:																				
- Romanian market	-	-	-	-	-	2700	5000	8000	8000	8000	8000	8000	8000	8000	8000	8000	8000	8000	8000	8000
- PTA market	-	-	-	-	-	300	500	800	900	1000	1050	1100	1150	1200	1250	1300	1350	1400	1450	1500
Capacity utilisation (%)						30	55	88	89	90	90.5	91	91.5	92	92.5	93	93.5	94	94.5	95
Sales as % of demand (PTA market)						24	39	60	66	71	72	74	75	76	76	77	78	78	79	79

Source: WS Atkins

figures (in Table 3.12) have to be reduced by 20%. This means that sales to the PTA market as a percentage of demand in the case of the Romanian mill is close to 100% in the latter years of the project.

It needs to be recognised that both mills are small by Western European standards. The capacities chosen have been dictated, in the case of the Romanian mill, by the terms of the Romanian technical proposal, and, in the case of the small mill, by the size of the regional market and the need to operate at an efficient production level relative to capacity. This is not to say that mills of these capacities are necessarily uneconomic from the point of view of operation (see the break-even analyses in Section 10.10), but their size imposes difficulties in financing capital costs.

3.4 Sales Revenues

Sales revenues are estimated in Tables 3.16 (Romanian mill) and 3.17 (Small mill). These revenues are based on ex-works prices. The calculations make use of:

* the product segmentation ratios estimated in Section 3.1.5
* the breakdown between . . markets derived from Table 3.12
* the sales forecasts estimated in Table 3.15
* the ex-works prices derived from Table 3.13.

Sales to Zambia, and 20% of sales to other PTA markets, produce revenues in local currency. The balance is priced in US Dollars.

3.5 Marketing

Marketing rolled products in the PTA market will be largely a matter of developing awareness among potential end-users, and ensuring that prices, quality and delivery are competitive with European imports.

TABLE 3.16 - SALES REVENUES (Romanian Mill)

All Revenues in $ '000s (Constant Prices)

		PRICES ($/tonne)		1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Total Sales to PTA (tonnes)				300.0	500.0	800.0	900.0	1000.0	1050.0	1100.0	1150.0	1200.0	1250.0	1300.0	1350.0	1400.0	1450.0	1500.0
ZAMBIA	0.43																	
sheet	80%	4432		103.2	172.0	275.2	309.6	344.0	361.2	378.4	395.6	412.8	430.0	447.2	464.4	481.6	498.8	516.0
strip	20%	4633		25.8	43.0	68.8	77.4	86.0	90.3	94.6	98.9	103.2	107.5	111.8	116.1	120.4	124.7	129.0
Total Sales (tonnes)				129.0	215.0	344.0	387.0	430.0	451.5	473.0	494.5	516.0	537.5	559.0	580.5	602.0	623.5	645.0
Revenue				576.9	961.5	1538.4	1730.7	1923.0	2019.2	2115.4	2211.5	2307.7	2403.8	2500.0	2596.1	2692.3	2788.4	2884.6
KENYA	0.24																	
sheet	80%	4933		57.6	96.0	153.6	172.8	192.0	201.6	211.2	220.8	230.4	240.0	249.6	259.2	268.8	278.4	288.0
strip	20%	5163		14.4	24.0	38.4	43.2	48.0	50.4	52.8	55.2	57.6	60.0	62.4	64.8	67.2	69.6	72.0
Total Sales (tonnes)				72.0	120.0	192.0	216.0	240.0	252.0	264.0	276.0	288.0	300.0	312.0	324.0	336.0	348.0	360.0
Revenue				358.5	597.5	956.0	1075.5	1195.0	1254.7	1314.5	1374.2	1434.0	1493.7	1553.4	1613.2	1672.9	1732.7	1792.4
ZIMBABWE	0.19																	
sheet	80%	4282		45.6	76.0	121.6	136.8	152.0	159.6	167.2	174.8	182.4	190.0	197.6	205.2	212.8	220.4	228.0
strip	20%	4478		11.4	19.0	30.4	34.2	38.0	39.9	41.8	43.7	45.6	47.5	49.4	51.3	53.2	55.1	57.0
Total Sales (tonnes)				57.0	95.0	152.0	171.0	190.0	199.5	209.0	218.5	228.0	237.5	247.0	256.5	266.0	275.5	285.0
Revenue				246.3	410.5	656.8	738.9	821.0	862.1	903.1	944.2	985.2	1026.3	1067.3	1108.4	1149.4	1190.5	1231.5
TANZANIA	0.06																	
sheet	80%	4979		14.4	24.0	38.4	43.2	48.0	50.4	52.8	55.2	57.6	60.0	62.4	64.8	67.2	69.6	72.0
strip	20%	5210		3.6	6.0	9.6	10.8	12.0	12.6	13.2	13.8	14.4	15.0	15.6	16.2	16.8	17.4	18.0
Total Sales (tonnes)				18.0	30.0	48.0	54.0	60.0	63.0	66.0	69.0	72.0	75.0	78.0	81.0	84.0	87.0	90.0
Revenue				90.5	150.8	241.2	271.4	301.5	316.6	331.7	346.7	361.8	376.9	392.0	407.0	422.1	437.2	452.3
OTHERS	0.08																	
sheet	80%	4514		19.2	32.0	51.2	57.6	64.0	67.2	70.4	73.6	76.8	80.0	83.2	86.4	89.6	92.8	96.0
strip	20%	4722		4.8	8.0	12.8	14.4	16.0	16.8	17.6	18.4	19.2	20.0	20.8	21.6	22.4	23.2	24.0
Total Sales (tonnes)				24.0	40.0	64.0	72.0	80.0	84.0	88.0	92.0	96.0	100.0	104.0	108.0	112.0	116.0	120.0
Revenue				109.3	182.2	291.6	328.0	364.4	382.7	400.9	419.1	437.3	455.6	473.8	492.0	510.2	528.4	546.7
ROMANIA																		
Assumed Consumption			0.8															
sheet	50%	3817		1350.0	2500.0	4000.0	4000.0	4000.0	4000.0	4000.0	4000.0	4000.0	4000.0	4000.0	4000.0	4000.0	4000.0	4000.0
strip	50%	4001		1350.0	2500.0	4000.0	4000.0	4000.0	4000.0	4000.0	4000.0	4000.0	4000.0	4000.0	4000.0	4000.0	4000.0	4000.0
Total Sales (tonnes)				2700	5000	8000	8000	8000	8000	8000	8000	8000	8000	8000	8000	8000	8000	8000
Revenue				10554.3	19545.0	31272.0	31272.0	31272.0	31272.0	31272.0	31272.0	31272.0	31272.0	31272.0	31272.0	31272.0	31272.0	31272.0
TOTAL PROJECT REVENUE				11935.0	21847.5	34956.0	35416.5	35877.0	36107.2	36337.5	36567.7	36798.0	37028.2	37258.5	37488.7	37719.0	37949.2	38179.5
Local Currency				737.8	1229.7	1967.5	2213.5	2459.4	2582.4	2705.4	2828.4	2951.3	3074.3	3197.3	3320.2	3443.2	3566.2	3689.2

TABLE 3.17 - SALES REVENUES (Small Mill)

All Revenues in $ '000s (Constant Prices)

		PRICES ($/tonne)		1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Total Sales (tonnes)			1.03	225.00	525.00	675.00	1125.00	1158.75	1193.51	1229.32	1266.20	1304.18	1343.31	1383.61	1425.12	1467.87	1500.00	1500.00
ZAMBIA	0.43																	
sheet	65%	4432		62.89	146.74	188.66	314.44	323.87	333.59	343.59	353.90	364.52	375.45	386.72	398.32	410.27	419.25	419.25
strip	15%	4633		14.51	33.86	43.54	72.56	74.74	76.98	79.29	81.67	84.12	86.64	89.24	91.92	94.68	96.75	96.75
foil	20%	5069		19.35	45.15	58.05	96.75	99.65	102.64	105.72	108.89	112.16	115.52	118.99	122.56	126.24	129.00	129.00
Total Sales (tonnes)				96.75	225.75	290.25	483.75	498.26	513.21	528.61	544.46	560.80	577.62	594.95	612.80	631.18	645.00	645.00
Revenue				444.04	1036.09	1332.12	2220.19	2286.80	2355.40	2426.07	2498.85	2573.81	2651.03	2730.56	2812.48	2896.85	2960.26	2960.26
KENYA	0.24																	
sheet	65%	4933		35.10	81.90	105.30	175.50	180.77	186.19	191.77	197.53	203.45	209.56	215.84	222.32	228.99	234.00	234.00
strip	15%	5163		8.10	18.90	24.30	40.50	41.72	42.97	44.26	45.58	46.95	48.36	49.81	51.30	52.84	54.00	54.00
foil	20%	5662		10.80	25.20	32.40	54.00	55.62	57.29	59.01	60.78	62.60	64.48	66.41	68.41	70.46	72.00	72.00
Total Sales (tonnes)				54.00	126.00	162.00	270.00	278.10	286.44	295.04	303.89	313.00	322.39	332.07	342.03	352.29	360.00	360.00
Revenue				274.12	644.20	828.35	1380.59	1422.01	1464.67	1508.61	1553.87	1600.48	1648.50	1697.95	1748.89	1801.36	1840.79	1840.79
ZIMBABWE	0.19																	
sheet	65%	4282		27.79	64.84	83.36	138.94	143.11	147.40	151.82	156.38	161.07	165.90	170.88	176.00	181.28	185.25	185.25
strip	15%	4470		6.41	14.96	19.24	32.06	33.02	34.02	35.04	36.09	37.17	38.28	39.43	40.62	41.83	42.75	42.75
foil	20%	4904		8.55	19.95	25.65	42.75	44.03	45.35	46.71	48.12	49.56	51.05	52.58	54.15	55.78	57.00	57.00
Total Sales (tonnes)				42.75	99.75	128.25	213.75	220.16	226.77	233.57	240.58	247.79	255.23	262.89	270.77	278.90	285.00	285.00
Revenue				189.63	442.47	568.89	948.15	976.60	1005.89	1036.07	1067.15	1099.17	1132.14	1166.11	1201.09	1237.12	1264.20	1264.20
TANZANIA	0.06																	
sheet	65%	4979		8.78	20.48	26.33	43.88	45.19	46.55	47.94	49.38	50.86	52.39	53.96	55.58	57.25	58.50	58.50
strip	15%	5210		2.03	4.73	6.08	10.13	10.43	10.74	11.06	11.40	11.74	12.09	12.45	12.83	13.21	13.50	13.50
foil	20%	5711		2.70	6.30	8.10	13.50	13.91	14.32	14.75	15.19	15.65	16.12	16.60	17.10	17.61	18.00	18.00
Total Sales (tonnes)				13.50	31.50	40.50	67.50	69.53	71.61	73.76	75.97	78.25	80.60	83.02	85.51	88.07	90.00	90.00
Revenue				69.66	162.54	208.98	348.30	358.75	369.52	380.60	392.02	403.78	415.89	428.37	441.22	454.46	464.40	464.40
OTHERS	0.08																	
sheet	65%	4514		11.70	27.30	35.10	58.50	60.26	62.06	63.92	65.84	67.82	69.85	71.95	74.11	76.33	78.00	78.00
strip	15%	4722		2.70	6.30	8.10	13.50	13.91	14.32	14.75	15.19	15.65	16.12	16.60	17.10	17.61	18.00	18.00
foil	20%	5173		3.60	8.40	10.80	18.00	18.54	19.10	19.67	20.26	20.87	21.49	22.14	22.80	23.49	24.00	24.00
Total Sales (tonnes)				18.00	42.00	54.00	90.00	92.70	95.48	98.35	101.30	104.33	107.46	110.69	114.01	117.43	120.00	120.00
Revenue				84.19	196.43	252.56	420.93	433.56	446.56	459.96	473.76	487.97	502.61	517.69	533.22	549.22	561.24	561.24
TOTAL PROJECT REVENUE				1061.63	2481.01	3190.90	5318.17	5477.72	5642.05	5811.31	5985.65	6165.22	6350.17	6540.68	6736.90	6939.01	7090.90	7090.90
Local Currency				567.96	1325.24	1703.87	2839.79	2924.98	3012.73	3103.12	3196.21	3292.10	3390.86	3492.58	3597.36	3705.28	3786.39	3786.39
Foreign Currency				495.68	1156.50	1487.03	2478.38	2552.73	2629.31	2708.19	2789.44	2873.12	2959.32	3048.10	3139.54	3233.73	3304.51	3304.51

An important component of the marketing strategy will be to survey potential end-users during the pre-production stage to evaluate requirements and bring to their attention the manufacturing facility to be developed in Zambia. Since the number of end-users is presently limited, the budget for sales promotion during the pre-production phase has been kept relatively low.

There will be little need for expensive advertising and other promotional campaigns. Sales will depend principally on price, delivery and quality. Assuming that prices are pitched at levels lower than those of landed European imports, the project is only vulnerable with respect to delivery, and then only in markets like Kenya and Mozambique where transport from Zambia can be difficult. It will be important for the project to obtain satisfactory service from a freight haulage contractor. It will also be necessary for marketing personnel to make sales visits to major customers on a periodic basis, and where problems arise.

4. MATERIALS AND INPUTS

4.1 Raw Materials

4.1.1 Copper

The principal raw material is copper cathode, which would be supplied by ZCCM.

There are inevitable irrecoverable metal losses during production, and it is estimated that an input of copper cathode equivalent to 105% of the output tonnage would be needed.

In the case of the Romanian mill, a significant volume of scrap will be generated during production, and this will be returned to the metal store to be incorporated in the melt charges. Some will be off-cuts from the castings and hot-rolled strips, some millings, and some cuttings from sheet or strip. Storage bins will have to be provided for each type of scrap.

At full capacity, the Romanian mill would require about 200 tonnes of cathode per week, equivalent to about 10 truck loads of 20 tonnes each. Since the plant is to be located adjacent to a railway line (see Section 5), it would be most economic to tranship the cathode from the refineries by rail, and then by siding directly into the factory. The trucks would be shunted into the metal store and off-loaded by overhead crane.

The small mill would require one 20 tonne delivery per week when operating with one shift, and two deliveries on two shifts. Lorries would be used for this purpose.

Since copper is the principal cost component associated with rolled products, it is important to minimise stocks. Since the plant would be located close to the refineries, it should be possible to reduce stocks to one week. Interior storage facilities for copper cathode have been built in to the design of both mills, and costed accordingly. Surplus can be stored temporarily outside, as is practiced at plants like Zamefa, Cafca and Almin.

It is important to note that it is not in ZCCM's interests to supply cathode to a domestic manufacturer. ZCCM is already struggling to fulfil its commitments to customers, and is having to buy copper to cover the shortfall. More importantly, local deliveries payable in Kwacha result in a fall in forex earnings which are needed desperately to finance the importation of spares to maintain production levels. In this context, the diversion of even 10,000 t/pa (only 2% of current sales) to the local market will be unpopular. Since a strip mill can accept low quality copper as raw material feed, an alternative would be for ZCCM to supply reject and low grade copper, which would fetch a discount of about $80/tonne on the LME price for Grade A cathode. However, ZCCM does not appear to have sufficient quantities of this type of copper to provide a satisfactory supply.

ZCCM has confirmed to us, however, that it would comply with government wishes in this regard, and guarantee the rolling mill a secure supply of copper. ZCCM also advised us that the rolling mill would receive the same price terms as Zamefa. This involves a discount of about $104/tonne on the LME price of Grade A cathode (since the LME price includes transport from producer to Europe), and a quality rebate of about $ 30/tonne to compensate the rolling mill for having to use Grade A cathode. The LME price has been averaged for mid-1988 at $2142/tonne. Subtracting the discounts, and adding transport from refinery to mill at $4/tonne, gives a delivered price of $2012/tonne.

4.1.2 Phosphor copper

Both mills will also require phosphor copper for deoxidation purposes. This is usually supplied as a copper/15% phosphorus alloy.

With respect to the Romanian mill, it will be necessary to melt 1.8 tonnes to produce 1 tonne of output. With phosphor copper required at a rate of 1.2 kg/tonne of metal cast, it needs to be supplied at a rate of 2.2 kg/tonne of output.

The small mill will have a slightly higher melt to output ratio, and the requirement for phosphor copper is estimated at 2.4 kg/tonne of output.

Phosphor copper will have to be imported. Mid-1988 prices range from $2,700/tonne to $2,900/tonne for 10 tonne lots. The Romanian mill will be able to import at these prices, since its annual consumption will be in the order of 21 tonnes. The delivered price to the rolling mill including transport, and an effective rate of duty of 37.5%, is calculated at $3994/tonne. Stocks of 6 months are recommended, since lower levels would incur penalties on price and the quantity of capital tied up is low.

The small mill, with consumption peaking 3.6 t/pa, will pay a premium over quoted prices. The delivered price mid 1988 is estimated at $ 4345/tonne. Stock levels will also be 6 months.

4.1.3 Zinc

Zinc is required for the small mill to manufacture brass strip and foil. Only 10% of output will be brass, so the consumption of zinc will be (33% of 10%) 3.3% of output.

Zinc will be supplied by ZCCM at a discount of $ 50/tonne over the LME price, which averaged $ 1224/tonne mid 1988. Subtracting the discount and adding transport from Kabwe at $5/tonne, gives a delivered price of $ 1179/tonne. Deliveries can be made by truck. Stocks of one month would be sensible.

4.2 Auxiliary Materials

4.2.1 Industrial gases

The specification of the Romanian mill calls for the annealing of coils to be done in bell type furnaces with a protective atmosphere provided by burning methane. The flow rate of the protective gas is estimated at 140 to 150 Nm^3/tonne of output. Methane is not available locally in Zambia, but since the gas obtained by the combustion of methane consists essentially of nitrogen with 1 to 2.5% hydrogen, it could be replaced by a nitrogen/hydrogen mix. Both gases are available from the Zamox plant in Ndola.

All the production has to be annealed once in coil form in the bell furnace. Material cut to sheet is annealed afterwards in a roller hearth furnace. This is supplied with a protective atmosphere from the same gas generator as the bell furnace. No data is provided in the Romanian technical proposal, but it is assumed that the consumption will be similar to bell furnace. With a 50:50 split between sheet and coil, the requirement for protective atmosphere gas will be around 280 to 290 Nm^3/tonne of output.

This requirement for nitrogen/hydrogen seems abnormally high, and implies a cost of around $740/tonne of output (which is about 18 to 19% of European sales prices). We would estimate real requirements at $100 Nm^3/tonne of output, which is consistent with the Dutch consultants' figure and with observed consumption in UK mills.

The small mill also requires a nitrogen/hydrogen supply for annealing. Consumption is estimated at 100 Nm^3/tonne of output.

The Romanian mill also specifies methane for the "walking beam" furnace, for hot rolling. Since methane is not available locally in Zambia, LPG could be used as an alternative. Consumption of LPG is estimated at $40Nm^3$/tonne of output.

Since the small mill option is designed with cold rolling only, there is no requirement for methane or LPG for slab reheating.

LPG, nitrogen and hydrogen can be supplied by Zamox in Ndola in pressurised containers. Prices mid 1988 work out at $120/tonne of output for LPG (priced at K24.66/Nm^3), and $261/tonne of output for the nitrogen 98%/ hydrogen 2% mix (nitrogen is priced at K21.43/Nm^3). Since deliveries are local, stocks can be maintained at one week.

These prices are high by Western standards, so it may be worth investigating whether to use vacuum annealing, which is now fairly common for copper wire and strip. However, since the Romanian technical proposal specifies protective gas atmospheres, we have calculated operating costs on this basis.

4.2.2 Industrial materials

The main factory consumables are as follows:

* refractories for melting furnaces, which would be imported at a probable cost of $0.3/tonne of output

* cutting emulsion for the slab saw and miller, at a consumption rate of 10 litres/tonne of output (Romanian mill), and, for the miller (small mill), at a rate of 4 litres/tonne of output

* oil for roll bearings and hydraulic drives - this is recycled but there are some losses of between 2 to 3 litres/tonne of output

* emulsion for cold rolling - this is also recycled, but there is some loss due to evaporation, and eventually it will need replacing through metal pick-up. A consumption rate of 3 litres/tonne of output is reasonable

* miscellaneous lubricating oils and greases, at a consumption rate of 1 litre/tonne of output

* for brass strip (small mill option), the pickling/cleaning line creates a demand for sulphuric acid. Consumption would be 1 kg acid/tonne brass pickled, or 2 kg/tonne if the pickling is carried out twice

* cleaning materials for the rolls (mostly paraffin)

* saw tips

* tools.

The total cost of these materials is estimated at $35/tonne, including transport and duties. Since most will have to be imported, it is recommended that stocks of 3 months be maintained.

4.3 Spares and Maintenance

For plant and equipment, two years' spares should be provided as part of the turnkey contract with the supplier. After this period, spares are valued at 3% of initial capital costs per annum. This is based on the experience of factories currently operating in this sector, with which Atkins is familiar.

Plant and equipment spares will be imported, mostly from the original supplier. It is recommended, therefore, that stocks of 3 months are maintained.

Materials and costs associated with the upkeep of the factory buildings and outlying area are estimated at 1.5% pa of initial capital costs. This is also based on observable expenditures at comparable factories.

A large percentage of building materials are available locally. Although several important items will be imported, notably spares for the heavy electrical gear, it is reasonable to assume an average stock level of one month.

It is assumed that the maintenance of the housing colonies associated with the mills will be financed out of rents. No provision has been made in the estimates of operating costs to cover this item.

4.4 Utilities

4.4.1 Electricity

Only the main items of equipment listed in the Romanian technical proposal have data on power requirements. Even some of these omit important information, for example, the cathode shear, the baler and the slitter. These have been estimated.

The main items of plant have a total power requirement of about 5,350 kW. There are many auxiliary items such as pumps, extraction fans, miscellaneous drives, gantry cranes and lifting gear, and lighting facilities, for which power figures have not been supplied. Our estimate for installed power is 6,500 kW to 7,000 kW. Maximum demand can be estimated at 2/3 of installed power, i.e. 4,350 kW to 4,700 kW.

Electricity consumption is difficult to calculate since it depends on the yield of material shipped as compared with metal melted, and the rolling schedules which are not specified. The largest single requirement is for melting. With a 60% yield, electricity consumption would be 800 kWh/tonne. Our estimates of other operations, making allowances for yield, gives a total of 2,500 to 3,000 kWh/tonne shipped.

The total installed power for the small mill option is estimated at 2,500 kW, allowing 375 kW for miscellaneous items. Maximum demand would be 1,675 kW.

Electricity consumption is estimated at 2,500 kWh/tonne output.

Electricity data and local price information are summarised in Table 4.1.

TABLE 4.1 - ELECTRICITY DATA

	Romanian Mill	Small Mill
Installed power (kW)	6,500-7,000	2,500
Maximum demand (kW)	4,350-4,700	1,675
Electricity consumption (kWh/tonne output)	2,500-3,000	2,500
Fixed monthly charge (Kwacha)	17,225.00	1,722.50
Maximum demand monthly charge (Kwacha/kW)	11.80	13.81
Unit charge (ngee/kWh)	3.51	5.33
Sales tax (%)	15	15

Sources: WS Atkins
Zambia Electricity Supply Corporation Ltd

4.4.2 Water

The Romanian mill will require some 15m^3 water/tonne of output, over and above recirculated water (i.e. 15,000 litres/tonne).

The small mill, on the other hand, will consume water at an estimated rate of $7m^3$ water/tonne (i.e. 7,000 litres/tonne).

Costs have been based on rates set by Kitwe District Council. The appropriate rate for industrial consumers is K 1.20 per 1,000 litres.

5. LOCATION AND SITE

5.1 Location

Kitwe has been selected as the location for the mill. The reasons for this are various. Kitwe is located close to the copper refineries, and is also well placed with respect to the domestic market, which is concentrated in the Copperbelt.

Kitwe is also served by the railway line which connects the Copperbelt with Dar-es-Salaam, on the one hand, and Lusaka, on the other.

Kitwe also has an abundance of industrial land, and a large pool of labour. The town, by Zambian standards, offers a relatively wide range of industrial and building services, which will be important in maintaining production levels.

INDECO has indicated that it accepts Kitwe as a suitable location.

5.2 Site

For the Romanian mill, a greenfield site has been selected in an area set aside for industrial development in north-west Kitwe. The site is well placed alongside the main road to Ndola and Lusaka and the railway line. A railway siding could be constructed to bring railway trucks directly into the factory, thus minimising break-bulk costs.

The site is not developed, but is close to existing services. The cost of linking the site to main services has been included in the civil works costs prepared by the engineering consultancy, Arup (Zambia).

The site is flat, and well drained. The soil conditions are not perfect, but the water table level is not a problem. Arup (Zambia) has inspected the site, and foresees no problems in developing it for the Romanian mill.

Following discussions with Indeco, an existing Indeco industrial site was selected for the small mill option. This is quite small, but large enough for the mill. It has good road access, and has the advantage that no costs would be incurred in land acquisition.

The existing building is unsuitable, and would have to be demolished. The foundations would also have to be altered, and the services redeveloped.

Arup (Zambia) argues, however, that the cost of redeveloping the site would not be significantly lower than developing a greenfield location.

It should be noted that site requirements are not a major constraint on the project. There is ample land available for industrial development in Kitwe, and most of it is suitable for civil works of the type required for the mills.

The climate is not problematic as far as the project is concerned. The production process does not generate a great deal of heat, so there would be no need for cooling systems, provided sufficient ventilation is provided. In fact, the favourable climate leads to lower construction and operating costs than would be experienced by a similar mill in Europe, since the buildings do not have to be designed to withstand harsh winters, nor does heating have to be provided for offices and other cold areas.

5.3 Costs

Kitwe District Council was quite unable to provide estimates of the present day costs of connecting the greenfield site to main services. For this reason, these costs have been calculated by Arup (Zambia), and included in our estimates of civil works costs.

Land acquisition costs, set by the Ministry of Lands, are nominal, and can be ignored for the purposes of calculating investment outlays.

Kitwe District Council was also vague on the question of rates. We have therefore extrapolated estimates of rates from known rates being paid by similar factories in the area. Our estimates are $5,000 pa for the Romanian mill and $1,000 pa for the small mill.

5.4 Environmental Impact

5.4.1 Emissions, noise and waste

There will be no noxious emissions from the Romanian mill. Melting copper produces no fume, since the furnaces are electrically heated. The combustion of fuel for preheating will result in a small emission of combustion products, mainly carbon dioxide, but there will be no sulphur dioxide.

Rolling produces a small amount of oil fume, which is to be exhausted via a stack after passing through a filter to remove oil mist.

Periodically, the rolling oil emulsion may need renewal due to pick-up of copper. In a highly industrialised area, the emulsion would probably be broken down by alkali treatment, and the oil skimmed off before passing the liquid to a settling bed before discharge. However, since space is not a problem on the site selected for the project, the waste could simply be lagooned where the oil would separate as water drains into the subsoil.

Noise from the plant would not be problematic. The mill is small by western standards, and the chosen site is far from housing.

Similarly, the small rolling mill will have very little impact as regards emissions, waste and noise. Melting copper will cause no fume, and since all furnaces will be electrically heated there will be no combustion products.

The rolling mills will be low speed, and will not give rise to significant oil fume. Because of the small volume production disposal of waste oils will not cause problems. If necessary, the small amounts involved could simply be incinerated.

Production of brass would introduce minor emissions of zinc oxide fume during melting. These are white in colour and harmless. A fan in the melting area is all that is required to remove them.

It would be necessary to pickle the brass in dilute sulphuric acid, and it would be advisable to include a simple treatment plant to neutralise the rinse water and waste acid, allowing the metal salts to settle before discharge. The volume of effluent is unlikely to exceed $5m^3$/hour. This could be treated continuously or collected and treated with lime once a day. After the metal hydroxides have settled, the water is safe to discharge into any convenient drainage system. The sludge of metal hydroxides would be best lagooned to dry out, but it is of no commercial value. Construction of an effluent treatment plant with pH control would not cost more than $10,000.

The noise associated with the plant will be relatively minor, and acceptable for the industrial site suggested for the project.

5.4.2 Infrastructure and population

The two plants will place significant pressure on the local housing stock in Kitwe suitable for managerial and technical staff, and skilled workers. It is concluded that <u>the construction of a housing</u>

colony would be necessary to cover the shortfall in existing housing and attract employees from elsewhere in the country. The costs associated with housing are estimated in Section 6.4.

The demands placed upon utilities in Kitwe will not be problematic, nor will there by any serious disruption of the traffic network. The Romanian mill would create a significant volume of traffic if lorries were used both for the importation of raw materials and the distribution of finished products, but very little if the railway line is used for these purposes, as recommended.

6. PROJECT ENGINEERING

6.1 Project Layouts

6.1.1 Romanian mill

The Romanian technical proposal did not contain information on project layout. Figure 6.1, which shows the layout of the factory, is based on Atkins' interpretation of the information relating to technology and machinery set out in the proposal.

The layout is relatively simple, with the factory partitioned into six areas:

* offices
* raw material delivery, storage and charge make-up
* melting furnaces, holding furnace and casting machine
* preheating furnace, hot/cold rolling mills, and milling machine
* annealing bells and roller hearth furnace
* test and inspection, packaging and despatch.

The factory covers 8,350 m^2.

Figure 6.2 shows a suggested design for the works area. It has been

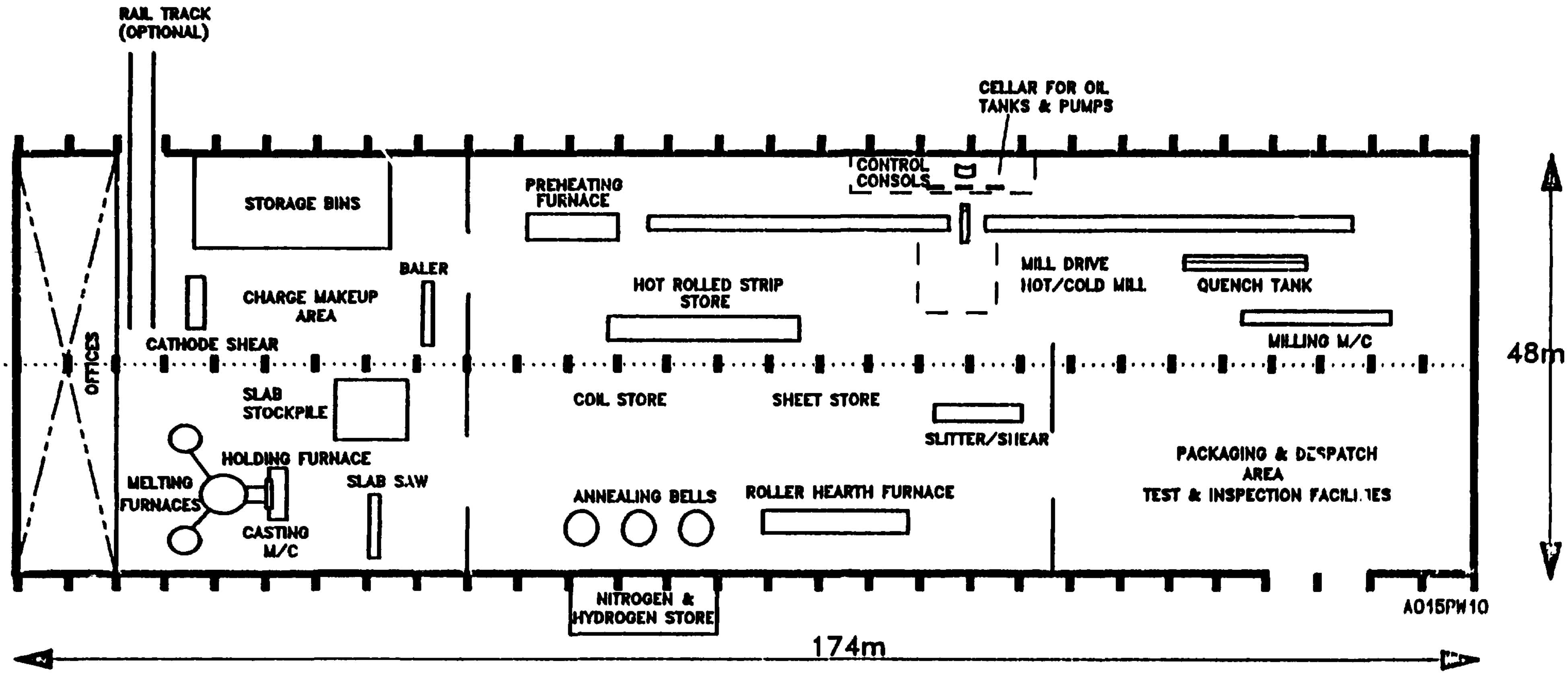


FIGURE 6.1 PLANT LAYOUT (ROMANIAN MILL)

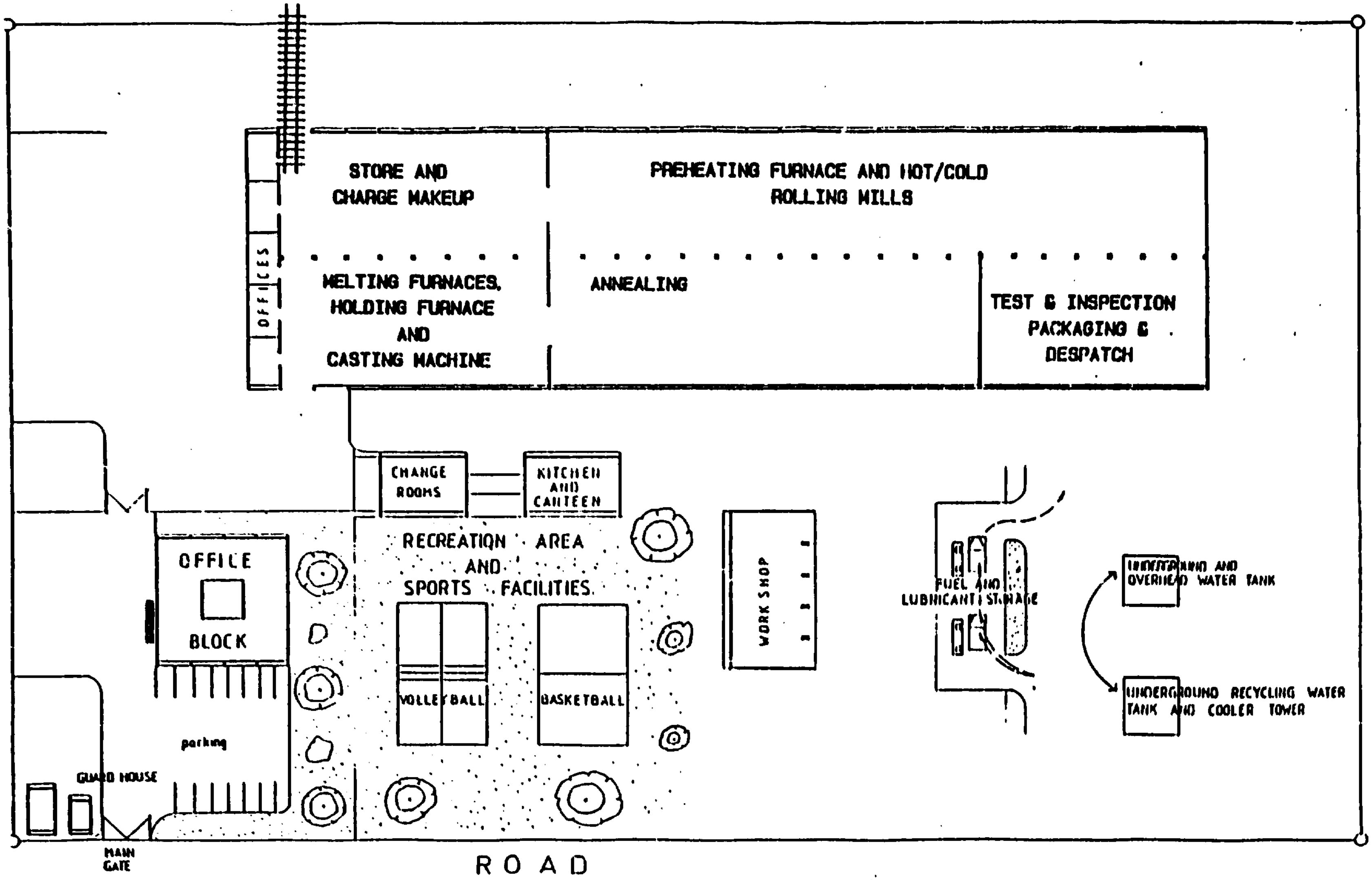


FIGURE 6.2 - WORKS LAYOUT (ROMANIAN MILL)

decided to locate outside the plant:

* management offices and car park
* electricity substation
* changing rooms, kitchen and canteen for the workers
* recreational facilities
* workshop
* fuel and lubricant store
* underground and overhead water tank, underground recycling water tank and cooler tower.

6.1.2 Small mill

Figure 6.3 shows a suggested plant layout for the small mill. The factory is divided into five main areas:

* offices, containing workshop
* store, cathode shear and baler
* furnace
* process area, containing rolling mills, miller, bell furnace, annealing furnace and pickling/cleaning line
* test and inspection, packaging and despatch.

Given the nature of the site chosen for this mill, it will be necessary to have a relatively compact works area. Effluent treatment and the water tank are located alongside the factory.

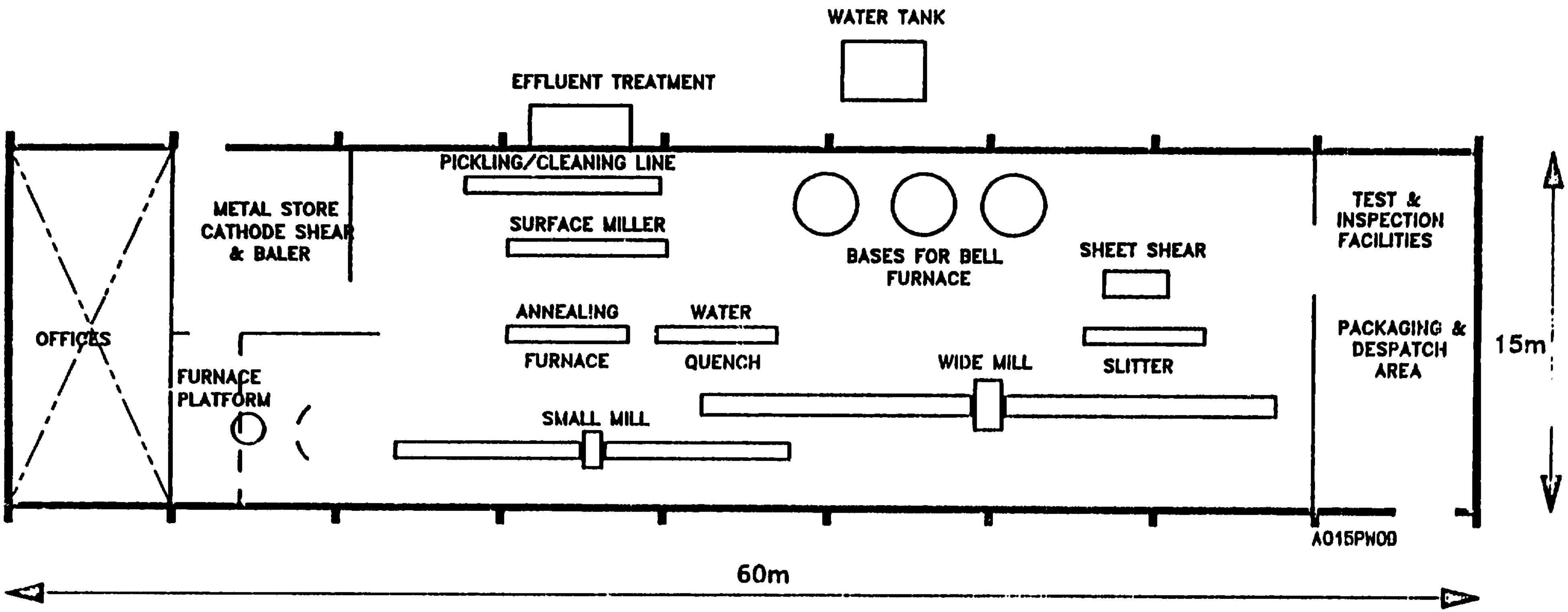


FIGURE 6.3 PLANT LAYOUT (SMALL MILL)

There will be no discreet office area separate from the factory, and no recreational facilities. For this reason, a separate diagram of the works area has not been provided.

6.2 Technology

6.2.1 Romanian mill

The Romanian technical proposal provides a comprehensive description of the plant to be supplied and the associated technology, but no details of the cost of equipment, the manning levels, or operating costs. These have been estimated, or calculated from first principles, where necessary.

The Romanian mill is designed as a single product plant, producing 1,000 mm copper strip with a thickness range 0.5 to 3.0 mm, which can be marketed either as 1,000 mm x 2,000 mm sheet or in coil slit to the width required by the customer. The products would comply with DIN 1792 or BS 2870 C106, phosphorus deoxidised copper. The production process may be summarised as follows:

Charge Makeup

Assuming a 5 day week of 15 shifts, it is necessary to melt 75 tonnes/day. This is made up partly of cathode and partly of process scrap. Imported cathodes are cut in a guillotine shear into small pieces. Strip and sheet scrap is compressed in a baling machine. The chopped cathodes plus scrap is loaded into buckets (capacity 400 kg), and lifted by crane onto the furnace platform of the adjacent melting/casting shop.

Phosphorus is added at the melting stage. This acts as a deoxidant downstream when the strip is brazed or welded (as in the manufacture of geysers), otherwise hydrogen and oxygen in the copper combine to produce steam, rendering it brittle. Oxygen free copper, such as is used by Zamefa for wire-rod, would be unsuitable. Phosphorus is not added to Zamefa's feed, since it reduces the conductivity of the copper.

Melting and Casting

Melting is carried out in two channel type low frequency induction furnaces, each with a capacity of 1.5 tonnes/hour. These are used to replenish a similar type of furnace of 5 tonnes capacity which acts as a reservoir of molten metal to feed the casting machine.

The casting machine is a vertical semi-continuous machine in which the molten metal is poured into a short water cooled copper mould in which solidification takes place. The casting is withdrawn downwards on a hydraulic ram at a maximum speed of 135 mm/minute with direct water cooling of the slab. The slab size is 120 mm x 1,050 mm x 3,200 mm, which provides two rolling slabs. The yield of metal cast to rolling slab is 93.75%. The process is semi-continuous in the sense that the caster produces slabs (of 3.2 metres length) discreetly. The mould has to be filled again before another slab can be produced.

The casting machine and its hydraulic ram require the sinking and lining of a pit 8 metres deep. This has been costed in the civil engineering estimates. A water flow rate of 120 m^3/hour maximum is required, 50% of which is closed circuit. For safety reasons, it is recommended that this should be supplied via a water tower to provide a gravity feed in case of pump failure.

As the rate of casting is less than 1 drop/hour, melting and casting will have to operate for 15 shifts per week. The melting furnaces should not be emptied or allowed to freeze, so they will have to run on low power during the weekends.

The melting furnaces will need new refractory linings from time to time.

Sawing Rolling Slabs

The cast slabs are taken to a circular saw where they are stockpiled for sawing into rolling slabs. The ends of the casting have to be rejected, so the sawing produces two rolling slabs 1,500 mm long from each cast. These are stockpiled for rolling.

Rolling

The novel feature of the Romanian proposal is that a single mill will be used both for hot-rolling and cold-rolling. It is intended that it will operate as two-high mill for 10 days of each month, accumulating a stock of hot-rolled strip. The rolls will then be removed and two pairs of rolls will be inserted (i.e a work roll and a backing roll), converting the mill to a 4-high mill for cold rolling the accumulated stock for the rest of the month.

For hot rolling, the slabs are brought to a temperature of 850 to 900°C in a "walking beam" furnace with a throughput of 4 slabs/hour. To obtain full capacity production, this furnace and the hot mill have to work continuously for 9 or 10 days in each month.

The furnace is 10 metres long, and is fired with methane gas, although this would be best replaced in Zambia with LPG which is available locally. The furnace requires 210,000 kcals/tonne of output, or 1,470,000 kcals/hour of operation.

The hot mill is a reversing mill with conventional powered run-out tables. The output of 4 strips/hour is limited by the output of the preheating furnace. Slabs are discharged from the preheating furrace onto the table of the hot mill. They are rolled from a thickness of 120mm to 14.5mm in 7 passes according to a pre-set schedule. The rolls are cooled with water sprays. At this stage the strips will be about 12.5 metres long. They are quenched in a water tank alongside the run-out table, then removed and stored alongside.

Before the strips can be cold rolled, they have to be milled, removing about 0.5 mm from each side. This is carried out on a milling machine which flattens the strips, crops the ends, and then mills them one side at a time (line speed 10 m/minute). The chips are pneumatically collected. The milled strips are stored ready for cold rolling.

The technical proposal suggests that the hot mill can be converted to cold rolling in one shift of 8 hours. This involves withdrawing the rolls and removing the run-out tables, thoroughly cleaning down, and inserting the pairs of rolls for cold rolling and the appropriate run-out tables. The necessary guage control instrumentation would also have to be put in place, and the mill drives coupled.

The strips are cold rolled in a series of passes from a thickness of 13.5mm to 4.5mm, by which time they will be about 38 metres long. At this juncture, a coiler is positioned either side of the mill, and rolling is continued coil to coil for 5 further passes to 3mm thick.

The strip is subsequently bright annealed in coils. The coils are then further cold rolled to a minimum thickness of 0.5mm or to an intermediate thickness depending on the final requirement. They are annealed again, either at the final thickness or within one or two passes of the final thickness depending on the quality required, i.e. soft, half-hard or hard.

Finishing

The finishing operation in the production of strip is to edge trim, slit to the required widths, and recoil. The trim is automatically chopped up to fall into a scrap bin. For sheet, the strip after edge trimming enters a cutting shear where it is cut to length. The cut sheets are then annealed in packs in a roller hearth bright annealing furnace.

Annealing

Annealing of coils is carried out in bell type furnaces with a protective atmosphere provided by burning methane. The annealing furnaces are situated in a separate bay parallel with the rolling bay.

There are three bases for annealing, one loading or unloading, one heating and one cooling. An electrically heated bell and a water cooled cooling bell can be located over any base. The maximum charge weight is 13 tonnes. The heating and soaking time is specified at 9 hours, giving a maximum throughout of 1 tonne/hour.

The methane atmosphere can be replaced by a nitrogen/hydrogen mix containing 1 to 2.5 % hydrogen, since these gases are available locally in Zambia.

All the production has to be annealed once in coil form in the bell furnace, and most coil has to be annealed twice in the furnace. Material cut to sheet is annealed afterwards in a roller hearth furnace. This is electrically heated, and is supplied with a protective atmosphere from the same gas generator as the bell furnace. It has two zones: the first is heated and the second, which has a double wall structure through which cooling water flows, is a cooling zone. Both zones are supplied with the protective atmosphere, but no data on flow rates are provided (but will be similar to the bell furnace). The throughput is 0.5 tonnes/hour.

Packaging and Despatch

The end of the bay used for annealing is intended to house the area for packaging the products and despatching them. Sheets will have to be packed in wooden crates, and interleaved with paper. Material shipped in coil, particularly small coils of narrow strip, would also require protection. Thus it may be necessary to have a carpenter's shop to produce crates and boxes, unless these can be provided by the haulage contractor. No provision has been made in the Romanian proposal for this either as regards equipment or labour, but the equipment is unlikely to cost more than $25,000.

Inspection and Control

Inspection is made at various stages of processing to ensure that the material is of suitable quality. A final inspection for surface quality and guage can be carried out at the slitting stage or during packing.

Depending on the origin and consistency of the incoming metal it may be possible to avoid analysing the cathodes. The phosphorus content of the melts will have to be controlled, but if the copper is consistent this can be some simply by a conductivity measuring instrument. Otherwise, spectrometric analysis will be needed, and an instrument will have to be provided (about $150,000).

Hardness measurements will have to be made regularly on the output, and simple metallographic facilities will be needed to enable grain size measurements to be made. It will be necessary to have certificates of tensile properties for some orders, and thus tensile testing equipment will have to be installed. A small laboratory to house the instruments and a lathe and milling machine to prepare test pieces would seem to be essential. To equip such a laboratory would cost in the region of $100,000.

Works Transport

The proposal specifies a gantry crane in each of the four bays of a capacity suitable to the operations in each bay. These are not included among the items to be supplied (but are included in our estimates of building costs). However, it is certain that additional transport and lifting facilities will be needed in a works of this kind, and it is recommended that provision be made for two fork lift trucks.

A process flow chart is provided in Figure 6.4.

Discussion

The mill follows conventional practice for the manufacture of copper sheet and strip. Many plants of this type were built in the 1950's, and many of these continue in operation although most will have been considerably updated in the intervening years.

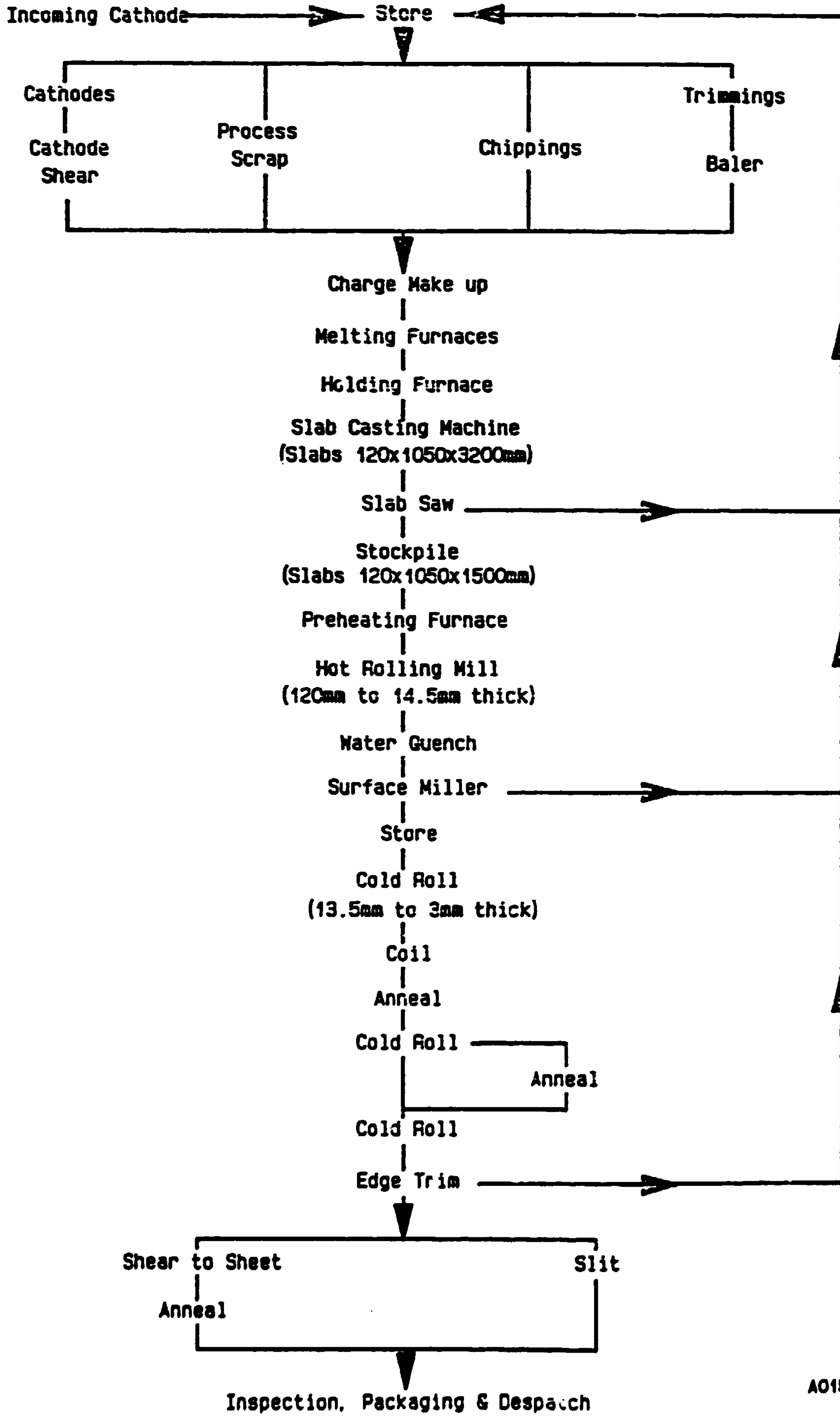
The novel feature of the proposal is that a single mill will be used both for hot and cold rolling. This approach has been adopted to minimise the cost of rolling mills, which are the most expensive items of equipment.

In principle, there is no reason why this procedure cannot be used, although as far as is known, there are no mills operating in this manner. There are good practical reasons against it, quite apart from the inconvenience and wasted production time lost in making a roll charge. It is not possible to evaluate this loss accurately because we do not have sufficient details of the mill construction. The Romanian proposal gives the impression that such a mill exists only as a design concept, and has not actually been built. However, it does mention special facilities for effecting the roll changes.

The Romanian delegation indicated that the change over could be accomplished during a single shift, and it has been assumed in calculating the manning levels that the change would be made by the normal mill operating crews assisted by the shift electricians and fitters together with a crane operator and possibly a fork-lift truck driver.

Our opinion is that the change would take longer than one shift, and would probably result in the loss of one day's production unless scheduled over the week-end.

FIGURE 6.4 PROCESS FLOW CHART (ROMANIAN MILL)



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It has to be agreed that moving heavy gear of this kind could increase the chance of an accident to personnel and also the possibility of damage to equipment. Much would depend on the training of the operatives and on the quality of the supervision.

In heating copper to the hot-rolling temperature it becomes covered with an oxide scale, and this continuously reforms while the surface is being extended during rolling. This scale tends to be brittle and to exfoliate, so that the mill and its associated run-out tables accumulate a considerable amount of oxide flakes or particles. Some of these are rolled into the copper which is one of the reasons why it has to be surface milled after hot rolling.

To use the same mill for cold rolling would involve a very thorough cleaning of the whole area to ensure absolute removal of all oxide particles, otherwise there would be a strong possibility of particles being picked up and rolled into the strip.

Cleaning the mill and ancillary equipment to the standard required may not be impossible, but it would be quite difficult and time consuming. In practice, oxide particles may remain on the copper as lubricant residues tend to be good adhesives. One can envisage having to clean down thoroughly using copious amounts of, say, kerosene.

Once oxide particles have been rolled into the surface of the copper they would be difficult to remove, and if removed would leave a pitted surface. Abrasive cleaning would be risky as the abrasive itself could become embedded in the soft copper. Acid pickling would probably be the best solution, but this would entail a considerable change to the plant. Pickling would best be carried out near the end of the rolling schedule, and would involve the addition of a continuous pickling, washing and drying line. This itself would be costly although there is the possibility of eliminating some of the bright annealing. However, a continuous pickling line would be more expensive than the annealing plant.

Detection of rolled-in oxide would require some method for automatically scanning the strip for inclusions possibly carried out in line with a finishing operation such as edge trimming.

It is not easy to assess the magnitude of the hazard or how much weight should be attached to the possibility of rolling in oxide scale largely because there would seem to be no practical experience of using the same mill for both hot and cold rolling. The problem is recognised to some extent in the Romanian proposal which includes the dismantling of the hot rolling feed tables and replacement by other tables during the change of rolls. It is not possible to predict whether this precaution would be adequate to overcome the risks of picking up oxide particles.

The presence of oxide scale inclusions would not be harmful for low grade applications of the copper sheet such as for roofing or damp courses. It would, however, prevent the strip being marketed for applications where visual appearance is important, and where the oxide could be a potential source of pitting corrosion in an application such as hot water cylinders. Inclusions would also be deleterious if the strip were further reduced to produce radiator fin stock since the inclusions would then become significant in relation to the thickness of the metal.

A further disadvantage with the design is the delay imposed on the production process. Stock would be tied up in hot rolling for 10 days, plus about a further two days for annealing to soften the strip. This means that it will take a minimum of 12 days before cold rolling the product can begin. It is for this reason that work-in-progress has been set at 3 weeks for the Romanian mill. In Europe, this would be regarded as a serious disadvantage.

A further problem is that the mill is not designed to produce strip thin enough for radiator applications (the minimum guage is said to be 0.5 mm). This limits the regional market for the plant. A further rolling mill would have to be installed to roll down to radiator foil guages.

6.2.2 Small mill

This plant is conceived as a flexible unit capable of producing both sheet and strip in copper, and strip in brass. It would have a capacity up to 2,250 t/pa, depending on the mix of sheet and strip, with three shift working, 5 days per week. However, the melting and casting unit is designed for intermittent operation, and it is suggested that a start should be made with single shift working. This would reduce the output to 750 t/pa, but output could be increased to 1,500 t/pa with two shift, as demand warranted and as production efficiency increases.

The method of operation may be summarised as follows:

Metal Preparation

The copper will be received in the form of cathodes, which will require shearing into pieces suitable for loading into the melting furnace. As the yield of finished product to metal melted is unlikely to exceed 60%, there will be process scrap returned from various stages, and some of this will require baling before it can be charged into the furnace.

Charges will be made up in skips holding about 450 kg which will be hoisted onto the raised furnace platform by crane and emptied onto a shute feeding the furnace.

Melting and Casting

A 1 tonne coreless induction furnace will be used for melting, which will tilt for pouring. An addition of phosphor copper would be necessary at this stage.

Moulds will be made from copper plate surrounded by a water jacket. Three moulds are suggested, 400 mm x 50 mm x 1.5 mm each. These would be located on a carousel, to bring each in turn to the furnace. The moulds open to enable the casting to be lowered onto a trolley for transport to the rolling mill.

The maximum output of the furnace would be 0.8 tonnes/hour, equivalent to 3 slabs.

First Rolling

Initial rolling will be on a narrow 2-high mill with large diameter rolls to accept thick slabs. The slabs are reduced in thickness from 50 mm to 25 mm in four passes, during which they are cycled round the mill on a trolley. Starting at 1.5 metres long, the slabs finish 3 metres long. Capacity is about 24 slabs/shift.

Slab Anneal

The rolled slabs are loaded in batches into a simple annealing furnace which does not require a protective atmosphere. After annealing they are removed into a water quench where most of the scale will flake off.

Surface Milling

The slabs are surface milled, both sides simultaneously, removing 0.5 mm/side. The miller specified in the equipment list leaves a slightly ridged surface, but the markings are obliterated during rolling.

Second Rolling

Rolling continues on the same mill, reducing the thickness from 24 mm to 10 mm in about 5 passes. The strips finish 7.5 metres long. Capacity is 24 strips/shift. The treatment thereafter depends on the end product.

Sheet

For sheet, the strip ends are trimmed and then cut to 1 metre lengths with a circular saw. The lengths are stacked with ceramic spacers in a bell furnace and annealed with a hydrogen/nitrogen protective atmosphere, up to 140 pieces/shift.

The lengths are then cross rolled on the wide mill from 10 mm to 3 mm thick in a sequence of passes, to give sheets 1,000 mm wide and 1,330 mm long. These are reannealed in the bell furnace, and rolled to finished guage to customer requirements. This produces half hard sheet. The sheets are then sheared to customer specifications.

Strip

Rolling can be continued on the same mill or on the wide mill in straight passes to 5 mm thick, when it can be up-coiled.

According to the final product required rolling may be continued, coiling after each pass, or the strip may be annealed in the bell furnace in coil before final rolling (up to a maximum of 24 coils/shift). To avoid directional properties in the final strip, the rolling reduction immediately before the final anneal should not exceed 50%, and the rolling/annealing schedule has to be chosen accordingly. Brass strip could be produced with the addition of a simple, inexpensive pickling/cleaning unit.

The strip is finally edge trimmed, and slit to customer requirements.

A process flow chart is set out in Figure 6.5.

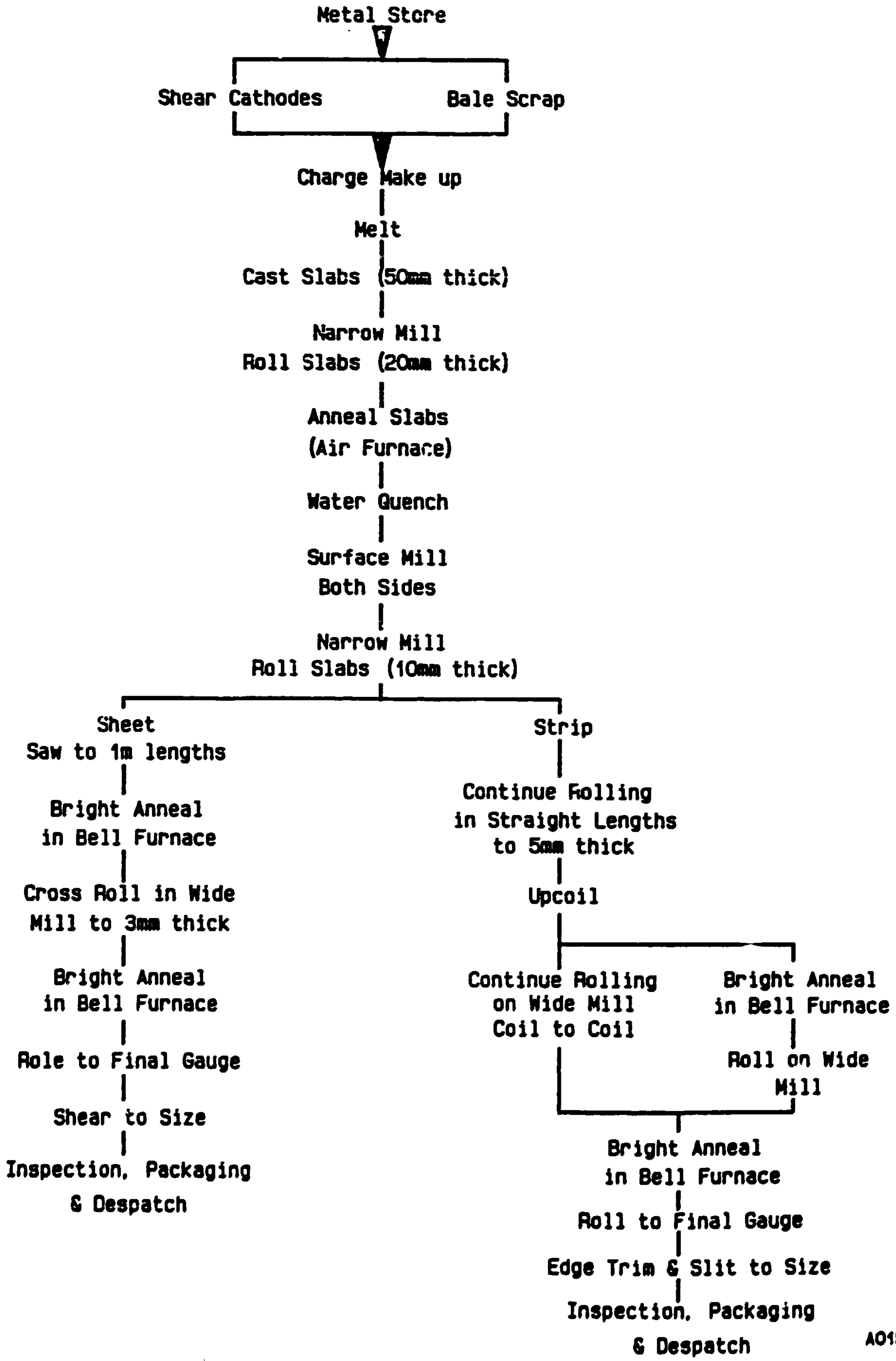
Discussion

The suggested design for the small volume plant follows practices which are now largely outdated, and the production route would not be competitive with conventional plants. It is proposed only as a possible means for satisfying the regional market, with minimal capital investment.

The most serious problem is that low volume producers of copper alloy strip have adopted increasingly continuous strip casting since this avoids much laborious rolling of thick sectioned castings. Strip casting is carried out using graphite dies or moulds, one end of the die being permanently immersed in the molten metal. Unfortunately, strip casting with submerged graphite dies, as suggested in the Dutch consultants' report, is not a practical proposition for phosphorus deoxidised copper, which is necessary if strip is to be brazed (as, for example, in the manufacture of copper water cylinders). This is because phosphate slag particles, which form when phosphorus is added to molten copper, accumulate in the entry to the die. A consequence is that the surface quality of the strip deteriorates. Furthermore, it is unlikely that a die life of more than 10 hours casting could be obtained. This is equivalent to a die cost of about $85/tonne cast, which would be quite unacceptable. There would also be considerable interruption to production.

Although this problem has been overcome in casting round billets by the submerged die technique, the solution would not be applicable to thin strip dies. So far as is known, no-one is casting successfully deoxidised copper strip by this method. In theory, it should be possible to avoid the formation of slag by melting in a two compartment furnace, but this would be an experimental plant and too risky to recommend. For this reason, it is proposed that rolling

FIGURE 6.5 PROCESS FLOW CHART (SMALL MILL)



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slabs should be produced by static casting, as practiced by Zamefa (i.e where slabs are cast individually in stationary moulds). The cast slabs would then be processed entirely by cold rolling. This is an unconventional method for manufacturing copper sheet and strip, which is normally initially hot rolled from somewhat larger slabs, as in the Romanian proposal. However, the capital cost of hot rolling mills, and the associated preheating furnace is too high for the method to be considered for small volume production.

The problem could be overcome if geyser manufacturers in the region could be persuaded to accept a copper/zinc alloy instead of phosphorus deoxidised copper, since the former are readily cast by the submerged die process. There are two possible alloys: cap copper to BS 2870 CZ 125 which is copper/5% zinc; and gilding metal to BS 2870 CZ 101 which has 10% zinc. The alloys have a golden colour, and are used for architectural work and jewellery. Both alloys are easily brazed, and both have corrosion resistance comparable to that of copper. Using one or other of these alloys it would be possible to cast strip continuously, say 16 mm thick, and up to 1,000 mm wide.

The output of well designed casting machines is about 3 kg/mm width of strip/hour. With 1,000 mm wide strip the output would be approaching that of the Romanian plant, and there would be obvious problems in marketing the products within the PTA region. However, a plant casting 500 mm wide strip, having a potential output of 3,000 t/pa, might not be unreasonable. It would be possible to widen the strip by cross rolling.

Using this technique the preliminary stages of rolling are avoided. As cast the strip would be 16 mm thick, and it would then be surface milled to 15 mm thick before cold rolling. At this stage it approximates to the hot rolled and milled strip of the Romanian proposal, the hot rolling stage having been bypassed.

Cold rolling would be either as strip 500 mm wide eventually coiled, or the milled strip could be cut into approximately 1 metre lengths and cross rolled; i.e. rolled in the short direction increasing the 500 mm to 2 metres or more to produce sheet as in the later stages of the small mill option described above. Intermediate annealing and a final anneal would be required, and this would be carried out without a protective atmosphere. After annealing it would be necessary to pickle in dilute sulphuric acid, rinse in hot water and lightly brush to give a clean bright surface.

The potential output of the plant exceeds significantly the present and forecast demand for sheet in the region, but the alloys would be satisfactory substitutes for copper as radiator fin stock. The thermal conductivity is about 67% of that of deoxidised copper, and it could be rolled to foil. The golden colour might not be so acceptable for spun wares, but the plant could be used to produce limited quantities of oxygen free or low oxygen copper strip for this trade. The same equipment could also be used to make brass strip 70/30 or 64/36 without modification.

However, it is unknown whether the products of this plant could gain acceptance from end-users in the region, and it is likely that the plant would never operate above 50% capacity. For these reasons, we have proceeded to examine the feasibility of the small mill option, using static casting and phosphorus deoxidised copper.

A further problem with the small mill is that the chief domestic demand currently is for sheet for the manufacture of geysers. For this the sheet has to be 1 metre wide. This is most efficiently produced with a wide rolling mill. However, the cost of rolling mills tends to increase exponentially with width; i.e. doubling the width, quadruples the cost. Thus, a very expensive mill would be required, even though the demand is only a few hundred tonnes per annum. For this reason, cross rolling has been recommended, but this is relatively inefficient.

With the same aim of minimising the capital cost of equipment, it has been proposed to carry out reduction with cold rolling only and with a 2-high mill. Although it is possible to roll down to guages of 0.08mm with this system, and thus satisfy the demand for radiator foil, several passes through the rolls are necessary. This is also relatively inefficient, although less so where labour is cheap.

UNIDO Technical Staff have made two comments on the small mill design:

* since the width of the first mill is only 400mm, the aspect ratio of material to be cross rolled at the second mill is small, which may introduce difficulties in cross rolling squarely and thus reduce yield. It was suggested that cast slab width be expanded up to about 800mm

* rather than increase the width of the first rolling mill to 800mm, it was suggested that first rolling should be carried out by the second (finishing) mill. This would require the finishing mill to be 4-high, with roughing rolling carried out only with the backup rolls.

The point about the aspect ratio of the material for cross rolling is appreciated, although with proper guides it should be possible to enter the material into the rolls squarely. There are also very important practical problems in producing wider material for the cross rolling stage.

Casting a wider slab was considered, but it was thought that there would be difficulties in increasing the slab width without at the same time increasing slab thickness. It would be unusual to cast a slab 800mm wide and only 50mm thick. There would be problems in obtaining a uniform distribution of molten metal along a narrow section of such length. It would be desirable to increase the thickness to 75mm or more in this case so that the solidification time in the mould was sufficient for the metal to become evenly distributed. However, increasing the slab thickness would necessitate more cold rolling and would probably add another anneal to the schedule and it was ruled out for these reasons. It is just possible that a wide thin slab could be produced by semi-continuous casting by extending the mould into a graphite "hot top", but this again would add to plant costs. It also is the case that wide mills are not common in the copper industry.

The idea of using the backing rolls of the finishing mill for the rough rolling is feasible, but not so desirable from the point of view of productivity. Time would be lost in removing the work rolls, and production would have to be scheduled to allow for a campaign of breaking down rolling followed by one of finishing. Manning levels would remain about the same. There is a possibility for eliminating a foreman and 4 operatives associated with the breaking down mill, but extra work would have to be done on the finishing mill which would involve another shift.

Incidentally, the difference in plant capital costs between casting statically a slab 800mm wide and one 400mm wide would be minimal if a single rolling mill were to be employed for both roughing and finishing. However, if a separate rough rolling mill is decided upon the greater slab width would increase considerably the cost of the roughing mill with adverse effects on the economics of the project.

The single rolling mill idea would have an impact on capital costs for the project, and this has been carried forward to Sections 6.3.2 and 10.11.

6.3 Equipment

6.3.1 Romanian mill

The main items of equipment are specified in the Romanian technical proposal. A copy of the list of equipment is included in Appendix 1.

There appear to be no inaccuracies or inconsistencies in the specifications, but the list is not comprehensive and the quality of the machinery and finished product cannot be checked without first-hand investigation.

The probable capital cost of the plant and equipment is set out below. This is based on a verbal estimate given by the Romanian delegation:

* plant and equipment: $20 million
* transport, installation and commissioning: $10 million

The estimate for the plant and equipment seems low. A figure nearer $25 million would be more realistic if the equipment were procured from Western Europe.

The cost of cranes and power supply have been included in the civil engineering costs.

The commissioning cost includes the costs of trial runs and materials, ancillary equipment, and expatriate supervision.

It is assumed that the plant and equipment will be provided with a two year supply of spares, or access to spares free of charge.

It is also assumed that imports of plant and equipment for the project will be free of customs and sales tax under Article 21 of the Industrial Development Act.

6.3.2 Small mill

The main items of equipment for the small mill option and budget prices are set out in Table 6.1. The prices have been quoted by UK manufacturers and merchants.

TABLE 6.1 - MAJOR ITEMS OF PLANT AND EQUIPMENT FOR THE SMALL MILL

Processing stage	Equipment	Estimated cost ($'000s)
Metal preparation	Cathode shear Baler for process scrap	170 (1) 50
Melting & casting	1 tonne mains frequency furnace with water circuit and transformer 3 moulds	645 (2) 35
First rolling	2 high 450 x 650mm rolls non reversing with electrics	935
Surface milling	Surface miller	210 (3)
Second rolling	2 high 300-400mm rolls x 1.2 metre wide non reversing	2,550
Annealing	Bell annealing furnace 3 bases (nitrogen/hydrogen atmosphere)	510
Finishing	Slitter for coil and shear for sheet Roll grinder, circular saws, run out tables and misc. minor equipment	425 850
		6,380 (4)

Source: WS Atkins

Notes: (1) This is expensive for a machine cutting a relatively small number of cathodes, and a less costly solution might be researched

(2) This seems expensive, but is based on an existing installation, and includes erection and commissioning

(3) This is an inexpensive miller but considered suitable if milling is done at an early stage. Better ones cost around $680,000

(4) The cost of setting up a plant using the submerged die process and manufacturing copper/zinc alloys (as described in Section 6.2.2) is estimated as follows:

	$'000s
Cathode shear and baler	220
1.5 tonne channel type induction furnace	128
500mm wide strip casting machine	595
Surface miller	680
1.2m wide rolling mill	2,550
Annealing, pickling and cleaning unit	170
Edge trimming and slitting	340
Ancillaries	850
Total	5,533

It should be possible to reduce the capital cost by about $1.7 million if suitable reconditioned mills can be found. Cheaper unreconditioned equipment can be found, but it is essential to recognise that refurbishment costs for second hand plant can be expensive and unpredictable. Often the electrics will have disappeared, and the drives and bearings damaged.

Enquiries have revealed that there is a good supply of second hand equipment on the market, with agents specialising in its procurement. Since this reduces the cost of equipment by over 25%, it has been decided to investigate the feasibility of the small mill option both on the basis of using new and second hand equipment.

[illegible] the single rolling mill is used, costs can be reduced by about $[illegible] llion for new equipment and $0.75 million for second hand equipment.

Installation and commissioning would cost in the region of $1.7 million, this including trials, trial materials, ancillary equipment, and expatriate supervision.

Costs may be reduced to an estimated $1.5 million if the single rolling mill concept is used.

Design, installation and commissioning would be best carried out as a turn-key contract by an engineering concern in this field. The contractor would undertake procurement, and be responsible for refurbishment if necessary.

It is assumed that the contractor will supply spares for two years free of charge.

6.4 Civil Engineering Works

6.4.1 Romanian mill

Civil engineering costs for the factory buildings and works are estimated in Table 6.2. A preliminary design of the main building is set out in Figure 6.6.

Import requirements for the project are estimated as follows:

* available locally: sand, cement, stone, bricks, asbestos, roof sheets, design, project management, contracting, and other professional services, labour, land procurement, conveyance fees, council scrutiny fees (approx 45 to 50% of costs)

* available locally, but in short supply, and imported indirectly: window frames, door frames, glazing, floor tiles, reinforcement steel, paint, electrical transformers (approx 25% of costs)

* materials to be imported directly: structural steel, gantry cranes, electrical components, mechanical fixtures (approx 25 to 30% of costs).

Import content is estimated at 55%. Imports of materials and manufactures for civil engineering works have been costed inclusive of transport costs and customs and sales tax duties at an effective rate of 37.5%.

It will also be necessary to provide a housing colony. Table 6.3 provides an estimate of the cost. This is based on the assumption that expatriates and all Zambian management will be provided with high cost housing, technicians with medium cost housing, and overhead skilled labour with low cost housing (see Section 8 for manning levels).

The import content for housing is estimated at 25%.

TABLE 6.2 - CIVIL ENGINEERING COSTS - (Romanian Mill)

Item	Estimated cost (K'000s)	
Buildings		
Main factory:		
Building fabric	8,350m^2 @ K 3,500/m^2	29,225
Ground floor slab and machine bases	8,350m^2 @ K 1,500/m^2	12,525
Gantry cranes	4 x K 2,500,000	10,000
Mechanical services		4,000
Electrical services	2 No. 2 x 1000 kVA 11/0.4 kV substation including switchgears	2,000
	2 No. 1 x 1000 kVa 11/0.4 kV substation including switchgears	1,400
	1 No. 33/11 kV substation including switchgears	8,000
	Lights, power outlets and general electrical works	600
Offices (including building services)	600m^2 @ K 5,500/m^2	3,300
Change room, kitchen	500m^2 @ K 5,000/m^2	2,500
Workshops (including building services)	540m^2 @ K 5,000/m^2	2,700
Fuel storage		1,000
Guard house	50m^2 @ K 3,500/m^2	175
Sub-total		77,425
Civil and external works		
Concrete roadways/hardstanding/office parking	4,000m^2 @ K 250/m^2	1,000
Site levelling/landscaping/stormwater drains	4,000m^2 @ K 120/m^2	480
Fencing	750m^2 @ K 500/m^2	375
Borehole x 2	2 x K 75,000	150
Sub-total		2,005
Total cost		79,430
Contingencies (10%)		7,943
Preliminary and general (10%)		8,737
Total budget estimate		96,110

Source: Arup (Zambia)

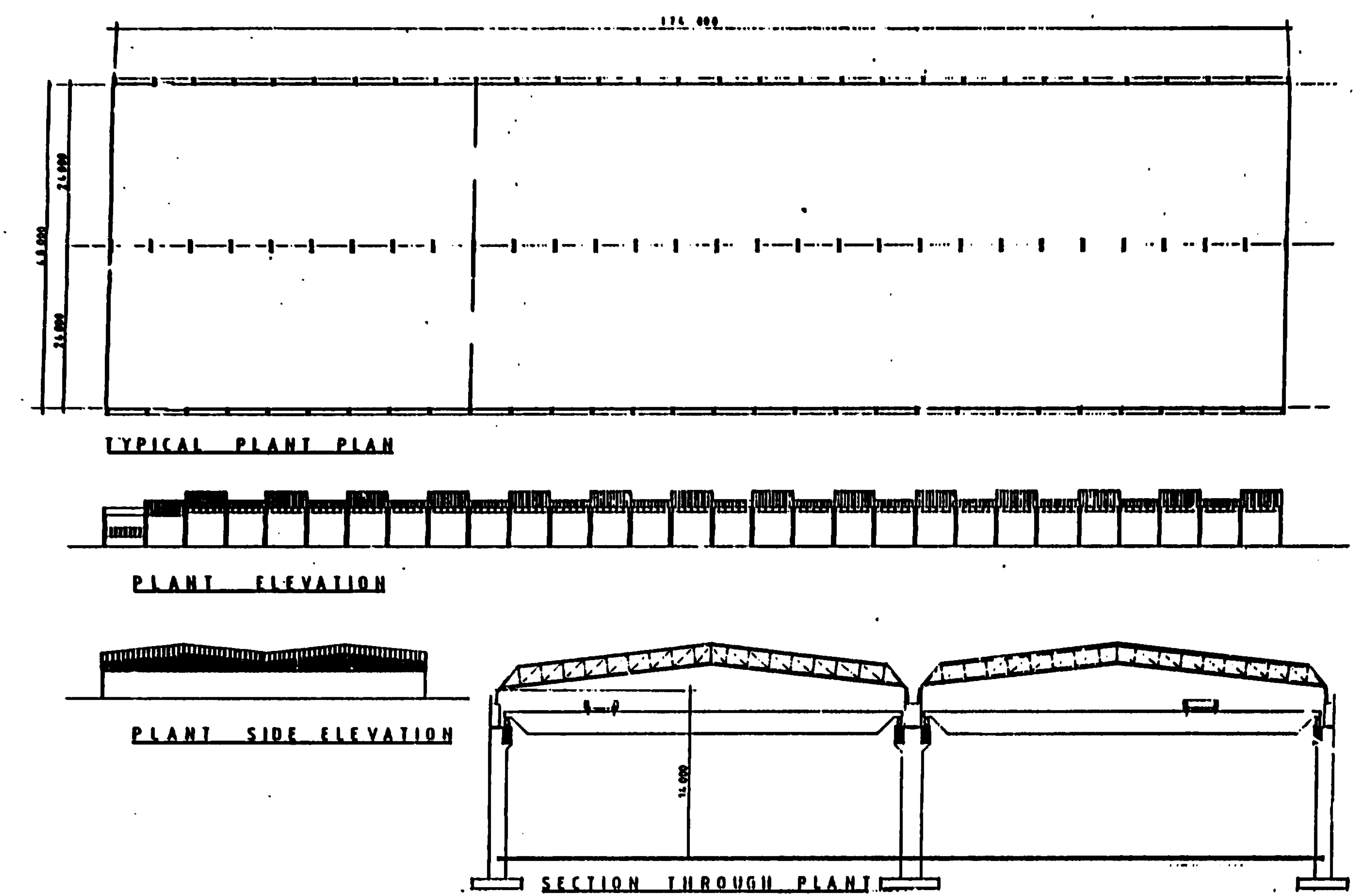

FIGURE 6.6 - PRELIMINARY DESIGN OF MAIN BUILDING
(ROMANIAN MILL)

TABLE 6.3 - HOUSING COSTS (Romanian Mill)

Type of housing	No.	Estimated size (m^2)	Estimated cost per m^2 (K)	Total cost (K'000s)
High cost housing	24	80	2,000	3,840
Medium cost housing	30	70	1,800	3,780
Low cost housing	35	45	1,300	2,048
Totals	89			9,668

Sources: WS Atkins
Indeco (for sizes of housing and costs/m^2)

6.4.2 Small mill

Civil engineering costs for the factory building and works are estimated in Table 6.4. A preliminary design of the factory is set out in Figure 6.7. The assumptions regarding import content and the customs and sales tax duties are the same as those for the Romanian mill.

Housing costs are set out in Table 6.5. The assumptions regarding which staff are to be assigned housing is the same as that used for the Romanian mill.

TABLE 6.5 - HOUSING COSTS (Small Mill)

Type of housing	No.	Estimated size (m^2)	Estimated cost per m^2 (K)	Total cost (K'000s)
High cost housing	14	80	2,000	2,240
Medium cost housing	16	70	1,800	2,016
Low cost housing	19	45	1,300	1,112
Totals	49			5,368

Sources: WS Atkins
Indeco (for sizes of housing and costs/m^2)

TABLE 6.4 - CIVIL ENGINEERING COSTS - (Small Mill)

Item	Estimated cost (K'000s)	
Buildings		
Main factory:		
Building fabric	900m^2 @ K 3,000/m^2	2,700
Ground floor slab and machine bases	900m^2 @ K 1,000/m^2	900
Gantry cranes		1,500
Mechanical services		1,500
Electrical services	1 No. 2 x 1000 kVA 11/0.4 kV substation including switchgears	1,000
	1 No. 1 x 1000 kVA 11/0.4 kV substation including switchgears	700
	Switching station	1,500
	Possible need for upgrading ZESCO's 11 kV line (1 km)	1,000
	Lights, power outlets and general electrical work	200
Offices	included in factory	
Change room, kitchen	150m^2 @ K 5,000/m^2	750
Canteen (including building services)		
Workshop (including building services)	150m^2 @ K 5,000/m^2	750
Fuel storage		250
Sub-total		12,750
Civil and external works		
Concrete roadways/hardstanding	1,000m^2 @ K 250/m^2	250
Site levelling/landscaping	1,000m^2 @ K 120/m^2	120
Fencing		100
Borehole		75
Sub-total		545
Total cost		13,295
Contingencies (10%)		1,330
Preliminary and general (10%)		1,462
Total budget estimate		16,087

Source: Arup (Zambia)

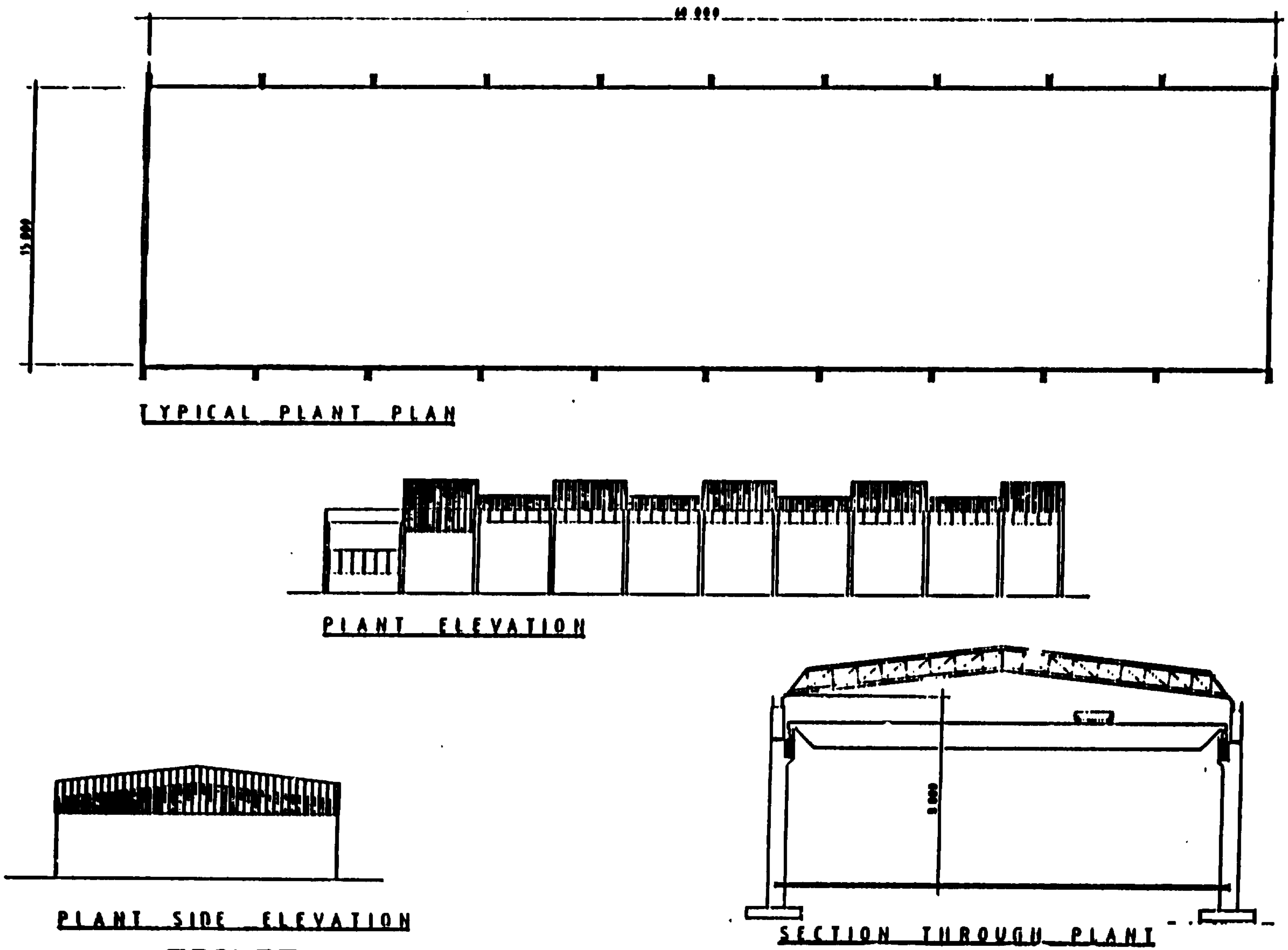

FIGURE 6.7 - PRELIMINARY DESIGN OF FACTORY BUILDING (SMALL MILL)

6.5 Summary of Costs

The investment costs of plant and equipment and civil engineering are summarised in Table 6.6 for the three options under review: the Romanian mill, the small mill with new plant and equipment, and the small mill with second hand plant and equipment.

TABLE 6.6 - ESTIMATED COSTS OF PLANT AND EQUIPMENT AND CIVIL ENGINEERING
(all costs in $'000s)

Item	Romanian mill			Small mill (new plant and equipment)			Small mill (second hand plant and equipment)		
	Foreign currency	Local currency	Total	Foreign currency	Local currency	Total	Foreign currency	Local currency	Total
Plant and equipment	20,000	-	20,000	6,380	-	6,380	4,680	-	4,680
Installation and commissioning	10,000	-	10,000	1,700	-	1,700	1,700	-	1,700
Factory buildings	5,181	4,239	9,420	852	698	1,550	852	698	1,550
Works, preliminary and general	715	585	1,300	137	113	250	137	113	250
Housing	294	882	1,176	163	490	653	163	490	653
Contingencies	5,119	571	5,690	1,327	130	1,457	1,072	130	1,202
Total	41,309	6,277	47,586	10,559	1,431	11,990	8,604	1,431	10,035

Source: WS Atkins

Notes: (1) Where costs have been calculated originally in Kwacha, conversion to Dollars has been made at the official rate of 1 $ = 8.22 Kwacha. Figures have been rounded up or down where appropriate
(2) Contingencies are 10% for buildings and works, and 15% for plant and equipment

7. PLANT ORGANISATION AND OVERHEAD COSTS

Overhead costs are estimated in Table 7.1.

TABLE 7.1 - OVERHEAD COSTS
($/pa)

Cost items	Romanian mill	Small mill
Consumables	100,000	20,000
Communications	10,000	5,000
Travel	10,000	5,000
Rates	5,000	1,000
Insurance	1.4% value of plant & equipment & buildings	1.4% value of plant & equipment & buildings
Distribution	10,000	2,000
Depreciation:		
* Plant & machinery	50% year 1 30% thereafter on written down value	50% year 1 30% thereafter on written down value
* Buildings	15% year 1 5% thereafter on written down value	15% year 1 5% thereafter on written down value

Sources: WS Atkins
Indeco (for insurance rates and depreciation schedules)

The item for consumables includes materials for maintenance as well as office supplies.

There is no provision for utilities. It is assumed that these costs are allocated fully to the factory. The proportion consumed by offices will be negligible.

Distribution includes only the cost of packaging materials. Since we are working in ex-works prices, the cost of freight is treated as external to the project.

The depreciation schedule is based on information provided by Indeco. Depreciation charges are calculated on a declining balance, rather than a straight line basis.

8. MANPOWER

8.1 Romanian Mill

8.1.1 Management

The managerial resources for the Romanian project are specified in Table 8.1, including initial expatriate requirements.

TABLE 8.1 - MANAGERIAL RESOURCES
(Romanian Mill)

	Zambians (including counterparts)	Expatriates at project outset
Upper management		
Managing director	x	x
Works manager	x	x
Production manager	x	x
Accountant/company secretary	x	
Sales/marketing manager	x	x
Lower management		
Stock control/purchasing manager	x	x
Transport manager	x	x
Personnel manager	x	
Quality control manager	x	x
Maintenance manager	x	

Sources: WS Atkins
Uzinexportimport Technical Proposal

It has been proposed that 30 expatriate Romanians (including technicians) will work on the project during erection and commissioning, with 12 to 15 remaining for initial running and training purposes.

Expatriate labour required during erection and commissioning is treated as part of the commissioning cost. Expatriate labour required during operation is treated as part of the operating costs. The Romanians have also offered to provide training in Romania for Zambians while the plant and equipment is being manufactured. The purpose of this is to have trained Zambians ready to work as counterparts to expatriate managerial staff and as technicians when the plant begins production. The costs associated with training have not been provided by the Romanians, but have been estimated and included in the pre-production costs (see Section 10).

The experience of Zamefa demonstrates that expatriate management will be a feature for many years in a project of this nature. Zamefa still operates with 8 Phelps-Dodge employees in senior management after 17 years of production, and used 48 expatriates during the setting up phase. Several of these expatriates are shadowed by Zambian counterparts, being trained to take their places. This in part reflects the fact that Phelps-Dodge has a stake in the project, but we would expect to follow this practice in the case of both mill options. This results in considerable duplication of duties during the early years of operation, but the gains in efficiency will justify the costs. There will be gradual run-down in the use of expatriates over the lifetime of the project.

8.1.2 Labour

The production manpower requirements for the project (excluding expatriates) are estimated in Table 8.2. These figures are based on an appraisal of the Romanians' technical proposal, which did not contain information on manning levels. The figures are built up by breaking down the production process into activities, and calculating for each activity the necessary shifts and labour requirements per shift.

TABLE 8.2 - PRODUCTION MANPOWER BREAKDOWN (Romanian Mill)

Activity	No. of shifts	Foremen/ technicians per shift	Total	Operators per shift	Total	Crane drivers per shift	Total	Forklift drivers	Total
1 Metal preparation and charge make-up:	3	1	3						
- incoming metal	1			2	2	1	1		
- shearing cathodes	3			3	9			0.5	1.5
- baling returned scrap	2			2	4			0.5	1
- charge make-up	3			2	6	1	3		
2 Melting and casting	3	1	3	2 (furnace)	4	1	3		
				2 (casting)	4				
3 Sawing rolling slabs	1			3	3	0.5	0.5		
4 First 10 days of month									
- preheating furnace	3	1	3	2	6	1	3		
- hot rolling	3	1	3	6	18	share with furnace			
- milling	1			2	2	0.5	0.5		
5 Second 20 days of month:									
- strip rolling	3	same crew as for hot rolling							
- annealing coils	3	1	3	1	3	1	3		
- annealing sheet	3	same crew as for preheating furnace							
6 Finishing:									
- slitting	3	1	3	4	12			0.5	1.5
- sheet shearing	1	foreman shared with slitting		2	2				
- packaging and inspection	1	1	1	10	10			1	1
7 Testing and inspection:	1	1 (chief inspector)	1						
- surface inspection & hardness measurement	1			6	6			0.25	0.25
- analysis	1	1	1						
- mechanical testing	1	1	1					0.5	0.5
- machining test pieces	1			1	1			0.25	0.25
Sub-total			22		92		14		
8 Maintenance:									
- electrician	3	1	3	1	3				
- fitter	3	1	3	1	3				
- storekeeper	1			1	1				
- workshop foreman	1	1	1						
- roll grinding, saw sharpening, repairs	1			6	6				
Totals			29		105		14		6

Source: WS Atkins

Combination of Tables 8.1 and 8.2, and the addition of estimates on indirect and expatriate labour requirements, gives Table 8.3. This sets out in full the project manpower requirements, divided by skill levels, origin, and categorised as "direct" (i.e. production labour) or "indirect" (i.e. overhead labour).

TABLE 8.3 - TOTAL MANPOWER REQUIREMENTS
(Romanian Mill)

	Zambians	Expatriates at project outset	Direct labour	Indirect labour
Upper management	5	4	-	9
Lower management	5	3	-	8
Technicians/foremen:				
- security officer	1	-	-	1
- foremen	20	5	25	-
- technicians	9	2	11	-
Skilled labour:				
- crane drivers	14	-	14	-
- secretaries	10	-	-	10
- clerks/typists	25	-	-	25
- operators	21	-	21	-
- forklift drivers	6	-	6	-
Unskilled labour	84	-	84	-
Totals	200	14	161	53

Source: WS Atkins

It is assumed that Romanian personnel will be needed for each activity for which a foreman is necessary (i.e. 5).

The Zambian manpower requirement of 200 is identical to the Romanian's verbal estimate.

8.1.3 Costs

An estimate of labour costs for the Romanian mill is set out in Table 8.4. The costs are broken down into "direct" and "indirect", and into local and foreign currency.

The costs of Zambian labour are based on figures provided by Indeco. They include allowances, estimated at 50% of basic salary. The unit cost of expatriate salaries has been estimated on the basis of salary levels known to prevail in Eastern Europe, and include allowances for posting in Zambia. The Romanian technical proposal contained no information on the costs of expatriate workers. Under direction from Indeco, it has been assumed that 33% of expatriate salaries are paid in foreign currency.

8.2 Small Mill

8.2.1 Management

The managerial resources for the small mill project are specified in Table 8.5, including initial expatriate requirements. A complication is introduced by the planned move from one shift to two in Year 4.

There is scheduled to be a high degree of expatriate involvement in the early years of the project, with Zambian managers acting initially as counterparts. The duplication of tasks will lower labour productivity during the initial years of the project, but this is considered necessary for the development of competitive levels of efficiency.

Expatriates will have to be recruited on short-term contracts, probably from a European manufacturer rather than the supplier of the plant and equipment, which may come from many sources.

A provision for training has been included in the pre-production expenses (see Section 10).

TABLE 8.4 - TOTAL MANPOWER COSTS (Romanian Mill)

Skill category	Unit cost Zambian labour (k/pa)	Zambians		Unit cost expatriates ($/pa)	Expatriates							
					Years 1-2		Years 3-4		Years 5-9		Years 10+	
		D	I		D	I	D	I	D	I	D	I
Upper management	100,000	-	5	35,000	-	4	-	3	-	3	-	2
Lower management	65,000	-	5	30,000	-	3	-	2	-	2	-	1
Technicians/foremen	42,000	29	1	25,000	7	-	7	-	7	-	-	-
Skilled labour	18-21,000	41	35	-	-	-	-	-	-	-	-	-
Unskilled labour	12-15,000	84	-	-	-	-	-	-	-	-	-	-
Total cost local currency ($'000s)	-	383.4	188.5	-	117.2	154.1	117.2	110.5	117.2	110.5	-	67.0
Total cost foreign currency ($'000s)	-	-	-	-	57.8	75.9	57.8	54.5	57.8	54.5	-	33.0

Sources: WS Atkins
Indeco

Note: D = Direct, I = Indirect

TABLE 8.5 - MANAGERIAL RESOURCES
(Small Mill)

	Zambians (inc. counterparts)	Expatriates at project outset
Upper management		
General manager	x	x
Works manager	x	x
Accountant	x	
Purchasing & sales manager	x	x
Lower management		
Personnel manager	x	

Source: WS Atkins

8.2.2 Labour

The production manpower requirements (excluding expatriates) of the project are set out in Table 8.6 for one shift working.

Combination of Tables 8.5 and 8.6, with the addition of estimates of indirect and expatriate labour requirements, gives Table 8.7. This sets out in full the project manpower requirements, divided by skill level and categorised as direct or indirect. It has been assumed that there will be a need for an expatriate for each activity where a foreman is necessary (i.e. 5).

The table also shows requirements for two shift working. There is no change in expatriate manning at two shifts, but there is an addition of one Zambian shift manager, a doubling of direct labour requirements, and an adjustment upwards of about 25% of indirect labour.

8.2.3 Costs

An estimate of labour costs for the small mill option is provided in Table 8.8, broken down into "direct" and "indirect", and into foreign and local currency.

TABLE 8.6 - PRODUCTION MANPOWER BREAKDOWN : ONE SHIFT WORKING
(Small Mill)

Activity	No. of shifts	Foremen/ technicians per shift	Total	Operators per shift	Total	Forklift drivers per shift	Total
1 Metal preparation and charge make-up	1	) 1	1	2	2	0.25	0.25
2 Melting and casting	1	)		3	3		
3 Breaking down mill	1	) 1	1	4	4		
4 Surface milling, strip sawing and rough annealing	1	)		2	2		
5 Annealing	1	0.5	0.5	2	2	0.5	0.5
6 Finishing mill	2	1	2	4	8		
7 Finishing sheet and strip	1	0.5	0.5	4	4		
8 Packaging and inspection	1	1	1	4	4	0.25	0.25
9 Services	1	3	3	3	3		
Totals	-	-	9	-	32	-	1

Source: WS Atkins

Note: The finishing mill would normally have one shift, but needs two if a large percentage of sheet is made

TABLE 8.7 - TOTAL MANPOWER REQUIREMENTS (Small Mill)

	One shift working				Two shift working			
	Zambians	Expatriates at project outset	Direct labour	Indirect labour	Zambians	Expatriates at project outset	Direct labour	Indirect labour
Upper management	4	3	-	7	5	3	-	8
Lower management	1	-	-	1	1	-	-	1
Technicians/foremen:								
- foremen	6	5	11	-	12	5	17	-
- technicians	3	-	3	-	6	-	6	-
Skilled labour:								
- forklift drivers	1	-	1	-	2	-	2	-
- operators	6	-	6	-	12	-	12	-
- secretaries	4	-	-	4	5	-	-	5
- clerks/typists	10	-	-	10	14	-	-	14
Unskilled labour	26	-	26	-	52	-	52	-
Totals	61	8	47	22	109	8	89	28

Source: WS Atkins

TABLE 8.8 - TOTAL MANPOWER COSTS (Small Mill)

Skill category	Unit cost Zambian labour (k/pa)	One shift		Two shifts		Unit cost expatriates ($/pa)	Expatriates							
							Years 1-2		Years 3-4		Years 5-9		Years 10+	
		D	I	D	I		D	I	D	I	D	I	D	I
Upper management	100,000	-	4	-	5	60,000	-	3	-	2	-	1	-	1
Lower management	65,000	-	1	-	1	50,000	-	-	-	-	-	-	-	-
Technicians/foremen	42,000	9	-	18	-	40,000	5	-	5	-	2	-	-	-
Skilled labour	18-21,000	7	14	14	19	-	-	-	-	-	-	-	-	-
Unskilled labour	12-15,000	26	-	52	-	-	-	-	-	-	-	-	-	-
Total cost local currency ($'000s)	-	105.3	89.8	210.6	113.8	-	134.0	120.6	134.0	80.4	53.6	40.2	-	40.2
Total cost foreign currency ($'000s)	-	-	-	-	-	-	66.0	59.4	66.0	39.6	26.4	19.8	-	19.8

Sources: WS Atkins
Indeco

Note: D = Direct, I = Indirect

The table includes a calculation of labour costs with two shift working, which is scheduled to begin in Year 4 of operation.

The cost of expatriate workers is set higher than in Table 8.4 to reflect the higher salaries in Western Europe and the difficulty of attracting staff from these countries to work in Zambia. Inducement allowances, gratuities and travel perks will have to be added to basic salaries. It has been assumed that 33% of expatriate salaries are payable in foreign currency.

9. IMPLEMENTATION SCHEDULING

9.1 Romanian Mill

The suggested implementation scheduling for the Romanian mill is set out in Figure 9.1. This assumes that a decision to proceed is made on 1st January 1989.

The first year is taken up in establishing an Indeco project team, company formation, arrangement of finance, the appointment of project management consultants for both civils and plant and equipment, procurement of land and site survey, the preparation of tender documents and the allocation of contracts for the civil engineering works and housing colony.

The plant and equipment is ordered on December 31st 1989/1st January 1990, with completion expected after 24 months. This is based on a verbal estimate provided by the Romanian delegation. Construction of the works and housing colony also begins early in 1990, and is, according to Arup (Zambia), expected to take 30 months. It is scheduled to be ready in time for the delivery of plant and equipment, which will take place around June 1992. Erection and installation of plant and equipment is expected to take about 6 months, and commissioning 9 months. Production can begin in the later months of 1993, when an output of 20% is estimated. Production builds up to 50 to 60% in 1994.

Key personnel for the project (5 upper management) are recruited early in 1991 to join the Indeco project team. Further staff are recruited around April 1992, starting with the foremen and lower management who, together with some upper management, attend a 6 months training course in Romania in the second half of 1992. They

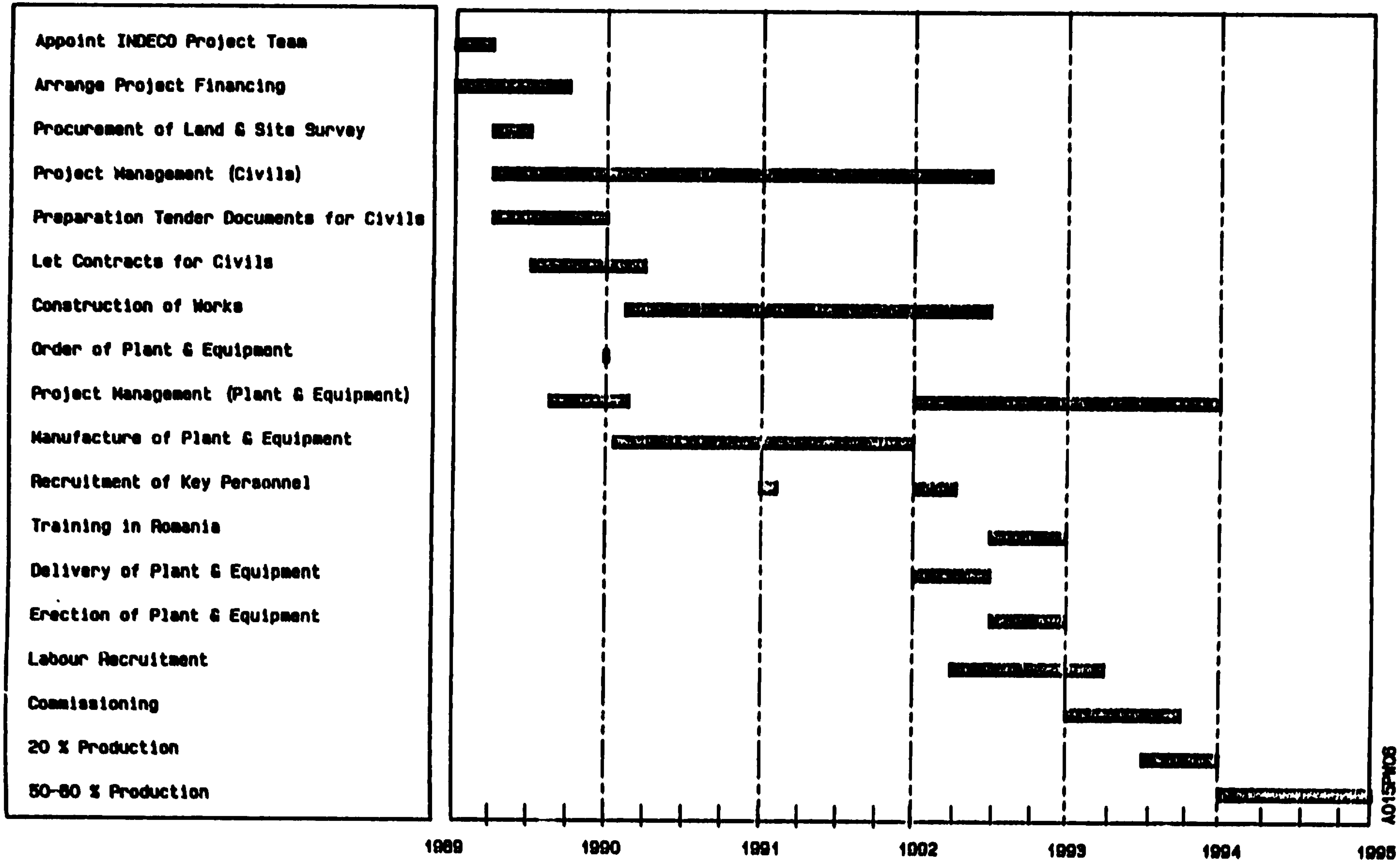

FIGURE 9.1 IMPLEMENTATION (ROMANIAN MILL)

return in time for commissioning at the beginning of 1993. Meanwhile, recruitment of other manpower resources continues, ready to achieve a full complement early in 1993.

9.2 Small Mill

The suggested implementation scheduling for the small mill project is set out in Figure 9.2. This also assumes that a decision to proceed is made on 1st January 1989.

The first year activities include the appointment of an Indeco project team, company formation, the arrangement of project finance, and the procurement of land and site survey. Project Management Consultants will also be appointed for civils and for the plant and equipment. Tender documents for the civil engineering and housing project will be drawn up in the first year, and the contracts let up to about February 1990. Negotiations with plant and equipment suppliers will also begin in 1989, leading to the preparation of tender documents and the signing of contracts by the end of 1989. It is expected that the contract would be placed as a turnkey operation with an engineering concern able to offer design, procurement, and manufacturing services, as well as installation and commissioning.

Design, procurement and manufacturing of the plant and equipment package will begin in early 1990. Completion is expected after 12 to 18 months. Construction of the works and housing colony will also begin in early 1990, with completion after 12 to 15 months. Delivery of the plant and equipment will take 3 months, and a further 3 months for erection and installation. Commissioning is anticipated to take 6 to 9 months, and should take place at the latest by 1st January 1992. About 30% of full production from one shift will be achieved in Year 1 (1992), building up to 70% and 90% in Years 2 and 3 (1993 and 1994 respectively). In Year 4 (1995), the plant moves to two shift production.

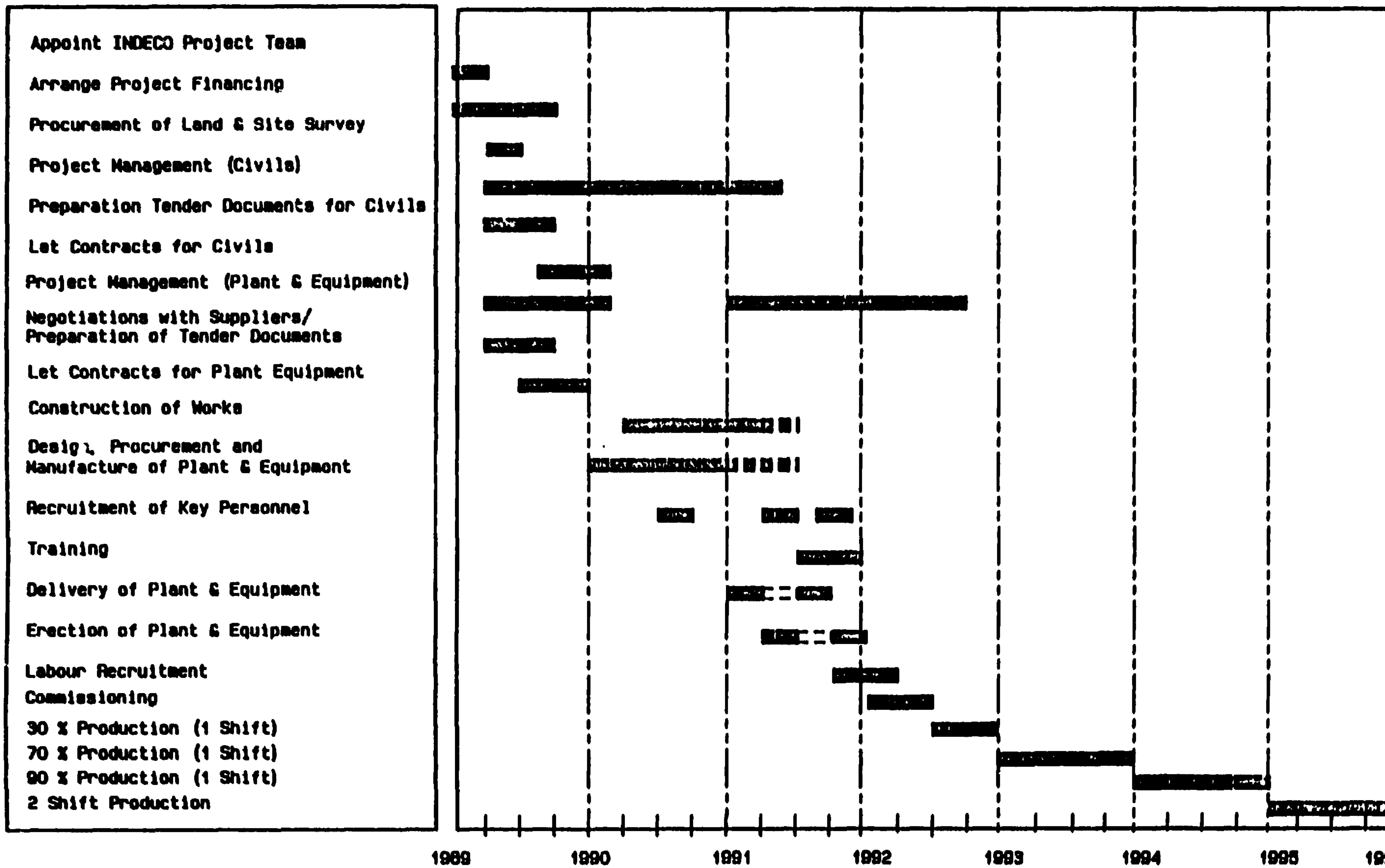

FIGURE 9.2 IMPLEMENTATION (SMALL MILL)

Key personnel (4 upper management) will be recruited in mid 1990, to join the Indeco project team. The foremen will be recruited in 1991, and, together with the Works Manager, will commence 6 months training overseas. They will return to Zambia is time to participate in the commissioning process. Recruitment of expatriates will take place in the second half of 1991, for arrival in Zambia in time for commissioning the plant and equipment. Recruitment of labour is also scheduled for late 1991 and early 1992.

10. FINANCIAL EVALUATION

All values shown in the tables following are expressed in US $.

10.1 Pre-Production Costs

10.1.1 Romanian mill

Pre-production costs for the Romanian mill are estimated in Table 10.1, and total $ 720,000.

The major item is consultancy fees for project management, site survey, building design, and further economic studies, including a survey of potential customers. There is also a provision for legal expenses.

The item for salaries for key personnel is based on five management level Zambians for two years.

Training costs are based on 22 Zambians (foremen, Works Manager and Production Manager) spending 6 months in Romania. The estimate includes travel and subsistence for the Zambian team at $ 88,000, and a training fee of $62,000 based on the salaries of three Romanians plus a 100 % fee.

The cost of preparatory installations has been included in the civil engineering costs. Trials and commissioning costs are included in the commissioning costs quoted by the suppliers, and are found in Table 6.6.

Table 10.1 also shows the expected phasing of the pre-production expenses in constant mid 1988 prices, and breaks down the costs into foreign and local currency, using assumptions on the import content for each item.

10.1.2 Small mill

Pre-production expenses are estimated in Table 10.2 for the mill using new plant and equipment, and in Table 10.3 for the mill using second hand plant and equipment. The figures are identical, and total $505,000.

The salaries of key personnel are based on 4 Zambian managers working for 18 months.

The training costs are based on 7 Zambians (foremen and the Works Manager) spending 6 months at a European rolling mill. The cost includes travel and subsistence for the Zambian team at $49,000, and training at $61,000 based on two men's salaries plus a 100 % fee.

Tables 10.2 and 10.3 also show the expected phasing of the pre-production expenses in constant mid 1988 prices, and the breakdown between foreign and local currency.

10.2 Expenditure on Fixed Assets

10.2.1 Romanian mill

The phasing of expenditure on fixed assets for the Romanian mill is set out in Table 10.4, in constant mid 1988 prices. Expenditure is broken down by year, and separated into foreign and local currency. Expenditures total $47.6 million, including contingencies (10% for buildings and works, and 15% for plant and equipment).

Investment costs are derived from Table 6.6. Import content figures are estimated in Section 6.4.

TABLE 10.1 - PHASING OF PRE-PRODUCTION COSTS (Romanian Mill)

All Values in $ '000s (Constant Prices)

ITEM	TOTAL	Foreign Component	Local Component	1989	1990	1991	1992	1993	1994
CONSULTANCY FEES	350.00	0.40	0.60						
* Percentage				30.00	40.00	20.00	10.00		
* Foreign expenditure				42.00	56.00	28.00	14.00		
* Local expenditure				63.00	84.00	42.00	21.00		
LEGAL EXPENSES	80.00	0.00	1.00						
* Percentage				70.00	20.00	10.00			
* Foreign expenditure				0.00	0.00	0.00			
* Local expenditure				56.00	16.00	8.00			
SALARIES OF KEY STAFF	120.00	0.00	1.00						
* Percentage						30.00	70.00		
* Foreign expenditure						0.00	0.00		
* Local expenditure						36.00	84.00		
TRAINING									
* Percentage	150.00	1.00	0.00				100.00		
* Foreign expenditure							150.00		
* Local expenditure							0.00		
PROMOTION									
* Percentage	20.00	0.00	1.00				100.00		
* Foreign expenditure							0.00		
* Local expenditure							20.00		
TOTAL FOREIGN EXPENDITURE				42.00	56.00	28.00	164.00	0.00	0.00
TOTAL LOCAL EXPENDITURE				119.00	100.00	86.00	125.00	0.00	0.00

TABLE 10.2 - PHASING OF PRE-PRODUCTION COSTS (Small Mill with New Plant & Euipment)

All Values in $ '000s (Constant Prices)

ITEM	TOTAL	Foreign Component	Local Component	1989	1990	1991	1992	1993	1994
CONSULTANCY FEES	250.00	0.40	0.60						
* Percentage				30.00	45.00	20.00	5.00		
* Foreign expenditure				30.00	45.00	20.00	5.00		
* Local expenditure				45.00	67.50	30.00	7.50		
LEGAL EXPENSES	50.00	0.00	1.00						
* Percentage				70.00	20.00	10.00			
* Foreign expenditure				0.00	0.00	0.00			
* Local expenditure				35.00	10.00	5.00			
SALARIES OF KEY STAFF	75.00	0.00	1.00						
* Percentage					30.00	70.00			
* Foreign expenditure					0.00	0.00			
* Local expenditure					22.50	52.50			
TRAINING									
* Percentage	110.00	1.00	0.00			100.00			
* Foreign expenditure						110.00			
* Local expenditure						0.00			
PROMOTION									
* Percentage	20.00	0.00	1.00			100.00			
* Foreign expenditure						0.00			
* Local expenditure						20.00			
TOTAL FOREIGN EXPENDITURE				30.00	45.00	130.00	5.00	0.00	0.00
TOTAL LOCAL EXPENDITURE				80.00	100.00	107.50	7.50	0.00	0.00

TABLE 10.3 - PHASING OF PRE-PRODUCTION COSTS (Small Mill with Second Hand Plant & Euipment)

All Values in $ '000s (Constant Prices)

ITEM	TOTAL	Foreign Component	Local Component	1989	1990	1991	1992	1993	1994
CONSULTANCY FEES	250.00	0.40	0.60						
* Percentage				30.00	45.00	20.00	5.00		
* Foreign expenditure				30.00	45.00	20.00	5.00		
* Local expenditure				45.00	67.50	30.00	7.50		
LEGAL EXPENSES	50.00	0.00	1.00						
* Percentage				70.00	20.00	10.00			
* Foreign expenditure				0.00	0.00	0.00			
* Local expenditure				35.00	10.00	5.00			
SALARIES OF KEY STAFF	75.00	0.00	1.00						
* Percentage					30.00	70.00			
* Foreign expenditure					0.00	0.00			
* Local expenditure					22.50	52.50			
TRAINING									
* Percentage	110.00	1.00	0.00			100.00			
* Foreign expenditure						110.00			
* Local expenditure						0.00			
PROMOTION									
* Percentage	20.00	0.00	1.00			100.00			
* Foreign expenditure						0.00			
* Local expenditure						20.00			
TOTAL FOREIGN EXPENDITURE				30.00	45.00	130.00	5.00	0.00	0.00
TOTAL LOCAL EXPENDITURE				80.00	100.00	107.50	7.50	0.00	0.00

TABLE 10.4 - PHASING OF EXPENDITURE ON FIXED ASSESTS (Rumanian Mill)

All Values in $ '000s (Constant Prices)

ITEM	TOTAL	Foreign Component	Local Component	1989	1990	1991	1992	1993	1994
CIVIL WORKS	1300.00	0.55	0.45						
* Percentage				10.00	40.00	40.00	5.00	5.00	
* Foreign expenditure				71.50	286.00	286.00	35.75	35.75	
* Local expenditure				58.50	234.00	234.00	29.25	29.25	
HOUSING	1176.13	0.25	0.75						
* Percentage				0.00	10.00	45.00	40.00	5.00	
* Foreign expenditure				0.00	29.40	132.31	117.61	14.70	
* Local expenditure				0.00	88.21	396.94	352.84	44.10	
STRUCTURES	9420.10	0.55	0.45						
* Percentage				10.00	60.00	20.00	5.00	5.00	
* Foreign expenditure				518.11	3108.63	1036.21	259.05	259.05	
* Local expenditure				423.90	2543.43	847.81	211.95	211.95	
PLANT & EQUIPMENT	20000.00	1.00	0.00						
* Percentage				10.00	40.00	40.00	10.00		
* Foreign expenditure				2000.00	8000.00	8000.00	2000.00		
* Local expenditure				0.00	0.00	0.0.	0.00		
INSTALLATION & COMMISSIONING	10000.00	1.00	0.00						
* Percentage						0.00	35.00	60.00	5.00
* Foreign expenditure						0.00	3500.00	6000.00	500.00
* Local expenditure						0.00	0.00	0.00	0.00
Sub Total Foreign Expenditure				2589.61	11424.04	9454.53	5912.42	6309.50	500.00
Sub Total Local Expenditure				482.40	2865.64	1478.75	594.04	285.31	0.00
Foreign Cont. (Build's & Wks)				58.96	342.40	145.45	41.24	30.95	0.00
Local Cont. (Build's & Wks)				48.24	286.56	147.88	59.40	28.53	0.00
Foreign Cont. (Plant & Equip)				300.00	1200.00	1200.00	825.00	900.00	75.00
Local Cont. (Plant & Equip)				0.00	0.00	0.00	0.00	0.00	0.00
TOTAL FOREIGN EXPENDITURE				2948.57	12966.44	10799.98	677[illegible]	7240.45	575.00
TOTAL LOCAL EXPENDITURE				530.64	3152.20	1626.63	653.45	313.84	0.00
Contingencies (Build's & Wks)	0.10								
Contingencies (Plant & Equip)	0.15								

The phasing of expenditure on plant and equipment and installation and commissioning is based on our discussions with the Romanian delegation. Some 10% of the cost of plant and equipment is payable on order in 1989, and 10% on delivery in 1992. The balance is divided equally between 1990 and 1991.

Installation and commissioning charges are incurred in 1992, when the plant and equipment is delivered and erected, and in 1993 when commissioning takes place. A 5% retention is payable in 1994.

The civil works commences in 1990, preceded by a 10% advance in 1989. Payments follow the usual S shaped curve for civil contracts, with the bulk payable in 1990 and 1991, and only 5% due in 1992 on completion. A 5% retention is payable in 1993. Work on the housing complex begins in 1991, preceded by a 10% advance. The project is completed in 1992, by which time 95% will be paid. A 5% retention is due in 1993. These payment schedules are based on figures prepared by Arup (Zambia), which has considerable experience of such projects in Zambia.

10.2.2 Small mill

The phasing of expenditure on fixed assets is set out in Table 10.5 for the small mill with new plant and equipment and Table 10.6 for the small mill with second hand plant and equipment. Table 10.6 shows a lower figure for expenditure on plant and equipment, but all other figures are identical to Table 10.5. Values are expressed in constant mid 1988 prices. Expenditures total $12.0 million for the mill with new plant and equipment, and $10.0 million for the mill with second hand plant and equipment.

Investment costs are derived from Table 6.6. Import content figures are estimated in Section 6.4.

The payment schedules for plant and equipment and installation and commissioning are based on information provided by plant suppliers. The order for plant and equipment is placed in 1989, and a 10%

TABLE 10.5 - PHASING OF EXPENDITURE ON FIXED ASSESTS (Small Mill with new Plant & Equipment)

All Values in $ '000s (Constant Prices)

ITEM	TOTAL	Foreign Component	Local Component	1989	1990	1991	1992	1993	1994
CIVIL WORKS	250.00	0.55	0.45						
• Percentage				10.00	50.00	35.00	5.00	0.00	
• Foreign expenditure				13.75	68.75	48.13	6.88	0.00	
• Local expenditure				11.25	56.25	39.38	5.63	0.00	
HOUSING	653.00	0.25	0.75						
• Percentage				10.00	60.00	30.00			
• Foreign expenditure				16.33	97.95	48.98			
• Local expenditure				48.98	293.85	146.93			
STRUCTURES	1550.00	0.55	0.45						
• Percentage				10.00	35.00	50.00	5.00	0.00	
• Foreign expenditure				85.25	298.38	426.25	42.63	0.00	
• Local expenditure				69.75	244.13	348.75	34.88	0.00	
PLANT & EQUIPMENT	6380.00	1.00	0.00						
• Percentage				10.00	60.00	30.00			
• Foreign expenditure				638.00	3828.00	1914.00			
• Local expenditure				0.00	0.00	0.00			
INSTALLATION & COMMISSIONING	1700.00	1.00	0.00						
• Percentage						80.00	15.00	5.00	0.00
• Foreign expenditure						1360.00	255.00	85.00	0.00
• Local expenditure						0.00	0.00	0.00	0.00
Sub Total Foreign Expenditure				753.33	4293.08	3797.35	304.50	85.00	0.00
Sub Total Local Expenditure				129.98	594.23	535.05	40.50	0.00	0.00
Foreign Cont. (Build's & Wks)				11.53	46.51	52.34	4.95	0.00	0.00
Local Cont. (Build's & Wks)				13.00	59.42	53.51	4.05	0.00	0.00
Foreign Cont. (Plant & Equip)				95.70	574.20	491.10	38.25	12.75	0.00
Local Cont. (Plant & Equip)				0.00	0.00	0.00	0.00	0.00	0.00
TOTAL FOREIGN EXPENDITURE				860.56	4913.78	4340.79	347.70	97.75	0.00
TOTAL LOCAL EXPENDITURE				142.97	653.65	588.56	44.55	0.00	0.00
Contingencies (Build's & Wks)	0.10								
Contingencies (Plant & Equip)	0.15								

TABLE 10.6 - PHASING OF EXPENDITURE ON FIXED ASSESTS (Small Mill with Second Hand Plant & Equipment)

All Values in $ '000s (Constant Prices)

ITEM	TOTAL	Foreign Component	Local Component	1989	1990	1991	1992	1993	1994
CIVIL WORKS	250.00	0.55	0.45						
* Percentage				10.00	50.00	35.00	5.00	0.00	
* Foreign expenditure				13.75	68.75	48.13	6.88	0.00	
* Local expenditure				11.25	56.25	39.38	5.63	0.00	
HOUSING	653.00	0.25	0.75						
* Percentage				10.00	60.00	30.00			
* Foreign expenditure				16.33	97.95	48.98			
* Local expenditure				48.98	293.85	146.93			
STRUCTURES	1550.00	0.55	0.45						
* Percentage				10.00	35.00	50.00	5.00	0.00	
* Foreign expenditure				85.25	298.38	426.25	42.63	0.00	
* Local expenditure				69.75	244.13	348.75	34.88	0.00	
PLANT & EQUIPMENT	4680.00	1.00	0.00						
* Percentage				10.00	60.00	30.00			
* Foreign expenditure				468.00	2808.00	1404.00			
* Local expenditure				0.00	0.00	0.00			
INSTALLATION & COMMISSIONING	1700.00	1.00	0.00						
* Percentage						80.00	15.00	5.00	0.00
* Foreign expenditure						1360.00	255.00	85.00	0.00
* Local expenditure						0.00	0.00	0.00	0.00
Sub Total Foreign Expenditure				583.33	3273.08	3287.35	304.50	85.00	0.00
Sub Total Local Expenditure				129.98	594.23	535.05	40.50	0.00	0.00
Foreign Cont. (Build's & Wks)				11.53	46.51	52.34	4.95	0.00	0.00
Local Cont. (Build's & Wks)				13.00	59.42	53.51	4.05	0.00	0.00
Foreign Cont. (Plant & Equip)				70.20	421.20	414.60	38.25	12.75	0.00
Local Cont. (Plant & Equip)				0.00	0.00	0.00	0.00	0.00	0.00
TOTAL FOREIGN EXPENDITURE				665.06	3740.78	3754.29	347.70	97.75	0.00
TOTAL LOCAL EXPENDITURE				142.97	653.65	588.56	44.55	0.00	0.00
Contingencies (Build's & Wks)	0.10								
Contingencies (Plant & Equip)	0.15								

downpayment is required. The plant is delivered in 1991. It is estimated that 60% will be payable in 1990 and 30% in 1991. Installation and commissioning takes place in 1991 and 1992, the bulk of the payments falling due in 1991. A 5% retention has been scheduled for 1993, one year after commissioning.

Civil works and construction of the housing complex commences early in 1990. Advance payments of 10% fall due in 1989. Work finishes in late 1991 in the case of structures and works, and mid 1991 in the case of housing. Retentions of 5% fall due in 1992 in the case of structures and civil works. The schedule of payments shows that 60% is paid by 1990 in the case of works and 45% in the case of structures. This reflects the phasing of construction work on the factory site. These repayment schedules are based on information provided by Arup (Zambia).

10.3 Operating Costs

Tables 10.7, 10.8 and 10.9 show the estimated operating costs for the Romanian mill and the two small mill options.

As with the sales revenues (Tables 3.16 and 3.17), the operating costs are calculated for a project life of 15 years. The Romanian mill has an operating life from 1993 to 2007, while the small mill is scheduled to operate from 1992 to 2006.

The tables bring together the information on the costs of raw materials, auxiliary materials, spares and maintenance and utilities (Section 4), overheads (Table 7.1), and manpower (Tables 8.4 and 8.8).

The figures are expressed in constant mid 1988 prices, and broken down into foreign and local currency. A contingency of 5% is added to total operating costs.

TABLE 10.7 - OPERATING COSTS (Rwandan Mill)

All Values in $ '000s (Constant Prices)

Exch Rate 0.22	Foreign Component	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Production (tonnes)	(%)	3000.0	5500.0	8000.0	8900.0	9000.0	9050.0	9100.0	9150.0	9200.0	9250.0	9300.0	9350.0	9400.0	9450.0	9500.0
MATERIALS AND INPUTS																
Copper	0.0	6337.8	11619.3	18590.9	18802.1	19013.4	19119.0	19224.7	19330.3	19435.9	19541.6	19647.2	19752.8	19858.4	19964.1	20069.7
Zinc	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Phosphor Copper	100.0	26.4	48.3	77.3	78.2	79.1	79.5	80.0	80.4	80.8	81.3	81.7	82.2	82.6	83.0	83.5
Gases																
+ Methane or LPG	0.0	360.0	660.0	1056.0	1068.0	1080.0	1086.0	1092.0	1098.0	1104.0	1110.0	1116.0	1122.0	1128.0	1134.0	1140.0
+ N2/HC	0.0	783.0	1435.5	2296.0	2322.9	2349.0	2362.1	2375.1	2388.2	2401.2	2414.3	2427.3	2440.4	2453.4	2466.5	2479.5
Materials	90.0	105.0	192.5	300.0	311.5	315.0	316.8	318.5	320.3	322.0	323.8	325.5	327.3	329.0	330.8	332.5
Electricity																
+ fixed charge	0.0	110.6	110.6	110.6	110.6	110.6	110.6	110.6	110.6	110.6	110.6	110.6	110.6	110.6	110.6	110.6
+ per tonne	0.0	40.5	74.3	110.0	120.2	121.5	122.2	122.9	123.6	124.2	124.9	125.6	126.3	126.9	127.6	128.3
Water	0.0	6.6	12.0	19.3	19.5	19.7	19.8	19.9	20.0	20.1	20.3	20.4	20.5	20.6	20.7	20.8
SUB TOTAL		7777.0	14160.5	22585.7	22841.0	23096.3	23223.9	23351.6	23479.3	23606.9	23734.6	23862.2	23989.9	24117.5	24245.2	24372.8
DIRECT MANPOWER																
Local	0.0	383.4	383.4	383.4	383.4	383.4	383.4	383.4	383.4	383.4	383.4	383.4	383.4	383.4	383.4	383.4
Expatriate	33.3	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0	0.0	0.0	0.0	0.0	0.0
SUB TOTAL		558.4	558.4	558.4	558.4	558.4	558.4	558.4	558.4	558.4	558.4	383.4	383.4	383.4	383.4	383.4
MAINTENANCE & SPARES																
Plant & Equipment	100.0	0.0	0.0	1035.0	1035.0	1035.0	1035.0	1035.0	1035.0	1035.0	1035.0	1035.0	1035.0	1035.0	1035.0	1035.0
Buildings	55.0	176.9	176.9	176.9	176.9	176.9	176.9	176.9	176.9	176.9	176.9	176.9	176.9	176.9	176.9	176.9
SUB TOTAL		176.9	176.9	1211.9	1211.9	1211.9	1211.9	1211.9	1211.9	1211.9	1211.9	1211.9	1211.9	1211.9	1211.9	1211.9
ADMINISTRATIVE OVERHEAD COSTS																
Manpower																
+ Local	0.0	188.5	188.5	188.5	188.5	188.5	188.5	188.5	188.5	188.5	188.5	188.5	188.5	188.5	188.5	188.5
+ Expatriate	33.3	230.0	230.0	165.0	165.0	165.0	165.0	165.0	165.0	165.0	165.0	100.0	100.0	100.0	100.0	100.0
Rates	0.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Consumables	90.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Insurance at 1.4%	0.0	646.5	646.5	646.5	646.5	646.5	646.5	646.5	646.5	646.5	646.5	646.5	646.5	646.5	646.5	646.5
Communications, travel	0.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
SUB TOTAL		1190.0	1190.0	1125.0	1125.0	1125.0	1125.0	1125.0	1125.0	1125.0	1125.0	1060.0	1060.0	1060.0	1060.0	1060.0
SALES & DISTRIBUTION COSTS	0.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
CONTINGENCY(5% of sub totals)		405.7	795.4	1213.5	1226.2	1239.0	1245.4	1251.7	1258.1	1264.5	1270.9	1265.3	1271.7	1278.0	1284.4	1290.8
TOTAL OPERATING COSTS		10118.0	16891.3	26704.4	26972.5	27240.6	27374.6	27508.6	27642.7	27776.7	27910.8	27792.8	27926.8	28060.9	28194.9	28328.9
Foreign Currency		463.4	568.6	1766.3	1770.6	1774.8	1776.9	1779.1	1781.2	1783.3	1785.4	1704.2	1706.3	1708.4	1710.5	1712.7
Local Currency		9735.4	16322.6	24938.1	25201.9	25465.8	25597.7	25729.6	25861.5	25993.4	26125.3	26088.6	26220.5	26352.5	26484.4	26616.3

TABLE 10.0 - OPERATING COSTS (Small Mill with New Plant & Equipment)

All Values in $ '000s (Constant Prices)

Exch Rate 0.22	Foreign Component	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Production (tonnes)	(%)	225.0	525.0	675.0	1125.0	1150.0	1193.5	1229.3	1266.2	1304.2	1343.3	1383.6	1425.1	1467.9	1500.0	1500.0
MATERIALS AND INPUTS																
Copper	0.0	459.6	1072.5	1378.9	2298.2	2367.2	2438.2	2511.4	2586.7	2664.3	2744.2	2826.6	2911.3	2998.7	3064.3	3064.3
Zinc	0.0	8.8	20.4	26.3	43.8	45.1	46.4	47.8	49.3	50.7	52.3	53.8	55.4	57.1	58.4	58.4
Phosphor Copper	100.0	2.3	5.5	7.0	11.7	12.1	12.4	12.8	13.2	13.6	14.0	14.4	14.9	15.3	15.6	15.6
Gases																
* Methane or LPG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
* N2/H2	0.0	53.7	137.0	176.2	293.6	302.4	311.5	320.9	330.5	340.4	350.6	361.1	372.0	383.1	391.5	391.5
Materials	90.0	7.9	18.4	23.6	39.4	40.6	41.8	43.0	44.3	45.6	47.0	48.4	49.9	51.4	52.5	52.5
Electricity																
* fixed charge	0.0	41.7	41.7	41.7	41.7	41.7	41.7	41.7	41.7	41.7	41.7	41.7	41.7	41.7	41.7	41.7
* per tonne	0.0	4.2	9.8	12.6	21.0	21.6	22.2	22.9	23.6	24.3	25.0	25.8	26.6	27.4	28.0	28.0
Water	0.0	0.2	0.5	0.7	1.1	1.2	1.2	1.3	1.3	1.3	1.4	1.4	1.5	1.5	1.5	1.5
SUB TOTAL		583.5	1305.9	1667.0	2750.6	2831.9	2915.6	3001.8	3090.6	3182.0	3276.3	3373.3	3473.2	3576.2	3653.6	3653.6
DIRECT MANPOWER																
Local	0.0	105.3	105.3	105.3	210.6	210.6	210.6	210.6	210.6	210.6	210.6	210.6	210.6	210.6	210.6	210.6
Expatriate	33.3	200.0	200.0	200.0	200.0	80.0	80.0	80.0	80.0	80.0	0.0	0.0	0.0	0.0	0.0	0.0
SUB TOTAL		305.3	305.3	305.3	410.6	290.6	290.6	290.6	290.6	290.6	210.6	210.6	210.6	210.6	210.6	210.6
MAINTENANCE & SPARES																
Plant & Equipment	100.0	0.0	0.0	270.8	270.8	270.8	270.8	270.8	270.8	270.8	270.8	270.8	270.8	270.8	270.8	270.8
Buildings	55.0	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7
SUB TOTAL		29.7	29.7	300.5	300.5	300.5	300.5	300.5	300.5	300.5	300.5	300.5	300.5	300.5	300.5	300.5
ADMINISTRATIVE OVERHEAD COSTS																
Manpower																
* Local	0.0	89.8	89.8	89.8	113.8	113.8	113.8	113.8	113.8	113.8	113.8	113.8	113.8	113.8	113.8	113.8
* Expatriate	33.3	180.0	180.0	120.0	[illegible]	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0
Rates	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Consumables	90.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
Insurance at 1.4%	0.0	156.2	156.2	156.2	156.2	156.2	156.2	156.2	156.2	156.2	156.2	156.2	156.2	156.2	156.2	156.2
Communications, travel	0.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
SUB TOTAL		457.0	457.0	397.0	421.0	361.0	361.0	361.0	361.0	361.0	361.0	361.0	361.0	361.0	361.0	361.0
SALES & DISTRIBUTION COSTS	0.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
CONTINGENCY(5% of sub totals)		68.9	103.4	118.5	179.1	174.2	178.4	182.7	187.1	191.7	192.4	197.2	202.2	207.4	211.3	211.3
TOTAL OPERATING COSTS		1446.4	2203.3	2798.3	4071.8	3968.1	4056.0	4146.5	4239.8	4335.8	4350.7	4452.6	4557.6	4665.7	4746.9	4746.9
Foreign Currency		177.9	190.9	466.6	487.0	426.1	427.6	429.2	430.9	432.6	406.5	408.3	410.1	412.0	413.4	413.4
Local Currency		1268.5	2012.4	2331.7	3584.8	3542.1	3628.4	3717.3	3808.9	3903.3	3944.3	4044.4	4147.5	4253.7	4333.5	4333.5

TABLE 10.9 - OPERATING COSTS (Small Mill with Second Hand Plant & Equipment)

All Values in $ '000s (Constant Prices)

Exch Rate 0.22	Foreign Component	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Production (tonnes)	(%)	225.0	525.0	675.0	1125.0	1158.0	1193.5	1229.3	1266.2	1304.2	1343.3	1383.6	1425.1	1467.9	1500.0	1500.0
MATERIALS AND INPUTS																
Copper	0.0	459.6	1072.5	1378.9	2298.2	2367.2	2438.2	2511.4	2586.7	2664.3	2744.2	2826.6	2911.3	2998.7	3064.3	3064.3
Zinc	0.0	8.8	20.4	26.3	43.8	45.1	46.4	47.8	49.3	50.7	52.3	53.8	55.4	57.1	58.4	58.4
Phosphor Copper	100.0	2.3	5.5	7.0	11.7	12.1	12.4	12.8	13.2	13.6	14.0	14.4	14.9	15.3	15.6	15.6
Gases																
+ Methane or LPG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
+ N2/H2	0.0	58.7	137.0	176.2	293.6	302.4	311.5	320.9	330.5	340.4	350.6	361.1	372.0	383.1	391.5	391.5
Materials	90.0	7.9	18.4	23.6	39.4	40.6	41.8	43.0	44.3	45.6	47.0	48.4	49.9	51.4	52.5	52.5
Electricity																
+ fixed charge	0.0	41.7	41.7	41.7	41.7	41.7	41.7	41.7	41.7	41.7	41.7	41.7	41.7	41.7	41.7	41.7
+ per tonne	0.0	4.2	9.8	12.6	21.0	21.6	22.2	22.9	23.6	24.3	25.0	25.8	26.6	27.4	28.0	28.0
Water	0.0	0.2	0.5	0.7	1.1	1.2	1.2	1.3	1.3	1.3	1.4	1.4	1.5	1.5	1.5	1.5
SUB TOTAL		583.5	1305.9	1667.0	2750.6	2831.9	2915.6	3001.0	3090.6	3182.0	3276.3	3373.3	3473.2	3576.2	3653.6	3653.6
DIRECT MANPOWER																
Local	0.0	105.3	105.3	105.3	210.6	210.6	210.6	210.6	210.6	210.6	210.6	210.6	210.6	210.6	210.6	210.6
Expatriate	33.3	200.0	200.0	200.0	200.0	80.0	80.0	80.0	80.0	80.0	0.0	0.0	0.0	0.0	0.0	0.0
SUB TOTAL		305.3	305.3	305.3	410.6	290.6	290.6	290.6	290.6	290.6	210.6	210.6	210.6	210.6	210.6	210.6
MAINTENANCE & SPARES																
Plant & Equipment	100.0	0.0	0.0	220.1	220.1	220.1	220.1	220.1	220.1	220.1	220.1	220.1	220.1	220.1	220.1	220.1
Buildings	55.0	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7
SUB TOTAL		29.7	29.7	249.8	249.8	249.8	249.8	249.8	249.8	249.8	249.8	249.8	249.8	249.8	249.8	249.8
ADMINISTRATIVE OVERHEAD COSTS																
Manpower																
+ Local	0.0	89.8	89.8	89.8	113.8	113.8	113.8	113.8	113.8	113.8	113.8	113.8	113.8	113.8	113.8	113.8
+ Expatriate	33.3	180.0	180.0	120.0	120.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0
Rates	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Consumables	90.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
Insurance at 1.4%	0.0	128.9	128.9	128.9	128.9	128.9	128.9	128.9	128.9	128.9	128.9	128.9	128.9	128.9	128.9	128.9
Communications, travel	0.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
SUB TOTAL		429.7	429.7	369.7	393.7	333.7	333.7	333.7	333.7	333.7	333.7	333.7	333.7	333.7	333.7	333.7
SALES & DISTRIBUTION COSTS	0.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
CONTINGENCY(5% of sub totals)		67.5	102.0	117.1	177.7	172.8	177.0	181.3	185.7	190.3	191.0	195.9	200.9	206.0	209.9	209.9
TOTAL OPERATING COSTS		1417.7	2174.6	2710.9	3984.4	3880.0	3968.7	4059.2	4152.4	4248.5	4263.4	4365.3	4470.2	4578.3	4659.5	4659.5
Foreign Currency		177.9	190.9	405.7	426.0	365.0	366.6	368.2	369.8	371.5	345.4	347.2	349.0	350.9	352.3	352.3
Local Currency		1239.9	1983.7	2305.2	3558.4	3515.7	3602.1	3691.0	3782.6	3877.0	3918.0	4018.1	4121.2	4227.4	4307.2	4307.2

Tables 10.8 and 10.9 show differences only in the costs of spares and maintenance and insurance (and hence, contingencies). These stem from differences in the value of plant and equipment.

The breakdown between variable and fixed costs is shown in the break-even analysis (Section 10.10).

10.4 Working Capital

Working capital estimates are set out in Tables 10.10, 10.11 and 10.12 for the three options. The figures are presented in constant mid 1988 prices.

Net working capital is defined as accounts receivable plus prepayments, inventory and cash in hand, less accounts payable.

The assumptions regarding stocks are set out in Section 4. Work in progress for the Romanian mill is set at a relatively high 3 weeks because of the interrupted production process which necessitates an accumulation of stocks for the first 10 days of every month (see Section 6.2.1). Work in progress for the small mill is estimated at 1 week. Stocks of finished products are set at 2 weeks for both the small and Romanian mill.

The assumptions used for accounts receivable, prepayments, cash in hand and accounts payable are shown on the tables. These are consistent between the various options.

Net working capital and changes in working capital are broken down between local and foreign currency. These figures are created by multiplying the various working capital items by their respective "average foreign component". These components are calculated from Tables 10.7 to 10.9 (operating costs) and Tables 3.16 and 3.17 (sales revenues).

TABLE 10.10 - WORKING CAPITAL (Ruwanian Mill)

SUMMARY TABLE OF REVENUES AND OPERATING COSTS
All Values in $ '000s (Constant Prices)

	Average Foreign Component	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
PRODUCTION COSTS	0.06	10198.0	16091.3	26704.4	26972.5	27240.6	27374.6	27508.6	27642.7	27776.7	27910.8	27792.0	27926.0	28060.9	28194.9	28328.9
DIRECT COSTS	0.06	8938.0	15640.6	25573.8	25841.0	26109.9	26744.0	26378.0	26512.0	26646.1	26780.1	26730.4	26864.4	26998.5	27132.5	27266.5
SALES	0.92	11935.8	21047.5	34956.0	35416.5	35877.0	36107.2	36337.5	36567.7	36798.0	37028.2	37258.5	37488.7	37719.0	37949.2	38179.5
FOREIGN MATERIALS	1.00	308.2	408.9	1576.0	1580.0	1584.9	1586.9	1588.9	1590.9	1592.9	1594.9	1597.0	1599.0	1601.0	1603.0	1605.0
ELECTRICITY & WATER	0.00	165.6	204.9	256.7	258.2	259.8	260.6	261.4	262.2	262.9	263.7	264.5	265.3	266.1	266.9	267.7
LABOUR COSTS	0.11	976.9	976.9	911.9	911.9	911.9	911.9	911.9	911.9	911.9	911.9	671.9	671.9	671.9	671.9	671.9
DOMESTIC COSTS(ex elec,water,labour)	0.06	8748.1	15300.6	23959.0	24221.5	24484.0	24615.2	24746.5	24877.7	25008.9	25140.2	25259.4	25390.7	25521.9	25653 !	25784.4

WORKING CAPITAL

	Average Foreign Component	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
ACCOUNTS RECEIVABLE (Sales + 2 weeks)	0.92	459.1	840.3	1344.5	1362.2	1379.9	1388.7	1397.6	1406.5	1415.3	1424.2	1433.0	1441.9	1450.7	1459.6	1468.4
PREPAYMENTS (Foreign Materials + 1 week)	1.00	5.9	7.9	30.3	30.4	30.5	30.5	30.6	30.6	30.6	30.7	30.7	30.7	30.8	30.8	30.9
INVENTORY																
Copper (1 week)	0.00	121.9	223.4	357.5	361.6	365.6	367.7	369.7	371.7	373.8	375.8	377.8	379.9	381.9	383.9	386.0
Zinc	0.00	0.0														
Phosphor Copper (6 months)	1.00	13.2	24.2	38.7	39.1	39.5	39.8	40.0	40.2	40.4	40.6	40.9	41.1	41.3	41.5	41.7
Gases																
+ Methane or LPG (1 week)	0.00	6.9	12.7	20.3	20.5	20.8	20.9	21.0	21.1	21.2	21.3	21.5	21.6	21.7	21.8	21.9
+ N2/H2 (1 week)	0.00	15.1	27.6	44.2	44.7	45.2	45.4	45.7	45.9	46.2	46.4	46.7	46.9	47.2	47.4	47.7
Materials (3 months)	0.90	26.3	48.1	77.0	77.9	78.8	79.2	79.6	80.1	80.5	80.9	81.4	81.8	82.3	82.7	83.1
Plant & Equipment Spares(3 months)	1.00	0.0	0.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0
Buildings Spares(1 month)	0.55	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7
Consumables (3 months)	0.90	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
Work in Progress (3 weeks of direct costs)	0.06	515.7	902.3	1475.4	1490.9	1506.3	1514.1	1521.8	1529.5	1537.3	1545.0	1542.1	1549.9	1557.6	1565.3	1573.1
Finished Products (2 weeks of prod costs)	0.06	392.3	619.7	1027.1	1037.4	1047.7	1052.9	1058.0	1063.2	1068.3	1073.5	1069.0	1074.1	1079.3	1084.4	1089.6
SUB TOTAL (Inventory)		1131.0	1927.8	3338.7	3370.5	3402.4	3418.4	3434.3	3450.3	3466.2	3482.1	3477.8	3493.7	3509.7	3525.6	3541.6
CASH IN HAND (2% of prod costs)	0.06	204.0	337.0	534.1	539.5	544.8	547.5	550.2	552.9	555.5	558.2	555.9	558.5	561.2	563.9	566.6
ACCOUNTS PAYABLE																
Electricity & Water (1 month)	0.00	13.8	17.1	21.4	21.5	21.7	21.7	21.8	21.8	21.9	22.0	22.0	22.1	22.2	22.2	22.3
Labour Costs (2 weeks)	0.11	37.6	37.6	35.1	35.1	35.1	35.1	35.1	35.1	35.1	35.1	25.8	25.8	25.8	25.8	25.8
Other Costs (1 week)	0.06	168.2	294.2	460.8	465.8	470.8	473.4	475.9	478.4	480.9	483.5	485.8	488.3	490.8	493.3	495.9
NET WORKING CAPITAL		1580.4	2764.9	4730.3	4780.2	4830.0	4855.0	4879.9	4904.8	4929.7	4954.7	4963.7	4988.7	5013.6	5038.5	5063.4
+ foreign currency		550.7	974.8	1821.9	1841.1	1860.4	1870.0	1879.6	1889.2	1898.9	1908.5	1917.5	1927.1	1936.8	1946.4	1956.0
+ local currency		1029.7	1790.0	2908.4	2939.0	2969.7	2985.0	3000.3	3015.6	3030.9	3046.2	3046.2	3061.5	3076.8	3092.1	3107.5
CHANGES IN WORKING CAPITAL		1580.4	1184.5	1965.4	49.9	49.9	24.9	24.9	24.9	24.9	24.9	9.1	24.9	24.9	24.9	24.9
+ foreign currency		550.7	424.2	847.1	19.2	19.2	9.6	9.6	9.6	9.6	9.6	9.0	9.6	9.6	9.6	9.6
+ local currency		1029.7	760.4	1118.4	30.6	30.6	15.3	15.3	15.3	15.3	15.3	0.0	15.3	15.3	15.3	15.3

TABLE 10.11 - WORKING CAPITAL (Small Mill with New Plant & Equipment)

SUMMARY TABLE OF REVENUES AND OPERATING COSTS
All Values in $ '000s (Constant Prices)

	Average Foreign Component	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
PRODUCTION COSTS	0.10	1446.4	2203.3	2798.3	4071.0	3960.1	4056.0	4146.5	4239.0	4335.0	4350.7	4452.6	4557.6	4665.7	4746.9	4746.9
DIRECT COSTS	0.10	964.4	1722.9	2394.9	3643.2	3602.5	3690.4	3780.9	3874.2	3970.2	3985.1	4087.0	4192.0	4300.0	4381.3	4381.3
SALES	0.47	1063.6	2401.8	3190.9	5310.2	5477.7	5642.0	5811.3	5985.6	6165.2	6350.2	6540.7	6736.9	6939.0	7090.9	7090.9
FOREIGN MATERIALS	1.00	43.0	56.3	341.4	360.3	361.7	363.2	364.7	366.2	367.8	369.5	371.1	372.9	374.7	376.0	376.0
ELECTRICITY & WATER	0.00	46.2	52.0	55.0	63.8	64.5	65.2	65.9	66.6	67.4	68.1	68.9	69.7	70.6	71.2	71.2
LABOUR COSTS	0.12	575.1	575.1	515.1	644.4	464.4	464.4	464.4	464.4	464.4	384.4	384.4	384.4	384.4	384.4	384.4
DOMESTIC COSTS(ex elec,water,labour)	0.10	781.4	1519.8	1886.8	3003.3	3077.5	3163.3	3251.6	3342.5	3436.2	3520.0	3628.2	3730.5	3836.0	3915.3	3915.3
WORKING CAPITAL																
ACCOUNTS RECEIVABLE (Sales * 2 weeks)	0.47	40.9	95.5	122.7	204.5	210.7	217.0	223.5	230.2	237.1	244.2	251.6	259.1	266.9	272.7	272.7
PREPAYMENTS (Foreign Materials * 1 week)	1.00	0.8	1.1	6.6	6.9	7.0	7.0	7.0	7.0	7.1	7.1	7.1	7.2	7.2	7.2	7.2
INVENTORY																
Copper (1 week)	0.00	8.0	20.6	26.5	44.2	45.5	46.9	48.3	49.7	51.2	52.8	54.4	56.0	57.7	58.9	58.9
Zinc (1 month)	0.00	0.7	1.7	2.2	3.6	3.8	3.9	4.0	4.1	4.2	4.4	4.5	4.6	4.8	4.9	4.9
Phosphor Copper (6 months)	1.00	1.2	2.7	3.5	5.9	6.0	6.2	6.4	6.6	6.8	7.0	7.2	7.4	7.7	7.8	7.8
Gases																
* Methane or LPG	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
* N2/H2 (1 week)	0.00	1.1	2.6	3.4	5.6	5.8	6.0	6.2	6.4	6.5	6.7	6.9	7.2	7.4	7.5	7.5
Materials (3 months)	0.90	2.0	4.6	5.9	9.8	10.1	10.4	10.8	11.1	11.4	11.8	12.1	12.5	12.8	13.1	13.1
Plant & Equipment Spares (3 months)	1.00	0.0	0.0	69.7	69.7	69.7	69.7	69.7	69.7	69.7	69.7	69.7	69.7	69.7	69.7	69.7
Buildings Spares (3 months)	0.55	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4
Consumables (3 months)	0.90	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Work in Progress (1 week of direct costs)	0.10	18.5	33.1	46.1	70.1	69.3	71.0	72.7	74.5	76.4	76.6	78.6	80.6	82.7	84.3	84.3
Finished Products (2 weeks of prod costs)	0.10	55.6	84.7	107.6	156.6	152.6	156.0	159.5	163.1	166.8	167.3	171.3	175.3	179.4	182.6	182.6
SUB TOTAL (Inventory)		100.4	162.6	277.3	378.0	375.3	382.5	389.9	397.6	405.5	408.7	417.1	425.7	434.6	441.2	441.2
CASH IN HAND (2% of prod costs)	0.10	28.9	44.1	56.0	81.4	79.4	81.1	82.9	84.8	86.7	87.0	89.1	91.2	93.3	94.9	94.9
ACCOUNTS PAYABLE																
Electricity & Water (1 month)	0.00	3.8	4.3	4.6	5.3	5.4	5.4	5.5	5.6	5.6	5.7	5.7	5.8	5.9	5.9	5.9
Labour Costs (2 weeks)	0.12	22.1	22.1	19.8	24.8	17.9	17.9	17.9	17.9	17.9	14.8	14.8	14.8	14.8	14.8	14.8
Other Costs (1 week)	0.10	15.0	29.2	36.3	57.8	59.2	60.8	62.5	64.3	66.1	67.9	69.8	71.7	73.8	75.3	75.3
NET WORKING CAPITAL		130.1	247.5	401.9	583.0	589.9	603.5	617.5	631.9	646.8	658.8	674.5	690.8	707.5	720.1	720.1
* foreign component		37.7	71.8	166.1	217.6	220.9	224.9	228.9	233.1	237.5	241.6	246.2	250.9	255.8	259.4	259.4
* local component		92.4	175.7	235.9	365.4	369.0	378.6	388.6	398.8	409.4	417.1	428.3	439.9	451.8	460.7	460.7
CHANGES IN WORKING CAPITAL		130.1	117.4	154.4	181.1	6.8	13.6	14.0	14.4	14.9	11.9	15.8	16.3	16.7	12.6	0.0
* foreign component		37.7	34.1	94.2	51.6	3.3	4.0	4.1	4.2	4.3	4.2	4.6	4.7	4.9	3.7	0.0
* local component		92.4	83.3	60.2	129.6	3.5	9.7	9.9	10.2	10.6	7.8	11.2	11.5	11.9	8.9	0.0

TABLE 10.12 - WORKING CAPITAL (Small Mill with Second Hand Plant & Equipment)

SUMMARY TABLE OF REVENUES AND OPERATING COSTS
All Values in $ ' 000s (Constant Prices)

	Average Foreign Component	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
PRODUCTION COSTS	0.09	1417.7	2174.6	2710.9	3984.4	3880.0	3960.7	4059.2	4152.4	4240.5	4263.4	4345.3	4470.2	4578.3	4659.5	4659.5
DIRECT COSTS	0.09	964.4	1722.9	2333.3	3581.5	3540.9	3620.0	3719.3	3812.5	3900.6	3923.5	4025.4	4130.3	4238.4	4319.6	4319.6
SALES	0.47	1063.6	2401.0	3190.9	5310.2	5477.7	5642.0	5811.3	5985.6	6165.2	6350.2	6540.7	6736.9	6939.0	7090.9	7090.9
FOREIGN MATERIALS	1.00	43.0	56.3	202.7	301.6	303.0	304.5	306.0	307.5	309.1	310.8	312.4	314.2	316.0	317.3	317.3
ELECTRICITY & WATER	0.00	46.2	52.0	55.0	63.0	64.5	65.2	65.9	66.6	67.4	68.1	68.9	69.7	70.6	71.2	71.2
LABOUR COSTS	0.12	575.1	575.1	515.1	644.4	464.4	464.4	464.4	464.4	464.4	384.4	384.4	384.4	384.4	384.4	384.4
DOMESTIC COSTS (ex elec,water,labour)	0.09	752.7	1491.1	1850.1	2974.6	3040.0	3134.6	3222.9	3313.9	3407.6	3500.1	3599.5	3701.9	3807.3	3886.6	3886.6

WORKING CAPITAL

	Average Foreign Component	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
ACCOUNTS RECEIVABLE (Sales + 2 weeks)	0.47	40.9	95.5	122.7	204.5	210.7	217.0	223.5	230.2	237.1	244.2	251.6	259.1	266.9	272.7	272.7
PREPAYMENTS (Foreign Materials + 1 week)	1.00	0.8	1.1	5.4	5.8	5.8	5.9	5.9	5.9	5.9	6.0	6.0	6.0	6.1	6.1	6.1
INVENTORY																
Copper (1 week)	0.00	8.8	20.6	26.5	44.2	45.5	46.9	48.3	49.7	51.2	52.8	54.4	56.0	57.7	58.9	58.9
Zinc (1 month)	0.00	0.7	1.7	2.2	3.6	3.8	3.9	4.0	4.1	4.2	4.4	4.5	4.6	4.8	4.9	4.9
Phosphor Copper (6 months)	1.00	1.2	2.7	3.5	5.9	6.0	6.2	6.4	6.6	6.8	7.0	7.2	7.4	7.7	7.8	7.8
Gases																
+ Methane or LPG	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
+ N2/H2 (1 week)	0.00	1.1	2.6	3.4	5.6	5.8	6.0	6.2	6.4	6.5	6.7	6.9	7.2	7.4	7.5	7.5
Materials (3 months)	0.90	2.0	4.6	5.9	9.8	10.1	10.4	10.8	11.1	11.4	11.8	12.1	12.5	12.8	13.1	13.1
Plant & Equipment Spares (3 months)	1.00	0.0	0.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0	55.6	55.0
Buildings Spares (3 months)	0.55	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4
Consumables (3 months)	0.90	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Work in Progress (1 week of direct costs)	0.09	18.5	33.1	44.9	68.9	68.1	69.8	71.5	73.3	75.2	75.5	77.4	79.4	81.5	83.1	83.1
Finished Products (2 weeks of prod costs)	0.09	54.5	83.6	104.3	153.2	149.3	152.6	156.1	159.7	163.4	164.0	167.9	171.9	176.1	179.2	179.2
SUB TOTAL (Inventory)		99.3	161.5	258.1	358.8	356.1	363.3	370.7	378.4	386.2	389.5	397.9	406.5	415.3	422.0	422.0
CASH IN HAND (2% of prod costs)	0.09	28.4	43.5	54.2	79.7	77.6	79.4	81.2	83.0	85.0	85.3	87.3	89.4	91.6	93.2	93.2
ACCOUNTS PAYABLE																
Electricity & Water (1 month)	0.00	3.8	4.3	4.6	5.3	5.4	5.4	5.5	5.6	5.6	5.7	5.7	5.8	5.9	5.9	5.9
Labour Costs (2 weeks)	0.12	22.1	22.1	19.8	24.8	17.9	17.9	17.9	17.9	17.9	14.8	14.8	14.8	14.8	14.8	14.8
Other Costs (1 week)	0.09	14.5	28.7	35.7	57.2	58.6	60.3	62.0	63.7	65.5	67.3	69.2	71.2	73.2	74.7	74.7
NET WORKING CAPITAL		129.0	246.4	380.4	561.5	568.3	581.9	596.0	610.4	625.3	637.2	653.0	669.2	686.0	698.6	698.6
+ foreign component		36.6	70.2	147.7	198.4	201.8	205.7	209.7	213.8	218.1	222.2	226.7	231.4	236.2	239.8	239.8
+ local component		92.4	176.2	232.7	363.1	366.6	376.3	386.3	396.6	407.2	415.0	426.3	437.9	449.8	458.8	458.8
CHANGES IN WORKING CAPITAL		129.0	117.4	134.0	181.1	6.8	13.6	14.0	14.4	14.9	11.9	15.8	16.3	16.7	12.6	0.0
+ foreign component		36.6	33.6	77.5	50.7	3.4	3.9	4.0	4.1	4.3	4.2	4.5	4.6	4.8	3.6	0.0
+ local component		92.4	83.8	56.4	130.5	3.4	9.7	10.0	10.3	10.6	7.8	11.3	11.6	12.0	9.0	0.0

10.5 Cash Flows before Financing

Cash flows before financing in constant mid 1988 prices are presented in Tables 10.13 to 10.15 for the three options. For the sake of convenience, the tables show figures from 1988 (commencement of payments), through 1992 (commencement of production for the small mill) and 1993 (commencement of production for the Romanian mill) to 2003. This represents 11 years of production in the case of the Romanian mill, and 12 years in the case of the small mill.

The cash flows bring together the information on:

* the phasing of expenditure on pre-production costs (Tables 10.1 to 10.3)

* the phasing of expenditure on fixed assets (Tables 10.4 to 10.6)

* operating costs (Tables 10.7 to 10.9)

* increases in working capital (from Tables 10.10 to 10.12).

Prices are assumed to be mid year.

The residual value of fixed assets is set at 10% of the original expenditure, and appears in Year 16.

The realisation of cumulative working capital is also allocated to Year 16.

The expenditures have been divided into foreign and local currency, but the cash flows are expressed in US Dollars.

TABLE 10.13 - CASH FLOWS BEFORE FINANCING (Romanian Mill)

Exchange Rate (K/$) 0.22

All Values in $ '000s (Constant Prices)

ITEM	CASH FLOWS IN CONSTANT MID 1988 PRICES ($ '000)														
Expenditure in Foreign Currency ($)	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Fixed Assets	2948.57	12966.44	10799.98	6778.66	7240.45	575.00									
Pre-production & Special Expenses	42.00	56.00	28.00	164.00											
Increase in Working Capital				0.00	550.66	424.16	847.07	19.24	19.24	9.62	9.62	9.62	9.62	9.62	9.05
Operating Costs				0.00	463.39	568.62	1766.32	1770.57	1774.81	1776.94	1779.06	1781.18	1783.31	1785.43	1706.17
Total Cash Out	2990.57	13022.44	10827.98	6942.66	8254.51	1567.78	2613.39	1789.80	1794.05	1786.56	1788.68	1790.80	1792.93	1795.05	1715.21
Revenue in Foreign Currency				0.00	11197.97	20617.78	32988.45	33203.00	33417.56	33524.84	33632.11	33739.39	33846.67	33953.95	34063.23
Net Foreign Cash Flow	-2990.57	-13022.44	-10827.98	-6942.66	2943.46	19049.99	30375.06	31413.20	31623.51	31738.28	31843.43	31948.59	32053.74	32158.90	32348.01

ITEM	CASH FLOWS IN CONSTANT MID 1988 PRICES ($ '000)														
Expenditure in Local Currency ($)	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Fixed Assets	530.64	3152.20	1626.63	653.45	313.04										
Pre-production & Special Expenses	119.00	100.00	86.00	125.00	0.00										
Increase in Working Capital				0.00	1029.69	760.35	1110.37	30.62	30.62	15.31	15.31	15.31	15.31	15.31	0.01
Operating Costs				0.00	9735.36	16322.63	24938.11	25201.94	25465.76	25597.68	25729.59	25861.50	25993.42	26125.33	26088.63
Total Cash Out	649.64	3252.20	1712.63	778.45	11078.09	17082.98	26048.48	25232.56	25496.38	25612.99	25744.90	25876.81	26008.73	26140.64	26088.64
Revenue in Local Currency				0.00	737.03	1229.72	1967.55	2213.49	2459.44	2582.41	2705.38	2828.35	2951.32	3074.29	3197.27
Net Local Cash Flow	-649.64	-3252.20	-1712.63	-778.45	-10341.06	-15853.27	-24080.93	-23019.07	-23036.95	-23030.58	-23039.52	-23048.46	-23057.40	-23066.35	-22891.37
TOTAL NET CASH FLOW ($)	-3640.21	-16274.64	-12540.61	-7721.10	-7397.61	3196.73	6286.12	8394.13	8586.56	8707.70	8803.91	8900.13	8996.34	9092.55	9456.64

Internal Rate of Return on Total Net Cash Flow = 10.612 %

Net Present Value @ 8 % = 9458.75

Net Present Value @ 10 % = 1080.18

Net Present Value @ 12 % = -3653.26

TABLE 10.14 - CASH FLOWS BEFORE FINANCING (Small Mill with new Plant & Equipment)

Exchange Rate (K/$) 0.22

All Values In $ '000s (Constant Prices)

ITEM	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	CASH FLOWS IN CONSTANT MID 1988 PRICES ($ '000)														
Expenditure in Foreign Currency ($)															
Fixed Assets	840.56	4913.78	4340.79	347.70	97.75	0.00									
Pre-production & Special Expenses	30.00	45.00	130.00	5.00	0.00										
Increase in Working Capital				37.74	34.09	94.23	51.57	3.30	3.95	4.07	4.19	4.32	4.16	4.50	4.72
Operating Costs				177.85	190.91	466.59	487.02	426.07	427.63	429.23	430.88	432.57	406.47	408.27	410.11
Total Cash Out	890.56	4958.78	4470.79	568.29	322.75	560.82	538.59	429.38	431.58	433.30	435.07	436.89	410.63	412.85	414.33
Revenue in Foreign Currency				495.68	1156.58	1487.03	2478.38	2552.73	2629.31	2708.19	2789.44	2873.12	2959.32	3048.10	3139.54
Net Foreign Cash Flow	-890.56	-4958.78	-4470.79	-72.61	833.83	926.21	1939.79	2123.35	2197.73	2274.90	2354.37	2436.23	2548.69	2635.25	2724.71
	CASH FLOWS IN CONSTANT MID 1988 PRICES ($ '000)														
Expenditure in Local Currency ($)	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Fixed Assets	142.97	653.65	588.56	44.55	0.00										
Pre-production & Special Expenses	80.00	100.00	107.50	7.50	0.00										
Increase in Working Capital				92.39	83.29	60.17	129.57	3.53	9.66	9.95	10.25	10.55	7.79	11.20	11.53
Operating Costs				1268.52	2012.37	2331.73	3584.78	3542.06	3628.39	3717.32	3808.91	3903.26	3944.28	4044.37	4147.47
Total Cash Out	222.97	753.65	696.06	1412.97	2095.66	2391.90	3714.35	3545.59	3638.05	3727.27	3819.16	3913.81	3952.07	4055.57	4159.00
Revenue in Local Currency				567.96	1325.24	1703.87	2839.79	2924.98	3012.73	3103.12	3196.21	3292.10	3390.86	3492.58	3597.16
Net Local Cash Flow	-222.97	-753.65	-696.06	-845.01	-770.42	-688.02	-874.56	-620.61	-625.32	-624.15	-622.95	-621.72	-561.21	-562.98	-561.84
TOTAL NET CASH FLOW ($)	-1113.53	-5712.43	-5166.84	-917.62	63.41	238.19	1065.23	1502.75	1572.42	1650.74	1731.42	1814.52	1987.48	2072.27	2163.07

Internal Rate of Return on Total Net Cash Flow	=	6.267 %
Net Present Value @ 8 %	=	-1625.30
Net Present Value @ 10 %	=	-3005.23
Net Present Value @ 12 %	=	-3991.52

TABLE 10.15 - CASH FLOWS BEFORE FINANCING (Small Mill with Second Hand Plant & Equipment)

Exchange Rate 8.22

All Values in . . .os (Constant Prices)

Item	CASH FLOWS IN CONSTANT MID 1988 PRICES ($ '000)														
Expenditure in Foreign Currency ($)	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Fixed Assets	665.06	3740.78	3754.29	347.70	97.75	0.00									
Pre-production & Special Expenses	30.00	45.00	130.00	5.00	0.00										
Increase in Working Capital				36.60	33.57	77.54	50.67	3.40	3.89	4.01	4.13	4.25	4.16	4.51	4.65
Operating Costs				177.85	190.90	405.74	426.00	365.02	366.57	368.16	369.80	371.48	345.37	347.16	349.00
Total Cash Out	695.06	3785.78	3884.29	567.16	322.22	483.27	476.66	368.	370.46	372.17	373.92	375.74	349.53	351.67	353.64
Revenue in Foreign Currency				495.68	1156.56	1487.03	2478.38	2552.73	2629.31	2708.19	2789.44	2873.12	2959.32	3048.10	3139.54
Net Foreign Cash Flow	-695.06	-3765.78	-3884.29	-71.48	834.35	003.76	2001.72	2184.31	2258.86	2336.03	2415.51	2497.39	2609.78	2696.43	2785.90

ITEM	CASH FLOWS IN CONSTANT MID 1988 PRICES ($ '000)														
Expenditure in Local Currency ($)	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Fixed Assets	142.97	653.65	588.56	44.55	0.00										
Pre-production & Special Expenses	80.00	100.00	107.50	7.50	0.00										
Increase in Working Capital				92.40	83.01	56.44	130.47	3.44	9.72	10.01	10.31	10.62	7.78	11.27	11.60
Operating Costs				1239.86	1983.70	2305.21	3558.44	3515.75	3602.09	3691.03	3782.63	3876.98	3918.02	4018.12	4121.22
Total Cash Out	222.97	753.65	696.06	1384.31	2067.52	2361.65	3688.91	3519.18	3611.81	3701.04	3792.94	3887.60	3925.80	4029.38	4132.83
Revenue in Local Currency				567.96	1325.24	1703.87	2839.79	2924.98	3012.73	3103.12	3196.21	3292.10	3390.86	3492.58	3597.36
Net Local Cash Flow	-222.97	-753.65	-696.06	-816.35	-742.28	-657.78	-849.12	-594.20	-599.08	-597.92	-596.73	-595.50	-534.94	-536.80	-535.46
TOTAL NET CASH FLOW ($)	-918.03	-4539.43	-4580.34	-887.83	92.07	345.98	1152.60	1590.11	1659.78	1738.11	1818.79	1901.88	2074.85	2159.63	2250.45

Internal Rate of Return on Total Net Cash Flow	=	8.393 %
Net Present Value @ 8 %	=	500.89
Net Present Value @ 10 %	=	-1017.92
Net Present Value @ 12 %	=	-2125.62

The results in real terms of the base case scenarios are as follows:

	Internal Rate of Return (%)	NPV at 12% (millions $)
Romanian Mill	10.61	-3.65
Small Mill with New Plant & Equipment	6.27	-3.99
Small Mill with Second Hand Plant & Equipment	8.59	-2.13

All project options generate IRR's lower than 12%, the cut off point specified by Indeco.

However, it should be noted that the Romanian mill does generate significant foreign exchange earnings, which, in itself, makes the project quite attractive. These revenues total $471.5 million (in real terms) over the project life, but they depend on the assumption that 80% of the mill's capacity will be sold to Romania, and that the surplus (of copper over the volume needed to pay off the loan for plant and equipment) will be purchased in hard currency.

10.6 Inflated Cash Flows and Depreciation

Inflated cash flows before financing are presented in Tables 10.16 to 10.18.

Foreign inflation is assumed to be 5% pa, and Zambian inflation 20% pa. It is further assumed that the exchange rate adjusts continually to compensate for the difference in inflation rates. Thus, since all costs and revenues are expressed in US $, constant price cash flows can be converted to current price cash flows by inflating costs and revenues by 5% pa.

TABLE 10.16 - INFLATED CASH FLOWS BEFORE FINANCING (Romanian Mill)

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Foreign inflation		5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%
Zambian inflation		20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%
Exchange Rate	8.22	9.39	10.74	12.27	14.02	16.03	18.32	20.93	23.92	27.34	31.25	35.71	40.81	46.64	53.30	60.92
Foreign Inflation factor	1.00	1.05	1.10	1.16	1.22	1.28	1.34	1.41	1.48	1.55	1.63	1.71	1.80	1.89	1.98	2.08
Local Inflation factor	1.00	1.20	1.44	1.73	2.07	2.49	2.99	3.58	4.30	5.16	6.19	7.43	8.92	10.70	12.84	15.41

All Values in $ '000s (Current Prices)

ITEM :	CASH FLOWS with Inflation				($ '000)										
Expenditure in Foreign Currency :	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Fixed Assets :	3095.99	14295.50	12502.32	8239.50	9240.84	770.55									
Pre-production & Special Expenses :	44.10	61.74	32.41	199.34	6.00	0.00									
Increase in Working Capital :					702.80	603.56	1257.24	156.60	165.05	159.97	168.75	178.01	187.78	198.07	207.74
Operating Costs :					591.42	762.01	2485.39	2615.93	2753.12	2894.44	3042.80	3198.75	3362.69	3535.03	3542.84
Total Cash Out :	3140.09	14357.24	12534.74	8438.84	10535.08	2136.12	3742.62	2772.53	2919.17	3054.41	3211.55	3376.76	3550.47	3733.10	3750.58
Revenue in Foreign Currency :					14291.76	27629.80	46418.06	49055.96	51841.69	54608.43	57522.33	60591.10	63822.94	67226.49	70810.84
Net Foreign Cash Flow :	-3140.09	-14357.24	-12534.74	-8438.84	3756.68	25493.67	42675.44	46283.42	48922.43	51554.01	54310.78	57214.34	60272.47	63493.39	67060.26

ITEM :	CASH FLOWS with Inflation				($ '000)										
Expenditure in Local Currency :	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Fixed Assets :	557.2	3475.3	1883.0	794.3	400.5										
Pre-production & Special Expenses :	125.0	110.3	99.6	151.9	0.0										
Increase in Working Capital :					1314.2	1084.7	1693.6	249.9	264.6	255.3	269.3	284.1	299.6	316.1	301.0
Operating Costs :					12425.1	21873.9	35090.4	37234.7	39505.8	41695.9	44006.3	46443.5	49014.5	51726.4	54236.4
Total Cash Out :	682.1	3585.6	1982.6	946.2	14139.8	22958.5	36784.0	37484.6	39770.4	41951.2	44275.6	46727.6	49314.1	52042.4	54538.0
Revenue in Local Currency :					941.7	1647.9	2768.5	3270.3	3815.4	4206.5	4627.1	5079.3	5565.2	6086.9	6646.9
Net Local Cash Flow :	-682.1	-3585.6	-1982.6	-946.2	-13198.1	-21310.6	-34015.5	-34214.3	-35955.0	-37744.7	-39648.5	-41648.3	-43749.0	-45955.5	-47891.1
TOTAL NET CASH FLOW ($) :	-3822.22	-17942.79	-14517.32	-9385.05	-9441.43	4163.07	8659.95	12069.16	12967.45	13809.78	14662.27	15566.04	16523.52	17537.85	19169.18
Loan Drawdown	3140.09	14357.24	12534.74	8438.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Repayments	0.00	0.00	0.00	0.00	0.00	0.00	9313.29	9313.29	9313.29	9313.29	9313.29	3728.36	3728.36	3728.36	0.00
Interests	0.00	0.00	0.00	0.00	6276.58	7342.35	6662.34	6564.38	6063.09	5400.85	4565.64	4649.71	3973.76	3147.69	2441.31
Cash Flow with Financing	-682.13	-3585.55	-1982.58	-946.21	-15718.01	-3179.28	-7315.69	-3808.52	-2408.94	-904.86	783.34	7187.97	8821.41	10661.80	16727.87

Internal Rate of Return on Total Net Cash Flow with Financing = 12.87%
Internal Rate of Return in Real Terms = 7.50%

TABLE 10.17 - INFLATED CASH FLOWS BEFORE FINANCING (Small Mill with New Plant & Equipment)

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Foreign inflation		5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%
Zambian inflation		20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%
Exchange Rate	8.22	9.39	10.74	12.27	14.02	16.03	18.32	20.93	23.92	27.34	31.25	35.71	40.81	46.64	53.30	60.92
Foreign Inflation factor	1.00	1.05	1.10	1.16	1.22	1.28	1.34	1.41	1.48	1.55	1.63	1.71	1.80	1.89	1.98	2.08
Local Inflation factor	1.00	1.20	1.44	1.73	2.07	2.49	2.99	3.58	4.30	5.16	6.19	7.43	8.92	10.70	12.84	15.41

All Values in $ '000s (Current Prices)

ITEM :	CASH FLOWS with Inflation ($ '000)														
Expenditure in Foreign Currency :	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Fixed Assets :	903.59	5417.45	5025.00	422.63	124.76	0.00									
Pre-production & Special Expenses :	31.50	49.61	150.49	6.08	0.00	0.00									
Increase in Working Capital :				45.87	15.80	130.86	83.69	20.19	22.45	24.07	25.82	27.69	29.16	31.85	34.18
Operating Costs :				216.18	273.65	625.27	685.29	629.51	663.39	699.17	736.94	776.83	766.46	808.34	852.59
Total Cash Out :	935.09	5467.06	5175.49	690.76	414.21	756.13	768.98	649.70	685.84	723.24	762.76	804.53	795.62	840.19	886.78
Revenue in Foreign Currency :				602.50	1476.12	1992.76	3487.33	3771.55	4078.93	4411.36	4770.89	5159.72	5580.23	6035.02	6526.88
Net Foreign Cash Flow :	-935.09	-5467.06	-5175.49	-88.26	1061.91	1236.63	2718.35	3121.85	3393.09	3688.12	4008.13	4355.19	4784.61	5194.84	5640.10

ITEM :	CASH FLOWS with Inflation ($ '000)														
Expenditure in Local Currency :	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Fixed Assets :	150.1	720.6	681.3	54.2	0.0										
Pre-production & Special Expenses :	84.0	110.3	124.4	9.1	0.0										
Increase in Working Capital :				112.3	111.9	91.8	198.1	30.9	42.2	45.6	49.2	53.1	51.4	61.5	66.4
Operating Costs :				1541.9	2568.3	3124.7	5044.1	5233.2	5628.8	6055.1	6514.5	7009.7	7437.5	8007.6	8622.3
Total Cash Out :	234.1	830.9	805.8	1717.5	2680.3	3216.6	5242.3	5264.2	5671.1	6100.7	6563.7	7062.7	7489.0	8069.1	8688.7
Revenue in Local Currency :				690.4	1691.4	2283.4	3995.9	4321.5	4673.7	5054.6	5466.6	5912.1	6394.0	6915.1	7478.7
Net Local Cash Flow :	-234.1	-830.9	-805.8	-1027.1	-988.9	-933.2	-1246.4	-942.6	-997.3	-1046.0	-1097.1	-1150.6	-1095.0	-1154.0	-1210.0
TOTAL NET CASH FLOW ($) :	-1169.21	-6297.95	-5981.26	-1115.37	73.02	303.41	1471.96	2179.22	2395.76	2642.08	2911.02	3204.57	3689.61	4040.84	4430.09
Loan Drawdown	935	5467	5175	88	0	0	0	0	0	0	0	0	0	0	0
Repayments	0	0	0	0	0	0	3622	3622	3622	3622	3622	0	0	0	0
Interest	0	0	0	2717	2717	3021	2803	2905	2938	2949	2913	3428	3467	3455	3401
Cash Flow with Financing	-234.12	-830.90	-805.77	-3743.63	-2643.50	-2717.11	-4953.08	-4347.93	-4163.91	-3928.95	-3644.33	-223.67	222.31	585.77	1029.46

Internal Rate of Return on Total Net Cash Flow with Financing = -16.81%
Internal Rate of Return in Real Terms = -20.77%

TABLE 10.18 - INFLATED CASH FLOWS BEFORE FINANCING (Small Mill with Second Hand Plant & Equipment)

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Foreign inflation		5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%
Zambian inflation		20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%
Exchange Rate	8.22	9.39	10.74	12.27	14.02	16.03	18.32	20.93	23.92	27.34	31.25	35.71	40.81	46.64	53.30	60.92
Foreign Inflation factor	1.00	1.05	1.10	1.16	1.22	1.28	1.34	1.41	1.48	1.55	1.63	1.71	1.80	1.89	1.98	2.08
Local Inflation factor	1.00	1.20	1.44	1.73	2.07	2.49	2.99	3.58	4.30	5.16	6.19	7.43	8.92	10.70	12.84	15.41

All Values in $ '000s (Current Prices)

ITEM : CASH FLOWS with Inflation ($ '000)															
Expenditure in Foreign Currency	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Fixed Assets	698.31	4124.21	4346.05	422.63	124.76	0.00									
Pre-production & Special Expenses	31.50	49.61	150.49	6.00	0.00	0.00									
Increase in Working Capital				44.49	45.07	100.30	81.19	18.98	20.94	22.40	24.14	25.92	27.43	29.00	32.10
Operating Costs				216.18	243.65	543.73	599.42	539.30	568.67	599.69	632.48	667.13	651.24	687.34	725.54
Total Cash Out	729.81	4173.83	4496.55	689.30	413.47	652.11	680.61	558.28	589.61	622.17	656.62	693.05	678.67	717.23	757.64
Revenue in Foreign Currency				602.50	1476.12	1992.76	3487.33	3771.55	4078.93	4411.36	4770.89	5159.72	5580.23	6035.02	6526.98
Net Foreign Cash Flow	-729.81	-4173.83	-4496.55	-86.89	1062.65	1340.65	2806.72	3213.27	3489.32	3789.19	4114.27	4466.66	4901.56	5317.80	5769.74

ITEM : CASH FLOWS with Inflation ($ '000)															
Expenditure in Local Currency	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Fixed Assets	150.1	720.6	681.3	54.2	0.0										
Pre-production & Special Expenses	84.0	110.3	124.4	9.1	0.0										
Increase in Working Capital				112.3	112.6	86.9	199.2	38.6	42.2	45.5	49.1	53.0	51.2	61.4	66.3
Operating Costs				1507.1	2531.8	3089.2	5067.1	5194.4	5588.0	6012.3	6469.6	6962.5	7388.0	7955.6	8567.7
Total Cash Out	234.1	830.9	805.8	1682.6	2644.4	3176.1	5266.3	5225.0	5630.2	6057.8	6518.7	7015.5	7439.2	8017.0	8634.0
Revenue in Local Currency				690.4	1691.4	2283.4	3995.9	4321.5	4673.7	5054.6	5466.6	5912.1	6394.0	6915.1	7478.7
Net Local Cash Flow	-234.1	-830.9	-805.8	-992.3	-953.0	-892.7	-1210.4	-903.5	-956.4	-1003.1	-1052.1	-1103.4	-1045.3	-1102.0	-1155.4
TOTAL NET CASH FLOW ($)	-963.93	-5004.72	-5302.32	-1079.16	109.67	447.92	1596.33	2309.81	2532.88	2786.06	3062.20	3363.31	3856.29	4215.04	4613.85
Loan Drawdown	730	4174	4497	87	0	0	0	0	0	0	0	0	0	0	0
Repayments	0	0	0	0	0	0	2910	2910	2910	2910	2310	0	0	0	0
Interest	0	0	0	2100	2100	2427	2231	2265	2221	2147	2035	2320	2252	2112	1937
Cash Flow with Financing	-234.12	-830.90	-805.77	-3100.71	-2078.76	-1979.57	-3552.20	-2873.04	-2606.19	-2278.55	-1090.25	1034.80	1490.00	2104.07	2676.40

Internal Rate of Return on Total Net Cash Flow with Financing = -1.51%
Internal Rate of Return in Real Terms = -6.20%

Depreciation calculations are presented in Taoles 10.19 to 10.21. The depreciation schedule is taken from Table 7.1, with the exception of the pre-production expenses, which have been depreciated over 5 years on a straight line basis. The calculations are based on the phasing of expenditure on pre-production expenses and fixed assets set out in Tables 10.1 to 10.6 (but inflated by 5% pa).

10.7 Financing

The possibility of financing part or all of the project with a soft term loan has been discussed with aid and bank officials in the UK.

Assistance towards the Romanian mill is out of the question. No western donor will be interested in subsidising the purchase of Romanian plant and equipment. Assistance towards the small mill option is more likely, especially if tied to the purchase of the donor's plant and equipment, but Zambia now has a very poor credit rating (in the UK, export credit guarantees are no longer being issued for Zambia), and, for this reason, there seems little liklihood of securing a loan on soft terms. Most UK aid to Zambia, for example, is being disbursed in the form of tied grants, up to a ceiling of about $3.5 million. Moreover, priority is being accorded rural rather than industrial development. The last loan to Zambia was granted in 1980. For the purposes of this analysis, therefore, soft term loans, or grants, from western sources have not been used in the project financing scenario.

We have assumed, therefore, that finance will be sourced from the Development Bank of Zambia (DBZ) and, in the case of the Romanian mill, Uzinexportimport.

The Uzinexportimport loan is for plant and equipment only. The maximum facility is $ 20 million. The terms of this loan are negotiable, but on the basis of our discussions with the Romanian delegation, we have assumed the following scenario:

TABLE 10.19 - DEPRECIATION CALCULATIONS (Romanian Mill)

All Values in £ '000s (Current Prices)

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Investment (Build's & Wks - inflated)	1230	7620	3735	1346	835	0									
Investment (Plant & Eqp. - inflated)	2415	10143	10650	7688	8806	771									
Pre-Production & Special Expenses	169	172	132	351	0	0									
TOTAL INVESTMENT	3822	17943	14517	9385	9641	771									
Depreciation for Buildings					739	702	667	634	602	572	543	516	490	446	413
Depreciation for Plant and Machinery					5955	1803	1636	1554	1476	1402	1332	1266	1202	1162	1105
Depreciation for Pre-Prod & Spec. Expen.					165	165	165	165	165						
TOTAL DEPRECIATION					6859	2670	2468	2352	2243	1974	1876	1782	1693	1608	1520

MARGINS	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Operating Surplus - Foreign (£)	0	0	0	0	13700	26868	43933	46440	49088	51714	54480	57392	60460	63691	67268
Operating Surplus - Local (£)	0	0	0	0	-11483	-20226	-32322	-33964	-35690	-37489	-39379	-41364	-43449	-45639	-47590
Operating Surplus - TOTAL (£)	0	0	0	0	2217	6642	11611	12476	13398	14225	15100	16028	17011	18052	19679
Depreciation	0	0	0	0	6859	2670	2468	2352	2243	1974	1876	1782	1693	1608	1520
Profit after Depreciation	0	0	0	0	-4642	3972	9143	10123	11155	12250	13225	14246	15318	16444	18151
Increase in Working Capital	0	0	0	0	2017	1680	2951	406	430	415	438	462	487	514	509

TABLE 10.20 - DEPRECIATION CALCULATIONS (Small Mill with New Plant & Equipment)

All Values in $ '000s (Current Prices)

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Investment (Build's & Wks - inflated)	283	1285	1348	120	0	0									
Investment (Plant & Eqp. - inflated)	770	4853	4359	356	125	0									
Pre-Production & Special Expenses	116	160	275	15	0	0									
TOTAL INVESTMENT	1169	6298	5981	492	125	0									
Depreciation for Buildings				152	144	137	130	124	117	112	106	101	96	91	86
Depreciation for Plant and Machinery				1551	458	423	402	382	362	344	327	311	295	280	266
Depreciation for Pre-Prod & Spec. Expen.				113	113	113	113	113							
TOTAL DEPRECIATION				1816	715	673	645	618	480	456	433	411	391	371	353

MARGINS	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Operating Surplus - Foreign ($)	0	0	0	386	1232	1367	2802	3142	3416	3712	4034	4383	4814	5227	5674
Operating Surplus - Local ($)	0	0	0	-852	-877	-841	-1048	-912	-955	-1000	-1048	-1098	-1044	-1073	-1144
Operating Surplus - TOTAL ($)	0	0	0	-465	355	526	1754	2230	2461	2712	2986	3285	3770	4154	4531
Depreciation	0	0	0	1816	715	673	645	618	480	456	433	411	391	371	353
Profit after Depreciation	0	0	0	-2281	-360	-147	1109	1612	1981	2256	2553	2874	3379	3783	4178
Increase in Working Capital	0	0	0	158	158	223	202	51	65	70	75	81	81	93	101

TABLE 10.21 - DEPRECIATION CALCULATIONS (Small Mill Second Hand New Plant & Equipment)

All Values in £ '000s (Current Prices)

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Investment (Build's & Wks - inflated)	203	1285	1348	120	0	0									
Investment (Plant & Eqp. - inflated)	545	3560	3680	356	125	0									
Pre-Production & Special Expenses	116	160	275	15	0	0									
TOTAL INVESTMENT	864	5005	5302	492	125	0									
Depreciation for Buildings				152	144	137	130	124	117	112	106	101	96	91	86
Depreciation for Plant and Machinery				1224	366	335	318	302	287	273	259	246	234	222	211
Depreciation for Pre-Prod & Spec. Expen.				113	113	113	113	113							
TOTAL DEPRECIATION				1489	623	585	561	539	405	384	365	347	329	313	297

MARGINS	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Operating Surplus - Foreign (1)	0	0	0	386	1232	1449	2088	3232	3510	3812	4138	4493	4929	5348	5401
Operating Surplus - Local (1)	0	0	0	-817	-840	-806	-1011	-873	-914	-958	-1003	-1050	-994	-1041	-1089
Operating Surplus - TOTAL (1)	0	0	0	-430	392	643	1077	2359	2596	2854	3135	3442	3935	4307	4312
Depreciation	0	0	0	1489	623	585	561	539	405	384	365	347	329	313	297
Profit after Depreciation	0	0	0	-1919	-231	58	1315	1821	2191	2470	2770	3095	3605	3994	4015
Increase in Working Capital	0	0	0	157	158	195	200	50	63	68	73	79	79	91	96

* interest rate: 7% pa

* repayment period: 10 years

* grace period: 3 years from delivery of plant and equipment (i.e 1992).

A further assumption is that repayments are paid in the year they fall due.

Interest is capitalised up to 1993, in the case of the Romanian mill (the first year of operations), and 1992, in the case of the small mill.

Under guidance from Indeco, the terms of the DBZ loan are assumed to be as follows:

* interest rate: 15% pa

* repayment period: 7 years

* grace period: 3 years.

The assumptions regarding payment of the principal and the capitalisation of interest are the same as those specified for the Romanian mill.

The small mill options source finance from the DBZ on the same terms as those set out above. Interest is also capitalised up to the first year of operation.

Further assumptions, applicable to all options, are as follows:

* interest rate on cash balance: 9% pa

* interest rate on short term loans: 11.5% pa

* equity : limited to 33% of investment in local currency

* dividend policy : 4% of equity (not dependent on profits)

* corporate tax : 35% with holiday for five years from commencement of production.

The interest rates for the cash balance and the short term loans are based on information provided by Barclays Bank, which has representation in Zambia.

It should be recognised that investment costs in local currency for the three options represent only 13.2%, 11.9% and 14.3% respectively of total investment costs. For this reason, it has been assumed that all investment costs in local currency are covered by equity. This leads inevitably to very high debt/equity ratios, well in excess of conventional figures. The Romanians have not offered to provide equity to the project.

The loan repayment schedules are set out in Tables 10.22 to 10.24.

10.8 Financial Statements

Profit and loss statements for the three options are set out in Tables 10.25 to 10.27. Sources and applications of funds are presented in Tables 10.28 to 10.30. Finally, Tables 10.31 to 10.33 show the project balance sheets.

10.8.1 Romanian mill

The major conclusions arising from the financial statements are as follows:

* short term loans, which are planned to meet cash requirements in any particular year, grow in the early years to cover after tax losses to 1994, and peak in 1999

TABLE 10.22 - LOAN REPAYMENT SCHEDULE (Romanian Mill)

All Values in $ '000s (Current Prices)

TAX/INTEREST RATE		1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Corporate Tax Rate		35.0%	35.0%	35.0%	35.0%	35.0%	35.0%	35.0%	35.0%	35.0%	35.0%	35.0%	35.0%	35.0%	35.0%	35.0%
Interest Rate on Cash Balance		9.0%	9.0%	9.0%	9.0%	9.0%	9.0%	9.0%	9.0%	9.0%	9.0%	9.0%	9.0%	9.0%	9.0%	9.0%
Short Term Loan Interest Rate		11.5%	11.5%	11.5%	11.5%	11.5%	11.5%	11.5%	11.5%	11.5%	11.5%	11.5%	11.5%	11.5%	11.5%	11.5%
ROMANIAN DOLLAR LOAN	Maximum Facility ($)	20000														
Interest Rate		7.0%	7.0%	7.0%	7.0%	7.0%	7.0%	7.0%	7.0%	7.0%	7.0%	7.0%	7.0%	7.0%	7.0%	7.0%
Loan at start of Year		0	3140	17937	22951	26164	29827	29827	26098	22370	18642	14913	11185	7457	3728	0
Interest Capitalised		0	220	1256	1607	1831	0	0	0	0	0	0	0	0	0	0
Interest Paid		0	0	0	0	2088	2088	1827	1566	1305	1044	783	522	261	0	0
Drawdown in Period		3140	14357	2503	0	0	0	0	0	0	0	0	0	0	0	0
Repayment		0	0	0	0	0	0	3728	3728	3728	3728	3728	3728	3728	3728	0
Loan at end of Year		3140	17937	22951	26164	29827	29827	26098	22370	18642	14913	11185	7457	3728	0	0
Interest Due		220	1256	1607	1831	2088	2088	1827	1566	1305	1044	783	522	261	0	0
DEV. BANK OF ZAMBIA DOLLAR LOAN																
Interest Rate		15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%
Loan at start of Year		0	0	0	10032	21481	27925	27925	22340	16755	11170	5585	0	0	0	0
Interest Capitalised		0	0	0	1505	3222	0	0	0	0	0	0	0	0	0	0
Interest Paid		0	0	0	0	4189	4189	3351	2513	1675	838	0	0	0	0	0
Drawdown in Period		0	0	10032	8439	0	0	0	0	0	0	0	0	0	0	0
Repayment		0	0	0	0	0	0	5585	5585	5585	5585	5585	0	0	0	0
Loan at end of Year		0	0	10032	21481	27925	27925	22340	16755	11170	5585	0	0	0	0	0
Interest Due		0	0	1505	3222	4189	4189	3351	2513	1675	838	0	0	0	0	0

TABLE 10.23 - LOAN REPAYMENT SCHEDULE (Small Mill with New Plant & Equipment)

All Values in $ '000s (Current Prices)

TAX/INTEREST RATE		1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Corporate Tax Rate		35.0%	35.0%	35.0%	35.0%	35.0%	35.0%	35.0%	35.0%	35.0%	35.0%	35.0%	35.0%	35.0%	35.0%	35.0%
Interest Rate on Cash Balance		9.0%	9.0%	9.0%	9.0%	9.0%	9.0%	9.0%	9.0%	9.0%	9.0%	9.0%	9.0%	9.0%	9.0%	9.0%
Short Term Loan Interest Rate		11.5%	11.5%	11.5%	11.5%	11.5%	11.5%	11.5%	11.5%	11.5%	11.5%	11.5%	11.5%	11.5%	11.5%	11.5%
ROMANIAN DOLLAR LOAN	Maximum Facility ($)	0														
Interest Rate		7.0%	7.0%	7.0%	7.0%	7.0%	7.0%	7.0%	7.0%	7.0%	7.0%	7.0%	7.0%	7.0%	7.0%	7.0%
Loan at start of Year		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Interest Capitalised		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Interest Paid		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Drawdown in Period		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Repayment		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Loan at end of Year		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Interest Due		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DEV. BANK OF ZAMBIA DOLLAR LOAN																
Interest Rate		15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%
Loan at start of Year		0	935	6603	13863	18110	18110	18110	14488	10866	7244	3622	0	0	0	0
Interest Capitalised		0	140	1002	2079	0	0	0	0	0	0	0	0	0	0	0
Interest Paid		0	0	0	2717	2717	2717	2173	1630	1087	543	0	0	0	0	0
Drawdown in Period		935	5467	5175	88	0	0	0	0	0	0	0	0	0	0	0
Repayment		0	0	0	0	0	0	3622	3622	3622	3622	3622	0	0	0	0
Loan at end of Year		935	6603	13863	18110	18110	18110	14488	10866	7244	3622	0	0	0	0	0
Interest Due		140	1002	2079	2717	2717	2717	2173	1630	1087	543	0	0	0	0	0

TABLE 10.24 - LOAN REPAYMENT SCHEDULE (Small Mill with Second Hand Plant & Equipment)

All Values in $ '000s (Current Prices)

TAX/INTEREST RATE		1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Corporate Tax Rate		35.0%	35.0%	35.0%	35.0%	35.0%	35.0%	35.0%	35.0%	35.0%	35.0%	35.0%	35.0%	35.0%	35.0%	35.0%
Interest Rate on Cash Balance		9.0%	9.0%	9.0%	9.0%	9.0%	9.0%	9.0%	9.0%	9.0%	9.0%	9.0%	9.0%	9.0%	9.0%	9.0%
Short Term Loan Interest Rate		11.5%	11.5%	11.5%	11.5%	11.5%	11.5%	11.5%	11.5%	11.5%	11.5%	11.5%	11.5%	11.5%	11.5%	11.5%
ROMANIAN DOLLAR LOAN	Maximum Facility ($)	0														
Interest Rate		7.0%	7.0%	7.0%	7.0%	7.0%	7.0%	7.0%	7.0%	7.0%	7.0%	..0%	7.0%	7.0%	7.0%	7.0%
Loan at start of Year		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Interest Capitalised		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Interest Paid		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Drawdown in Period		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Repayment		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Loan at end of Year		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Interest Due		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DEV. BANK OF ZAMBIA DOLLAR LOAN																
Interest Rate		15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%
Loan at start of Year		0	730	5123	11156	14590	14590	14590	11672	8754	5836	2918	0	0	0	0
Interest Capitalised		0	109	768	1673	0	0	0	0	0	0	0	0	0	0	0
Interest Paid		0	0	0	2188	2188	2188	1751	1313	875	438	0	0	0	0	0
Drawdown in Period		730	4174	4497	87	0	0	0	0	0	0	0	0	0	0	0
Repayment		0	0	0	0	0	0	2918	2918	2918	2918	2918	0	0	0	0
Loan at end of Year		730	5123	11156	14590	14590	14590	11672	8754	5836	2918	0	0	0	0	0
Interest Due		109	768	1673	2188	2188	2188	1751	1313	875	438	0	0	0	0	0

* profit after tax is negative for the first two years of operation, and then becomes positive in 1995

* the profit margin on sales grows over the project period from 5% in 1995 to 18% by the end of the project period

* return on capital employed also improves, from 5% in 1995 to a peak of 33% in 2004

* retained earnings become positive in 1995

* the current ratio (which is an indication of the cover available to creditors and short term lenders) is unsatisfactory (below 1.5:1) until the year 2003. In general, a 2:1 ratio is considered satisfactory, although an acceptable minimum is 1.5:1 for this kind of business

* the debt: equity ratio is very high, up to 90% and not lower than 80% throughout the nineties

* owing to the large amounts of interest to be paid on borrowing (around $6 million pa between 1983 and 1987), debt service is not adequately covered by profits until 1999

* the liquidity ratio (current assets less stock/current liabilities) varies from 0.09 in 1993 to 1.07 in 2004. The ratio is well below an acceptable 1.0 throughout most of the project period. This is indicative of a fragile balance sheet.

10.8.2 Small mill with new plant and equipment

The major conclusions arising from the financial statements with respect to the small mill with new plant and equipment may be summarised as follows:

* short term loans grow in the early years to cover after tax losses up to 2001, and peak in 2002

* profit after tax is negative for the first 10 years of operation, and then become positive in 2002

* the profit margin on sales becomes positive in 2002, and grows only to 9% by the end of the project period

* return on capital employed is also very poor, and recovers to 23% only by the end of the project period

* retained earnings become positive in 2002

* the current ratio from 1993, when the short term loans commence, is unsatisfactory throughout the project (i.e. below 1.5:1)

* the debt: equity ratio is very high, and stays over 80% throughout the project

* because the project is very highly geared, debt service is not adequately covered by profits at any point in the project period

* the liquidity ratio is very poor throughout the project period, peaking at 0.06 after 1993.

10.8.3 Small mill with second hand plant and equipment

The major findings with regard to this option are as follows:

* short term loans grow in the early years to cover after tax losses up to 1997, and peak in 2000

* profit after tax is negative for the first six years of operation, and then becomes positive in 1998

* the profit margin on sales becomes positive in 1997, and grows to 17% by the end of the project period

* return on capital employed is also very poor, but reaches 27% by 2003

* retained earnings become positive in 1998

* the current ratio from 1993, when the short term loans commence, is unsatisfactory throughout the project (i.e. below 1.5:1)

* the debt: equity ratio is very high, and stays over 80% until 2003

* because the project is very highly geared, debt service is not adequately covered by profits until 2004

* the liquidity ratio is very poor throughout the project period, peaking at 0.11 in the final year.

All the projects generate poor P/L statements and balance sheets but the small mill options are clearly inferior, and cannot be considered viable. Interestingly, an increase in the short term interest rate from 11.5% to 13.5% still gives an IRR (with financing) of 11.79% for the Romanian mill (see Section 10.9). In contrast, in order to produce a positive IRR (with financing) in real terms for the small mill with second hand plant and equipment, the short term interest rate must be reduced to 4%. Even if the short term interest rate is reduced to 0%, the small mill with new plant and equipment does not achieve a positive IRR (with financing) in real terms.

TABLE 10.25 - PROFIT AND LOSS STATEMENT (Romanian Mill)

All Values in $ '000s (Current Prices)

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Revenue	0	0	0	0	15233	29278	49187	52326	55657	58815	62149	65670	69388	73313	77458
Operating Costs	0	0	0	0	13016	22636	37576	39851	42259	44590	47049	49642	52377	55261	57779
Operating Surplus/Loss	0	0	0	0	2217	6642	11611	12476	13398	14225	15100	16028	17011	18052	19679
Interest Received	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0
Interest paid	0	0	0	0	6277	7362	6662	6564	6063	5401	4566	4650	3974	3148	2441
Depreciation	0	0	0	0	6859	2670	2468	2352	2243	1974	1876	1782	1693	1608	1520
Taxable Profit	0	0	0	0	-10919	-3390	2481	3559	5092	6849	8659	9597	11344	13296	15707
Tax Paid	0	0	0	0	0	0	0	0	0	2397	3031	3359	3971	4653	5496
Profit after Tax	0	0	0	0	-10919	-3390	2481	3559	5092	4452	5628	6238	7374	8643	10211
Long Term Loan Interest	0	0	0	0	6277	6277	5178	4079	2980	1882	783	522	261	0	0
Short Term Loan Interest	0	0	0	0	0	1086	1484	2485	3083	3519	3783	4128	3713	3148	2441
Total Interest	0	0	0	0	6277	7362	6662	6564	6063	5401	4566	4650	3974	3148	2441
Equity drawdown	682	3586	1983	946	0	0	0	0	0	0	0	0	0	0	0
Cumulative Equity	682	4268	6250	7196	7196	7196	7196	7196	7196	7196	7196	7196	7196	7196	7196
Dividend Due	0	0	0	0	288	288	288	288	288	288	288	288	288	288	288
Retained Earnings	0	0	0	0	-11207	-3678	2193	3271	4804	4164	5341	5950	7086	8355	9923

TABLE 10.26 - PROFIT AND LOSS STATEMENT (Small Mill with New Plant & Equipment)

All Values in $ '000s (Current Prices)

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Revenue	0	0	0	1293	3167	4276	7403	8093	8753	9466	10237	11072	11974	12950	14006
Operating Costs	0	0	0	1758	2812	3750	5729	5863	6292	6754	7251	7787	8204	8816	9475
Operating Surplus/Loss	0	0	0	-465	355	526	1754	2230	2460	2712	2986	3285	3770	4134	4531
Interest Received	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Interest paid	0	0	0	2717	2717	3021	2803	2905	2930	2949	2933	3428	3467	3455	3401
Depreciation	0	0	0	1816	715	673	645	618	480	456	433	411	391	371	353
Taxable Profit	0	0	0	-4997	-3076	-3167	-1694	-1293	-957	-693	-380	-554	-88	308	777
Tax Paid	0	0	0	0	0	0	0	0	0	0	0	0	0	108	272
Profit after tax	0	0	0	-4997	-3076	-3167	-1694	-1293	-957	-693	-380	-554	-88	200	505
Long Term Loan Interest	0	0	0	2717	2717	2717	2173	1630	1087	543	0	0	0	0	0
Short Term Loan Interest	0	0	0	0	0	304	630	1275	1851	2406	2933	3428	3467	3455	3401
Total Interest	0	0	0	2717	2717	3021	2803	2905	2938	2949	2933	3428	3467	3455	3401
Interest Received	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Profit after Interest	0	0	0	-4997	-3076	-3167	-1694	-1293	-957	-693	-380	-554	-88	308	777
Tax Due	0	0	0	0	0	0	0	0	0	0	0	0	0	108	272
Profit after Tax	0	0	0	-4997	-3076	-3167	-1694	-1293	-957	-693	-380	-554	-88	200	505
Equity drawdown	234	831	806	1027	0	0	0	0	0	0	0	0	0	0	0
Cumulative Equity	234	1065	1871	2898	2898	2898	2898	2898	2898	2898	2898	2898	2898	2898	2898
Dividend Due	0	0	0	0	116	116	116	116	116	116	116	116	116	116	116
Retained Earnings	0	0	0	-4997	-3192	-3283	-1810	-1409	-1073	-809	-496	-670	-204	84	389

TABLE 10.27 - PROFIT AND LOSS STATEMENT (Small Mill with Second Hand Plant & Equipment)

All Values in $ '000s (Current Prices)

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Revenue	0	0	0	1293	3167	4276	7403	8093	8753	9466	10237	11072	11974	12950	14006
Operating Costs	0	0	0	1723	2775	3633	5607	5734	6157	6612	7102	7630	8039	8643	9293
Operating Surplus/Loss	0	0	0	-430	392	643	1877	2359	2596	2854	3135	3442	3935	4307	4712
Interest Received	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Interest paid	0	0	0	2188	2188	2427	2231	2265	2221	2147	2035	2328	2252	2112	1937
Depreciation	0	0	0	1489	623	585	561	539	405	384	365	347	329	313	297
Taxable Profit	0	0	0	-4108	-2419	-2369	-915	-444	-30	323	736	767	1351	1882	2477
Tax Paid	0	0	0	0	0	0	0	0	0	113	258	268	474	659	867
Profit after tax	0	0	0	-4108	-2419	-2369	-915	-444	-30	210	478	499	880	1224	1610
Long Term Loan Interest	0	0	0	2188	2188	2188	1751	1313	875	438	0	0	0	0	0
Short Term Loan Interest	0	0	0	0	0	239	480	952	1346	1709	2035	2328	2252	2112	1937
Total Interest	0	0	0	2188	2188	2427	2231	2265	2221	2147	2035	2328	2252	2112	1937
Interest Received	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Profit after Interest	0	0	0	-4108	-2419	-2369	-915	-444	-30	323	736	767	1353	1882	2477
Tax Due	0	0	0	0	0	0	0	0	0	113	258	268	474	659	867
Profit after Tax	0	0	0	-4108	-2419	-2369	-915	-444	-30	210	478	499	880	1224	1610
Equity drawdown	234	831	806	992	0	0	0	0	0	0	0	0	0	0	0
Cumulative Equity	234	1065	1871	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863
Dividend Due	0	0	0	0	115	115	115	115	115	115	115	115	115	115	115
Retained Earnings	0	0	0	-4108	-2534	-2484	-1030	-559	-144	95	364	384	765	1109	1496

TABLE 10.28 - SOURCES AND APPLICATIONS OF FUNDS (Romanian Mill)

All Values in $ '000s (Current Prices)

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
SOURCES OF FUNDS															
Drawing on Long Term Loans	3140	14357	12535	8439	0	0	0	0	0	0	0	0	0	0	0
Equity Subscription	682	3586	1983	946	0	0	0	0	0	0	0	0	0	0	0
Drawing on Short Term loans	0	0	0	0	9441	12909	21611	26806	30601	32893	35893	32285	27371	21229	9442
SUB TOTAL	3822	17943	14517	9365	9441	12909	21611	26806	30601	32893	35893	32285	27371	21229	9442
Depreciation	0	0	0	0	6859	2670	2460	2352	2243	1974	1876	1782	1693	1608	1528
Interest Received	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Profit after Depreciation	0	0	0	0	-4642	3972	9143	10123	11155	12250	13225	14246	15318	15444	18151
Total Source of Funds	3822	17943	14517	9385	11658	19550	33222	39282	43999	47117	50994	48313	44302	39281	29121
USES OF FUNDS															
Direct Investment	3653	17771	14385	9034	9641	771	0	0	0	0	0	0	0	0	0
Pre-Production & Special Expenses	169	172	132	351	0	0	0	0	0	0	0	0	0	0	0
Long Term Loan Repayment	0	0	0	[illegible]	0	0	9313	9313	9313	9313	9313	3728	3728	3728	0
Short Term Loan Repayment	0	0	0	[illegible]	0	9441	12909	21611	26806	30601	32893	35893	32285	27371	21229
Tax Paid	0	0	0	0	0	0	0	0	0	0	2397	3031	3359	3971	4654
LT Loan Interest Paid	0	0	0	0	0	6277	6277	5170	4079	2980	1882	783	52[illegible]	261	0
ST Loan Interest Paid	0	0	0	0	0	1086	1484	2485	3083	3519	3783	4128	3713	3148	2441
Dividend Paid	0	0	0	0	0	200	200	200	200	200	200	200	200	200	200
Increase in Working Capital	0	0	0	0	2817	1600	2951	406	430	415	430	462	487	514	509
Surplus Cash before ST loan	0	0	0	0	-9441	-12909	-21611	-26806	-30601	-32893	-35893	-32285	-27371	-21229	-9442
Total Applications	3822	17943	14517	9385	11658	19550	33222	39282	43999	47117	50994	48313	44302	39281	29121
Cum. Surplus Cash before ST loan	0	0	0	0	-9441	-12909	-21611	-26806	-30601	-32893	-35893	-32285	-27371	-21229	-9442
Short Term Loan	0	0	0	0	9441	12909	21611	26806	30601	32893	35893	32285	27371	21229	9442
Cum. Surplus Cash after ST loan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

TABLE 10.29 - SOURCES AND APPLICATIONS OF FUNDS (Small Mill with New Plant & Equipment)

All Values in $ '000s (Current Prices)

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
SOURCES OF FUNDS															
Drawing on Long Term Loans	935	5467	5175	88	0	0	0	0	0	0	0	0	0	0	0
Equity Subscription	234	831	806	1027	0	0	0	0	0	0	0	0	0	0	0
Drawing on Short Term loans	0	0	0	0	2644	5477	11089	16096	20919	25507	29811	30150	30044	29574	28769
SUB TOTAL	1169	6298	5981	1115	2644	5477	11089	16096	20919	25507	29811	30150	30044	29574	28769
Depreciation	0	0	0	1816	715	673	645	618	400	456	433	411	391	371	353
Interest Received	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Profit after Depreciation	0	0	0	-2281	-360	-147	1109	1612	1981	2256	2553	2874	3379	3743	4178
Total Source of Funds	1169	6298	5981	650	2999	6003	12843	18326	23380	28219	32797	33436	33814	33708	33299
USES OF FUNDS															
Direct Investment	1054	6138	5706	477	125	0	0	0	0	0	0	0	0	0	0
Pre-Production & Special Expenses	116	160	275	15	0	0	0	0	0	0	0	0	0	0	0
Long Term Loan Repayment	0	0	0	0	0	0	3622	3622	3622	3622	3622	0	0	0	0
Short Term Loan Repayment	0	0	0	0	0	2644	5477	11089	16096	20919	25507	29811	30150	30044	29574
Tax Paid	0	0	0	0	0	0	0	0	0	0	0	0	0	0	108
LT Loan Interest Paid	0	0	0	0	2717	2717	2717	2173	1630	1087	543	0	0	0	0
ST Loan Interest Paid	0	0	0	0	0	304	630	1275	1851	2406	2933	3420	3467	3455	3401
Dividend Paid	0	0	0	0	0	116	116	116	116	116	116	116	116	116	116
Increase in Working Capital	0	0	0	158	158	223	282	51	65	70	75	81	81	93	101
Surplus Cash before ST loan	0	0	0	0	-2644	-5477	-11089	-16096	-20919	-25507	-29811	-30150	-30044	-29574	-28769
Total Applications	1169	6298	5981	650	2999	6003	12843	18326	23380	28219	32797	33436	33814	33708	33299
Cum. Surplus Cash before ST loan	0	0	0	0	-2644	-5477	-11089	-16096	-20919	-25507	-29811	-30150	-30044	-29574	-28769
Short Term Loan	0	0	0	0	2644	5477	11089	16096	20919	25507	29811	30150	30044	29574	28769
Cum. Surplus Cash after ST loan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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TABLE 10.30 - SOURCES AND APPLICATIONS OF FUNDS (Small Mill with Second Hand Plant & Equipment)

All Values in $ '000s (Current Prices)

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
SOURCES OF FUNDS															
Drawing on Long Term Loans	730	4174	4497	87	0	0	0	0	0	0	0	0	0	0	0
Equity Subscription	234	831	806	992	0	0	0	0	0	0	0	0	0	0	0
Drawing on Short Term loans	0	0	0	0	2079	4173	8277	11703	14861	17692	20247	19584	18363	16847	14944
SUB TOTAL	964	5005	5302	1079	2079	4173	8277	11703	14861	17692	20247	19584	18363	16847	14944
Depreciation	0	0	0	1489	623	585	561	539	485	384	365	347	329	313	297
Interest Received	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Profit after Depreciation	0	0	0	-1919	-231	58	1315	1821	2191	2470	2770	3095	3605	3994	4115
Total Source of Funds	964	5005	5302	649	2471	4816	10154	14062	17457	20546	23383	23027	22298	21155	19657
USES OF FUNDS															
Direct Investment	848	4845	5027	477	125	0	0	0	0	0	0	0	0	0	0
Pre-Production & Special Expenses	116	160	275	15	0	0	0	0	0	0	0	0	0	0	0
Long Term Loan Repayment	0	0	0	0	0	0	2918	2918	2918	2918	2918	0	0	0	0
Short Term Loan Repayment	0	0	0	0	0	2079	4173	8277	11703	14861	17692	20247	19584	18363	16847
Tax Paid	0	0	0	0	0	0	0	0	0	0	113	258	260	474	659
LT Loan Interest Paid	0	0	0	0	2188	2188	2188	1751	1313	875	438	0	0	0	0
ST Loan Interest Paid	0	0	0	0	0	239	480	952	1346	1709	2035	2328	2252	2112	1937
Dividend Paid	0	0	0	0	0	115	115	115	115	115	115	115	115	115	115
Increase in Working Capital	0	0	0	157	158	195	280	50	63	68	73	79	79	91	98
Surplus Cash before ST loan	0	0	0	0	-2079	-4173	-8277	-11703	-14861	-17692	-20247	-19584	-18363	-16847	-14944
Total Applications	964	5005	5302	649	2471	4816	10154	14062	17457	20546	23383	23027	22298	21155	19657
Cum. Surplus Cash before ST loan	0	0	0	0	-2079	-4173	-8277	-11703	-14861	-17692	-20247	-19584	-18363	-16847	-14944
Short Term Loan	0	0	0	0	2079	4173	8277	11703	14861	17692	20247	19584	18363	16847	14944
Cum. Surplus Cash after ST loan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

TABLE 10.31 - BALANCE SHEET (Romanian Mill)

All Values in $ '000s (Current Prices)

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Assets															
Cumulative Cash Surplus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Minimum Cash	0	0	0	0	260	453	752	797	845	892	941	993	1048	1105	1156
Total Cash	0	0	0	0	260	453	752	797	845	892	941	993	1048	1105	1156
Debtors	0	0	0	0	593	1137	1934	2057	2188	2312	2443	2581	2727	2880	3043
Stocks	0	0	0	0	1443	2583	4698	4980	5278	5568	5874	6196	6536	6894	7230
Current Assets	0	0	0	0	2297	4173	7384	7834	8311	8772	9257	9770	10310	10880	11429
Fixed Assets	3822	17943	14517	9385	9641	771	0	0	0	0	0	0	0	0	0
Cumulative Fixed Assets	3822	21765	36282	45667	55309	56079	56079	56079	56079	56079	56079	56079	56079	56079	56079
Cumulative Depreciation	0	0	0	0	6859	9529	11997	14349	16593	18567	20442	22224	23917	25525	27053
Net Fixed Assets	3822	21765	36282	45667	48449	46550	44082	41730	39487	37512	35637	33855	32162	30554	29026
TOTAL Assets	3822	21765	36282	45667	50747	50723	51466	49564	47798	46284	44894	43625	42472	41434	40455
Liabilities															
Creditors	0	0	0	0	280	468	728	772	818	864	911	961	1014	1070	1109
Tax Due	0	0	0	0	0	0	0	6	0	2397	3031	3359	3971	4654	5498
Dividend Due	0	0	0	0	288	288	288	288	288	288	288	288	288	288	288
Short Term Loan	0	0	0	0	9441	12909	21611	26806	30601	32893	35893	32285	27371	21729	9442
Current Liabilities	0	0	0	0	10010	13664	22626	27866	31708	36442	40123	36893	32644	27740	16338
Long Term Loan	3140	17497	30032	38471	44747	44747	34335	23923	13511	3099	-7313	-11302	-15291	-19281	-19281
Total Equity	682	4268	6250	7196	7196	7196	7196	7196	7196	7196	7196	7196	7196	7196	7196
Retained Earnings	0	0	0	0	-11207	-14885	-12692	-9421	-4617	-453	4887	10837	17923	26278	36201
TOTAL Liabilities	3822	21765	36282	45667	50747	50723	51466	49564	47798	46784	44894	43625	42472	41434	40455
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FINANCIAL RATIOS															
LT Loans/(LT Loans+Equity)	82%	80%	83%	84%	86%	86%	83%	77%	65%	30%	6796%	275%	189%	160%	160%
Loans/(Loans+Equity)	82%	80%	83%	84%	88%	89%	89%	88%	86%	83%	80%	74%	63%	21%	372%
Interest Cover after Dep & Interest	0%	0%	0%	0%	-74%	54%	137%	154%	184%	227%	290%	306%	385%	522%	743%
Current Ratio	0%	0%	0%	0%	23%	18%	23%	21%	20%	19%	21%	24%	28%	40%	70%
Operating Surplus to Sales	0%	0%	0%	0%	15%	23%	24%	24%	24%	24%	24%	24%	25%	25%	25%
Sales to Capital Employed	0%	0%	6%	0%	30%	59%	97%	108%	119%	138%	153%	168%	187%	207%	231%
Profit after Tax to Sales	0%	0%	0%	0%	-72%	-12%	5%	7%	9%	8%	9%	9%	11%	12%	13%
Profit after Tax to Capital Employed	0%	0%	0%	0%	-22%	-7%	5%	7%	11%	10%	14%	16%	20%	24%	30%
Liquidity Ratio					0.09	0.12	0.12	0.10	0.10	0.09	0.08	0.10	0.12	0.15	0.26
PAYBACK PERIOD															
Cumulative Net Cash Flow (constant terms)	-3640.21	-19914.85	-32455.46	-40176.56	-47574.17	-44177.44	-38091.31	-29697.18	-21110.62	-12402.92	-3599.00	5301.12	14297.46	23390.02	32846.66
Year of Payback	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2000.00	0.00	0.00	0.00

Payback Period (Years) 11

SIMPLE RATE OF RETURN (1995)

On Total invest. costs 16.3%

On Equity Capital 34.5%

TABLE 10.32 - BALANCE SHEET (Small Mill with New Plant & Equipment)

All Values in $ '000s (Current Prices)

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Assets															
Cumulative Cash Surplus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Minimum Cash	0	0	0	35	56	75	115	117	126	135	145	156	164	176	189
Total Cash	0	0	0	35	56	75	115	117	126	135	145	156	164	176	189
Debtors	0	0	0	51	123	173	298	322	347	376	406	439	474	512	554
Stocks	0	0	0	122	200	372	532	554	593	635	680	728	771	826	885
Current Assets	0	0	0	208	387	620	944	993	1067	1146	1231	1322	1409	1514	1628
Fixed Assets	1169	6298	5981	492	125	0	0	0	0	0	0	0	0	0	0
Cumulative Fixed Assets	1169	7467	13448	13940	14065	14065	14065	14065	14065	14065	14065	14065	14065	14065	14065
Cumulative Depreciation	0	0	0	1816	2531	3204	3849	4467	4947	5403	5836	6247	6638	7010	7362
Net Fixed Assets	1169	7467	13448	12125	11534	10861	10216	9598	9118	8662	8229	7818	7427	7055	6703
TOTAL Assets	1169	7467	13448	12333	11921	11481	11160	10591	10185	9808	9460	9140	8836	8570	8331
Liabilities															
Creditors	0	0	0	50	71	81	124	122	131	140	150	161	167	179	192
Tax Due	0	0	0	0	0	0	0	0	0	0	0	0	0	168	272
Dividend Due	0	0	0	0	116	116	116	116	116	116	116	116	116	116	116
Short Term Loan	0	0	0	0	2644	5477	11089	16096	20919	25507	29811	30150	30044	29574	28769
Current Liabilities	0	0	0	50	2830	5674	11328	16334	21166	25763	30077	30427	30326	29977	29349
Long Term Loan	935	6402	11570	14302	14302	14302	10217	6052	1806	2279	-6444	-6444	-6444	-6444	-6444
Total Equity	234	1065	1871	2098	2898	2098	2898	2098	2098	2898	2898	2898	2898	2898	2898
Retained Earnings	0	0	0	-4997	-8190	-11473	-13203	-14692	-15765	-16574	-17070	-17741	-17945	-17860	-17471
TOTAL Liabilities	1169	7467	13448	12333	11921	11481	11160	10591	10185	9808	9460	9140	8836	8570	8331
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FINANCIAL RATIOS															
LT Loans/(LT Loans+Equity)	80%	86%	86%	83%	83%	83%	78%	68%	39%	-368%	102%	102%	102%	102%	102%
Loans/(Loans+Equity)	80%	86%	86%	83%	85%	87%	88%	88%	89%	89%	89%	89%	89%	89%	89%
Interest Cover after Dep & Interest	0%	0%	0%	-84%	-13%	-5%	40%	55%	67%	76%	87%	84%	97%	109%	123%
Current Ratio	0%	0%	0%	417%	14%	7%	6%	5%	4%	4%	4%	4%	5%	5%	6%
Operating Surplus to Sales	0%	0%	0%	-36%	11%	12%	23%	28%	28%	29%	29%	30%	31%	32%	32%
Sales to Capital Employed	0%	0%	0%	11%	27%	38%	69%	78%	88%	99%	111%	125%	140%	159%	181%
Profit after Tax to Sales	0%	0%	0%	-387%	-97%	-74%	-23%	-16%	-11%	-7%	-4%	-5%	-1%	2%	4%
Profit after Tax to Capital Employed	0%	0%	0%	-41%	-26%	-28%	-16%	-12%	-10%	-7%	-4%	-6%	-1%	2%	7%
Liquidity Ratio				1.72	0.06	0.04	0.04	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.03
PAYBACK PERIOD															
Cumulative Net Cash Flow (constant terms)	-1113.53	-6825.96	-11992.80	-12910.42	-12847.01	-12600.82	-11543.59	-10040.84	-8468.43	-6817.68	-5086.76	-3271.75	-1284.27	788.00	2151.07
Year of Payback	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2002.00	0.00

Payback Period (Years) 13

SIMPLE RATE OF RETURN (1995)

On Total invest. costs 7.9%

On Equity Capital -58.5%

TABLE 10.33 - BALANCE SHEET (Small Mill with Second Hand Plant & Equipment)

All Values in $ '000s (Current Prices)

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Assets															
Cumulative Cash Surplus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Minimum Cash	0	0	0	34	56	73	112	115	123	132	142	153	161	173	186
Total Cash	0	0	0	34	56	73	112	115	123	132	142	153	161	173	186
Debtors	0	0	0	51	123	172	296	320	346	374	404	437	472	510	551
Stocks	0	0	0	121	206	346	505	526	564	604	647	694	734	788	845
Current Assets	0	0	0	206	385	590	913	961	1032	1110	1193	1283	1367	1471	1582
Fixed Assets	964	5005	5302	492	125	0	0	0	0	0	0	0	0	0	0
Cumulative Fixed Assets	964	5969	11271	11763	11886	11888	11888	11888	11888	11888	11888	11888	11888	11888	11888
Cumulative Depreciation	0	0	0	1489	2112	2697	3258	3797	4202	4586	4951	5298	5627	5940	6238
Net Fixed Assets	964	5969	11271	10274	9776	9191	8629	8091	7686	7302	6937	6590	6260	5947	5650
TOTAL Assets	964	5969	11271	10480	10161	9781	9542	9051	8718	8411	8130	7873	7627	7418	7232
Liabilities															
Creditors	0	0	0	49	70	81	123	121	130	139	149	160	166	178	191
Tax Due	0	0	0	0	0	0	0	0	0	113	258	268	474	659	867
Dividend Due	0	0	0	0	115	115	115	115	115	115	115	115	115	115	115
Short Term Loan	0	0	0	0	2079	4173	8277	11703	14861	17692	20247	19584	18363	16847	14944
Current Liabilities	0	0	0	49	2264	4368	8515	11938	15105	18058	20768	20127	19117	17798	16117
Long Term Loan	730	4904	9400	11676	11676	11676	8320	4964	1609	-1747	-5102	-5102	-5102	-5102	-5102
Total Equity	234	1065	1871	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863
Retained Earnings	0	0	0	-4108	-6642	-9125	-10155	-10714	-10858	-10763	-10399	-10015	-9250	-8141	-6645
TOTAL Liabilities	964	5969	11271	10480	10161	9781	9542	9051	8718	8411	8130	7873	7627	7418	7232
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FINANCIAL RATIOS															
LT Loans/(LT Loans+Equity)	76%	82%	83%	80%	80%	80%	74%	63%	36%	-157%	228%	228%	228%	228%	228%
Loans/(Loans+Equity)	76%	82%	83%	86%	81%	85%	85%	85%	85%	85%	84%	83%	82%	80%	77%
Interest Cover after Dep & Interest	0%	0%	0%	-88%	-11%	2%	59%	80%	99%	115%	136%	133%	160%	189%	228%
Current Ratio	0%	0%	0%	415%	17%	8%	8%	6%	6%	5%	6%	6%	7%	8%	10%
Operating Surplus to Sales	0%	0%	0%	-33%	12%	15%	25%	29%	30%	30%	31%	31%	33%	33%	34%
Sales to Capital Employed	0%	0%	0%	12%	32%	45%	80%	92%	103%	110%	135%	151%	174%	200%	231%
Profit after Tax to Sales	0%	0%	0%	-318%	-76%	-55%	-12%	-5%	0%	2%	5%	5%	7%	9%	11%
Profit after Tax to Capital Employed	0%	0%	0%	-39%	-24%	-25%	-10%	-5%	0%	3%	6%	7%	13%	19%	27%
Liquidity Ratio				1.73	0.08	0.06	0.05	0.04	0.03	0.03	0.03	0.03	0.03	0.04	0.05
PAYBACK PERIOD															
Cumulative Net Cash Flow (constant terms)	-918.03	-5457.46	-10037.80	-10925.63	-10833.56	-10487.58	-9334.98	-7744.87	-6085.09	-4346.98	-2528.20	-626.32	1448.53	3600.16	5858.59
Year of Payback	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2001.00	0.00	0.00

Payback Period (Years) 12

SIMPLE RATE OF RETURN (1995)

On Total invest. costs 11.12

On Equity Capital -32.02

10.9 Payback Period, Simple Rate of Return and IRR (with financing)

The calculations regarding payback period, simple rate of return, and IRR with financing are presented in Tables 10.16 to 10.18 and 10.31 to 10.33. The relevant figures are reproduced below, in Table 10.34.

The results are consistent with the IRR and NPV figures in Section 10.5. The small mill options are clearly inferior to the Romanian mill (under the commercial terms assumed), and cannot be considered viable. The Romanian option generates an IRR with financing in real terms of 7.5%, but this is very marginal.

10.10 Break Even Analysis

The break even analyses are shown in Tables 10.35 to 10.37. The break even points (in tonnes/pa) are calculated, first, with reference only to operating costs, and second, adding to operating costs depreciation, financing charges, and tax.

The figures show that the Romanian mill breaks even (after depreciation, tax and interest) in the third year of production (when sales exceed the break-even point), the break-even point steadily declining to below 50% of sales by the final year of production.

In contrast, the small mill with new plant and equipment breaks even in 2002, after 11 years of production.

The small mill with second hand plant and equipment breaks even in the 7th year of production.

These figures also indicate that the preferred option is the Romanian mill, and that the small mills are operating at too low a volume of production to be viable.

TABLE 10.34 - PAYBACK, SIMPLE RATE OF RETURN, AND IRR WITH FINANCING

	Payback Period (years from 1989)	Simple Rate of Return on Investment Costs (%) (1995)	Simple Rate of Return on Equity Capital (%)	IRR with Financing (%)	IRR with Financing in Real Terms (%)
Romanian mill	11	16.3	34.5	12.9	7.5
Small Mill with New Plant and Equipment	13	7.9	-58.5	-16.81	-20.77
Small Mill with Second Hand Plant and Equipment	12	11.1	-32.0	-1.51	-6.2

Source: WS Atkins

TABLE 10.35 - BREAK EVEN ANALYSIS (Romanian Mill)

All Values in $'000s (Current Prices)

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Sales (Tonnes)	3000	5500	8000	8900	9000	9050	9100	9150	9200	9250	9300	9350	9400	9450	9500
Project Revenue	15233	29270	49187	52326	55457	58815	62149	65670	69388	73313	77458	81833	86453	91329	96478
Average Price (per tonne)	5.08	5.32	5.59	5.88	6.18	6.50	6.83	7.18	7.54	7.93	8.33	8.75	9.20	9.66	10.16
Capacity (tonnes/pa)	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
Total Operating Costs	13016	22536	37576	39851	42259	44590	47049	49642	52377	55261	57779	60961	64316	67854	71586
Variable Costs (per tonne)	3.42	3.59	3.76	3.95	4.15	4.36	4.57	4.80	5.04	5.29	5.56	5.84	6.13	6.44	6.76
Fixed Costs	2752	2090	4460	4691	4926	5172	5430	5702	5987	6286	6077	6381	6700	7035	7386
Break Even (tonnes/pa)	1662	1660	2445	2432	2419	2413	2407	2401	2395	2389	2194	2189	2184	2179	2174
B as a % of sales forecast	55.4%	30.3%	27.0%	27.3%	26.9%	26.7%	26.5%	26.2%	26.0%	25.8%	23.6%	23.4%	23.2%	23.1%	22.9%
B as a % of capacity	16.6%	16.7%	24.5%	24.3%	24.2%	24.1%	24.1%	24.0%	24.0%	23.9%	21.9%	21.9%	21.8%	21.8%	21.7%
Depreciation	6859	2670	2468	2352	2243	1974	1876	1782	1693	1608	1528	1451	1379	1310	1244
Financing Charges	6277	7362	6662	6544	6063	5401	4566	4650	3974	3140	2441	1046	-359	-1726	-3246
Tax	0	0	0	0	0	2397	3031	3359	3971	4654	5490	6417	7391	8362	9413
Break Even (tonnes/pa) allowing for deprec., tax & charges	9592	7456	7442	7055	6499	6975	6605	6523	6250	5965	5613	5261	4926	4640	4355
B as a % of sales forecast	319.7%	135.6%	84.6%	79.3%	72.2%	77.0%	72.6%	71.3%	67.9%	64.5%	60.4%	56.3%	52.4%	49.1%	45.8%
B as a % of capacity	95.9%	74.6%	74.4%	70.5%	65.0%	69.7%	66.1%	65.2%	62.5%	59.7%	56.1%	[illegible]	49.3%	46.4%	43.6%

TABLE 10.36 - BREAK EVEN ANALYSIS (Small Mill with New Plant & Equipment)

All Values in £'000s (Current Prices)

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Sales (Tonnes)	225	525	675	1125	1159	1194	1229	1266	1304	1343	1384	1425	1468	1500	1500
Project Revenue	1293	3167	4276	7483	8093	8753	9466	10237	11072	11974	12950	14006	15147	16252	17065
Average Price (per tonne)	5.75	6.03	6.33	6.65	6.98	7.33	7.70	8.09	8.49	8.91	9.36	9.83	10.32	10.83	11.38
Capacity (tonnes/pa)	750	750	750	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
Total Operating Costs	1758.00	2812.00	3750.01	5729.44	5862.74	6292.22	6754.29	7251.40	7784.53	8203.99	8815.92	9474.09	10184.58	10880.00	11424.60
Variable Costs (per tonne)	3.07	3.22	3.36	3.54	3.72	3.90	4.10	4.30	4.52	4.75	4.98	5.23	5.50	5.77	6.06
Fixed Costs	1066.62	1119.95	1483.02	1749.05	1557.26	1635.13	1716.08	1802.73	1892.06	1829.11	1920.57	2016.60	2117.03	2223.30	2334.46
Break Even (tonnes/pa)	399.05	398.51	498.32	561.74	476.42	476.50	476.58	476.66	476.74	438.01	438.80	438.95	439.01	439.05	439.05
• as a % of sales forecast	177.4%	75.9%	73.8%	49.9%	41.1%	39.9%	38.8%	37.6%	36.6%	32.7%	31.7%	30.8%	29.9%	29.3%	29.3%
• as a % of capacity	53.2%	53.1%	66.4%	37.4%	31.8%	31.8%	31.8%	31.8%	31.8%	29.3%	29.3%	29.3%	29.3%	29.3%	29.3%
Depreciation	1015.73	715.43	672.03	644.85	618.26	479.90	455.91	433.11	411.46	390.88	371.34	352.77	335.13	318.30	302.46
Financing Charges	2716.52	2716.32	3020.32	2003.01	2905.13	2937.64	2949.00	2933.34	3428.24	3467.30	3455.06	3401.03	3300.40	3175.75	3001.18
Tax	0	0	0	0	0	0	0	0	0	0	108	272	462	659	818
Break Even (tonnes/pa) allowing for deprec., tax & charges	2099.69	1619.67	1730.66	1669.09	1554.33	1472.43	1421.74	1366.79	1443.01	1364.41	1337.09	1315.21	1290.13	1258.83	1214.25
• as a % of sales forecast	931.0%	308.5%	257.6%	148.4%	134.1%	123.4%	115.7%	107.9%	110.7%	101.6%	96.7%	92.3%	87.9%	83.9%	81.0%
• as a % of capacity	279.3%	216.0%	231.0%	111.3%	103.6%	98.2%	94.8%	91.1%	96.3%	91.0%	89.2%	87.7%	86.0%	83.9%	81.0%

TABLE 10.37 - BREAK EVEN ANALYSIS (Small Mill with Second Hand Plant & Equipment)

All Values in £'000s (Current Prices)

	1992	1993	1994	1995	1996	1997	1998	1999
Sales (Tonnes)	225	525	675	1125	1159	1194	1229	1266
Project Revenue	1293	3167	4276	7483	8093	8753	9466	10237
Average Price (per tonne)	5.75	6.03	6.33	6.65	6.98	7.33	7.70	8.09
Capacity (tonnes/pa)	750	750	750	1500	1500	1500	1500	1500
Total Operating Costs	1723.24	2775.41	3632.93	5606.51	5733.66	6156.69	6611.90	7102.06
Variable Costs (per tonne)	3.07	3.22	3.36	3.54	3.72	3.91	4.10	4.31
Fixed Costs	1031.78	1003.37	1362.81	1621.99	1423.85	1495.04	1569.79	1640.28
Break Even (tonnes/pa)	386.02	385.49	458.57	521.55	436.10	436.16	436.22	436.28
♦ as a % of sales forecast	171.6%	73.4%	67.9%	46.4%	37.6%	36.5%	35.5%	34.5%
♦ as a % of capacity	51.5%	51.4%	61.1%	34.8%	29.1%	29.1%	29.1%	29.1%
Depreciation	1409.11	672.00	584.92	561.33	530.92	404.53	384.30	365.09
Financing Charges	2100.43	2100.43	2427.49	2230.63	2264.95	2221.16	2146.69	2034.54
Tax	0	0	0	0	0	0	113	250
Break Even (tonnes/pa) allowing for deprec. and charges	1761.89	1385.02	1472.22	1419.30	1294.08	1202.18	1170.97	1139.60
♦ as a % of sales forecast	783.1%	264.0%	218.1%	126.2%	111.7%	100.7%	95.3%	90.0%
♦ as a % of capacity	234.9%	184.8%	196.3%	94.6%	86.3%	80.1%	78.1%	76.0%

	2000	2001	2002	2003	2004	2005	2006
Sales (Tonnes)	1304	1343	1384	1425	1468	1500	1500
Project Revenue	11072	11974	12950	14006	15147	16252	17065
Average Price (per tonne)	8.49	8.91	9.36	9.83	10.32	10.83	11.38
Capacity (tonnes/pa)	1500	1500	1500	1500	1500	1500	1500
Total Operating Costs	7629.63	8039.25	8642.94	9293.26	9993.88	10679.76	11213.75
Variable Costs (per tonne)	4.52	4.75	4.99	5.24	5.50	5.78	6.06
Fixed Costs	1730.70	1650.04	1741.78	1828.07	1920.31	2016.33	2117.14
Break Even (tonnes/pa)	436.34	398.36	398.41	398.46	398.50	398.53	398.53
♦ as a % of sales forecast	33.5%	29.7%	28.8%	28.0%	27.1%	26.6%	26.6%
♦ as a % of capacity	29.1%	26.6%	26.6%	26.6%	26.6%	26.6%	26.6%
Depreciation	346.83	329.49	313.02	297.36	282.50	268.37	254.95
Financing Charges	2320.43	2252.20	2111.77	1937.44	1710.59	1448.71	1126.42
Tax	268	474	659	867	1103	1349	1564
Break Even (tonnes/pa) allowing for deprec. and charges	1178.50	1132.07	1103.74	1074.27	1042.70	1004.65	953.67
♦ as a % of sales forecast	90.4%	84.3%	79.8%	75.4%	71.0%	67.0%	63.5%
♦ as a % of capacity	78.6%	75.5%	73.6%	71.6%	69.5%	67.0%	63.5%

10.11 Sensitivity Analysis

The following scenarios have been selected for the sensitivity analysis:

* variations in the price discount rate for the PTA market (vis a vis European imports)
* variations in the level of competition from Radiator & Tinning
* variations in the demand forecast for the PTA market
* general price increase/decrease of 10%
* operating costs increase/decrease of 10%
* copper price increase/decrease of 10%
* expenditure on fixed assets increase/decrease of 10%
* general sales decreases of 10% and 20%.

The results of the sensitivity analysis (on IRR without financing) are presented in Table 10.38.

The analysis of variations in the price discount (relative to European imports) for sales to PTA markets shows that:

* the Romanian mill project is not very sensitive to such changes, since 80% of capacity is sold outside the PTA
* the three projects achieve an acceptable rate of return only with a price premium over European imports of between 5 and 15%.

TABLE 10.38 - SENSITIVITY ANALYSIS

	Romanian Mill		Small Mill with New Plant and Equipment		Small Mill with Second Hand Plant and Equipment	
	IRR (%)	NPV at 12% ($'000s)	IRR (%)	NPV at 12% ($'000s)	IRR (%)	NPV at 12% ($'000s)
Base Case	10.61	-3,653	6.27	-3,992	8.59	-2,126
Variations in the Price Discount Rate (Base Case = 5% Discount)						
No price discount	10.97	-2,733	8.05	-2.864	10.46	-998
5% premium	11.32	-1,812	9.69	-1,737	12.19	129
10% premium	11.67	-892	11.21	-610	13.81	1,256
15% premium	12.01	28.51	12.65	518	15.33	2,384
10% discount	10.25	-4,574	4.32	-5,119	6.55	-3,253
15% discount	9.87	-5,494	2.15	-6,246	4.29	-4,380
Variations in Competition from Radiator & Tinning (Base Case= 20% Zimbabwean market 15% other adjacent PTA markets)						
Scenario 1: 80% Zimbabwe, 50% others	10.04	-5,064	2.77	-5,919	4.95	-4,053
Scenario 2: 50% Zimbabwe, 30% others	10.34	-4,333	4.72	-4,901	6.96	-3,036
Variations in Demand Forecast For PTA Market (Base Case = 3% pa)						
Scenario 1: 1% pa	10.00	-5,135	2.43	-5,866	4.88	-3,887
Scenario 2: 5% pa	11.36	-1,729	8.23	-2,697	10.70	-831
Other Variations						
Sales price increase @ 10%	15.42	9,905	9.69	-1,734	12.19	129
Sales price decrease @ 10%	4.58	-17,200	2.15	-6,246	4.29	-4,380
Operating costs increase @ 10%	5.90	-15,165	2.36	-6,140	4.39	-4,377
Operating costs decrease @ 10%	14.30	6,454	8.30	-2,645	10.72	-815
Copper price increase @ 10%	7.43	-11,299	4.50	-5,025	6.74	-3,159
Copper price decrease @ 10%	13.44	3,992	7.90	-2,958	10.31	-1,092
Expenditure on fixed assets increase @ 10%	9.50	-5,774	5.39	-4,892	7.66	-2,876
Expenditure on fixed assets decrease @ 10%	11.88	-292	7.25	-3,091	9.65	-1,376
Sales decrease @ 10%	5.15	-16,121	-0.93	-7,131	1.26	-5,265
Sales decrease @ 20%	-2.17	-28,590	-7.49	-9,089	-5.69	-7,223

The impact of this price premium will be offset by a reduction in sales arising from imports. For this reason, we believe it is unrealistic to proceed on the basis of selling products at prices above those of European imports.

The effect of variations in the level of competition from Radiator & Tinning was evaluated under two scenarios:

* Radiator & Tinning has 80% of the Zimbabwean market, and 50% of adjacent markets

* Radiator & Tinning has 50% of the Zimbabwean market, and 30% of adjacent markets.

Both scenarios have little impact on the Romanian project, since over 80% of sales are outside the PTA. However, the effect is quite marked for the small mill, which is clearly very sensitive to any fall of sales.

This is also clear from the sensitivity analysis of variations in demand forecasts for the PTA market. Two scenarios were examined in addition to the base case: 1% pa and 5% pa growth. Again, there is little impact on the Romanian project, but the effect is significant for the small mill option. It should be noted, however, that neither of the two small mill projects would produce IRR's in excess of 12% with 5% pa growth in PTA demand. With 5% pa growth in the market, the small mill could add a third shift by Year 9 which would improve the situation. In our view, however, it is unrealistic to assume such a high level of growth for a region currently experiencing severe economic problems.

The other results show that projects are more sensitive to changes in prices and operating costs, than expenditure on fixed assets. This is unfortunate from the point of view of negotiating with suppliers of plant and equipment and with contractors.

Both small mill options produce IRRs lower than 12% in all cases, with the exception of a price increase of 10% in the case of the small mill with second hand plant and equipment. This is probably an unrealistic assumption since the price of copper sheet and strip is heavily influenced by the price of copper, and a price movement in one will be followed or preceded by a similar price movement in the other.

A few cases produce IRRs in excess of 12% for the Romanian mill. However, the validity of these scenarios is questionable. A decrease in operating costs or the price of copper should, realistically, be matched with a similar decrease in the price of copper sheet and strip. A decrease in operating costs, other than copper, has very little effect on the viability of the projects.

An IRR of 11.88% with a decrease in expenditure on fixed assets is encouraging, but the quoted price for the Romanian plant and equipment may in fact be an underestimate (see Section 6.3.1). A decrease in expenditure on fixed assets, while improving the figures for the small mill, does not produce a rate of return over 12%.

The effect of changing the design of the small mill production process to include only one rolling mill (as suggested by UNIDO) was also considered. Although this design would lower productivity, it would save about 15% on the cost of plant and equipment, installation and commissioning. The analysis shows, however, that a saving of 39% on these costs would be necessary to produce a rate of return of 12% for the second hand plant. In our view, such savings would not be achievable.

All options are <u>very</u> sensitive to variations in sales. This is particularly important to bear in mind with regard to the Romanian mill, where sales well in excess of that needed to pay off the Romanian credit, have been assumed. Sales of about 7,000 tonnes would be needed between 1995 and 2002 to cover the repayment of the Romanian loan of $20 million. This is only 10% of the 69,000 tonnes projected sales throughout the period.

Note that the impact of sales increases had not been examined. The reason for this is that each mill option is operating very close to capacity in every year after the first 3 or 4. It is unrealistic to postulate a significant sales increase. An increase of only 5% would bring the small mill up to 100% capacity in every year (although there is scope for adding a third shift). This is equally true of the Romanian mill.

11. ECONOMIC EVALUATION

11.1 Approach to the Economic Analysis

The aim of economic analysis in project evaluation is, taken over a large number of projects, to direct the allocation of resources in such a way as to assist in the achievement of national development objectives. Since, from the national standpoint, money values are an imperfect measure of resource costs and prices, it is necessary to have a common unit of account, or numeraire, in terms of which everything is measured. The use of economic cost-benefit analysis arises from the need to express costs and prices in terms of this numeraire by adjusting for distortions in product and factor markets caused by market imperfections and the effects of fiscal measures.

The economic evaluation for this study was carried out within the framework of an approach,(1) which is now the generally accepted World Bank method for the economic evaluation of projects in all sectors. The numeraire in this method is uncommitted government income measured in terms of foreign exchange. This is expressed at border prices by converting into domestic currency at the official exchange rate. The methodology involves the separation of benefits and costs into traded, potentially traded and non-traded goods. Traded goods are valued directly at border prices. Some adjustment may then need to be made to these prices to allow for transportation and handling, depending upon the common point of valuation. Potentially traded goods may be valued directly at border prices or treated as non-traded depending upon how trade policy in the goods

(1) Project Appraisal and Planning for Developing Countries, by IMD Little and JA Mirlees.
Economic Analysis of Projects, by Lyn Squire and H van der Tak (World Bank Publications).

is expected to change, if at all, over the evaluation period of the project. With respect to non-traded goods, the principle is to break them down into their traded and non-traded elements until only the primary traded and non-traded components are left. In practice, it is usually only necessary to break down each non-traded good once, value the traded elements at border prices and value the non-traded elements in terms of the numeraire by multiplying by the appropriate conversion factor.

Domestic price distortions are adjusted for by netting out the effects of all taxes, duties, subsidies and similar types of transfers within the economy, which represent a financial cost to those paying the tax, but do not reflect the consumption of economic resources.

11.2 Conversion Factors and Economic Costs

Conversion factors are required, in the absence of more detailed information, to change the value of non-traded costs and benefits measured at domestic market prices into their border price values. A value multiplied by a conversion factor retains its domestic currency denomination but this domestic currency now represents the value of the good at border prices or its foreign exchange equivalent value. The standard conversion factor (SCF) is a weighted average for the whole economy and is used to estimate the economic prices of goods which cannot be directly revalued at border prices because of inadequate data. The SCF is equivalent to the inverse of the shadow exchange rate.

There was insufficient information available to be able to estimate a complete range of conversion factors from primary data. However, the Indeco Economic Evaluation Unit has developed conversion factors for the most important items, as follows:

	Conversion factor
Land	1.00
Construction	0.80
Local machinery and equipment	0.85
Management and supervisory labour	1.00
Skilled labour	0.96
Semi-skilled labour	0.67
Unskilled labour	0.50
Power	0.80
Fuel	1.00
Water	0.95
Transport	0.80

These conversion factors were adopted for the purposes of this evaluation. However, the SCF was recalculated using the latest available data. Table 11.1 sets out the base data used. This yielded a five year average SCF of 0.86. which is comparable with values used by the World Bank for countries at similar stages of development in east and southern Africa.

11.3 Valuation of Cash Flows

Starting with the cash flows in constant price terms at market prices, as set out in Section 10, each of the individual elements of the cash flow items were revalued in economic terms in accordance with the foregoing principles. The factory gate was taken as the common point of valuation for all project inputs and output.

The copper cathode raw material inputs represent a potentially tradeable commodity and were therefore valued in terms of their opportunity costs to the Zambian economy. This was based on the LME price less sea and land freight charges; the Kwacha road freight costs within Zambia being adjusted by means of the conversion factor for transport. For the other inputs, the foreign exchange and local currency elements were separated, the local components being multiplied by the relevant conversion factor

TABLE 11.1 - DATA USED IN THE ESTIMATION OF THE STANDARD CONVERSION FACTOR
Value in the Year (K million)

Item	1982	1983	1984	1985	1986	Total
Value of exports (fob)	880.2	1204.1	1650.0	2502.5	5366.6	11603.4
Value of imports (cif)	932.0	895.2	1108.0	1793.8	4028.6	8757.6
Taxes on foreign trade:						
Sales tax	58.7	44.5	64.5	157.0	414.6	739.3
Customs duties	42.3	38.8	63.2	138.6	406.8	689.7

Source: Bank of Zambia, Annual Report and Statement of Accounts, 1987 or the SCF, as appropriate. For electricity and water, the respective specific conversion factors were used. Manpower costs were broken down into the managerial, skilled, semi-skilled and unskilled elements and the appropriate conversion factors applied.

On the revenue side, domestic sales were valued in terms of foreign exchange on the basis of the cif prices of imported copper sheet and strip, since they represent import substitution. For sales to the PTA countries, the foreign exchange element of revenue was separated out and added to the local currency element adjusted by the SCF. Sales to Romania were based on the LME prices of sheet and strip, adjusted for sea freight charges and appropriately converted land transportation costs.

11.4 Results of the Economic Evaluation

The forecast cash flows in economic prices for the Romanian mill and the two small mill options are set out in Tables 11.2, 11.3 and 11.4 respectively. The results of the DCF analyses for each option are summarised in Table 11.5.

The internal rate of return for each of the options is below the minimum Indeco economic opportunity cost of capital requirement of 12%. The rates of return for the smaller mill options, at 4.8% for the new mill and 7.0% for the reconditioned mill, are such that these cannot be considered to be viable projects in economic terms. On the other hand, the rate of return on the Romanian mill investment of 11.1% is sufficiently close to the cut-off rate to warrant further consideration.

TABLE 11.2 - CASH FLOWS BEFORE FINANCING IN ECONOMIC PRICES (Romanian Mill)

All Values in $ '000s (Constant Prices)

ITEM : CASH FLOWS IN CONSTANT MID 1988 PRICES ($ '000)															
Expenditure in Foreign Currency ($)	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Fixed Assets	2948.57	12966.44	10799.90	6778.66	7240.45	575.00									
Pre-production & Special Expenses	42.00	56.00	28.00	164.00											
Increase in Working Capital				0.00	535.02	415.69	826.73	17.00	17.00	0.90	0.90	0.90	0.90	0.90	0.89
Operating Costs				0.00	375.35	459.02	1325.95	1329.09	1332.23	1333.70	1335.36	1336.84	1338.50	1339.97	1258.22
Total Cash Out	2990.57	13022.44	10827.90	6942.66	8150.82	1449.71	2152.68	1346.09	1350.02	1342.60	1336.26	1345.73	1347.40	1348.07	1267.11
Revenue in Foreign Currency				0.00	11197.97	20617.78	32988.45	[illegible]	33417.56	33524.04	33632.11	33739.39	33846.67	33953.95	34061.23
Net Foreign Cash Flow	-2990.57	-13022.44	-10827.90	-6942.66	3047.15	19168.07	30835.76	31856.11	32067.53	32187.24	32295.85	32393.66	32499.27	32605.08	32794.12

ITEM : CASH FLOWS IN CONSTANT MID 1988 PRICES ($ '000)															
Expenditure in Local Currency ($)	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Fixed Assets	424.52	2521.76	1311.30	522.76	251.07										
Pre-production & Special Expenses	102.34	86.00	79.00	119.26	0.00										
Increase in Working Capital				0.00	1025.22	771.06	1102.01	30.94	30.94	15.46	15.48	15.46	15.48	15.46	-0.37
Operating Costs				0.00	9536.04	16199.68	24932.93	25199.93	25467.04	25600.48	25734.04	25867.59	26001.05	26134.59	26099.57
Total Cash Out	526.86	2607.76	1390.30	642.02	10812.32	16970.73	26034.94	25230.87	25497.98	25615.93	25749.53	25883.05	26016.53	26150.05	26099.20
Revenue in Local Currency				0.00	635.50	1059.20	1694.70	1906.60	2118.40	2224.40	2330.30	2436.20	2542.10	2648.00	2754.00
Net Local Cash Flow	-526.86	-2607.76	-1390.30	-642.02	-10176.82	-15911.53	-24340.24	-23324.27	-23379.58	-23391.53	-23419.23	-23446.85	-23474.43	-23502.05	-23345.20
TOTAL NET CASH FLOW ($)	-3517.42	-15630.20	-12218.20	-7584.67	-7129.68	3256.54	6495.53	8531.84	8687.95	8796.70	8868.62	8946.81	9024.84	9103.03	9448.92

Internal Rate of Return on Total Net Cash Flow = 11.097 %

Net Present Value @ 8 % = 10957.55

Net Present Value @ 10 % = 3293.34

Net Present Value @ 12 % = -2320.97

TABLE 11.3 - CASH FLOWS BEFORE FINANCING IN ECONOMIC PRICES (Small Mill with New Plant & Equipment)

All Values in $ '000s (Constant Prices)

ITEM	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
CASH FLOWS IN CONSTANT MID 1988 PRICES ($ '000)															
Expenditure in Foreign Currency ($)															
Fixed Assets	840.56	4913.78	4340.79	347.70	97.75	0.00									
Pre-production & Special Expenses	30.00	45.00	130.00	5.00	0.00										
Increase in Working Capital				35.12	33.16	91.50	49.84	3.60	3.84	3.96	4.07	4.20	4.22	4.46	4.59
Operating Costs				165.43	175.00	371.06	386.10	324.65	325.79	327.04	328.30	329.46	302.07	304.24	305.53
Total Cash Out	890.56	4958.78	4470.79	553.25	306.79	462.56	435.94	328.25	329.64	331.00	332.27	333.66	307.09	308.70	310.12
Revenue in Foreign Currency				495.68	1156.58	1487.03	2478.38	2552.73	2629.31	2708.19	2789.44	2873.12	2959.32	3048.10	3139.54
Net Foreign Cash Flow	-890.56	-4958.78	-4470.79	-57.57	849.79	1024.47	2042.44	2224.48	2299.68	2377.20	2457.17	2539.46	2652.22	2739.40	2829.42
CASH FLOWS IN CONSTANT MID 1988 PRICES ($ '000)															
Expenditure in Local Currency ($)															
Fixed Assets	114.38	522.92	470.84	35.64	0.00										
Pre-production & Special Expenses	68.00	89.15	102.60	6.45	0.00										
Increase in Working Capital				80.06	80.54	53.61	124.46	2.82	9.34	9.62	9.90	10.21	7.74	10.03	11.15
Operating Costs				1197.32	1949.97	2276.76	3510.01	3468.37	3555.80	3645.86	3730.61	3834.16	3876.42	3977.79	4082.18
Total Cash Out	183.18	612.07	573.44	1320.26	2030.50	2330.37	3634.47	3471.18	3565.14	3655.48	3740.52	3844.36	3883.66	3988.62	4093.33
Revenue in Local Currency				490.20	1143.80	1470.60	2451.00	2524.50	2600.30	2678.30	2758.60	2841.40	2926.60	3014.40	3104.90
Net Local Cash Flow	-183.18	-612.07	-573.44	-830.06	-886.70	-859.77	-1183.47	-946.68	-964.84	-977.18	-989.92	-1002.96	-957.06	-974.22	-988.43
TOTAL NET CASH FLOW ($)	-1073.74	-5570.85	-5044.23	-895.64	-36.92	164.70	858.98	1277.80	1334.84	1400.01	1467.25	1536.50	1695.16	1765.18	1840.99

Internal Rate of Return on Total Net Cash Flow	=	4.037 %
Net Present Value @ 8 %	=	-2776.71
Net Present Value @ 10 %	=	-3096.03
Net Present Value @ 12 %	=	-4600.90

TABLE 11.4 - CASH FLOWS BEFORE FINANCING IN ECONOMIC PRICES (Small Mill with Second Hand Plant & Equipment)

All Values in $ '000s (Constant Prices)

ITEM	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	CASH FLOWS IN CONSTANT MID 1988 PRICES ($ '000)														
Expenditure in Foreign Currency ($)															
Fixed Assets	665.06	3740.70	3754.29	347.70	97.75	0.00									
Pre-production & Special Expenses	30.00	45.00	130.00	5.00	0.00										
Increase in Working Capital				34.29	32.75	75.44	49.15	3.67	3.80	3.91	4.02	4.15	4.23	4.40	4.53
Operating Costs				165.01	175.30	326.10	340.98	279.52	280.65	281.09	283.04	284.29	257.69	259.05	260.33
Total Cash Out	695.06	3785.70	3884.29	552.00	305.03	401.54	390.13	283.19	284.45	285.00	287.06	288.44	261.92	263.45	264.86
Revenue in Foreign Currency				494.88	1156.50	1407.03	2470.38	2552.73	2629.31	2708.19	2789.44	2873.12	2959.32	3048.10	3139.54
Net Foreign Cash Flow	-695.06	-3785.70	-3884.29	-57.12	850.75	1005.49	2080.25	2269.54	2344.87	2422.40	2502.38	2584.68	2697.40	2784.64	2874.68

ITEM	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	CASH FLOWS IN CONSTANT MID 1988 PRICES ($ '000)														
Expenditure in Local Currency ($)															
Fixed Assets	114.30	522.92	470.84	35.64	0.00										
Pre-production & Special Expenses	60.00	89.15	102.60	6.45	0.00										
Increase in Working Capital				88.73	80.95	50.81	125.15	2.74	9.39	9.67	9.95	10.26	7.23	10.88	11.20
Operating Costs				1172.36	1925.94	2254.39	3487.78	3446.17	3533.61	3623.68	3716.44	3811.99	3854.27	3955.65	4660.05
Total Cash Out	183.10	612.07	573.44	1303.18	2006.89	2305.20	3612.94	3448.91	3543.00	3633.35	3726.39	3822.25	3861.50	3966.53	4671.25
Revenue in Local Currency				490.20	1143.80	1470.60	2451.00	2524.50	2600.30	2678.30	2758.60	2841.40	2926.60	3014.40	3104.90
Net Local Cash Flow	-183.10	-612.07	-573.44	-812.98	-863.09	-834.60	-1161.94	-924.41	-942.70	-955.05	-967.79	-980.85	-934.90	-952.13	-1566.35
TOTAL NET CASH FLOW ($)	-878.24	-4397.85	-4457.73	-870.10	-12.35	250.89	926.31	1345.13	1402.17	1467.34	1534.59	1603.84	1762.56	1832.51	1308.33

Internal Rate of Return on Total Net Cash Flow	=	7.027 %
Net Present Value @ 8 %	=	-764.76
Net Present Value @ 10 %	=	-2043.11
Net Present Value @ 12 %	=	-2893.71

TABLE 11.5 - RESULTS OF THE ECONOMIC ANALYSES

Criterion	Romanian Mill	Small Mill with New Plant & Equipment	Small Mill with Second Hand Plant & Equipment
Internal Rate of Return (IRR)	11.1%	4.8%	7.0%
Net Present Value (NPV)			
@ 8.0%	-$10.96m	-$2.78m	-$0.76m
@ 10.0%	-$ 3.29m	-$3.90m	-$2.00m
@ 12.0%	-$ 2.32m	-$4.68m	-$2.89m

Source: WS Atkins

Gross value added by the Romanian project increases from $2.8 million (in constant prices) in 1993 (first year of operation) to $10.5 million by the end of the project period (Table 11.6).

TABLE 11.6 - ROMANIAN MILL: VALUE ADDED CALCULATION

All values in $'000s (Constant Prices)

	1993	2007
Sales	11936	38180
Less: Cost of Materials	8167	25591
: Cost of Spares etc.	186	1272
: Consumables	105	105
: Insurance	679	679
Gross Value Added	2799	10533

Source: WS Atkins

11.5 Foreign Exchange Effects of the Project

The preferred option, the Romanian mill, would have two important benefits for the Zambian economy:

* direct net foreign exchange earnings amounting to some $30 million per annum at mid 1988 prices in 1995

* an annual import substitution of copper sheet and strip totalling approximately $1.5 million at mid 1988 prices by 1995.

Table 10.13 shows the foreign exchange cash flows for the Romanian mill. This cash flow does not include the foreign exchange benefits resulting from the import substitution effect. The cash flow yields an IRR of 38% and an NPV of $90.1 million at 1988 prices. It is therefore clear that the project would generate substantial net foreign exchange benefits for the Zambian economy.

11.6 Employment Effects of the Project

Over the last decade employment opportunities in Zambia have not expanded to keep pace with the rate of growth of the labour force. In fact aggregate employment in the formal sector declined from a peak of some 381,000 in 1981 to around 361,000 in 1986. This has resulted in an increasing proportion of the economically active population remaining unemployed or grossly under-employed. In addition, because of the slow expansion of the country's industrial base, a large majority of the population continues to derive its income from activities with relatively low productivity. The problem may be characterised as one in which a large number of potential entrants to the modern sector have, of necessity, been absorbed into slow-growing sectors, such as traditional agriculture, artisanal manufacturing and low productivity service activities.

A principal effect of the construction of the Romanian Mill would be the generation of a significant number of new relatively high productivity employment opportunities, initially during the construction of the works and subsequently during its operation. It is estimated that the Romanian Mill option would give rise to some 214 permanent employment opportunities, as indicated in Table 8.3.

It is projected that 14 of these posts wouuld be taken by expatriates at the outset due to the shortage of suitably qualified and experienced Zambians. However, the majority of these posts could probably be localised in the medium term.

Whilst the impact of the project on employment outside the works is difficult to quantify, it is nevertheless potentially very significant. Studies in a number of both newly industrialising and developed countries have demonstrated that non-ferrous metals industries show a relatively high degree of interdependence as measured by the number of forward and backward linkages with other industries. The industries serving the works will be stimulated, as will transport and infrastructure facilities. The industries directly serving the works will include the copper refining industry, gas and electricity supply industries, firms supplying components and consumables and professional and other services. The purchases by the mill from other industries in Zambia may be derived from the statement of operating costs for the works (Table 10.7). At full output domestic purchases amount to some $25.4 million.

Forward linkages generated will include increases in capacity in the downstream industries induced by the reliability of the new source of supply, and its availability in local currency. The existing downstream industries include principally, geyser manufacture, copperwares and radiator assembly, together with some electrical component firms.

The new works and the linked industries will also induce tertiary employment. Induced tertiary activities will include such social and commercial activities as local administration, shops, banking and insurance services, educational, medical, cultural and sporting facilities.

An indication of the secondary and subsequent increases in employment in linked industries is given by the use of the employment multiplier. Employment multipliers may be derived by operating on an extended input-output matrix for the economy. Two types of multiplier are generally derived; Type 1 multipliers, which give the ratio between the direct and indirect employment changes to the initial direct employment change, and Type 2 multipliers which include the expenditure induced employment in the numerator. Such data were not available in Zambia and have been estimated for relatively few countries. However, World Bank Staff Working Paper No. 255 The Employment Impact of Industrial Investment quotes Type 1 and Type 2 multipliers which were developed for South Korea in the 1970's. To the extent that indutrial linkages in a newly industrialising Zambia are expected, over the next two decades, to eventually bear some resemblance to a more industrialised developing economy the comparison is relevant. The relevant multipliers for non-ferrous metals industries were as follows:

Type 1 Multiplier (Direct plus indirect employment)	3.00
Type 2 Multiplier (Direct plus indirect plus induced employment).	5.09

Based on these indicative multipliers, the new permanent employment opportunities generated by the Romanian mill may be summarised as follows:

	New Employment Opportunities
Within the new Mill	214
Within linked industries	428
Expenditure induced employment	447
Total Employment Generated	1089

It should be emphasised that these figures can only be indicative estimates. It should also be noted that multiplier analysis neglects the possible existence of supply constraints, including skilled labour, foreign exchange and savings, and gives no indication of the timing of the changes involved. Since the employment creation would necessitate some expansion in the capacity of existing downstream industries, and the development of new copper strip and sheet consuming industries, it is considered that the changes involved would not be substantially completed until at least 10 years from the start-up of the mill.

12. CONCLUSIONS AND RECOMMENDATIONS

The major conclusions of the study may be summarised as follows:

* investment in capacity to manufacture copper tubes is not recommended. The Zimbabwean company, Almin, has entered successfully this market, and could supply a large percentage of demand within the PTA. Moreover, both Zamefa (Zambia) and Booth Manufacturers (Kenya) have the capacity to produce tubes

* investment in capacity to manufacture copper and brass bars, shapes and sections is also not recommended. There are three existing producers in both Zambia and Zimbabwe, and one in Kenya, and these have sufficient capacity to cope with demand within their markets for the foreseeable future

* there is a market opportunity in the manufacture of copper and brass sheet, strip and foil. There are growing markets for rolled products in the region, particularly in radiator and geyser applications. There is also very little local competition. The feasibility of manufacturing rolled products in Zambia merits further investigation

* a Zambian manufacturer of rolled products will be heavily dependent on the PTA market, where high tariff barriers provide protection against third country imports. In major world markets, it will be at a competitive disadvantage, primarily because market requirements are so varied and different to the PTA, because customers demand just-in-time delivery, and because domestic producers, using scrap, have lower raw material costs

* the current consumption of copper sheet, strip and foil in the PTA market is estimated at 835 t/pa. Applying a multipler of 2.0 where copper products are purchased in local currencies, and allowing for competition from existing producers in the region, the current market available to a Zambian manufacturer of rolled products is estimated at 1,080 t/pa. This is projected to grow at 3% pa, giving a potential market of about 1,500 t/pa in the year 2000

* a mill with a capacity of 10,000 t/pa, as proposed by the Romanians, would need to sell outside the PTA the majority of its output. To operate near full capacity, sales of about 8,000 t/pa are needed to Romania, or other third countries

* a sensible alternative to examine, is a smaller mill oriented to the PTA market. The mill specified is this study has a capacity of 750 t/pa with one shift working, 1,500 t/pa with two, and 2,250 t/pa with three shift working. Both this and the Romanian mill are small by Western standards

* the technology specified for the Romanian mill is conventional, with the exception of the proposal to use a single mill for both hot and cold rolling. While this measure does reduce the capital cost of the project, it does have certain disadvantages, notably the delay imposed on the flow of product through the plant which results in high working capital costs

* the suggested technology for the small mill follows practices which are now largely outdated. It is proposed only as a possible means for satisfying the regional market, with minimum capital investment. There are significant inefficiencies associated with the use of cold rolling only in the reduction process, static casting, and cross rolling to produce wide sheet

* capital costs for the project, including plant and equipment, structures and civil engineering, pre-production expenses and contingencies are estimated as follows:

  - Romanian mill : $ 48.3 million
  - Small mill with new plant and equipment : $ 12.5 million
  - Small mill with second hand plant and equipment : $ 10.5 million

* the small mill options produce poor internal rates of return, well below the Indeco cut-off point of 12%. Payback, simple rate of return and IRR (with financing) figures are also very poor. The financial statements show high debt:equity ratios and unsatisfactory current and liquidity ratios. The projects are clearly not profitable and can be rejected. The break even analysis demonstrates that, while the mills are not uneconomically small from a production point of view, they are too small for the proposed financing scenario

* the Romanian mill produces an internal rate of return of 10.6%, which increases to 11.9% if capital costs are reduced by 10%. The financial statements and calculations of payback, break even and IRR (with financing) all show substantial improvements over the small mill options, although the project will still look vulnerable to investors and creditors

* <u>the main problem with the Romanian mill is that all the indications of commercial profitability are very sensitive to sales</u>. It has been assumed that 80% of the mill's output will be sold to Romania. We have no clear indication whether this would be acceptable, but it is well in excess of the sales needed to cover the Romanian credit. If sales are significantly less than those assumed, the project will be unprofitable

* all the projects suffer from a financing scenario which assumes no foreign equity participation, and no soft term loans except for the Romanian credit. For example, if the loans required for the Romanian mill over and above the Romanian credit, were supplied at an interest rate of 10% rather than 15%, the IRR in real terms (with financing) would improve from 7.5% to 10.9%. Similarly, if equity is increased from 15% of investment costs to 25%, the IRR in real terms (with financing) improves to 9.4%. Nevertheless, the financing scenarios assumed are, in our opinion, realistic

* the Romanian mill produces an IRR on the net cash flow in economic prices of 11.1%. This is sufficiently close to the Indeco cut-off point of 12% to justify further consideration of the project. The small mill options produce poor IRR's in economic prices, and can be eliminated

* the Romanian mill is attractive from the point of view of forex earnings. The forex cash flow (excluding the effects of import substitution) produces an IRR of 38%

* employment opportunities induced by the Romanian project within linked industries and elsewhere in the economy are likely to be very significant. They are estimated at 875, compared to 214 jobs within the mill.

The major recommendations of the study are as follows:

* the small mill options are unprofitable, and should be rejected

* although the Romanian mill does not meet the Indeco requirements for IRR either in economic or market terms, it does merit further investigation, because of the substantial net forex earnings. However, a final decision cannot be made until the full details of the Romanians' commercial offer are known. The key is the volume of sales which the Romanians

will accept (either as direct imports to Romania, or as re-exports). Anything significantly lower than 80% of the plant's output will render the project unprofitable. It will also be important to clarify the terms of the Romanian credit, and obtain a firm quotation for the plant and equipment

* Indeco should seek matching equity participation from the Romanians. This would improve significantly the project's acceptability from a financial point of view, and its attractiveness to creditors

* further attention should be directed towards secondary industries. A good example is the manufacture of copper and brass components (plumbing fittings, electrical contacts, nuts and bolts). Unlike copper semis manufacture, this type of industry requires comparatively little capital investment. With the recent expansion at Zamefa, the main raw material, copper and brass bars, can be sourced locally. Industries established in Kenya or Zimbabwe would have similar advantages, however, so a Zambian manufacturer could face significant competition within the PTA market. Nonetheless, the feasibility of such a project is well worth testing.

APPENDIX I - LIST OF EQUIPMENT FOR ROMANIAN MILL

3.3. SELLER'S SUPPLY

Item No.	Unit Designation	Pcs.	Weight tons
0	1	2	3
1.	Guillotine shear for cathode cutting	1	61
2.	Compound melting - soaking-casting semi-continuous line		
2.1.	Melting furnaces 1.5 t/h	2	35
2.2.	Soaking furnace 5 t	1	30
2.3.	Semi-continuous casting machine	1	29
3.	Circular saw for copper slab cutting	1	83
4.	Saw blade sharpening machine	1	1.8
5.	Walking beam furnace for the heating of the composed copper slabs		
3.1.	Driving mechanism for the furnace beam, sliding table, slab unpiler, copper slab pusher		78
3.2.	Walking beam furnace for the heating of the copper slabs (steel structure)etc. according to 3.1.5.		271
6.	Two-high-four-high reversing mill; hot-cold		
6.1.	Two-high - four-high, rolling stand	1	375
6.2.	Stand driving group	1	180
6.3.	Stand roll changing mechanism	1	36
6.4.	Roller tables (according to item 3.1.6.4. - 3.1.6.6.)	-	300
6.5.	Flat strip kicker	1	68
6.6.	Flat strip cooling tank	1	12
6.7.	Piler and unpiler for flat strips (according to item 3.1.6.9. and 3.1.6.10)	-	121

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0	1	2	3
6.8.	U n c o i l e r	1	27
6.9.	Pre-straightening machine	1	20
6.10.	C o i l e r	2	100
6.11.	Coil car	3	75
6.12.	Roller tables at stand	2	100
6.13.	Cover plates		112
6.14.	Vapour discharge unit at stand		26
6.15.	Emulsion cooling unit		24
6.16.	Hydraulic units		19
6.17.	Lubrication units (items 3.1.6.20 - 3.1.6.22)		20
6.18.	Electrical drives		115
6.19.	First outfit rolls ∅ 850 - 1200, equipped	4	72
	∅ 850 - 1200, non-equipped	4	40
	∅ 450 x 1200, equipped	6	36
	∅ 450 x 1200, non-equipped	20	60
	∅ 1020x1200, equipped	4	100
	∅ 1020x1200, non-equipped	2	29
7.	Flat strip straightening and milling line		
7.1.	Starting roller table	1	25
7.2.	Straightening machine	1	70
7.3.	Run-in roller table	1	25
7.4.	End cutting shear	1	40
7.5.	Run-out roller table from the milling machine	1	25
7.6.	Plate tilter	1	20

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0	1	2	3
7.7.	Transfer roller table, parallel to the milling line centerline	1	45
7.8.	Hydraulic, lubrication drives	1	33
7.9.	Plate milling machine proper	1	90
8.	Bell-type furnace for strip coil annealing, electrical with protective gas		
8.1.	Refractory brickwork with Fe_2O_3 below it	-	33
8.2.	Steel structure	ass'ies 3	60
8.3.	Refractory steel muffles and supports	3	24
8.4.	Vacuum cooling unit and protective gas unit	3	45
8.5.	Fan and recirculation bases	9	19
8.6.	Vacuum pumps	3	1
8.7.	Electrical resistors	3	1
8.8.	Instrumentation	3	2
9.	Coil tilter	1	16
10.	Electrical continuous furnace with roller hearth for Cu plate annealing in packs		
10.1.	Run-in conveyor	2	50
10.2.	Run-in - run-out roller table	2	40
10.3.	Roller drive mechanism in the furnace	1	10
10.4.	Refractory and heat insulating brick-work	ass'y 1	10
10.5.	Furnace steel structure	1	28

0	1	2	3
10.6.	Cooling, run-in and run-out unit for the protective gas	1	8
10.7.	Rollers in the furnace	1	7
10.8.	Protective gas station 150 m^3/h	1	15
10.9.	Electrical resistance, instrumentation	1	2
11.	Combined slitting and cutting-in coil line		
11.1.	Stocking ramp	1	2
11.2.	Coil car	1	2
11.3.	U n c o i l e r	1	12
11.4.	Slitting shears	1	14
11.5.	Side chopper	1	3
11.6.	Scrap run-out car	1	1
11.7.	Looping table and connection elements	1	4
11.8.	Strip brake	1	2
11.9.	C o i l e r	1	18
11.10.	Coil car	1	2
11.11.	Coil receiving device	1	4
11.12.	Straightening machine	1	11
11.13.	Roller curve table	1	4
11.14.	Cutting shears	1	9
11.15.	Stop conveyor	1	3
11.16.	Piling device	1	2
11.17.	Hydro-pneumatic, lubrication, electrical units	1	7
11.18.	Anchoring, covering parts	1	10
12.	Baling press	1	59
13.	Roll grinding machine	1	75
14.	Cutter sharpening machine	1	1
15.	Spare parts for 2 years		

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APPENDIX III

4. UNITS NOT INCLUDED IN THE OFFER

The following are not included in the Offer:

- lifting and transport means (overhead cranes);
- weighing machines, scrap buckets;
- ventilation units for furnaces, cellars, electrical rooms;
- equipment for electrical supplies, 11 kV cells, 0.4 kV distribution panel, supply transformers of 11/0.4 kV; accumulator batteries, power factor compensating unit (cos.ø);
- telephony unit;
- electrical cables;
- fire sensing and signalling unit;
- intercommunication unit;
- industrial television equipment;
- earthing networks;
- steel structures for electrical cable support;
- continuous foundations, cellars;
- supply and networks for water, compressed air, methane gas;
- erection and erection tools.