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United Nations Industrial Development Organization
Vienna

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(1 of 3)

RESTRICTED
December 1990
English

DEVELOPMENT AND RATIONALIZATION OF SMALL SCALE STEEL PLANTS IN THE PTA REGION

DP/RAF/88/072

TERMINAL REPORT

Prepared for the P.T.A.
by the United Nations Industrial Development Organization
acting as executing agency
for the United Nations Development Programme

Based on the work of R. Stefec & team,
Polytechna Corp. subcontractors

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EXPLANATORY NOTES

Exchange rates of local currencies and an explanation of abbreviations are given below.

A. Local currencies

Values of the local currencies during the period of the two field missions in terms of United States dollars (US $) were as follows:

Kenya	1 US $ ... 21.50 KES (March/April, 1990)
Mauritius	1 US $ ... 14.83 MUR (November/December, 1989) 1 US $ ... 13.85 MUR (April/May, 1990)
Mozambique	1 US $ ... 800 MZM (November, 1989) 1 US $ ... 905 MZM (April, 1990)
Tanzania	1 US $ ... 144 TSh (November, 1989) 1 US $ ... 192 TSh (April, 1990)
Zimbabwe	1 US $ ... 2.36 ZWD (April, 1990).

B. Abbreviations

B.1 Technical abbreviations

A.C.	alternating current
BEU	big-end-up (ingots)
BF	blast furnace
CC	continuous casting; continuously cast (billets)
dia.	diameter
DRI	direct reduction iron

EAF	electric arc furnace
LD	Linz-Donawitz (oxygen converter process)
SL/RN	Stelco-Lurgi-Republic Steel-National Lead DRI process
UTS	ultimate tensile strength
YS	yield strength

B.2 Acronyms and local abbreviations

ALAF	Aluminium Africa Limited
BS	British Standard
CIFEL	Companhia Industrial de Fundicao e Laminagem S.A.R.L.
GDP	gross domestic product
GPT	gross production time
IDDA	Industrial Development Decade for Africa
KES	Kenya shilling
KS	Kenya Standard
KUSCO	Kenya United Steel Corporation Limited
MUR	Mauritius rupee
MS	Mauritius Standard
MZM	Mozambique Metical/Meticais
NDC	National Development Corporation
NPT	net production time
PTA	Preferential Trade Area for Eastern and Southern African States
R.S.A.	Republic of South Africa
SRM	Steel Rolling Mills Limited
TISCO	Tanzanian Industrial Consulting Studies Organization
TMD	total mill delays
TSh	Tanzanian shilling
ZISCO	The Zimbabwe Iron and Steel Company Limited
ZWD	Zimbabwe dollar

B.3 Less familiar units of measure

cu m	meters cube
mln	million
MPa	megapascal
MVA	megavoltampere
MW	megawatt
tpd	tons per day
tpy	tons per year

ABSTRACT

Project title: Development and Rationalization of Selected Small Scale Steel Plants in the Eastern and Southern African States

Project number: DP/RAF/88/072

Purpose of project:
To produce increased output and an improvement in productivity and product quality at selected steel plants and rolling mills of the PTA region, and to assist in upgrading the skills of their operating and management personnel.

Project objectives:

1. To strengthen the technological capabilities of management and operation in steel plants and rolling mills through
   - provision of expertise,
   - the supply of metallurgical control and measuring equipment,
   - training of operating and management personnel, and
   - analysis of longer term plant rehabilitation strategies.
2. To increase the capacity utilization of steel plants and rolling mills, thereby increasing productivity of steel production in support of the over-all economic development of the PTA subregion and, in particular, of its engineering industries.

Project duration: 16 months

Conclusion:
The problems of seven project area steel plants relating to electric furnace and rolling mill technology, plant maintenance, production costs, and long-term development were analyzed in the PTA context. The plants received on-the-spot assistance including critical instrumentation and equipment. Recommendations to improve their capacity utilization, orient their development strategies, and benefit from training were formulated.

Further assistance by UNIDO is envisaged in selected priority areas focusing on coverage of more steel plants of the subregion, on subregional integration, and on training programs.

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INTRODUCTION

The whole project was planned and implemented in accordance with the Terms of Reference approved by UNDP, UNIDO, and the PTA.

As the Terms of Reference were well formulated and they still retain their validity, two sections of this Chapter (Project background, Objectives) are taken from the Terms of Reference without amendment, except for formal editing to take account of the progress of the project.

The other topics covered in this Chapter are the official arrangements concerning the project and the subcontract, and basic characterization of recommended training and installed new equipment.

A. Project background

There are about 23 steel plants/rolling mills in the PTA subregion capable of either melting scrap in an electric arc furnace for casting semi-products (billets, ingots) or processing semi-products into finished products such as bars, sections, etc. These steel mills, mainly small-scale, are located in Angola, Ethiopia, Kenya, Madagascar, Mauritius, Mozambique, Tanzania, Uganda and Zimbabwe. The only fully integrated iron and steel plant and the subregion's largest plant is the Zimbabwe Iron and Steel Company Ltd. (ZISCOSTEEL) at Redcliff, Zimbabwe. This plant is equipped with blast furnace and oxygen converters. The subregion's liquid steel making capacity is just over 1 mln tpy, most of which is in ZISCO.

In addition to the exclusive position of ZISCO, the over-all status of the steel industry in Eastern and Southern Africa is determined to a considerable degree by the following features:

- The highest concentration of steelworks can be found in Kenya.

- The subregion's aggregate steelmaking capacity is just over 1 mln tpy of liquid steel.

- Pencil ingots prevail but there are several continuous casters.

- The rather high imports of billets from outside the PTA subregion are being pushed down by fore limitations, and vice versa, the billets produced within the PTA have to compete on international markets while the PTA countries' requirements are not fully satisfied.

There is a number of common features but different levels of economy, raw material wealth, and availability of energy have to be considered individually for each country and, indeed, for each metallurgical plant.

One feature which applies to all the five countries covered by this project is that a considerable impetus is necessary to raise their metallurgical production.

The broader region is rich in raw materials to be processed by metallurgical industry. Nevertheless, the raw materials which could properly supply the metallurgical industry are yet to be exploited at a reasonable rate.

The energy potential required to turn these raw materials into finished goods is also far from being fully utilized.

In fact, all the crude steel producers in four out of the five countries covered employ the scrap process in what can be described as classical mini-steel mills, but all these mills operate under several constraints resulting in poor capacity utilization. Intra-regional trade in steel products (mainly billets and long rolled stock) also is hampered by a number of factors, with logistics ranking in a prominent position. The locations of raw materials, energy sources, and selling outlets are widely scattered.

Kenya has 13 steel mills; five of them have steel melting units (but only three were actually producing steel by 1988); all 13 can produce rolled stock, with two of them limited to cold rolling only (but four of them out of operation for protracted periods over the recent years). Kenya's economy being further developed than that of most of the PTA countries, the tendency in steel demand is somewhat depressed and is approaching that experienced in industrialized economies. There are forecasts however for a more vigorous growth of the whole Kenyan engineering sector, which could counterbalance the tendency to decline in steel consumption.

Zimbabwe being the largest sub-regional producer of steel, would be the natural potential supplier of special steels, high-alloy products, and plate and sheet products where a relatively high technological level is required. At the moment though there is little hope that ZISCO would engage in these activities soon.

Tanzania has two steel companies of which one has a steel melting facility and produces billets (along with operating a facility for cold rolling of steel sheet), while the other produces finished rolled stock (hot rolled bars and wire). A relatively [illegible] growth in consumption of steel plate has been experienced.

Mozambique has a foundry and rolling mill, plus some fabrication facilities, but the per capita consumption of steel is very low.

Mauritius has four companies with rollers. With its relatively diversified economy, the demand for steel products is expected to grow in spite of the small population.

These and other local conditions and interactions had to be considered when executing the present project.

The Preferential Trade Area's Secretariat for Eastern and Southern African States, PTA has intensified its efforts to develop its iron and steel industry and other metallurgical industries in support of its downstream engineering industries in its efforts for over-all industrial and economic development. In this connection, in addition to the rehabilitation of existing iron and steel plants and rolling mills within the subregion, extensions to existing plants and new plants are being considered. In line with the above, not only ZISCO but also all the small scale steel mills have expansion plans and intend to install new equipment in the near future. Finally, the commissioning of a sponge iron plant within the sub-region is also under consideration. Whilst the ZISCO plant is experiencing difficulties when striving to keep up its operations at an adequate level of technology, the numerous other small steel plant/rolling mills and re-rolling mills are, without exception, operating with substandard equipment, with a low level of technology, and with personnel which copes with their tasks but would benefit from advanced training.

If ZISCO is not included, the actual plant capacity utilization in the production of steel products in the subregion may in some cases drop to levels as low as 50% or even less. There are many factors responsible for the underutilization of installed steelmaking and rolling capacity in the subregion, including, inter alia, lack of raw materials, spare parts, electric power, infrastructural facilities, and specialized manpower.

A number of steps have already been taken to improve the current situation. The main initiative has been taken by the Iron and Steel Committee of the PTA which is planning the over-all development of the sector. The Committee has recognized the potential existing at ZISCO to assist in the long-term development of this sector and ZISCO, in turn, has been most effective in supporting the work of the Committee. UNIDO has also assisted the Committee and various activities have undertaken, some of which are mentioned below.

A long-term study, up to the year 1995, has been made by UNIDO of the supply and demand pattern for various steel products in each of the PTA countries, within a project aimed at surveying the iron and steel industry in African countries. It was felt that the results of this study would be useful for the short and long term planning needed to develop this sector.

UNIDO, together with the Commonwealth Secretariat, has made in-depth technological assessments of the small steel mills, rolling mills, and re-rolling mills in the PTA countries.

Technical assistance by specialized experts, new equipment as well as on-the-job training and longer term institutional training has been recommended. The follow-up of these assessments is the over-all objective of this project and covers the provision of experts and the arrangement of on-the-job training for the various senior operators and managers as well as follow-up workshops. It has been recognized that ZISCO in Zimbabwe, whilst operating an adequate training center of their own, would also benefit by being included in the training schemes proposed.

Very few of these small scale plants have adequate temperature measuring and metallurgical control equipment. It has been decided that part of this should be provided by UNIDO so as to enable an improved technical/metallurgical level of the plants' operation to be obtained. Detailed improvements in the layout and design of the plants need to be elaborated to increase the over-all steelmaking and rolling mill capacity of the subregion and appropriate detailed capital investment schemes need to be reviewed for the longer term rationalization/development of the sector.

The coordinated program of technical assistance and on-the-job training is expected to produce increased output as well as improvement in productivity and quality of final products and possibly range of steel products produced by the steel plants and rolling mills of the PTA subregion. In addition, the operating and management personnel should benefit from improved technological practices as a result of the expert assistance, training, and specialized metallurgical equipment and tooling provided by the project.

It must be understood however that even with the assistance provided by the project, all the steel mills will have to continue operating under severe constraints imposed by the limitations of the respective economies. These broader contexts linking the steel industry with the over-all economic climate must be taken into account.

This project, aimed at improving the situation in five PTA countries in the area of the metallurgical industry, is linked up with the following programs of action for Africa:

1. the goals defined for the PTA countries, particularly those set forth by the Iron and Steel Committee of the PTA which is planning the over-all development of the sector

2. the UN program of action for African economic recovery and development 1986-1990

3. the Industrial Development Decade for Africa (IDDA).

B. Official arrangements

The project was approved by Mr. Bax D. Nomvete, Secretary General of the PTA, on 29 July, 1988. UNDP approval was secured on 26 August, 1988.

UNIDO was selected as the executing agency. The project document was signed on behalf of UNIDO on 2 August, 1988.

A subcontract to execute the project was awarded by UNIDO to POLYTECHNA Corporation of Prague, Czechoslovakia on 21 September, 1989.

The proposed starting date of project activities was September, 1988. The actual starting date of project execution (the first field mission) was 30 October, 1989.

The planned project duration was 16 months. The actual period covering the two field missions and the delivery and installation of UNIDO-supplied equipment was seven months. It is expected the follow-up training proposed in this report will extend over a period of several months.

C. Contributions

Total contribution by UNDP (planned):

	1988	1989	Total
US $	13,000	299,791	312,791

Government inputs:

The Governments and the counterpart agency, PTA were expected to make available local facilities and provide counterpart staff, data on raw materials and local production and service costs, as well as the usual amenities.

Subcontract: US $ 122,893.

D. Objectives of the project

The development objective was to increase the capacity utilization of the steel plants and rolling mills in the PTA region to effect increased production of finished steel products so as to support the over-all industrial development of the subregion in general and the engineering industries in particular.

The immediate objective was to improve the operating practices at the plants by providing expert assistance, organizing specialized training, and supplying essential measuring and control equipment.

These objectives, encompassing seven selected steel plants in four countries of the subregion, are essentially valid for all the steel producing and processing countries of the PTA region.

The basic activities aimed at achieving the objectives are outlined in the subsections of Chapter I.

All the activities stipulated in the Terms of Reference were performed as planned, and the project objectives were attained.

E. Training

As confirmed by recent missions, most steel mills in the PTA countries suffer acutely from poor capacity utilization and are in sore need of rehabilitation.

Lack of adequate training ranks prominent among the factors which thwart the efforts to remedy the situation. Particularly at the middle level of management, there is a pronounced lack of metallurgical expertise in the EAF and casting shop, at the bar rolling mill, and in maintenance. Exposure to foreign (or even neighboring) mills of similar type and scale is entirely lacking, with the notable exception of participation by several mill staff members in the maintenance-oriented training project run with UNIDO support at ZISCO, Zimbabwe.

Consequently, the idea of training courses and workshops which would allow the individual steel plant shop managers to develop in their particular line of specializat on, was eagerly grasped at by the management of all the plants visited under the UNIDO project DP/RAF/88/072. Better trained operators and middle-level managers are a valuable asset to the mills in their efforts to upgrade production and product quality.

For these reasons, the field missions carried out under the UNIDO project DP/RAF/88/072 focused not only on on-the-spot assistance to the operating and managerial staff of the steel mills in the area of process and technology, but also resulted in four specific training proposals. These are

(a) On-the-job training
(b) Workshop on steelworks modeling
(c) PTA steel plant rehabilitation workshop
(d) Subregional steel plant exchange program.

These training and workshop schemes are outlined in Chapter V. Full particulars of the training projects are outlined in Annex H.

F. Equipment

On the basis of the diagnostic mission to the plants and taking into account the experience acquired while providing on-the-spot assistance, the measuring, control, and auxiliary equipment pinpointed as critical was specified in detail at very short notice by the team, one month in advance as against the project schedule. In fact, the team leader was recalled from Africa for mid-term debriefing at UNIDO HQ for this purpose.

Equipment specified by the team and promptly ordered by the Purchasing Section of UNIDO to the tune of US $ 102,000, includes

- temperature measuring systems for electric arc furnace and for billet reheating furnaces,
- an analyzer of furnace offgases,
- hot metal detectors,

- essential equipment for mechanical and electrical maintenance, and
- measuring equipment for rolling mill quality control.

For detailed equipment specification, see Annex D to this report.

During the second field mission, individual items of equipment arriving at the project area steel plants were inspected by the team and installation assistance was provided where feasible and necessary.

G. Subcontracting

The Czechoslovakian, Prague-based Foreign Trade Corporation, POLYTECHNA was selected by UNIDO as subcontractor for this steel plant oriented project conducted in Kenya, Tanzania, Zimbabwe, Mozambique, and Mauritius. Polytechna's partner taking care of coordination of the subcontract activities was the Prague Institute of Chemistry & Technology. This, in turn, was aided by experts from cooperating institutions. The principal organizations involved are identified below:

	POLYTECHNA
Address:	Panska 9, P.O. Box 834
	CS-11245 Prague 1
Telex:	121585 POLY C
Fax:	(422)-2321562
Phone:	(422)-2364565-70, (422)-2364574
	PRAGUE INSTITUTE OF CHEMISTRY & TECHNOLOGY
Address:	Technicka 5
	CS-16628 Prague 6
Telex:	122774 VSCH C
Fax:	(422)-3114769
Phone:	(422)-3117074, (422)-3323158, (422)-3124260
	RESEARCH INSTITUTE FOR IRON & STEEL TECHNOLOGY AND ECONOMICS
Address:	Modranska 18
	CS-14706 Prague 4
Phone:	(422)-463041, (422)-462372

FERROUS METALLURGY CORPORATION
Address: Slezska 9,
CS-12000 Prague 2
Phone: (422)-2152803

SKODA CORPORATION
Address: Nam. Ceskych bratri 13
Pilsen, CS
Phone: (019)-2152011

Total value of subcontract: US $ 122,893.

Work carried out by contractor: The subcontracted work consisted of three phases and entailed two field visits by a specialized team of experts/consultants with an intervening period of 3 months.

Outcome of subcontracted work (in the briefest outline): Revision of and assistance to seven steelworks in four countries mainly resulting in

- Interim report
- Terminal report
- Identification, purchase, and installation of equipment worth ca US $ 100,000 at the steel plants
- Various training schemes and follow-up training projects.

RECOMMENDATIONS

A. Recommendations to PTA and Governments

1. Extend further support to project area steel plants, for them to be able to fully benefit from this study and from the equipment supplied by UNIDO.

2. Through initiation of and participation in follow-up projects, intensify efforts to improve subregional communication and integration within the steel industry.

3. For purposes of subregional cooperation and trade in steel, steel products, and scrap, cooperate on the PTA-to-Governments and Government-to-Government basis in an effort to set up steel clearing centers in each PTA country.

4. Cooperate with UNIDO in implementation of proposed training schemes and workshops.

5. In view of necessary modifications to the time horizons, re-assess available studies on the long-term rehabilitation and development strategies for the steel industry in Tanzania and Mozambique.

6. Consider Government sponsored scrap collecting activity including mobile baling presses to bring badly needed scrap to the market.

B. Recommendations to steel mills

1. Implement suggested improvements (cf. Chapter IV, Sections A.1.3, B.1.3, B.2.3, C.1.3, D.1.3, D.2.3, and D.3.3).

2. Make efforts to upgrade maintenance, operation, and technology through improved plant-to-plant communication within the subregion.

3. Participate in the training schemes outlined in Chapter V.

C. Recommendations to UNIDO

1. Assist the PTA subregion and its steel mills through extending the present project, under the same Terms of Reference, to the remaining PTA countries (outside the project area for DP/RAF/88/072) where steel plants are operated.

2. Assist the PTA and the project area Governments and steel mills by undertaking to organize the training schemes and workshops specified hereunder (cf. Chapter V).

3. Recognize the rehabilitation of the steelmaking industry as an urgent task of the manufacturing sector and intensify assistance to PTA in this respect as far as feasible.

4. Implement suggested follow-up projects (cf. Chapter V).

5. Find ways and means for the UNIDO Country Directors from countries of the PTA subregion to attend the international workshop on steel plant rehabilitation proposed hereunder (cf. Chapter V, Section B.3).

I. PROJECT SCOPE

A. Countries and steel mills covered

In accordance with the Terms of reference[1] the countries and steel mills covered were as follows:

Kenya	Kenya United Steel Company Ltd., Mombasa
Mauritius	Desbro International, Port Louis
	Ship Breaking & Steel Rolling Industries Ltd. and Section Rolling Ltd., Plaine Lauzun (same owner)
Mozambique	Companhia Industrial Fundicao e Laminagem S.A.R.L, Maputo
Tanzania	Aluminium Africa Ltd., Steelcast Division, Dar es Salaam
	Steel Rolling Mills Ltd., Tanga
Zimbabwe[2]	The Zimbabwe Iron and Steel Company Ltd, Redcliff.

[1]The original Terms of reference also included Rollmil Co. in Nairobi, Kenya. As this was being covered at almost the same time under another UNIDO project, the Subcontractor was instructed by UNIDO to include instead the coverage of the rolling mill department of Kenya United Steel Company Limited in Mombasa (where the original Terms of reference covered only the steelmaking department).

[2]Training aspects only (outside the Terms of reference).

B. Professions covered

All the countries of the PTA subregion covered under the present project have existing and/or planned steel melting facilities, and likewise, all have established rolling and/or re-rolling facilities. The critical problems faced by these plants in the PTA subregion were pinpointed by the Project Document DP/RAF/88/072.

Hence, in compliance with the substantive terms of reference for the project, the specialized field team was composed of experts/consultants covering the following four professions:

(i) Electric furnace steelmaking
(ii) Billet reheating, rolling mill design and operation
(iii) Mechanical and electrical maintenance
(iv) Financial and cost control.

Attention was also focused on actual training requirements.

In addition, the subcontractor's headquarters (Polytechna Corp.) provided general field and home assistance.

II. PROJECT ENVIRONMENT (SUB-REGIONAL ASPECTS)

A. Raw materials for steelmaking and fabrication

Depending on the production practices and process units at a specific steel plant, the raw materials consumed during iron and steel production include:

- iron ore, metallurgical coal (which is first converted to coke), scrap, sponge iron, alloying elements;

- fluxes (limestone, lime, dolomite and fluor spar), refractories, graphite electrodes; and

- energy sources: electricity (particularly hydroelectric power) and natural gas.

Iron ore: Large resources of iron ore are known to occur in several countries of the PTA region. The geological reserves amount to at least 6,344 mln tons. Obviously, only a fraction of these reserves would be technically extractable and economically beneficiable for purposes of iron and steel production. By far the largest reserves are in Zimbabwe (with about 59 per cent of the total) and in Angola (which accounts for 19 per cent). In Kenya are traces of iron ore in various parts the country, but no serious exploration has been done to establish their viability for mining purposes. It is high time to undertake this exploration.

Coal: In spite of the vast reserves, commercial exploitation of coal is still at a relatively infant stage. Only Botswana, Mozambique, Zambia, Zimbabwe and in a small extent Tanzania now operate coal mines. In all cases except Zimbabwe, coal is produced for power generation and export. Whereas cokable coal occurs also in Mozambique and Swaziland, only that of Zimbabwe is employed for iron and steelmaking. The subregion's coal resources could be potentially useful as a reductant in coal based iron ore direct reduction processes for the production of sponge iron, a metallic alternative to ferrous scrap.

Ferrous scrap: Although scrap is not a natural resource per se, its importance derives from the fact that it is an important source of iron units, substituting for sponge iron and vice versa. In fact, all steel producing units in the countries covered under this project use ferrous scrap as their main input. An accurate scrap inventory in these countries has not yet been carried out.

Concerning the countries' scrap generation capability, it is to be noted that the local availability is constrained by the under-developed and currently depressed status of the economies in the subregion. This, among other things, leads to an enforced longevity of automobiles and other household appliances as consumers conserve and rehabilitate rather than dispose of serviceable assets. Furthermore, bottlenecks exist in inefficiencies of scrap collection, processing and delivery to steel plants. For these reasons, the differences between the prices of local and imported scrap have been narrowing, making the latter increasingly attractive, although its accessibility is now restricted by the prevailing foreign currency scarcity in the subregion. In the face of escalating scrap prices, as well as the obvious demand for it in the subregion, there is a need for establishment of enterprises devoted to the collection and processing of all available scrap sources.

Included among these sources are ships and carriers that could be the basis of shipbreaking enterprises at such ports as Mombasa, Dar es Salaam, Maputo and Port Louis. At present time the shipbreaking activities are not being carried out, even though it would serve the purpose of domestic supply of raw material for rerolling and/or of generating scrap for both the domestic and the export markets. In fact, there is a very minor shipbreaking operation still going on in Mauritius (in a company not covered by the present project).

Also, scrap collection is of course regarded as a matter of importance by the steel mills of the region where as a rule, the company management themselves are making efforts to organize scrap collection activities. However, there is no central, effective scrap collection in any of the countries of the region. Obviously, difficulties of transport contribute to the problem which sometimes is present even within one and the same country, where one region of the country is depleted of scrap because of collection by the steelworks over a limited area, while another region of the same country may have a local surplus of scrap. Intra-regional trade in scrap is totally absent in the PTA subregion and scrap is a scarce commodity in general (e.g., in Kenya, Tanzania, Zimbabwe) but at the same time, there is a number of countries (including Mozambique and Mauritius covered by this project) where there are no melting capacities whatsoever so scrap ought to be accumulating. Clearly, serious thought should be given to this problem.

In the absence of objective studies of the scrap sources, the indicative data gathered in an earlier study (prepared by the Regional and Country Studies Branch of UNIDO) were extrapolated to the year 1990 on the basis of the field experience of the present team, yielding indicative estimates of the annual scrap generation rates, exclusive of "home" scrap generated and consumed by operating steel plants:

Kenya	26,500 tpy
Tanzania	10,500 tpy
Mozambique	3,500 tpy
Mauritius	4,500 tpy

Availability of scrap is assumed to increase by 5 % per annum.

Estimates of scrap availability compared to present and potentially required use strongly confirms that the countries are running out of scrap. Therefore the likelihood is that improvements in gathering and processing practices as well as utilization of new sources would be necessary if increased scrap imports are to be avoided.

Summing up, it is clear that all the PTA countries on the African continent face considerable problems not only with the collection of steel scrap but also as regards the generation of scrap. This is particularly true of Kenya and Tanzania. In Mozambique there is potential for collecting considerable quantities of scrap because of the absence of any appreciable melting capacity. On a magnified scale, this is true of the island of Mauritius where at present, some scrap is exported (but not to the neighboring PTA countries).

Direct reduction iron (DRI): The deficit of metallics in the subregion can be covered in the future by production of DRI in the region. The SL/RN (coal based) production process would appear the most suitable, although the method does suffer from technical and operational handicaps that deserve fuller analysis before a decision is taken. A consideration of the most suitable location alternatives for DRI plants gave no firm conclusions and further technical investigation is needed. Possible locations in Mozambique and Tanzania are both based on a revival of projects formerly considered.

The slag forming and refractory minerals: The fluxing minerals in steelmaking are limestone, dolomite, fluorspar and silica. Limestone, dolomite and silica reserves of suitable quality for metallurgy occur widely across the subregion. Even where a particular country has no local resources, it should be possible to supply its requirements from other subregional sources. As for fluorspar, significant exploitation has been going on for some time in both Kenya and Zimbabwe. Other fluorspar resources may be located in other countries as the need for it in metallurgical applications develops.

Although several countries in the subregion are endowed with commercial reserves of some of the refractory minerals (silica, aluminosilicate, chromite, dolomite), only a narrow range of refractories, the simple fireclays, are now manufactured in Zimbabwe and Kenya for local consumption. The balance is imported from South Africa, Europe, and North America. With the possible exception of Zimbabwe, no individual country's refractories demand is sufficient to justify establishment of a viable plant to manufacture a wide range of refractories for its internal consumption in metallurgy alone. Accordingly, the refractories area presents an opportunity for subregional industrial cooperation aimed at supplying the needs of countries in the entire subregion.

<u>Alloying minerals and ferroalloys</u>: There are large deposits of the alloying minerals in several countries in the subregion. Chrome ore deposits are in Zimbabwe, which alone accounts for more than [illegible] % of the world's reserves of high chrome ores. Zambia has cobalt reserves, and significant reserves of nickel ore occur in Burundi, Zimbabwe, Botswana, and Madagascar. Basic ferroalloys needed for steel production such as ferromanganese and ferrosilicon are not produced in the subregion and must be imported; they are mostly imported from Europe.

<u>Electricity resources</u>: Tanzania, Mozambique and Zimbabwe have considerable electricity resources. At present, the total installed capacity in Mozambique is 2,275 MW of which 96 per cent is hydro, with the Cahora Bassa station accounting for 2,075 MW. Until 1984, in fact, Mozambique was an exporter of electricity to South Africa but then the disablement of the transmission line has cut off this valuable source of foreign exchange earnings. Electric power to the Maputo region now is mostly delivered from South Africa. The frequent outages are the single most important cause of downtime at the Mozambiquean metallurgical and engineering works.

In Tanzania, the total installed capacity is only 369 MW, of which about [illegible] MW is hydroelectric power. The future orientation is towards increased exploitation of hydro resources. However, for the purpose of the proposed Ruhuhu steel complex (of which

however the implementation had to be put off), a 300 MW coal fired station is planned in an effort to make maximum use of indigenous coal resources.
By the end of 1986, Zimbabwe's installed generating capacity was 2,145 MW of which 1,266 MW was hydro. Additional vast hydro resources are yet to be tapped, amounting to at least 4,566 MW. Zimbabwe and Zambia enjoy the advantage of drawing on the Kariba Dam power generating complex which however was seriously hampered by a 1989 emergency, but Zimbabwe at least has a number of other power stations in operation (including thermal stations).

In Kenya there are three EAFs in the country (as important electric power consumers) of which e.g., the KUSCO facility has to draw on power from a source (hydroelectric power station) some 700 miles away. Power is costly and is an important limiting factor of steel production; a special electricity tariff for the steel plants is a matter of concern to the industry.

Mauritius commissioned the Champagne Hydro-Power Station of 30 MW capacity in 1987 so total electricity generated from all sources went up to 487 GWh. However, the main power stations are thermal, diesel oil fired plants. At present, electric power supply exceeds demand.

Electric power requirements of the steel industry are essentially covered at present except in Mozambique but, generally, the problem of long-distance transmission and consequently, high cost of power must be faced by most of the producers in continental Africa.

Natural gas: Natural gas is an alternative hydrocarbon reductant for iron ore, and is particularly suitable for the modern direct reduction processes. Although virtually all the countries of Eastern and Southern Africa have, at one time or the other, issued gas exploitation concessions to the multinational energy firms, only three countries - Angola, Mozambique, and Tanzania- have been able to demonstrate that they are endowed with commercially exploitable natural gas resources. However, the is virtually no commercial extraction sofar and thus, no industrial applications. It is expected that a decisive impetus will be given to the gas extraction industry by the advance of major DRI and fertilizer production projects.

B. Role of steelmaking and fabrication in manufacturing

In all the countries of the subregion, iron and steel is a critical commodity for the industrialization of a nation. In Kenya this has been recognized very early and, hence, has been given considerable priority since independence. Many industries have been set up and there has been backward integration to the present time, where the billets and hot rolled coils remain the main imported raw materials.

The country therefore needs the facilities to make both billet and hot rolled coils for the existing and future downstream industries. Currently the country has 13 iron and steel mills having installed capacities of about 500,000 tpy, but the actual production is basically about 40% due to lack of raw materials. There are only two mills which use hot rolled coils to produce cold rolled coils.

Kenya requires a steel mill to produce billets and hot rolled coils for the existing mills urgently. After which any new area can be developed for the whole country as the need arises. Billet production can be given maximum capacity of 600,000 tpy while the hot rolled coils can be at a maximum of 400,000 tpy. Therefore a plant of capacity of 1 mln tons annual production can in principle be designed.

In Tanzania currently, the National Development Corporation (NDC) is responsible for the over-all running and development of metal working and metal forming industries, engineering industries, and electrical industries. Outside of ALAF and SRM (covered by the present project), the companies falling under the above categories are Ubungo Farm Implements (UFI), Zana za Kilimo (ZZK) of Mbeya, Tanzania Cables Ltd. (TCL), Metal Box Ltd. (MB), Tanelec, Light Sources, Kilimanjaro Machine Tools (KMT), National Engineering Co. (NECO), Mang'ula Mechanical and Machine Tools Co. (MMMTC), National Bicycle Co. (NABICO), and National Steel Corp. (NSC).

Throughout the period from 1980 to 1986, Tanzania went through the greatest depression since independence. All the economic performance indicators reflected a declining trend. Output in the manufacturing sector during this period fell by almost 17% and value added decreased by 11% per annum. The share of manufacturing value added in GDP also decreased from its peak of 13% in 1978 to only about 5% in 1984. Further, growth in GDP for the 1978 to 1985 period was 1.5% per annum on the average. The rate of inflation during this period was very high, around 35%. In this connection, there was practically no capital accumulation in terms of expansions and development of new industrial ventures, particularly in the above mentioned key sectors of the national economy. However, after the year 1986, thanks to the National Economic Recovery Program (ERP), the economy started picking up. The GDP growth increased from 3.6% in 1986 to 4.1% in 1988 and the capacity utilization of the above mentioned industries increased from 30% in 1986 to about 50% in 1988. The same is expected to increase to 60% and 70% in 1989 and 1990, respectively. Also the inflation has fallen from the rate of 35% to 29.9% in 1988.

In general terms, metal working industries are those industries which use products of basic metal industries for further transformation into metal products. The two Tanzanian companies covered by the project, i.e., ALAF and SRM, rank prominently in this sector. The products manufactured by the said companies include aluminum sheets, circles and foils, pipes, angles and other sections, cold rolled steel sheets, galvanized plain steel sheets, steel billets, and reinforcement steel rods. It can be noted that the roll to the national economy of this sector in general and of the above two companies in particular is extremely important. However, this sector like any other sector was very much hit by the national economic problems. In the period between 1980 and 1988, the sector experienced complete stagnation in its growth.

A brief survey of the said industries reveals the following status. At SRM Tanga, nothing new came up since launching commercial production in 1971. The expansion programs, which started in early eighties, are not yet completed because of the above mentioned economic problems. At ALAF all the planned expansion programs could not take off because, once again, of the economic problems. There was hardly any growth in the other companies of the sector either.

In view of the above stagnation in growth of this sector, it is the view of the NDC that unless and only if radical measures in expansions and completion of uncompleted projects take place immediately, the sector will not be able to cope with the increase in purchasing power (demand) resulting from the growth in GDP. It is in this framework that NDC must promptly come up with sectoral plans for future development to the year 2000 and beyond. Indeed, this has already been identified as the desirable NDC goal in the development of the sector. Already outcries of shortages of reinforcement bars, billets, Mabati type corrugated sheet, and manufactured equipment have started.

The role of steelmaking and steel fabrication in Mauritius must be seen in the light of the booming construction industry there. In view of the improving economic climate, there is considerable potential for the steel companies. The rolling mill production totals some 28,000 tpy (mostly of rebars) and 5,000-8,000 tpy more are imported; most of the imports is 6 mm wire. However, the local producers have to compete with the imports which tend to be less expensive, following an open door Government policy. Of course, all billets are imported, there being no melting furnace in the country. The same fact, i.e., that of absence of melting capacities, is responsible for the exports of scrap from Mauritius. The companies involved make efforts to specialize and/or cooperate when covering the local market.

ZISCO, being the dominant producer in Zimbabwe, are requested to produce a very wide range of products in order to cover the country's requirements. The view is held there that the total capacity of steel production, which is near 1 mln tpy from ZISCOSTEEL alone, ought to be enough for the whole of the PTA subregion; hence, efforts to set up large plants elsewhere in the subregion seem to be unwarranted by the present demand. ZISCO's future is threatened however by lack of financing and investment; should any serious difficulty develop as the mill equipment becomes worn out, the country would have to import everything.

The situation of Mozambique seems to be the least envious at the moment; much of the engineering industry would come to a halt should the present strains preventing Mozambiquean steel producers from actually producing persist much longer. The role of steelmaking in manufacturing should again become pivotal as soon as the external strains on the economy are eased. The projects of CIFEL rehabilitation would have to be given much higher priority then, but only on the condition that the rolling mill will be freed from the frequent power outages and other external problems. Of course, Mozambique also stands to benefit from all the flow of steel semis and products on the Beira line as soon as this is fully available again; this is a very important consideration to all the landlocked PTA countries.

C. Steel mills and related facilities

A global overview of the Kenyan iron and steel industry is shown in the Table overleaf, compiled from data furnished by the Kenya Ministry of Industry:

Existing installed capacities and actual production capacities for 1988 in metric tons:

Name of company	Installed Capacity	Actual Prod.	Operation 1988
Rolmil Kenya Ltd	30,800	16,271	melting and hot rolling
Special Steel Mills Ltd.	75,000	41,360	hot rolling
Steel Makers Ltd.	20,000	15,000	hot rolling
Emco Steel Works Ltd.	25,000	14,527	melting and hot rolling
Morris & Company Ltd.	25,000	16,000	hot rolling
Mabati Rolling Mills Ltd.	120,000	72,000	cold rolling
Iron International Ltd.	11,930	2,270	hot rolling
Iron Africa Ltd.	15,000	7,426	hot rolling
Standard Rolling Mills Ltd.	12,000	-	cold rolling
Steel Rolling Mills Ltd.	20,000	closed	hot rolling
Steel Billet Casting Ltd.	30,000	under receivership	melting and hot rolling
City Engineering Works Ltd.	5,000	-	melting and hot rolling

Kenya United Steel Company Ltd.	40,000	22,000	melting and hot rolling
TOTAL	429,730		

The above data represents the limits for the downstream industries where the users of wire rod are most important. The installed capacity for nine major users of wire rod is shown overleaf:

Name of company	Installed capacity (tpy)	Location
Fehmi Nail Works Ltd.	6,000	Mombasa
Flamingo Engineering Works Ltd.	600	Nakuru
Iron International Ltd.	2,400	Mombasa
Nalin Nail Works Ltd.	10,800	Nairobi
Kenya United Steel Co. Ltd.	2,400	Mombasa
Khetshi Dharamshi Ltd.	600	Mombasa
Sansora Wire & Nail Works Ltd.	840	Kisii
Steel Reinforcement Ltd.	720	Kikuyu
Wire Products Ltd.	3,000	Nairobi
TOTAL	27,360	

In Tanzania's metal working and metal forming industries, there is a smaller and yet substantial national capacity available as detailed below:

Name of company	Installed capacity (tpy)	Operation
Aluminium Africa Ltd.		
- Galco Division	36,000	
- Steelco Division	72,000	cold rolling
- Pipeco Division	18,000	
- Steelcast Division	18,600	melting
Steel Rolling Mills Tanga	20,000	hot rolling
Zana za Kilimo, Mbeya	4,000	
Ubungo Farm Implements	5,000	
National Bicycle Co.	3,000	
SIDO	5,000	

Others	2,000
TOTAL	183,000

It can be noted from above that the existing capacities of metal working and metal forming industries stand at 183,000 tpy as at 1989. This total capacity (if all metal forming and metal working industries were working at 100% of capacity), would cover 77% of the national demand. However, an analysis by the Government of capacity utilization of the said industries has revealed that the industries are working on an average of 50% for the year 1989. Consequently, in 1989 the metal working and metal forming industries covered only about 43% of national demand. It is noted that there is a large gap to balance the demand-supply equation. There is therefore a need to exploit fully the idle capacity, in order to make sure that at least, capacity utilization of the existing industries goes to about 80% which is the target set by NDC as representing a substantial help toward balancing the demand/supply situation.

D. Intra-regional trading in steel and steel products

The steel industry's product mix consists of blooms and billets (for further rolling) as well as "long" products for the construction and engineering industries, in the form of bars (round, square, and flat, plain and twisted), rods (for wire production) and light and medium sections (angles, channels, beams, and light rails). There is no facility for production of sheet, strip and plate, and the subregion's demand for this category of steel mill products is supplied through imports.

With the exception of Zimbabwe and to some extent, Kenya, none of the countries of the subregion participate regularly in the steel export trade, whether within or outside the PTA. The absolute quantity of steel traded within PTA is small both in the context of Zimbabwe's total exports and the subregion's total imports of steel from all sources. It has already been noted in earlier studies that the prospects clearly exist for an exploitation of the subregional market by producers in the region, in the near term, particularly Zimbabwe. Zimbabwe exported in addition to about 16,000 tpy of steel products exported inside PTA, about 90,000 tpy of basic steel products outside the subregion. The larger part of its steel exports are, however, in the form of low-margin (semi-processed) blooms and billets (200,000 tpy). Only about 10 per cent of this went to countries in the subregion. High transportation cost for delivering steel to the overseas customers tends to make Zimbabwean products less competitive on the world market, a situation that cuts into potential profit margins. In the medium and long-term, and in the interest of maximizing profits from the export trade, it would be in Zimbabwe's interest (as the leading steel producer in the subregion) to re-orient its product mix in favor of more sophisticated and higher-margin flat and high alloy products, for which there are currently no producers in the subregion.

The scope for subregional trade in steel will depend much on whether plate production will take place and the extent to which billets are supplied from Zimbabwe to the rest of the subregion. Of course, the plans to expand into flat products have been entertained at ZISCO for a long time but shortage of investment intervened sofar. If production for subregional consumption remains limited to present products, trade patterns will largely be as at present. If plate production covering only half of subregional demand is started by 1995, intertrade flows in basic steel products would at least increase by a factor of 5. If projected regional demand for billets in 1995 was covered as far as possible by Zimbabwean exports it would mean a 6-7 fold increase in the volume of billet trade.

One problem is that ZISCO in Zimbabwe stand very much alone in the subregion, and a situation may develop where the company would be "missing yardsticks" as to quality of production and trading orientation.

Another problem facing ZISCO and, for that matter, any other, potential large producer of basic steel products like ingots, blooms, and billets, is the surplus cost incurred due to long, inefficient transport. Indeed, ZISCO would be well advised to turn more to domestic sales so as to avoid losing on the railways.

Yet another problem is that ZISCO are requested to produce a very wide range of products while on the other hand, they may be better off themselves if they narrow down their product range, in conjunction with cooperation efforts.

E. Review of expansion and rehabilitation projects

Short term (1990-1995), medium term (1996-2000) and long term projects are reviewed.

Production of iron

1. iron ore restructuring project (including sinter plant), long term (ZISCO)
2. COREX direct reduction facility, long term (ZISCO)
3. exploitation of potential iron ore reserves, long term (Kenya Government)
4. Liganga iron ore project, long term (Tanzania Government)
5. exploitation of iron ore reserves, long term (Mozambique Government)

Steel melting

1. caster installation, short term (KUSCO)
2. EAF shop expansion, long term (KUSCO)
3. EAF shop expansion (installation of additional electric arc furnace), short term (ALAF)
4. new billet caster of 40,000 tpy capacity, medium term (ALAF)
5. new billet caster of 70,000 tpy capacity, medium term (SRM)
6. new billet caster, medium term (ZISCO)
7. installation of an induction furnace, short term (CIFEL)
8. foundry rehabilitation, short term (CIFEL)
9. mini-steel shop with caster, long term (CIFEL)
10. EAF & induction furnace, medium term (DESBRO)

Rolling of steel

1. rolling mill expansion, long term (KUSCO)
2. new section mill (36,000 tpy capacity), medium term (ALAF)
3. bar mill rehabilitation to 30,000 tpy capacity, short term (SRM)
4. commissioning of wire rod mill and drawn wire/secondary wire products plants (to 36,000 tpy and 12,000 tpy capacity, resp.), short term (SRM)

5. finishing mills, medium term (ZISCO)
6. wire and bar mill rehabilitation, short term (CIFEL)
7. new drawing machines, medium term (CIFEL)
8. bar rolling mill expansion (including new roughing mill), medium-to-long term (DESBRO)
9. cold rolling mill, long term (DESBRO)
10. sheet rolling mill, short term (ZISCO)

Other

1. continuous galvanizing line (coil-to-coil), short term ALAF)
2. shipbreaking, short term (ALAF)
3. shipbreaking, long term (Ship Breaking & Rolling Industries)
4. expansion of Pipeco Division (to the production of bigger size pipes), short term (ALAF)
5. annealing plant of 13,000 tpy capacity, short term (ALAF)
6. color coating plant at Galco Division (10,000 tpy capacity), medium term (ALAF)
7. production of high-alloy steel, medium-to-long term (ZISCO)
8. training center, short term (CIFEL).

F. Miscellaneous comments

General scarcity of scrap prevents all steelmaking companies from using a higher percentage of their capacities. In Kenya where there are five companies with steel melting facilities, they compete for available scrap.

In this situation, SRM in Tanzania (without any melting facility of their own) operate in an environment where scrap is relatively abundant and cannot be processed locally.

From som. countries, like Mauritius, scrap is exported but no to PTA countries.

Unlike the situation in most other PTA countries, relative overproduction of steel in Kenya is a general problem which is co-responsible for the generally low capacity utilization of all the Kenyan plants. Rather than having eventually to reduce the number of steel mills, a viable solution could be to investigate alternative lines of production, including alloy steel products.

The low production of steel in Tanzania, and virtually zero production in Mozambique, is a pressing problem which is aggravated by the generally low capacity utilization at ALAF the only billet producer in Tanzania suffering from shortage of scrap, and CIFEL an important consumer of billets suffering from a host of serious problems and not being able to draw on any melting capacity in all of Mozambique. In fact, melting capacities are also lacking or insufficient at Tanga, in Dar es Salaam, as well as in Port Louis.

Another pressing problem is the importation of wire products.

Flat products, as is well known, are not produced at all; this applies to all PTA countries.

The transport problem is omnipresent: in Tanzania, haulage of billets from Dar es Salaam to Tanga by trucks (sometimes, several trucks a day) is costly while alternative means of transport have never been seriously examined (coastal vessels, railway). This is so in spite of Tanga having adequate port facilities and, time to time, receiving shiploads of billets from abroad. In landlocked Zimbabwe, ZISCO are losing a substantial share of their profits to the rather inefficient railways in the transport of billets. The trunk railroad from Harare to Beira, Mozambique continues to be unreliable.

Most spares and consumables have to be purchased abroad, with forex allocation representing an important constraint. SRM with a 75% share of imported spare parts is a typical example of this problem.

Manpower problems are also present in the steel industry. At Ship Breaking & Rolling Industries in Mauritius, mill management are thwarted in their attempts to switch to two-shift operation by manpower problems. On the other hand, in Mozambique at CIFEL, management keep nominally three-shift operations in a plant where one shift should suffice for all their production.

III. ACTIVITIES

This Chapter presents an analytical account of activities. The method of work and the work phases including the two main field missions are outlined.

A. Method of work

The method of work involved

- a general approach shared by all team experts, incorporating a systems analytical approach applied in the two field missions
- profession-specific approaches for the four expert areas
- other substantive aspects (mainly, equipment and training).

A.1 General approach

A multidisciplinary team was formed so as to match the project requirements. The experience of the team members derived not solely from high capacity metallurgical units but also from simple, low capacity but efficiently operating facilities available in a number of the metallurgical enterprises of the subcontractor's country.

The field team was equipped to perform accurate temperature measurements on site and to instantly record the information gained. Cooperation with local staff was generally good.

While the first field mission was essentially diagnostic, efforts were made during the second field mission to consolidate the improvements, to assist in the installation of the newly acquired measuring and control equipment, and to secure the basic data necessary for an evaluation of a future rehabilitation procedure. During the second mission, KUSCO of Kenya was also diagnosed, thanks to the fact that the field team were able to successfully resolve the visa problem encountered during the first mission.

The approaches adopted concerning the profession related issues are considered below.

A.2 Electric furnace steelmaking

The project area countries visited have existing and/or planned steel melting facilities. They all use the scrap process.

The steelmaking expert

- gathered information on the layout as well as the technical and technological facilities of the steelmaking shop, the product mix, and the technology and process used; reviewed the raw materials, the general furnace practice, and the individual heat control; the pouring technology and practice; the caster if applicable; and the products

- assisted on the spot as far as practicable

- recommended improvements and possibly extension of production units and/or assemblies; process modification if necessary; process control instrumentation; manpower training

- proposed measuring and/or control instruments (to be purchased) for better process control and quality inspection.

A.3. Rolling mill operations

To improve the over-all production level and increase output and quality of finished rolled products, the following steps were taken:

- a proven technique of examining the rolling mill performance was used to obtain detailed information concerning mill capacity, capacity utilization, flexibility, and output; operating and maintenance practice; and auxiliary data

- attention was paid to mill stoppage analysis and breakdown, billet quality, furnace instrumentation, temperature and pressure control, rolling stand bearings, mill drives and power, tool life, etc.

A.4 Maintenance

The maintenance engineer assessed and analyzed the technical level and degree of complexity of the plant (mechanical, electrical, hydraulic, pneumatic); maintenance organization; the availability and quality of spares; and failures.

A.5 Finance/cost analysis

The over-all financial situation of the project area countries being constrained and forex being in universally short supply, this of course is reflected in the situation of the steel plants, particularly as concerns the funding of their development strategy.

In this area efforts were made to collect basic data on company turnover, the profit/loss situation, fixed assets, and production costs; range of commodities; domestic sales; exports and imports; and the market environment. However, chief attention was focused on the companies' short-term and long-term development, rehabilitation, and expansion plans.

It should be noted that most of the companies did not volunteer to provide their financial/cost data.

A.6 Other substantive aspects

Cross-sectoral aspects were tackled jointly by all team members. These concerned primarily

- the problem of properly specifying the control and measuring equipment to be purchased for the project area steel plants by UNIDO,
- the general problem of raising capacity utilization,
- the general problem of effecting process & product quality improvements, and
- the problem of upgrading the professional qualities of local staff through appropriate training.

B. Work phases

There were three phases.

Phase I activities probed into the following aspects of the project area steel plants:

- Problem diagnosis

- On-the-spot assistance
- Current operating and maintenance procedures
- Metallurgical control
- Productivity
- Product quality
- Identification of critical equipment and tools.

Phase II activities included

- Final specification of equipment and tools
- Suppliers and cost estimates
- Procurement of equipment and tools
- Delivery of equipment and tools to project area.

Phase III activities covered

- Consolidation of improved practices and procedures
- Inspection of delivered equipment and tools
- Improvement of metallurgical processing
- Improvements of operating and maintenance procedures
- Product quality improvement
- Productivity improvement
- Product mix modification
- Review of future expansion and rehabilitation plans.

IV. FINDINGS AND OUTPUTS

The findings and outputs are presented hereunder in a country-by-country arrangement, with sub-chapters devoted to the companies visited in each particular country. All information related to the visited companies is grouped as follows:

- Company background and performance
- Findings
- Problems and remedies (on-the-spot assistance incl. equipment from UNIDO, and suggested improvements)
- Future expansion and rehabilitation.

Specific mill data can be found in Annex G.

A. KENYA

A.1 Kenya United Steel Company Limited

Address: P.O. Box 90550, Miritini, Mombasa

A.1.1 Company background and performance

Background. In 1949, East African Wire Industries Limited (EAWIL) imported the first nail making machine into Kenya. In time it was joined by other machines for making rivets, screws, fencing staples etc. In 1964, EAWIL introduced a wire drawing plant which was, and is still, capable of producing wire from 6 mm down to 1.8 mm. Barbed wire, welded mesh, reinforcing fabric, and other wire based products were added on the manufacturing schedule, but the raw material for the drawing plant was still imported.

In an effort for vertical integration of the steel industry in Kenya, EAWIL entered into partnership with the Development Finance Company of Kenya, acquired a 23 acre site at Miritini (12 km from downtown Mombasa), and thus the Kenya United Steel Company Limited (KUSCO) was formed in June, 1969. The steel rolling mill went into production in 1970, and an EAF shop followed in 1975.

Range of products. The items manufactured by KUSCO include

- steel bars, rods, and allied products
- steel wire
- barbed wire, welded mesh, and steel wire fabric
- drive screws, shoe nails, clout nails, ceiling nails, cut tacks, panel pins, lost head nails, oval nails, tenter hooks, fencing staples, wire shapes, and rivets.

Square and round bars of reinforcing steel are made to KS 02-224970 (corresp. to BS 4449) in sizes from 6 to 40 mm. High tensile square twisted bars are made to BS 4461, and shafting bars are also made.

Steel wire is pickled and descaled, bright or galvanized. Some baling wire is also made.

Company performance. KUSCO production totalled 11,867 tpy in 1984 and was rising fairly steadily ever since, reaching 21,158 tpy in 1989. These figures are the total of rolled stock produced. Over the same period, KUSCO's EAF production rose from 11,358 to 18,547 tpy.

The production trends are shown below:

Year	Production of crude steel (tpy)	Rolled stock (tpy)
1984	11,358	11,867
1985	13,098	12,298
1986	15,023	14,090
1987	19,531	18,422
1988	19,379	18,420
1989	18,547	21,158

Production breakdown by destination:

Product group	Total production (tpy, 1989)	Internal consumption	Domestic market	Export
Crude steel	18,547	18,547	-	-
Hot rolled	21,158	635	16,292	4,232

Imports:

steel scrap	United Kingdom
graphite electrodes	West Germany
refractories	United Kingdom, Austria
ferroaloys	Europe

ingot molds	India
rolls	Sweden, India, Austria
wire rod	ZISCO, Zimbabwe

Market environment: Competitive, stabilized market. Market oriented prices. Stabilized sales. Exports to Rwanda, Tanzania, and Uganda (20-25% of production). Some 77% goes to the Kenyan market, and 3% are consumed within the company (secondary products).

Major products:

	Capacity (tpy)	Capacity (tpy/shift)
Ingots	27,000	9,000
CC billets	-	
Hot rolled products	35,000	17,500
Cold rolled/drawn products plus Secondary steel products	9,000	3,000
Other products	-	

Principal production units:

Plant/unit name	Supplier	Operated since	Capacity (tpy)
EAF	KGYB Hungary	1975	27,000
Caster[3]	India under Concast licence	not installed	
Bar mill	Danieli Italy	1968	35,000
Wire products section	Japan/India	1948	ca 7,000

Product mix breakdown:

Product	Description
Rebars, square and round	BS 4449 (mild steel), BS 4461 (high tensile), EN.8, EN.9 grade, from 8 to 40 mm dia.; mainly high yield cold-twisted square rebars
Flats	higher-carbon steel, 100 by 70 mm, mostly for agro-machinery (currently not produced)
Bright shafting bars	up to 40 mm dia.
Wire products	drawn wire, nails, roofing nails.

[3]The condition of the CC equipment (stored at KUSCO since 1984 but not installed) was checked by British consultants in 1989 and was found to be complete and capable of erection.

fencing staple, galvanized work, chain-link fencing, barbed wire, welded mesh, reinforcement fabric, baling wire

Mode of operation:
The EAF shop and the wire drawing section run in three-shift operation. The galvanizing shop also runs three shifts but not all the year round. The rolling mill runs generally in two shifts.

Employees:	total	ca 400
	office	ca 50
	shop	ca 350
	casuals	ca 150

Casuals (included in the number of shop employees) work mostly in loading/unloading and in scrap handling.

Qualifications:
Some 20 engineers and technicians; out of these there are ca
9 engineering graduates
4 "Polytechnic type" engineers
7 technicians with a 3-yr course

KUSCO being a family owned company, the fundamental management and organization are taken care of by the Senior owner. The posts of Works Manager, Maintenance Manager, and Development Manager are filled by expatriates. The total number of employees fluctuates between 400 and 500. There is a branch (sales) office in Nairobi.

For specific mill data, see Annex G.

A.1.2 **Findings**

<u>Scrap yard and charge preparation</u>. Light scrap is the dominant raw material. The stock quantity of scrap available during the team's visit was 300 - 400 tons. Shortage of scrap is a frequent phenomenon. Scrap is flame cut and baled. No blending of scrap takes place but for the products being turned out, the contents

of the deleterious elements (Cu, P, S) are low enough and do not present a problem.

The filling of the charging buckets is done by crane fitted with magnet and manually by scrapyard workers. The buckets are situated within the crane handling area on the floor of the scrapyard. Scrap weighing takes place on a rail type weigher.

The 1990 prices of scrap in Kenya fluctuate between KES 300 and 1,500 per ton.

Additions, alloys, and refractories. Limestone is used for slag formation. The SiO_2 content of this limestone is low, allowing for good dephosphorization and reducing lining wear.
The fluor spar used for slag dilution if necessary, is of good quality.
Crushed charcoal is added together with scrap.
Mill scale is used as oxidizer.
FeMn (containing 6% C and 70 % Mn), FeSi (containing 75 % Si), and aluminum are used for alloying and deoxidation purposes. All ferroalloys are imported.

Magnesite and chromomagnesite bricks are used for lining of EAF bottom and walls. The roof consists of high alumina quality roof bricks (up to 80% Al_2O_3). The fireclay bricks are used for lining of ladles. All refractories are imported from Europe and are of good quality.

Steelmaking process. The two EAFs were in good technical condition, including their electric accessories. Their operation is well organized, the management (production manager and production engineer) have adequate experience and qualification. The middle management are qualified to cope with the problems under guidance of the manager and engineer.

The single-slag process used in the production of grade BS 4449 steel is sufficient, owing to the low P and S contents encountered in the scrap. Slag is formed by charging ca 100 kg limestone onto the furnace hearth prior to charging the first bucket, plus ca 30 kg added before the last bucket. The first sample taken after full melting is analyzed for C and Mn. As a rule, P and S are not analyzed. Inasmuch as there is no need of dephosphorization, the carbon setpoint is 0.2-0.3% in the first sample. Without setting back the power input the melt is heated up to the tapping temperature of about 1670°C (measured in furnace) and pre-deoxidized using ca 25 kg FeMn, 10 kg FeSi, a 2 kg Al (fine FeMn, FeSi, and Al are added to ladle before tapping). In case of meltdown carbon below 0.15 % the bath is carburized by immersion of electrodes. The bath being over-oxidized it is difficult to deoxidize and the yield of alloying is reduced. The shop laboratory was able to perform routine C and Mn checks by classical volumetric analysis. Type ARL 33000-77 is available but is out of operation because of some vacuum problem. Steel temperature is estimated during the heat visually in a spoon test and also, before tapping using an immersion pyrometer with disposable tips (Pt-PtRh) on a lance and with recorder output.

The temperature in ladle is not measured. The team's measurements by precision infrared pyrometer indicated 1610°C. The share of heats with faulty chemical composition is ca 7%.

Casting pit. The charge is cast into one set of 48 inverted conical tarred moulds by bottom casting. Ingot dimensions: size 100 by 100 mm to 76 by 76 mm, 1.56 m long. Total casting time is ca 5 minutes. For casting, a 6-ton ladle with stopper rod teeming is used. The ladle is firebrick lined. A gasoline burner is used for preheating the ladles after relining. The ladle preparation shop is well operated and the quality of materials used is good, too. The rate of rejects due to poor pouring is low and the ingot surface finish is good.

Rolling mill. The situation at the rolling mill likewise is commensurate with usage and age. The mill is fully operable.

The declared rolling mill capacity is 30,000-35,000 tpy in three-shift operation (depending on product mix) while the actual production ranged between 18,500 and 21,500 tpy over the last three years. Hence, the capacity utilization at the rolling mill is over 70%. The yield of steel in rolling is 1,074 kg/ton on the average. This is also due to the fact that even short pieces (over 1 m length) can be redrawn and sold. Routine production reports are well kept and periodically evaluated. The roll pass design and pass routine are stabilized, without major problems. Time utilization is relatively high, as can be seen from the detailed analysis of mill utilization shown below.

MILL UTILIZATION

Calendar time: 365 x 24 hours		8,760
Working hours:	hours/shift	8
	shifts/day	2
		third shift for mill changes/repair

days/week		6	
overtime		occasionally	
total working hours available, GPT		6,467	
Breakdown of mill stoppages			
planned		589	
production		795	
mechanical		128	
electrical		176	
furnace		214	
Total mill delays (TMD)		1,902	
Net production time NPT = GPT - TMD, hours:		4,565	

Time utilization, %

Working hours available/calendar time	73.8
Net production time/working hours available	70.6

Mill output (1989):	tph	pieces
per gross hour	3.27	43
per net hour	4.63	61
Max. rolling rate:	5.2	67

Mill output targets:		
per net hour	5	65

Mill capacity, tpy:			
calculated	1 shift	2 shifts	3 shifts
at 70 % utilization	8.050	16,100	24,200
at 80 % utilization	9,200	18,400	27,600

Above calculation is based on 5 tph, 8-hour shifts, 6 days a week, 48 weeks a year, and the present product mix.

Note: the weight difference between square and round rebars of the same size is approx. 12.7%. This should be taken into account when comparing the mill output of KUSCO and, for example, that of SRM in Tanga.

Status of maintenance and servicing

Technical level:

The technical level of maintenance is quite satisfactory. There is enough equipment and the machines available are well suited for maintenance purposes. Likewise the working aids, tools, and materials including the spares for machine tools (bearings, transmissions, electric motors) are in good supply.

Degree of maintenance complexity:
Medium complexity, particularly with a view to the maintenance of machines in the wire products section where roofing nails, drive screws, shoenails, clout or ceiling nails, cut tacks, panel pins, fencing staples, lost head nails, and a considerable number of other allied products are made.

Failure rates of critical subassemblies and units:
Systematic planning and execution of maintenance makes it possible to operate both the steel making shop and the rolling mill, including the secondary products section, without major breakdowns. Production is continuous enough as long as there is enough scrap. No single production unit can be regarded as a bottleneck with regard to maintenance.

Filekeeping of failure rates:
Filekeeping of failure rates and the duration of individual failure-induced stoppages is part of the routine production reports.

Maintenance routine:
The production equipment working in cycles, the routine minor repairs are done as planned within the idle times during these cycles, whereas the medium and major repairs are done on Sundays as far as possible. The organization is good and material supply is regular so repairs proceed rapidly enough.

Maintenance prevention:
The low failure rates are accounted for by preventative maintenance.

Skills and experience of maintenance staff:
The repairmen are skilled enough for the work at hand. Some 40 men have been through an apprenticeship or have had some other training. The others work as helpers. The men in the machine shop are experienced and skilled enough to produce spares of medium complexity.

Maintenance and servicing equipment:
The park of available machine tools is in good technical condition and is being rejuvenated.

Organization of maintenance and servicing:
Mechanical maintenance and electrical maintenance each has its own Chief Maintenance Engineer. The former is departmentalized, incorporating maintenance of the EAFs, the rolling mill, the maintenance workshop proper, the cranes, twisting and bright bar department, the reheating furnace and general factory maintenance, and maintenance of the wire and wire products section.
The latter has two departments: EAF and rolling.
The two Maintenance Chiefs are supervised by the Chief Engineer. They cooperate closely with the Production Department Heads. No more than 19% of all staff work in maintenance. There is a scheme of premiums for repairmen depending on performance, skills, service life of spares, and material consumption.

Maintenance and servicing technology: Standard practice.

Spare parts:

availability	good, with adequate stocks in storage
quality	good in case of imported spares.
own production of spares	about 60%
reconditioning of spares	occasionally.

Tools:
Tools are available. Some instrumentation for electric maintenance is available, too. There is no device for hauling heavy loads (puller/pusher set). Temperature cannot be measured properly due to lack of instrumentation. There are no diagnostic tools for preventative maintenance.

Refractories and consumables:
All refractories are imported from Europe. Firebrick comes from GR Stein (Scotland), magnesite from Veitsch (Austria). Both are of very good quality. Electrodes are supplied from Germany. Other consumables, safety aids, lubricants etc. are obtained locally.

Training.

Two staff members attended a training course at ZISCO in 1988.

The complaint was voiced that experience from ZISCO operations (large mill) was incompatible with KUSCO practice (mini-mill). Training in a mill of similar size and production mix is desirable, as well as participation in a study exchange program focused on steelmaking and rolling mill operation and on detailed evaluation of expansion program variants.

A.1.3 Problems and remedies

Scrapyard and charge preparation. Recapitulating, the problems are as follows:

- different scrap sizes are not stored separately
- heavy scrap cannot be handled by available scrap preparation methods
- very light scrap cannot be compressed by existing press because of springloading effect
- too many buckets (4 - 5) must be charged in one heat because the scrap density is low and the share of large pieces is considerable
- pig iron and petroleum coke needed to raise the carbon content are not readily available.

It is recommended that the above problems and insufficiencies be rectified as follows:

1) By rearrangement of scrap handling: this should include
   - separate storage of different sizes and qualities
   - optimal scrap blending.

2) By cutting or compressing all long pieces of scrap to small pieces (max. 0.5 m in length). This can be done through
   - expanding the oxygen scrap-cutting gangs
   - acquiring a drop hammer for getting rid of heavy scrap, either cast iron or cast steel
   - making efforts to prepare scrap so as to avoid springloading which makes charging difficult

3) By raising the carbon content of the charge (to min. 0.30% C) through addition of pig iron or coke or coke fines to the first bucket.

The objective of above improvements is to attain the following target values:

- improved scrap density (0.75 ton/cu m)
- reduced charging and melting times (by 10 - 15 min)

- cutdown in power consumption (by 5 - 10 kWh/ton)
- lower consumption of refractories (by 1-2 kg/ton)
- achievement of standard melt-down analysis of carbon (0.30 % C).

Additions, alloys, and refractories.
- As limestone will need additional energy for calcination and furthermore will lose approx. 50% of its weight, it cannot be regarded as an advantageous slag former for the EAF.
- Charcoal is not a very efficient carburizing agent.

Suggested rectification for above problems is as follows:

Consider gaining access to a suitable source of burnt lime, to replace limestone. Check on the potential of producing soft burnt lime at the lime factory near Mombasa. Import coke breeze from ZISCO for effective carburization.

Steelmaking process. There are following major problems:

- the production of steel is the bottleneck of the production cycle, mainly because the two EAFs cannot be run simultaneously at daytime due to high cost of power
- the carbon content of the EAF charge is often low
- the tapping temperature is higher by no less than 30°C as against the temperature setpoint for the grade of steel in question taking into account the method of pouring and the size of the ingots, because of the high temperature differential in the ladle, and consequent difficulties at pouring of the pencil ingots
- poor heat output due to light scrap
- current recarburizing process (immersion of electrodes) is very expensive and ineffective in case of over-oxidized steel bath
- yield of alloying elements is poor, consumption of ferromanganese in 1989 was higher by more than 0.5 kg/ton (6.3 kg/ton) as against foregoing years and higher by ca 1 kg/ton than would correspond to good standard practice
- the technology used, giving no opportunity for systematic dephosphorization and desulfurization, with deficiencies in the area of temperature control, would prevent the production of higher grade steels and would also have to be changed in case of continuous casting
- chemical composition is out of bounds in 7% of cases which is higher than would correspond to standard practice for this plain carbon steel (max. 3%)
- the consumption rate of electrodes (7.2 kg/tons) as well as the electric power consumption (668 kWh/tons) are higher than

standard and experienced a growth in recent years. The reasons are steel overheating, a protracted charging period, and carburization of steel bath by immersion of electrodes.
- electrode control at no. 2 furnace needs readjustment
- analysis for carbon takes too long (10 minutes) because emission spectrometer is out of operation
- logbook entries lack downtime indications.

Above deficiencies can be rectified by

1) a national program of hydroelectric power development

2) ensuring a sufficient carbon content after melting (0.25-30%), through addition of suitable carbonaceous agents (see Rec.# 3 above)

3) decreasing the tapping temperature to ca 1640°C and limiting the temperature differential in ladle by ladle preheating; checking temperature by optical pyrometer during pouring

4) improved temperature and chemical composition control during the heat; this can be achieved through the use of a combination probe for simultaneous measurement of temperature and the carbon content

5) deoxidation of over-oxidized steel bath using aluminum pig or ingot fixed onto a steel pole

6) making efforts to be prepared for introduction of a controlled deoxidation process, in order to allow for the production of high-tensile strength deformed rebars; such a process will be indispensable anyway as soon as the caster is erected

7) mediation of contact with a servicing center in Europe to re-activate type ARL 3300-77 emission spectrometer which developed a vacuum problem.

The objective of above improvements is to attain the following target values:

- cutdown in tap-to-tap times to 130 min converting to a daily production increase from 38 tons to 44 tons (at 4 tons average weight of heat and assuming the present technology)

- cutdown in the specific consumption of electric power from [illegible] kWh/ton to 610 kWh/ton

- reduction of incidence of out-of-bounds chemical composition to

below 3%
- cutdown of electrode consumption from 7.2 to 6 kg/ton

- 5% cutdown in refractories consumption.

<u>Casting pit.</u> The following problems were identified:

- Ladles are not preheating between heats. Consequently, the temperature of the ladle lining is low (under 200°C). This is due to the high costs of operating the gasoline burner. Cold lining is responsible for the considerable drop in temperature before pouring is started, and for problems encountered at startup of pouring because of freezing at the narrow mold inlet. The crew tend to extremely overheat the steel to avoid this. Again, ladle preheating would help.

Suggested rectification involves the following action: Preheat ladles to min. 600°C. Reconstruct burner to accept cheaper fuel oil.

The objective of above improvements is to attain the following target values:

- lower tapping temperatures (by min. 30°C)
- lower firebrick consumption (by 10% thanks to less lining wear)
- avoid skulling in ladles.

- Molds for pencil ingots are not readily available. This is an additional argument in favor of CC.

<u>Priorities.</u> Summing up, the priorities of above problems and their effects on capacity utilization at the KUSCO steelmaking shop are as follows:

1) High cost of electric power (peak demand) preventing an economical operation of the two EAFs in parallel. This factor is entirely out of company control.

2) Shortage of scrap, scrap processing, and controlled carburization of EAF charge.

3) Elimination of heat control problems

4) Ladle preheating between heats.

<u>Rolling mill.</u> The following major problems were identified:

1) None of the six Kenyan rolling mills (incl. KUSCO) works to

full capacity, because of constraints but also because of slack demand for the given product mix. It is recommended that the product mix of KUSCO be gradually expanded by deformed rebars, a high-tensile steel grade, and wire rods down to 5.5 mm dia. This recommendation of course entails a number of measures at both the steelmaking shop and the rolling mill as discussed below. The benefits include reduced imports of billets, increased rolling mill throughput, and a less vulnerable position on the market.

2) KUSCO production of pencil ingots is not high enough to fully cover the need of starting stock for the rolling mill. Billets 80 by 80 mm must be imported. This bottleneck would be overcome by installation of the CC facility but this would have to be expanded from one-strand to two-strand. Reconsideration of shipbreaking as an alternative source of scrap would be worthwhile.

3) All wire for the fabrication of fences, barbed wire, and nails is purchased/imported. Rods of 8 mm diameter, available from own rolling mill is presently used for wire mesh (50 tons per month) but cannot be used for drawn wire production unless the steel composition can be better controlled and unless the finishing part of the rolling mill is modified and expanded so as to include additional finishing stands and controlled cooling or heat treatment. Hence, another 750 tons per month of low-carbon drawing stock is imported from ZISCO. Total tonnage of wire rod purchased is 24,000 - 27,000 tpy. A study into the possibility of establishing a wire rod mill would be worthwhile.

4) Cold-twisted, higher-tensile square rebars are the only type which meets present Kenyan standards; more sophisticated products like ribbed, high-tensile rebars would increase mill throughput at given capacity utilization and would save material (to the customer). High-tensile strength deformed rebars cannot be made unless the EAF process control is improved. Promotion of this kind of products should go hand in hand with metallurgical improvements in the steelmaking shop. The problems associated with the necessity to master the production of higher-tensile grades a KUSCO were discussed in detail with the management.

5) The existing reheating furnace is in good shape and capable of control. Instrumentation for offgas analysis would contribute to a higher standard of furnace operation and control. The furnace underwent considerable changes: the number of burners was reduced from four to two and the number of zones from two to one, with ensuing fuel savings. The chief recommendation was to use the reheating furnace offgas analyzer (on the list of UNIDO supplied equipment) to improve heating control and save fuel.

6) The furnace design, with a dropout type discharging system, causes downtimes amounting to 2 minutes per 10 pieces when charging ingots or billets. Every second pencil ingot must always be turned 180° after exiting from the furnace. The recommendation is to tackle this constraint together with general mill upgrading which would involve the installation of a new reheating furnace. The new furnace should be equipped with a recuperator.

7) The existing roughing mill stand has rolls of rather small diameters, making it difficult to run heavier starting stock. Moreover, the roughing mill is not equipped with a safety breaker. Rolls are fractured in case of a billet sticking. This is a serious constraint which makes it difficult to fully use the potential of the CC facility. It is recommended that, until and unless a decision is made on the general overhaul of the rolling mill train which would include e.g. a continuous roughing stand, the option of erecting a 16" roughing stand should be considered. Even a second-hand, reconditioned roughing mill would be acceptable.

8) Renovation of roughing mill rolls by overlaying and machining is not practiced. This should be introduced as soon as possible, making use e.g. of the experience of SRM, Tanga (cf. "Proposed training"). This would limit the imports of rolls (now imported from Sweden).

9) The service life of the fiber slide bearings on the roughing stand is too short. Imports from Germany should be replaced by imports from an alternative supplier (India) identified to KUSCO management.

10) Mild steel tubular guides wear rapidly at the outlet of the intermediate train. Recommended guides are heavy-wall, high-carbon or alloy steel seamless tube guides.

11) There is no optical pyrometer to measure temperature in furnace and along the train. An infrared optical pyrometer was put on the list of suggested UNIDO equipment. This is particularly useful not only to check on the reheating furnace temperature but also to check on the end temperature of rolling (needed when switching to the production of wire for subsequent drawing.

12) One crane for the rolling mill is not sufficient in case of three-shift operation. Mill changes and most repairwork are presently done mainly during the third shift. All development programs also must reckon with more than one crane, for adequate handling.

Quality control. This is not a serious problem at present, except for the spectrometer failure mentioned above. Also, KUSCO have a tensile tester as well as laboratory instrumentation for routine control of rolled stock produced. However, quality is a constraint in the sense that KUSCO cannot produce high tensile grades at present, and also cannot produce wire rod which can be drawn; these issues are attended to elsewhere in this report.

Maintenance. The problems are follows:
1) Heavy loads have to be handled by makeshift methods in absence of an adequate puller/pusher device. This is the case when dismantling the rolling mill equipment for repairs. An universal hydraulic puller/pusher set was recommended and furnished by UNIDO.
2) Maintenance of cranes suffers from lack of spares
Maintenance of cranes is an unresolved problem, with frequent gearing and gearbox failures and a general lack of spares.

Training. Management are very capable but training is required in the following specific areas: (i) utilization of computer assisted steelworks modeling (with the finance manager participating); (ii) participation in an exchange program where a KUSCO shop manager should visit ALAF (mainly for the purpose of gaining first-hand CC experience) and a maintenance manager should visit SRM (to share KUSCO practice and to acquire technologies practiced at SRM in the area of roughing roll renovation and wire rod mill operation)[4], while the finance and/or development managers would benefit most by visiting DESBRO and/or Sections Rolling (two other fairly successful private companies covering a similar product range); (iii) on-the-job training for a shop manager in a well run mill of comparable size; and (iv) the GM should attend a regional rehabilitation workshop.

Recapitulation of capacity utilization. Present capacity utilization figures at the EAF and rolling mill are 68.7-71.7 and 70.6 %, respectively. Conservative target figures that can be achieved without major investment, through implementation of the recommendations and measures outlined above, are 74 and 73 %, respectively. It has to be borne in mind that the time utilization figures are based on the present operating mode where the two EAFs rarely work simultaneously.

[4]Sharing of experience is particularly useful here because of small geographical distance, identical rolling mill supplier, and similar mill designs.

A.1.4 Future expansion and rehabilitation

The obvious main development will be the installation of the continuous casting machine which has been on site since 1982 but still in crates. The foundation have been constructed awaiting the equipment installation.

This machine with a radius of 4 meters was ordered from Concast of Zurich but manufactured in Italy. It has one strand but has provision for a second and is supplied with moulds for 80 mm x 80 mm billet. The machine has the capability of casting up to 130 mm x 130 mm billet.

The new equipment has been designed for KUSCO's present ladle size, but could accept a larger ladle. A change to a slide gate practice from the present stopper rod is proposed to coincide with the new caster.

The tundish has 3 tons capacity but is initially divided in two to minimize refractory until the second strand is added. It is planned to use cold board linings.

The billets are cut to length by a mechanical shear before being discharged onto a cooling bed.

At the rolling mill, Danieli of Italy suggested an upgrading program which would involve a new pusher furnace (8 m, 25-30 tph), a six-stand continuous roughing (dia. 420 mm), flying shears, a six-stand fast finishing block (750 kW d.c. with 11.2 mm starting dia., range 5.5-10 mm finished stock; 30 m/s exit velocity, loop layer with controlled cooling along the conveyer) to make wire rods. This was proposed in September 1989 and was characterized as costly by KUSCO management.

Suggested implementation:

On the basis of available information, the installation of the new CC facility would be of little benefit as long as the mill would continue turning out the same plain carbon grade it produces today: the enhancement of the steelmaking shop capacity would not be substantial enough and the unit costs would not decrease substantially either. Most of the real advantages of producing continuously cast billets would only be realized in the rolling mill but it is a marginal case.

The reasons are as follows:

- the low weight per heat and the impossibility of pouring more heats in succession prevent any marked improvement of steel yield as against pouring the pencil ingots

- the present process would have to be modified to upgrade quality and homogeneity to a level required in a CC facility. Such process modifications would entail longer tap-to-tap periods

- a CC crew is required

- the higher quality of production will find little appreciation in the present market.

A study should be conducted to ascertain the present costs and profitability of erecting and operating this CC with a view to over-all benefits for the company (i.e., including the rolling mill). Specifically, it should be decided

(i) whether or not to erect the caster now
(ii) who should supervise erection and commissioning (local expertise not being available).

- In connection with the installation of caster, it should be decided whether to cast strands up to 60 by 80 mm maximum (with no additional requirements on the rolling mill but with possible difficulties at the caster facility, because of the rather small cross section), or whether to prefer a caster modification allowing the casting of higher cross section strands (more advantageous for the caster operation proper but involving necessary modifications at the roughing stand of the rolling mill, or the inclusion of a new, more powerful roughing mill).

The basic contradiction is that the CC would have a relatively high throughput, as so would the new or reconstructed rolling mill, whereas the EAF capacity would remain a bottleneck unless a solution is found to the power cost problem; only then would it be possible to build a bigger EAF. Again, bigger EAF would need considerable changes to the over-all design and layout at the steelmaking shop. This is a clear-cut case for an optimization study, because of the number of possible variants and the need of a subtle balancing of capacities. Such a case of marginal payback should be treated by a computer model, in spite of this being a small mill. It is exactly for such cases (also encountered at NDC, at CIFEL, and in Mauritius) that the use of the World Bank co-sponsored steelworks evaluation modeling has been proposed (cf. Chapter V, Section B.2).

B. TANZANIA

B.1 Steelcast Division of Aluminium Africa Limited (ALAF)

Address: P.O. Box 2070, Dar es Salaam, Tanzania

B.1.1 Company background and performance

Background. ALAF went into commercial production as a small and privately owned company (ALCAST) in 1960. Initially, aluminum ingots and slabs were the only products. In the years 1960 - 1973 nothing much in the form of expansions and modernizations took place. When the Government took over in 1973 and resulting from the dilution effect which went with the acquisition, massive expansion, diversification, and modernization programs started. This gave birth to the current ALAF divisions Steelco, Aluco, Steelcast, Pipeco, and Asbesco. ALAF is member of NDC group of companies.

Range of products. The major (and only) product of Steelcast is mild and high tensile steel billets 80 by 80 mm for the rolling of rebars. This is grade BS 4449 steel.

The major products of the other Divisions of ALAF are cold rolled aluminum sheet, wrapping foil, and kitchenware (Aluco); various pipes and sections, body parts for pickups, square furniture sections, etc. (Pipeco); cold re-rolled strip and sheet (Steelco); and corrugated galvanized sheets (Galco).

Company performance. The design capacity of the EAF is 18,600 tpy while the actual production is less (the target of 16,800 tpy for 1989 was not reached). The caster facility has a rated capacity of 25,000 tpy (assuming the present strand size 80 by 80 mm). This capacity is permanently under-utilized.

The estimated demand for 1989 being 75,000 tpy of reinforcement steel for all of Tanzania, ALAF covers no more than 21 % of this demand.

The production and profit/loss data reflect the general slump of Tanzania's economy in the middle 1980s and subsequent recovery as shown overleaf.

Year	Production of billets, tpy	Profit (+) Loss (-)
1980	9,987	+ 3.5 mln TSh
1981	12,588	+12.3
1982	8,568	+ 8.6
1983	8,747	- 1.4
1984	6,736	- 8.2
1985	9,594	+ 5.0
1986	7,729	+17.9
1987	6,290	+ 6.1
1988	5,348	+18.0
1989	9,519	

Balance sheet components:

fixed assets	32,997 345 TSh
Production facilities and machinery	22,278 496 TSh
buildings	10,718 849 TSh

Production costs (1989):	TSh/ton	USD/ton
material and energy	53,590	372.15
tools and expendables	13,397	93.00
maintenance and repairs	4,336	30.00
spares	7,843	54.00
workforce	8,936	62.00
other	13,982	97.00
TOTAL	102,004	708.15

Breakdown of maintenance and repair costs, TSh/yr (1989):

production facilities and machinery	11,044 621
buildings & other	1,155 220
TOTAL:	12,191 841

Market environment: Definitely a seller's market. Stabilized supplier/customer relations. Fixed pricing system with high, artificial prices of steel and steel products. No competitors in the country.

Imports:

graphite electrodes	Germany
refractories	United Kingdom, Austria, Germany, India
ferroalloys	Norway

Mode of operation:

The EAF shop is run in three-shift operation. The billets are hauled to Tanga by trucks.

Employees:	staff	regular	casual	total
Manufacturing	10	181	75	266
Administration	30	-	3	33
Security	17	-	-	-
Total	57	181	78	316

Breakdown by professions:	
Furnace crew	15
CC crew	30
Maintenance	42
Other	46

The plant is run by mixed local and expatriate management. On the whole they are very experienced but concern has been voiced as to continuance of technical expertise on expiry of the expatriates' management and technical contracts. A great interest in the UNIDO training programs has been expressed.

For specific mill data, see Annex G.

B.1.2 **Findings**

Scrapyard and charge preparation Light scrap is the major raw material used. The stock of scrap available during the team's visit was about 1,000 tons. Scrap quality is poor and shortage of scrap is a permanent phenomenon. There being no scrap collecting organization in Tanzania, ALAF are taking care of this themselves: buying out scrap from owners within a limited area and transporting it to factory by own trucks. The only technique used is oxygen flame cutting. There is a transportable bundle press and hydraulic shears but both are out of operation. No blending of scrap takes place but for the products being turned out the contents of the deleterious elements (Cu, P, S) are low enough and do not present a problem.

The filling of the charging buckets is done by crane fitted with magnet and manually by scrapyard workers. The buckets are situated within the crane handling area on the floor of the scrapyard. Scrap weighing takes place on a rail type weigher.

Additions, alloys, and refractories. Limestone is used for slag formation. The SiO_2 content of this limestone is low, allowing for good dephosphorization and reducing lining wear.

The fluor spar used for slag dilution if necessary, is of good quality.

Crushed charcoal is added together with scrap. Deliveries of pig iron and petroleum coke needed to raise the carbon content are irregular.

Oxidizers like iron ore and mill scale are not readily available. FeMn (containing 6% C and 70 % Mn), FeSi (containing 75 % Si), and aluminum are used for alloying and deoxidation purposes. All ferroalloys are imported.

Magnesite and chromomagnesite bricks are used for lining of EAF bottom and walls. The roof consists of high alumina quality roof bricks (80% Al_2O_3). High alumina bricks (60% Al_2O_3) are also used for lining of ladles and tundish. All refractories are imported from Europe and are of good quality.

EAF operation. The general condition of the plant equipment is rather poor. The EAF is old, no longer up to the requirements. Much downtime is caused by frequent breakdowns of the furnace accessories. Production and technological data are well kept and management is judged adequate, with ample metallurgical expertise and with capacity to solve problems. The furnace technology is adequately covered by company regulations.

Steelmaking process:
After furnace fettling, approx. 300 kg limestone are charged on the EAF floor before the first bucket is charged. Second addition of limestone is made before the last bucket is charged.

For both steel grades produced, a two-slag process with a limited oxidation period is adopted. As soon as the charge is molten a sample is taken and analyzed for C, P, and S in the shop laboratory. There is no automatic analyzer. In case of phosphorus contents higher than 0.035% and carbon contents higher than 0.20% an oxidative slag is formed by addition of mill scale. In case of meltdown carbon below 0.15 % the bath is carburized by immersion of electrodes. On completion of the oxidation period, the 2nd sample for carbon analysis is taken, slag is raked off, and ground coal added if carbon is too low. As soon as the coal is picked up by the bath a reducing slag is formed by adding scrap aluminum and ground coal onto limestone. Then the bath is heated to the tapping temperature (min. 1680°C). Steel temperature is estimated during the heat visually in a spoon test and also, before tapping using an immersion pyrometer with disposable tips (Pt-PtRh) on a lance and with recorder output. The bath is deoxidized by adding 80 kg FeMn a 40 kg FeSi into the furnace and

50 kg SiMn plus 8 kg Al into the ladle, whereupon the furnace is tapped.

The share of heats with faulty chemical composition is ca 5%. The temperature in ladle is not measured. The team's measurements by precision infrared pyrometer indicated 1630°C.

Casting ladles. There are six 15-ton ladles with stopper rods, with high alumina lining of good quality. Only one oil burner is available for preheating. The ladles are only preheated after relining.

Continuous casting. The nominal maximum capacity for billets 80 by 80 mm is 25,000 tpy. The water-cooled copper molds with chromium cladding (800 mm long) withstand ca 130 casts on the average. There are two rows of water sprays for secondary cooling. The oscillation frequency is 140/min The 1.5-ton tundish is firebrick lined, covered with a lid, and placed on a manually controlled boogie taking it from the preheating station to the working position atop the molds. There is no stopper control; the ZrO_2 nozzles are of 13 mm dia. No insulation powders are used. Plant oil is metered out manually onto the mold walls for lubrication. The average casting speed for 80 by 80 mm billets is 3.3 m/min. The billets are flame cut by hand to 6-meter lengths. Instrumentation is lacking and considerable wear of the mechanical equipment is evident. The caster crew comprises nine skilled operators in each shift.

There is a ladle treatment station including automatic aluminum wire feeding; this could be used for some temperature homogenization. This station however is inactive because of poor mechanical condition.

The CC technology is all right as it goes. The surface finish of billets is good, too.

Status of maintenance and servicing.

Technical level:
: As concerns the skills of the personnel, the technical level is quite satisfactory. Considering that the shop runs in three-shift operation the number of staff engaged in repairwork is fairly low and these men are distributed over the shifts and workplaces effectively enough.

Degree of maintenance complexity: This is medium to high.

Failure rates of critical subassemblies and units:
The EAF, the caster, and the cranes show considerable wear and consequently are prone to rather frequent failures.

Filekeeping of failure rates:
Log sheets show failures encountered.

Maintenance routine:
Routine activities are well established.

Maintenance prevention:
Downtime is used for preventative maintenance.

Skills and experience of maintenance staff:
Most of the repairmen are skilled enough for the work at hand. Machine tool operators can manage the manufacture of simple spare parts.

Maintenance and servicing equipment:
Basic tools, equipment, and materials are available. The park of machine tools would deserve replacements to upgrade the over-all standard. There is no electric instrumentation and this is rather difficult to obtain in Tanzania.

Organization of maintenance and servicing:
At ALAF, this is decentralized; each individual Division has their own, even though limited, maintenance facilities.

Maintenance and servicing technology: Standard practice.

Spare parts:

availability	90% of spares are purchased from the outside according to a two-year plan; availability is rather poor.
quality	Good in case of imported spares.
own production of spares	Only 10%, simple spares for immediate use.
reconditioning of spares	Is not being done.

Tools:
Safety aids are available in sufficient quantities. Instrumentation of all kinds is generally lacking.

B.1.3 Problems and remedies

Scrapyard and charge preparation. Recapitulating, the problems are as follows:

- different scrap sizes are not stored separately
- very light scrap prevails but cannot be sufficiently compressed or cut because both the existing press and the hydraulic cutter are out of operation due to lack of spares
- too many buckets (4 - 5) must be charged in one heat because the scrap density is low and the share of large pieces is considerable
- pig iron and petroleum coke needed to raise the carbon content are not readily available.

It is recommended that the above problems and insufficiencies be rectified as follows:

1) By rearrangement of scrap handling: this should include
   - separate storage of different sizes and qualities
   - optimal scrap blending.

2) By cutting or compressing all long pieces of scrap to small pieces (max. 0.5 m in length). This can be done through
   - expanding the oxygen scrap-cutting gangs
   - making the press and the hydraulic shears operational again.

3) By raising the carbon content of the charge (to min. 0.30% C) through addition of pig iron or coke or coke fines to the first bucket.

The objective of above improvements is to attain the following target values:

- improved scrap density (0.75 ton/cu m)
- reduced charging and melting times (by 15 - 20 min)
- cutdown in power consumption (by 10-15 kWh/ton)
- lower consumption of refractories (by 1-2 kg/ton)
- achievement of standard melt-down analysis of carbon (0.30-0.40% C).

Additions, alloys, and refractories. The following problems were identified:

- As limestone will need additional energy for calcination and furthermore will lose approx. 50% of its weight, it cannot be regarded as an advantageous slag former for the EAF. Quality lime is not available though.

- Imported materials (electrodes, ferroalloys, refractories) cause bottlenecks because of irregular deliveries and lack of forex.

Suggested rectification consists in the following steps:

Consider gaining access to a suitable source of burnt lime, to replace limestone. Check on the potential of producing soft burnt lime at the lime factory near Tanga and hauling it to Dar es Salaam, possibly in rubber bags, by trucks returning from Tanga having transported billets to SRM. Cross-check with data from a parallel UNIDO study devoted to lime kilns in Tanzania (authored by Z. Daniszewski the cement technologist).

<u>EAF operation.</u> Here the major problems are as follows:

- capacity utilization of the EAF is low because of
  - shortage of scrap
  - irregular deliveries of electrodes, ferroalloys, refractories, and spares
  - power outages
  - its age and run-down condition;

- recommended practice often is not followed because of poor or nonexistent instrumentation (especially, the temperature measuring instruments are defective);

- prior to temperature measurement using the immersion tips, the steel bath is not stirred; this as a rule produces high reading if the probe is plunged under one of the electrodes;

- the work of the furnace crew during repairs is poorly organized;

- furnace door is kept open there being no mechanism to shut it;

- the carbon content of the EAF charge is often low and carburization is done by immersion of electrodes;

- the tapping temperature is higher by no less than 30°C as against the temperature setpoint for the grade of steel in question taking into account the method of pouring and the size of the strand. This overheating is due to inadequacies in furnace heat control, inaccuracy of temperature measurement, the high temperature differential in the ladle, poor bath homogenization, and consequent difficulties at the caster;

- poor heat output due to light scrap;

- chemical composition out of bounds in 5% of cases which is higher than would correspond to standard practice for this plain carbon steel (max. 3%). Such heats are not rejected though: they can still be sold, at a discount;

- the consumption rate of refractories per ton of billets produced is about 60 kg/ton; this is roughly by 10 kg/ton above the standard practice based on use of comparable refractories. At the EAF the consumption is higher by about 3 kg/tons, with the remainder lost in ladle and tundish lining;

- the consumption rate of electrodes (9 kg/tons) as well as the electric power consumption (850 kWh/tons) are higher than standard. The reasons are steel overheating, a protracted charging period, and carburization of steel bath by immersion of electrodes.

Above deficiencies can be rectified by

1) ensuring a sufficient carbon content after melting (0.25-30%), through addition of suitable carbonaceous agents (see Rec.# 3 above);

2) decreasing the tapping temperature to ca 1650°C and limit... the temperature differential in ladle by ladle preheating;

3) improved temperature and chemical composition control during the heat. This can be achieved through upgrading the laboratory equipment (by adding an automatic carbon and sulfur analyzer; the price of this analytic tool however was too high to include it on the list of equipment to be supplied by UNIDO within this project) and through replacement of faulty temperature indicating system by an immersion pyrometer (on the list of suggested UNIDO equipment);

4) cutting down the lining repairs between heats through improved organization of labor;

5) homogenization of steel in the furnace by agitation prior to taking temperature measurements using immersion thermocouples.

The objective of above improvements is to attain the following target values:

- cut down the average tap-to-tap time to 230 min by reducing the
    - repair time by 15 min,

- charging time by 5 min,
- time to full melting by 10 min, and
- refining time by 10 min,

thus achieving 40 min total cutdown. This converts to raising the daily EAF production from the present 75 tons (in three-shift operation) to 87.6 tons (assuming an average weight of 14 tons per heat)

- cut down the specific power consumption from the present 850 kWh/ton to 800 kWh/ton

- push down the percentage of heats giving out-of-bounds chemical compositions to under 3%

- cut down the electrode consumption rate from the present 9 kg/ton to 7.5 kg/ton

- cut down the consumption of EAF refractories by 3 kg/ton.

Casting ladles. There are three problems:

- ladles are not preheated between heats; cold lining combined with the high thermal conductivity of the high alumina material brings about a considerable temperature drop in the ladle which has to be compensated by tapping the steel at excessively high temperatures. Skulls in the ladles are frequent.
- the ladle preparation shop has not enough floor area
- too many ladles are kept in operation at one and the same time.

Above deficiencies can be rectified by

1) preheating the ladles to at least 600°C;

2) installing a second burner for ladle preheating;

3) using only three ladles;

4) making efforts to homogenize the steel temperature in the ladle; taking measurements.

The objective of above improvements is to attain the following target values:

- cut down the tapping temperatures by 30 - 40°C (as already suggested when analyzing the EAF process)
- cut down the specific consumption of high alumina bricks by 5 kg/ton of steel through extended service life of ladle and tundish linings

- eliminate skulling thus increasing the yield of steel by 5 kg/ton.

<u>Continuous casting.</u> Problems are stated as follows:

- the general assessment of the caster condition is the same as that of the furnace: instrumentation is lacking and considerable wear of the mechanical equipment is evident. Neither the draw-off velocity nor the solidified strand temperature can be measured
- the yield of molten steel is 1,162 kg per ton of billets; this is roughly 100 kg higher than good standard practice. Strand breakthrough and other casting failures are responsible

- caster capacity can never be fully used with the existing EAF

- billets 100 by 100 mm are kept in store, due to ALAF's inability to find a customer

- the ladle treatment station is out of operation.

Suggested rectification consists in the following action:

General overhaul of the CC facility, plus new accessories. Together with reduced tapping temperatures, this may realistically produce a much lower incidence of failures and a yield of molten steel under 1,100 kg/1,000 kg of billets assuming continuance of the technological practice and stability of chemical composition. At an annual production of 16,000 tons of steel, this converts to nearly 800 tons of surplus billets.

<u>Quality control.</u> Again, quality control is not a major constraint at present, considering that Tanzania is a seller's market. Out-of-bounds heats are much too frequent but can still be sold. Equipment for mechanical testing is available but the share of high-tensile grade where the mechanical values should be guaranteed is low (no more than 20%).

<u>Maintenance.</u> Because of low time utilization, the maintenance problems which otherwise might be prominent are somewhat hidden, but there is a slackness about maintenance, in spite of efforts by management. The EAF door which is kept open during the heat because of a hinge problem and because of absence of a pullrope is an example. Dismantling of caster components will be greatly facilitated by the universal puller/pusher set supplied by UNIDO. The electric instrumentation (also supplied) will aid prevention of electrical failures. It must be remembered that, of course, ALAF has several more Division where the maintenance staff can cooperate (e.g., cold strip mill, welded pipe mill).

Training. The expatriate management are very capable, with ample metallurgical expertise, but more training for their local counterparts, to increase their awareness of the problems which e.g. in the area of maintenance is lacking. Again, one of the local managers who has had training in a large steel plant overseas, still lacked practice from a well run mini-steel plant. The following training is recommended: (i) participation in a subregional exchange program where an ALAF shop manager, preferably the present deputy EAF manager, should visit KUSCO to learn better furnace practice and maintenance organization and, at the same time, to share experience from CC which would be appreciated at KUSCO; (ii) on-the-job training for an ALAF executive in a well run overseas plant of comparable size; (iii) utilization of computer assisted steelworks modeling at the level of NDC, to tackle steelmaking and rolling mill development issues; and (iv) the GM or an NDC or Ministry official charged with rehabilitation of the steelmaking and mechanical industries sector should attend a regional rehabilitation workshop.

Recapitulation of capacity utilization. Present capacity utilization is 59.6% at the EAF shop. However, the fact that in 1988 the utilization was no more than 34% shows that substantial external factors are at play; specifically, this includes shortages of scrap and supplies such as furnace electrodes. Conservative target value that can be achieved without major investment, through implementation of recommendations outlined above, is 70%.

Other recommendations.

- Try to offer to CIFEL the billets 100 by 100 mm kept in store at ALAF. Basically, CIFEL should be able to process this size.

- Pay more attention to personal safety aids (not worn by the furnace and caster crews) and to general tidiness of the workplace.

- Together with SRM, consider alternative means of transport of billets to Tanga. Trucking is expensive and the road is in very poor condition.

B.1.4 Future expansion and rehabilitation

There has been no investment into ALAF in recent years but the development plans are well-defined.

With a view to projected demand for steel and steel products, there is a wide scope for expansion and modernization at ALAF for the 1990-1995 period. At the level of the Steelcast Division covered by the present project, the major expansion items planned are an additional electric arc furnace, a bigger billet caster of 40,000 tpy capacity, and a section mill. At present with ALAF having no rolling capacity, the ALAF billets are rolled to bars in the SRM rolling mill at Tanga. The section mill at ALAF will be producing bigger size sections which are not manufactured by SRM.

A shipbreaking project is also entertained by ALAF.

Recommended implementation:

1. Major/general overhaul of standing EAF. USD 2-3 mln, 1992. This is seen as a reasonable first component of a stepwise rehabilitation program. If upgraded, the overhauled furnace would turn out all steel required to cover the present capacity of the CC and also of the SRM rolling mill, thus eliminating a forex constraint constantly encountered when purchasing billets abroad. This of course would benefit SRM directly and ALAF indirectly. The overhaul would have to entail the installation of a more powerful transformer and of intensification elements (oxygen lances to speed up melting and refining).

2. General overhaul of standing CC. USD 1-2 mln, 1992. This should go hand in hand with EAF overhaul since either will cause general shutdown of the plant. Part of the overhaul would have to be modification to allow sequential casting. The objective is to reach a capacity of 40,000-50,000 tpy for 100 by 100 mm billets.

3. New EAF at the melting shop. USD 5 mln (approx.), 1995-1998. At 25,000 tpy capacity this should be of design not too different from that of the old EAF, and would provide the boost necessary to eventually feed a reconstructed caster without significant constraint on either the furnace side or the caster side. It would make little sense though to construct a new furnace unless the section rolling mill project is approved (cf. item 5 below). An even more important prerequisite is to find a satisfactory solution to the scrap shortage problem. Again, at 40,000-50,000 tpy new EAF capacity this would satisfy the requirements of the

ALAF rolling mill to be built but might still constrain the standing SRM rolling mill. Also, a large furnace would require a new melting shop bay at ALAF.

4. New billet caster. This variant is regarded as only the second best at present because the reconstruction of the standing caster will yield the capacity required, at a more economical cost. The problem is however whether there will be anybody willing to do the reconstructing.

5. Section rolling mill 36,000 tpy capacity. USD 8 mln (approx.), 1995-2000. This would make ALAF and SRM more independent of one another, would end the haulage of billets, but might end up constraining SRM because there would not be enough capacity at ALAF for own rolling mill and for billets for SRM at the same time.

6. Shipbreaking facility. An independent study is available from Kamdar Dalal & Associates, Bombay, India.

B.2 Steel Rolling Mills Limited (SRM)

Address: P.O. Box 5034, Tanga, Tanzania

B.2.1 Company background and performance

Background. Steel Rolling Mills Ltd., Tanga was incorporated as an NDC's subsidiary in 1966 and commenced commercial production in March, 1971. The major objective of establishing the company was to make Tanzania self-reliant on reinforcement steel for the construction industry.

The company had by 1982 an issued share capital of 18 million TSh, out of which NDC owned 96% and Danieli & Co. of Italy owned 4%. By 1989 the Danieli share dropped to 2% and State ownership (NDC) rose to 98%. The issued share capital is 38 mln TSh as at 1990. The plant single shift capacity of reinforcement steel is 10,000 tpy.

Range of products. Mild steel round bars, wire rods, angles, flats, and high tensile deformed bars of different sizes are manufactured in accordance with British and American standard specifications. Test certificates are issued on the products. The company claims that the strength characteristics being achieved are by 15% higher than the required values.

The specifications applied are BS 4449 - 1969. Mild steel is produced to min 250 MPa YS, min 450 MPa UTS, and min 22% relative elongation.

High tensile bars are produced to min 410 MPa YS and to UTS greater by 15% as against YS.

Major products:

	Capacity (tpy)
Ingots	-
CC billets	-
Hot rolled products	
bar mill	10,000
wire rod mill (to be commissioned)	6,000
wire rod mill (after installation of larger reheating furnace)	18,000
Cold rolled/drawn products	11,000
Secondary steel products	8,000
Other products	-

Note: Capacity figures are based on single-shift operation.

Product mix breakdown:

Product	Description
Plain round bars	mild steel, 12 to 25 mm dia. in 12 m lengths
High tensile deformed bars	12 to 25 mm
Angles	1.5 to 2" by 1.5 to 2" by 3/16 to 1/4"
Flats	6 to 12 mm thick and 40 to 75 mm wide (presently not in production)

The company claims to find market for its high tensile deformed bars thanks to savings achieved due to the following factors:

(i) greater bond between concrete and reinforcement
(ii) much lesser overlapping lengths
(iii) total elimination of end-hooks
(iv) high working stress.

However, the share of high tensile has always been low as quality is not an important factor yet, in a seller's market environment.

The wire rods are low-carbon, SAE 1010 and 1012 steel.

Bolts and nuts are B. S. W. standard.

Detailed breakdown of production range:
Mild steel:

1. Plain round bars 12 to 25 mm dia. in 12 m lengths
2. High tensile deformed bars 12 to 25 mm
3. Angles 1.5 to 2" by 1.5 to 2" by 3/16 to 1/4"
4. Flats 6 to 12 mm thick and 40 to 75 mm wide

Wire rod coils, wire products, bolts and nuts, and other sizes of round and deformed bars are not produced at the present time.

<u>Company performance</u>.

Year	Production in tons
1984	7,213
1985	11,298
1986	11,282
1987	9,864
1988	10,498
1989	15,327

A minor share of production was exported to the neighboring countries, largely Kenya, Burundi, and Zambia in the early years (between 1973 and 1981). Owing to a growing demand at home, the company has shelved further exports.

Principal production units:

Plant/unit name	Supplier	Operated since	Capacity (tpy)
Rolling mill	Danieli	1971	20,000
Wire rod plant	Danieli	-	6,000
Drawn wire plant	Danieli	-	11,000
Sec. wire products section	Danieli	-	8,000

Mode of operation:
The bar mill runs in two-shift operation. The other mills are yet to be commissioned.

Employees:	total	375
	office (manpower dept. incl. security, administration, etc.)	94
	shop (tech. dept. incl. production, maintenance, garage, and quality control)	183
	others	98
	Qualifications:	
	engineers	4
	technicians	54
	workers	270
	others	47

The company had expatriates in the 1970s but has none now. Involvement of staff in training programs is desirable.

For specific mill data, see Annex G.

B.2.2 Findings

<u>Condition of production equipment.</u> The general condition of the plant equipment is fair to poor. At the bar rolling mill, heavy usage is evident but the mill is fully operable.

The reheating furnace is in poor condition. The side door needs repair urgently. Oil leakages are in evidence around the furnace.

Any failure of electric equipment (motors etc.) is bound to shut down the plant, because of lack of instrumentation. The unavailability of measurements of the insulation resistance of electric motors was identified as a major cause. A new motor (Siemens) was installed at the rolling mill.

Reconditioning of the roughing mill rolls is done locally by overlaying and machining, with good results. This is done using local armoid electrodes, without preheating.

The maintenance workshop has sufficient floor area. The machine tools are not new but are all in operating condition. Also, the workshop staff work as millmen.

The wire rod mill and wire drawing mill with the wire products section, yet to be commissioned, remains incomplete. This equipment appears to have survived years of inactivity since delivery in 1981 rather well; it is undamaged and generally in good condition, but can never be started up and efficiently operated without external assistance in the supply of the remaining about 10% of equipment and at the commissioning stage.

<u>Raw materials.</u> In a situation of an over-all shortage of scrap in the country, SRM operate in an environment where scrap is relatively abundant and cannot be processed locally.

As for the availability of billets which to SRM is the starting material, this also is a constraint because deliveries from both ALAF and ZISCO are irregular.

In recent years, SRM has had to cope with shortage of electric power, due to rationing and outages. This has an adverse effect on productivity but is outside company control. One of the immediate consequences is that the workshop cannot operate while the rolling mill is operating, because of lack of electric power.

Cylinder acetylene and oxygen also are in short supply.

An excessive oil consumption rate has been noted at the reheating furnace.

<u>Process and operation.</u> The process and operation at SRM are adequate, except for the generally irregular cadence of work arising from the bottleneck at the preheating furnace. Periods of activity and inactivity alternate with the availability or unavailability of hot billets from the furnace.

Overheating at the reheating furnace was spotted by the two field missions on both occasions. The furnace design is all right but its operation is totally uncontrolled. This results in excessive fuel oil consumption and overheated, highly scaled billets. The furnace temperature measurement system is inoperable. Thermocouples are missing. The furnace input is too high, the smokestack gate is not throttled, and the smokestack is very hot. All the five burners installed are operated simultaneously, more or less full-blast. The furnace operates with the door kept wide open, with damaging consequences for the heat regime and the steel structure of the furnace. Oil is leaking. Fuel oil consumption is too high.

The rolling mill is producing some scrap (cobbles and other discards) and this keeps accumulating at the rear of the bay. The method adopted in handling this scrap is dumping it onto a heap and then, time to time, flame cutting it at a considerable expense of labor and sending the cut pieces to ALAF for remelting. Under these conditions, it is poor practice to allow these pieces to become entangled. The manipulation area between furnace and mill is full of obstructions and the safety at work suffers.

There is no powered mechanical contraption (universal puller/pusher) that could be used in dismantling heavy machinery for repair. This is felt most acutely in SRM's inability to repair the billet cutting shears which has been out of operation for an extended period.

Hard physical labor remains a problem; the team witnessed manual discharging of billets from the reheating furnace, in absence of a properly functioning pusher. Also, there are no repeaters on the front side of the mill (for oval cross sections).

In the rolling mill bay there is only one crane. If the third shift were introduced, this would not be enough to serve the hot mill (mill changes) and the dispatching of rolled stock from the cooling bed.

At the rolling mill, the existing roughing mill is adjusted for 80 by 80 mm billets but can run heavier starting stock if the pass profiles are adapted.

Volume and efficiency of production. The rolling mill is mostly operated in two shifts (six days a week) and makes use of the night shift for all product size changes. The factors which prevent SRM from using a higher percentage of their capacity include:

- reheating furnace throughput (occasionally)
- mechanical breakdowns
- electric breakdowns
- billets in short supply (some 5,600 tpy are imported).

All SRM products are round bars made of mild steel (size range 12 to 25 mm dia.). In 1989, 60 tons of deformed rebars were produced.

The feasible normal mill capacity is 20,000 tpy. Typical production figures have been 10,000-15,000 tpy in recent years, representing a capacity utilization of 50-60%. This does not, of course, take into account the completely inactive wire products section of SRM.

MILL UTILIZATION

Calendar time: 365 x 24 hours		8,760	
Working hours:	hours/shift	8	
	shifts/day	2 (3) 3rd shift used for mill changes/repairs	
	days/week	6	
	weeks/year	48	
	overtime	occasionally	
total working hours available, GPT (1989)		4,661	
Breakdown of mill stoppages:		hours	%
	production	673.5	29.9
	mechanical	627.6	27.9
	electrical	252.8	11.3
	other	155.6	6.9
	downtime due to		
	billets	313.0	13.9
	electricity	0.0	0.0
	manpower	0.0	0.0
	other (maintenance)	228.0	10.1
Total mill delays (TMD)		2,250.5	100.0
Net production time NPT = GPT - TMD, hours: hours:		2,410.5	
Time utilization, %:			
	Gross production time/calendar time		53.2

Net production time/gross production time		51.7
Net production time/calendar time		27.5

Mill output (1989):	tph	pcs/h
per gross hour	3.29	35.3
per net hour	6.35	68.3

Mill output targets:

per net hour	7.5

Nominal maximum
mill capacity, tpy: 2 shifts

calculated,	
at 70 % utilization	24,200
at 80 % utilization	27,600

Above capacity calculation is based on 8 hours per shift, 6 days a week, 48 weeks a year, and mill output of 7.5 tph.

Status of maintenance and servicing

Technical level:
The technical level of maintenance suffers from lack of adequately trained workmen. Likewise the tooling is in short supply. The billet cutting shears was inoperative and could not be repaired because of the absence of an adequate device such as a hydraulic puller/pusher, to take the shears apart. Routine and medium repairs are done by repairmen who are assisted by millmen.

Degree of maintenance complexity:
Low to medium complexity. Simple, well accessible equipment, mechanically controlled.

Failure rates of critical subassemblies and units:
The pusher furnace represents a production bottleneck because of its low throughput. This also is why the crew tend to grossly overheat it (cf. above).

Filekeeping of failure rates:
The failure rates are kept on file all right. However, failures of equipment do not constitute the chief cause of downtime at the rolling mill.

Maintenance routine:
Usual procedure is followed in repair and maintenance work.

Maintenance prevention:
Downtime due to unavailability of billets is used for preventative maintenance.

Staffing in maintenance and servicing:

Total number of staff	89
technical personnel	10
engineers	2
technicians	5
others	3
laborers	
mech. workshop & fitters	35
electricians	11
furnace bricklayers	1
others	32

Skills and experience of maintenance staff:
Out of all the repairmen only 14 can work the machine tools. There are 10 locksmiths and 7 electricians who underwent regular apprenticeship. The other repairmen have had some training in their respective professions. Lack of skilled workmen will become a serious constraint after commissioning and startup of the wire mill and wire products section.

Maintenance and servicing equipment:
The park of available machine tools is in good technical condition, is not being put to much use, and meets the requirements of maintenance, except for items identified by the UNIDO team and discussed further on in the Chapter "Problems and remedies".

Maintenance and servicing technology: Standard practice now, but new maintenance technology and procedures will be required as soon as production is started at the two inactive departments.

Spare parts:

availability	very poor, particularly in case of imports
quality	good in case of imported spares; fair for local.
own production of spares	only about 25%
reconditioning of spares	minimum extent

Tools:

Most tools are not available. There is a lack of aids for personal protection, and lack of minor tooling. Acetylene gas and oxygen for cutting and welding is hard to obtain.

Refractories and consumables:

The same problem applies to the procurement of refractories and consumables; both are in short supply. Lining is done by National Engineering Co. of Dar es Salaam.

3.2.3 Problems and remedies

1. Storage of scrap. It is dangerous and uneconomical to have cobbles and other discards accumulating at the bay and obstructing operations. The first recommendation has been to make provisions to avoid entanglement of rods discarded from the rolling mill. A crew should be detailed to instantly clear away any discards: these must be cut to pieces (long bars must be bundled, short pieces must be filled into drums or crates) stored away to be ready for shipment to ALAF for remelting. The difference between making it irregularly and making it instantly means less involvement of labor, better shop floor utilization, and more regular deliveries of quality scrap to ALAF. Attention has also been called to the necessity of regularly clearing the manipulation area between furnace and mill. This has an indirect benefit of compensating the loss due to generation of discards.

A long term solution to this problem is the project of establishing a melting capacity at Tanga This would solve several problems at the same time:

- outlet for scrap which is relatively abundant in Tanga and sofar cannot be processed locally
- cutdown of expensive trucking over rough roads
- clearance of discards from the rolling mill bay.

2. Overheating at the reheating furnace; its operation is totally uncontrolled. There is a temperature measuring system but this has no thermocouples. Field measurements by a precision infrared optical pyrometer, taken on three successive days, indicated average overheating by 60-75^{o}C (as against the setpoint of about 1385^{o}C). Consequently, the damage to furnace lining by peeling, bursting, and surface melting of the refractories which brings about a premature shutdown for furnace

repair or relining is worth the production of 18 days on the average for a major repair. This converts to 1,480 tons of rolled stock lost (based on 70% over-all capacity utilization). However, the chief loss is indirect and relates to the excessive fuel oil consumption. cf. Problem 3 below. The recommendation has been to rehabilitate the reheating furnace temperature measurement system without delay (using thermocouples supplied by UNIDO) and reduce the furnace input accordingly, while also throttling the smokestack gate.

However, instrumentation is not everything here: the furnace throughput is too low for the capacity of the rolling mill, burners are inefficient, smokestack is very hot indicating after-combustion, and in fact, the entire heating system of the furnace should be redesigned and rebuilt.

It has been suggested that the first step, prior to any rebuilding, should be to conduct trials to find out whether less than the full complement of burners installed at the reheating furnace need be operated. The optical pyrometer can be used to advantage here. First of all, the side door must be repaired.

The objection that overheating is necessary for the furnace to keep pace with the rolling mill is not valid, because regular if slower rolling cadences are more economical in the long run than operating the mill in bursts.

3. Excessive fuel oil consumption at furnace. Oil leaks around furnace. The average consumption of 99.2 liters/ton of rolled stock was the highest encountered during the mission. The expected good standard consumption rate should be about half this amount, i.e., 50 l/ton maximum. Hence, with the present production volume the mill is wasting 600 tons of fuel in a year. This is a serious drawback which is bound to reflect in the balance sheet. Remedy: see Problem 2 above but also, throttling down fuel oil inputs when the rolling mill is idling, and repair seals and oil lines to stop oil leakages.

4. Mechanical and electric breakdowns. These constitute 27.9 and [illegible]1.3% of total downtime, respectively. This converts to approx. 15% and 5.4% of total working hours available (GPT), respectively. Conservative target values for a mill of this kind would be 5 and 2%. Hence, the production lost on this account amounts to 2,500 tons annually (based on 70% over-all capacity utilization). The universal hydraulic puller/pusher set and the electric instruments supplied by UNIDO should be able to pull the mill towards the target values. Also, the Atlas-Copco compressors which control the tilting table of the roughing mill and the

cutting shears are in critical condition but here the repair is beyond the scope of possible UNIDO assistance under the present project.

5. Electric instrumentation is lacking Out of the various electric parameters to be measured, the one which has considerable impact on the reliability of equipment and on maintenance is the insulation resistance of electric motors. The importance of the parameter is underlined by the fact that the company's maintenance workshop does not have the capability of rewinding short-circuited electric motors. The breakdowns that can be traced back to absence of measurements of electric resistance account for as much as 2% of unplanned downtime. This is worth 300-400 tons of rolled stock depending on the over-all improvement reached but, of course, this must be included in the over-all loss due to breakdowns as estimated above (cf. item 4). It is recommended that the insulation resistance meter supplied by UNIDO be used regularly to take measurements of the insulation resistance of all electric motors at the rolling mill. The other electric instruments furnished (digital multimeter, ammeter/voltmeter) can also assist maintenance, not in that it would directly reduce electric failures but rather, in speeding up failure localization and identification. Hence, this instrumentation is an important element of preventative maintenance.

6. Shortage of spare parts, tooling, and auxiliary mechanisms. This was alleviated by putting on the list of suggested UNIDO equipment the universal hydraulic puller/pusher set and other minor equipment for maintenance. Conservative estimate of the usefulness of this set of equipment is another 2% of production because of higher performance of the mill, plus energy conservation and labor savings (cf. next item).

7. Billet cutting shears is out of operation. This could never be repaired locally without the universal puller/pusher set mentioned above. Shears out of operation means flame cutting of billets which is poor practice and is expensive because it is energy and labor intensive. The costs of shearing can be estimated to be as low as 10% of the flame cutting costs.

8. No spare hot metal detectors. This is an important element of mill automation, with direct influence on mill performance. New hot metal detectors were put on the list and supplied by UNIDO. The major improvement achieved by this signalling and activating element is improvement of technology and standardization of production (uniform billet length). The loss of mill throughput due to inactive detectors has in this case been

estimated to convert to 300-400 tpy.

9. Hard physical labor remains a problem. This problem is particularly pronounced in handling of billets; also, there are no repeaters on the front side of the mill. It is recommended to install repeaters on the front side of the mill (for oval cross sections) where hard physical labor is presently required. Installation of repeaters must also be seen as a significant safety at work factor.

The pusher at the reheating furnace must be repaired, to eliminate manual discharging of billets from the reheating furnace. The recommendation to pay greater attention to safety at work also applies to personal safety aids.

10. Limited reheating furnace throughput. This problem, already urgent, will be even more so as the improvements as per items 2, 6, 7, and 8 are accomplished (cf. "Future expansion").

11. Shortage of billets (imports). There are three realistic ways toward improvement: imports from ZISCO, higher production at ALAF, or a CC facility at SRM (cf. "Future expansion and rehabilitation").

12. Only one crane in the rolling mill bay. If the third shift were introduced, this would not be enough to serve the hot mill (mill changes) and the dispatching of rolled stock from the cooling bed. Consider installing another crane. Also, with a single crane a crane failure will stop the whole mill.

13. Uneconomical transport of billets from Dar es Salaam. Haulage of billets from Dar es Salaam to Tanga by trucks is costly and alternative means of transport should be examined (coastal vessels, railway). It has been recommended that this issue be addressed in a broader context, in cooperation with local port authority and municipal and/or other company interests.

14. Power rationing and outages. This has a significant, adverse effect on production but is outside company responsibility.

Recapitulating, it is clear that items 2, 3, and 4 entail the most significant losses of production, while item 9 is most important for the health and safety of the workers.

<u>Quality control.</u> There is a quality control department, and a laboratory with a tensile tester. Basic measuring tools are available in a limited selection. For the given product mix the

quality control routine appears to be satisfactory and is backed by billet producers' certificates. Incoming billets are not inspected for surface quality.

Maintenance. The maintenance people will soon face an entirely new situation given by the commissioning of the wire products section. This will have to be overcome by investment in maintenance apparatus, by expanding the crews, and by training.

Training. There is no expatriate management but the local managers are quite good, with sufficient experience. Training is required in two directions: for standing operations, and for to operations of the new section to be commissioned. The following training is recommended: (i) participation in a subregional exchange program where a SRM shop manager, preferably the present production and technical manager, should visit KUSCO to learn better maintenance organization, better rolling practice, and the operations at a wire products section (about to be commissioned at SRM) while, at the same time, sharing with KUSCO the SRM experience in the area of roll renovation etc.; and (ii) on-the-job training for a SRM executive in a well run overseas plant of comparable size.

Recapitulation of capacity utilization. Present capacity utilization at the rolling mill is 51.7%. A conservative target figure that can be achieved without major investment, through implementation of the recommendations and measures outlined above, is 60%. Beyond this, there are considerable reserves in the supply of raw material (billets); this is a matter of future development.

B.2.4 Future expansion and rehabilitation

The plans for SRM, Tanga had to be modified considerably, due mainly to the general setback in the early 1980s, but now as before they have as their prime target the commissioning of the Drawn Wire and Secondary Wire Products plants.

The presently entertained development projects have been worked out to considerable detail. According to TISCO, the demand for rolled products in Tanzania is over 230,000 tpy in 1990, with a 10% increase expected every year. This includes the wire needed for the fabrication of fences, wire mesh, barbed wire, nails, screws, and bolts. The projects for starting up the wire mill and wire products section should be reassessed and the best project speedily implemented without further delay, seeing that misjudgment of the viability of earlier commissioning projects has already cost the company a considerable share of production. The project proposal presently considered is by Danieli & C. SpA of Italy who are the logical partner having supplied the shop equipment. The proposal comprises delivery of missing components, final erection, commissioning, and spare parts for 2 years. The entire project would then be to the tune of USD 12.5 mln, of which USD 7 mln is to be a grant by Italian Government, 2.6 mln is to be invested by SRM, and 2.8 mln is to be contributed by Incontra Commerce and Financing Co. Ltd. of Salzburg, Austria. The financing scheme may undergo some changes still, but the contract has been signed.

Shop operations are expected to start late in 1991, gradually picking up until the full operating range is reached by 1994. The design capacity is 18,000 tpy of wire rods. Hence, the final situation should be two parallel mills, the one being the present rod mill (partially rehabilitated) making round bars from billets, and the other being the new wire mill turning out 9,900 tpy of wire products.

According to latest analyses for the 1990-1995 period, the capacity of SRM on completion of the rehabilitation and expansion projects in the rolling mills are will be as follows:

Old mill	30,000 tpy
Wire rod mill	36,000 tpy
Wire products	11,000 tpy
Bolts and nuts	1,000 tpy
TOTAL	78,000 tpy.

Recommended implementation:

1. Completion and commissioning of the wire mill and wire products section. USD 12.5 mln total costs, 1991 (with production picking up until 1994). The scheme outlined above is strongly recommended because of
   - linkup with previous installation
   - high demand for the wire products
   - adequate financing
   - bridging the inactivity gap which inevitably, would reduce the equipment already installed to scrap within a few years.

2. Bar mill rehabilitation to 30,000 tpy capacity, 1992-1995. This involves mainly a new reheating furnace, plus rolling mill

train revamping (but not any new rolling mill stands) worth USD 3 mln. A second crane should be installed.

3. New EAF melting shop of 10,000 tpy capacity (1996-2000). This relatively modest project involving a 4-ton or 5-ton furnace would take care of available local scrap, would alleviate the transport situation, and would make SRM less dependent on purchased billets. Second-hand, reconditioned equipment can also be considered. Estimated costs: USD 6-8 mln.

4. New EAF melting shop followed by a billet caster of 70,000 tpy capacity (1996-2000). This development, entertained by NDC, cannot be recommended until and unless

- the pattern of inputs, markets, and demand is established by a thorough, independent study
- the immediate project of wire mill commissioning is successfully completed
- it is proved that this would be superior to expanding the production at ALAF while continuing the shuttling of billets from ALAF to SRM by road or whatever cheaper alternative route.

C. MOZAMBIQUE

C.1 Companhia Industrial de Fundicao e Laminagem S.A.R.L.

Address: P.O. Box 441, O. U. A. Ave. 485, Maputo, Mozambique

C.1.1 Company background and performance

Background. Established in 1955, Companhia Industria de Fundicao e Laminagem (CIFEL) remains the only cast steel foundry in Mozambique and, at the same time, one of two Mozambiquean rolling mill facilities. The company was private until 1977 at which time it came under Government control. Since 1989 it is fully state-owned. The company capital was 3,000 mln Meticais as at 1989.

The rated capacity of CIFEL is approx. 10 000 tpy of finished hot rolled products, 2000 tpy of cold drawn wire, 4000 tpy of steel, iron and non-ferrous castings,as well as some 1700 tpy of machined parts and steel structures. The total installed rolling mill capacity claimed by CIFEL is 70,000 tpy however.

Basically, CIFEL comprises the following production departments:

- bar and rod rolling mills
- wire drawing shop
- foundry shop
- mechanical workshops.

Range of products. This includes foundry products (sugar cane mill rolls and other ferrous and nonferrous castings of 5 tons maximum weight); round bars 6 to 40 mm dia.; square bars 12 to 50 mm; rolled and drawn wire 1 to 6 mm dia. (bright, galvanized, and annealed); exceptionally, flat bars and cold deformed bars.

Company performance. CIFEL experienced a more or less constant decline in production since the early 1970s. This has been accompanied by a general depreciation of the plant.

Capacity utilization is very low: in three-shift operation!, the company turns out no more than about 5,000 tpy of rolled stock which converts to about 18% utilization at the bar mill and about 10% utilization at the wire mill.

Major products:

	Capacity (tpy)
Ingots	500
Hot rolled products	40,000
Cold rolled/drawn products	3,000
Steel, iron, and non-ferrous castings	4,000
Other products (machine parts etc.)	1,500

Production of rolled stock by destination (tpy, 1987):

Total production	Internal consumption	Domestic market	Export
7,923	1,000	6,323	600

Annual production data by major production shops (t[illegible]):

Plant	1985	1986	1987	1988	1989
Bar mill	1,338	816	5,068	2,799	2,469
Wire rod mill	1,351	924	2,855	2,313	1,437

Balance sheet components (fixed assets, depreciated):

production facilities and machinery	US $ 450,330
buildings & other	399,224

Imports of billets from ZISCO, Zimbabwe: 8000 tons (1989)

Production cost estimates (US $/ton):

	Bars	Wire rods
material & energy	315.3	322.8
tools and expendables	11.5	10.0
maintenance	106.0	107.2

Breakdown of maintenance and repair costs (US $):

production facilities and machinery	333,466
buildings & other	83,900
TOTAL	417,360

Sales (US $, 1989):

domestic sales	33[illegible] 000
exports	290,000
TOTAL	620,000

Market environment: Captive market, fixed pricing system.

Principal production units.

Plant/unit name	Supplier	Operated since	Capacity (tpy)
Foundry (cupolas)		1955	1,500
EAF	R.S.A.	1963	500
Bar mill	Danieli Italy	1961	20,000
Wire rod mill	Danieli Italy	1958/1971	20,000
Wire drawing mill	Danieli Italy		3,000
Galvanizing line			700

Product mix breakdown::

Product	Description
Wire rolled	up 6 to 8 mm
Round bars	up 10 to 50 mm dia.
Drawn wire	up 4 to 16 mm
Cast iron	castings
Steel	castings
Nonferrous castings	bronze & brass (for sugar industry)

Mode of operation:

Foundry: one-shift operation
Bar mill, wire rod mill, wire drawing mill: three-shift operation

Employees:

office	141
shop	459
others	214

by qualification:

engineers	1
technicians	49
workers	703
skilled	216
unskilled	487

It can be seen that more than half of the total workforce are unskilled workers. There is one graduate engineer in the management. Management is hampered by serious external factors but also by the disjunct nature of CIFEL's production shops: foundry has little to contribute to rolling mill, the production of machined parts is separate from the other shops, etc. Hence, the company infrastructure is poor.

For specific mill data, see Annex G.

[illegible] Findings

Condition of production equipment. The general condition of the plant equipment is poor. This judgement applies particularly to the condition of the production equipment at the wire rod mill. The bar mill is only producing irregularly. The wire rod mill has been out of operation for a considerable period.

Out of the two, the bar mill is in a relatively better technical condition. At the bar mill, the general condition of equipment is commensurate with the years of service and with utilization.

A number of major constraints relating to the condition of the production and auxiliary equipment were identified:

All the side burners at the two reheating furnaces are inoperative. The furnaces are stripped of any temperature controls and indicators. The draught conduits are so designed that the furnace pressure cannot be controlled.

Loose and worn guides at both rolling mills cause the blanks to frequently run out, as documented by the heaps of cobbles and rejects outside the rolling mill bays.

Any failure of electric equipment (motors etc.) is bound to shut down the plant, because of lack of instrumentation. Same as at SRM in Tanga, the inability to measure the insulation resistance of electric motors was also identified as a major cause of problems at CIFEL.

At the wire rod mill, the electric motor drive of the roughing mill stand broke down because of ingress of water (free exposure to rainfall while the leaky roof was being repaired). The electric motor at the bar mill was lost in 1989 due to the same failure and for the same reason.

Uncontrolled ingress of water appears to be a general problem [illegible] water was also detected in the finishing block oil tank.

High contents of chlorides and mechanical impurities (scale) in cooling water are responsible for the low service life of slide bearings. Insufficient cooling of the roll grooves was witnessed on the bar mill - the water sprays were directed to outside the working area of the rolls.

The number 1 intermediate train of the wire rod mill is in very poor condition, undersized, and badly corroded.

Buildings are in considerable disrepair.

Raw materials and power. CIFEL is fully dependent on imports of billets. The major factors responsible for the shortage of billets include

- shortage of forex
- irregular delivery due to transport difficulties faced by the country.

Some years ago, molds for pencil ingots were supplied to CIFEL by a technical assistance program but the production of such ingots on the very small furnace available at CIFEL (1.5 ton EAF), which is complicated technically and unwarranted economically, would in any case be so low that it would hardly alleviate the shortage of billets.

In recent years, CIFEL has had to cope with shortage of electric power, due to rationing and outages. This has an adverse effect on productivity but is outside company control.

The mill has often had to be shut down for protracted periods due to power outages. Rationing of power can be offset by appropriate production planning but there is no defence against outages.

Process and operation. The process and operation issues at CIFEL cannot be addressed properly under conditions where the plant is operating under too many external constraints so that the operations at the individual production shops are only irregular.

This irregularity in itself reflects badly not only on the condition of equipment but above all, on the operating practice.

These issues are discussed elsewhere; out of the immediate process and operating problems diagnosed, the following two were identified as being of considerable importance:

The furnace bottom is not being cleansed of scale. In case of power outage, billets are left in the furnace; this has the consequence of slowing down the heating up of the furnace and causing excessive scaling and warping of the billets.

Same as at the other plants, there is no offgas analysis at the reheating furnace at CIFEL, with the consequence of running the furnace constantly with an excess of air, this oxidative atmosphere damaging both production and the furnace.

Mechanical maintenance also is a constraint, because of shortage of spare parts, tooling, and auxiliary mechanisms. Some 80% of spares have to be made at the plant. There is no mechanical device such as an universal puller/pusher which would assist in dismantling machinery for repair. However, the fairly well equipped mechanical workshop is often idle because of the very low production of castings at the CIFEL foundry.

CIFEL have no maintenance staff for keeping up the buildings which are in considerable disrepair.

Volume and efficiency of production. Low and decreasing volumes of production as well as inadherence to annual production plans are typical of CIFEL.

Production, technological, and cost data are well kept and even computerized, and management are well aware of the very comatose situation of the rolling division of CIFEL. Indeed, this situation has become even more aggravated when contrasting 1988 and 1989.

The bar rolling mill turned out no more than 2,470 tons of rebars in 1989, as against the target of 10,000 tons planned (which again would be no more than 50% of available capacity). The wire rod mill produced 1,438 tons of wire rods, as against 5,700 tons planned, and was shut down completely for a period of four months in 1989.

Hence, the capacity utilization has been very low indeed, something like 10-20%, regardless of differences in true capacity as determined by various estimating techniques.

The positive factor at the bar mill is that it is capable of processing not only 80 by 80 mm billets but also 100 by 100 mm stock. This widens the scope for purchasing billets abroad; for example, a sizable quantity of 100 by 100 mm billets has now been in storage at ALAF. Dar es Salaam, Tanzania for considerable time, unsold.

The production is inefficient, and ineffective. The product mix is unsuitable. The bar mill is rolling low-diameter bars (12 and 10 mm) where the wire rod mill would be more effective. The reason is that the wire rod mill is more complicated and more difficult to start up considering that the production lots are small.

Low production and low output manifest themselves by very high specific consumptions of materials and energy. To produce 1000 kg of bars on the bar mill and 1000 kg of wire rods on the wire rod mill, the consumptions of billets are 1217 and 1525 kg, respectively. The fuel oil consumptions (at the heating furnaces) are 193 and 330 liters per ton of production, respectively.

Three-shift operation (on both rolling mills) seems hardly to be warranted in a situation where the output is less than what could be made in a single shift. The time utilization on either mill runs below 20%, and the figure would be even more alarming if the considerably higher true mill capacities were taken into account.

People who are kept idle could engage in cutting the scrap and tidying up. Also, preventative maintenance could proceed without time constraints. Reconditioning of the crane wheels could be done locally.

MILL UTILIZATION, BAR MILL

Calendar time: 365 x 24 hours		8,760	
Working hours: hours/shift	8		
shifts/day	3		
days/week	6		
weeks/year	48		
overtime	occasionally		
Total working hours available, GPT		5,280	
Breakdown of mill stoppages:	hours		%
production	809		18.8
mechanical	490		11.5
electrical	559		13.0
other	991		23.2
downtime due to			
billets	1,155		26.9
electricity	46		1.1
gas	153		3.5
fuel	39		1.0
water	31		1.0
Total mill delays (TMD)	4,291		100.0
Net production time, GPT - TMD, hours:		989	
Time utilization, %:			
working hours available/calendar time			60.2

Net production time/working hours available 18.7

Mill output		tph	pieces
	per gross hour	0.47	3.7
	per net hour	2.5	20.0
Max. rolling rate 12 mm dia.		7.1	57.6

Mill output targets:

per gross hour 7.5 (not possible with existing product mix)

Mill capacity, tpy:

		1 shift	3 shifts
Actually planned			10,000
Calculated	at 70 % time utilization	12,100	36,300
	at 80 % time utilization	13,820	41,500

Capacity calculations based on 8 hour shift, 6 days/week, 48 weeks/year. output 7.5 tph.

MILL UTILIZATION, WIRE MILL

Calendar time: 365 x 24 hours 8,760

Working hours:	hours/shift	8
	shifts/day	3 (2)
	days/week	6
	weeks/year	41
	overtime	occasionally

Total working hours available, GPT 5,415

Breakdown of mill stoppages (1989):

	hours	%
production	788	16.2
mechanical	788	16.2
electrical	367	7.5
other	2,061	42.3
downtime due to		
billets	583	12.0
electricity	109	2.2
gas	90	1.7
water	67	1.4
fuel	27	0.5
Total mill delays (TMD)	4,853	100.0

Net production time (GPT - TMD), hours: 562

Time utilization, %:

Working hours available/Calendar time	61.8
Net production time/working hours available	10.5

Mill output (1989):	tph	pieces
per gross hour	0.27	2.7
per net hour	2.56	26
Max. rolling rate, 6 mm dia :	6.4	65

Mill capacity, tpy:		1 shift	3 shift
presently planned			10,000
calculated	at 70 % time utilization	11,290	33,870
	at 80 % time utilization	12,900	38,710

(capacity calculations based on 8 hours shift, 6 days/week, 48 weeks/year, and a mill output of 7 tph; the yield improvement expected due to more stable production is approx. 1,285 kg/ton)

Status of maintenance and servicing:

Technical level:

The technical standard of maintenance is relatively good, particularly as concerns the machines and equipment available. Spares however are lacking, both for production facilities and for auxiliary/service facilities. Some 80% of spare parts are manufactured at the works. The maintenance dept has not the funds to acquire special spares such as bearings, gearings, electric motors, chains etc. Delivery of such parts, if purchased, is rather slow. There is a shortage of tooling and auxiliary mechanisms. The chief drawback is a low capacity utilization at the mechanical workshop where castings and various materials are in short supply and the scope of work is mostly outdated machines for farmers. There is no designing department and no unit which would concern itself with future developments.

Degree of maintenance complexity:

Not very high; the production facilities are fairly simple, without automatic and electronic elements.

Failure rates of critical subassemblies and units:

Shortages of input materials and energy underlie the substantial downtime which however is used for preventative maintenance. Hence, there are no bottlenecks in maintenance. Higher failure rates are encountered at the wire mill producing coils.

Filekeeping of failure rates: Adequate monthly filekeeping.

Maintenance routine:
The production process is rather intermittent. The repairs of equipment are planned and only exceptionally have to be done following breakdowns. Because of the frequent mill stoppages (lack of billets, outages) the repairwork proceeds slowly and the productivity of the maintenance men is low.

Preventative maintenance:
This can be done thoroughly because there is enough time, with all the downtime. The stoppages have an adverse effect on furnace lining which peels off due to temperature fluctuations.

Staffing in maintenance and servicing:

Total number of staff	122
technical personnel	12
engineers	1
technicians	11
laborers	110
mech. workshop & fitters	38
electricians	22
furnace bricklayers	6
others	44

Skills and experience of maintenance staff:
Most of them are untrained but with some skills in selected professions. There are few men with adequate training and experience.

Maintenance and servicing equipment:
The machines and equipment are not up-to-date technically (installed 1955-1960). The machine tools are well maintained though, and adequate.

Organization of maintenance and servicing.
Centralized organization, supervised by Chief of Maintenance Division. There are three Department Chiefs: Foundry, Rolling Mills, and Annealing & Mechanical.

Maintenance and servicing technology: Standard practice.
Spare parts

availability	poor
quality	average or fair
own production of spares	20%
reconditioning of spares	yes, mainly rolling mill rolls

Tools: Shortages and poor availability for most groups of tools. Lack of measuring instruments indispensable for electrical maintenance. Diagnostic tools non-existent.

Refractories and consumables:
Imported from Zimbabwe, R. S. A., and Sweden. Same problems are faced here as with spares.

C.1.3 Problems and remedies

The problems faced by CIFEL are grave, long-term, and serious. At the level of individual shortcomings they are discussed above in the chapter "Findings". At a general level, they are broken down and analyzed below:

1 Shortage of raw materials. This is the paramount problem for CIFEL, due to a shortage of forex and aggravated by logistical problems. A temporary relief can be obtained by adding other sources of raw materials to the one from ZISCO; one such source identified by the mission is a stock of billets 100 by 100 mm available from ALAF (SRM cannot use them but CIFEL could, at their bar mill).

2 Irregularities of power supply. Again, there is very little the company can do about it.

3 Low and decreasing volumes of production, inadherence to annual production plans. Inefficient production. This is the [illegible] of 1, and 2). The recommendation is not to rigidly adhere to three-shift operation but rather, to concentrate production in [illegible] less likely to be affected by power disturbances. However, the technical aspects here must not suppress an [illegible] of the social aspect: the three shifts, even at [illegible] low capacity utilization, provide a degree of social security and stability to the workforce.
4. Low yield of [illegible]. The very low yield specified above in "Findings", is of course due to very low output. If the [illegible] of the recommendations made here can be combined with a

higher and more stabilized level of production, the yield can be expected to rise dramatically.

5. The high fuel oil consumptions can be remedied in the same way. However, reconstruction of the draft conduits is a pre-requisite. The achievable target is 50% of present consumption, considering the condition of the furnaces.

6. Poor condition of the production equipment. This applies both to the bar mill and to the wire rod mill; the wire rod mill is the worse of the two. Principally, this is a matter of future rehabilitation and development but even now, several improvements were suggested. The recommendations made are as follows: (i) Repair/replace loose and worn guides at both rolling mills. (ii) Intensify water cooling of roll grooves on the bar mill - direct the water sprays onto the working area of the rolls. (iii) Repair and, later, rehabilitate the number 1 intermediate train of the wire rod mill which is in very poor condition, undersized, and badly corroded. (iv) repair tilting table of the roughing stand of bar mill which is in critical condition; replace mechanical drive of which the gearbox is badly damaged by a pneumatic drive. A hydraulic drive is not recommended because of oil leakages and danger of fire.

7. Reheating furnace at the bar mill is in poor condition, lacks instrumentation and thermocouples, and is being overheated. This constraint can be overcome by installation of a temperature measuring system and of Pt/PtRh thermocouples supplied by UNIDO, and also by independent temperature measurements using an optical pyrometer (also recommended). The side burners at the two reheating furnaces (at the bar mill and the wire rod mill) need repair. During the team's visits, both furnaces were stripped of temperature controls and only the wire rod mill furnace had a temperature indicator. The draught conduits are so designed that the furnace pressure cannot be controlled.

8. Billet temperatures (at bar mill) and melt temperatures (in foundry) are not measured. An optical pyrometer was recommended [illegible] stabilization of the production practice.

9. A [illegible] detector was recommended for the wire rod mill, [illegible] cooling shear ahead of cooling bed. [illegible] the percentage of rejects in this [illegible] be quantified easily because of the extremely [illegible] of the mill, but is a necessary condition [illegible] of this part of the mill.

10. [illegible] from rolling mills. These keep accumul-

...ting and are coped with by flame cutting only which is inefficient. It has been recommended that measures be taken to get rid of heaps of entangled rods and wire discarded from the rolling mills, using manpower kept idle during shop shutdowns and power cutages. To facilitate this labor, a portable hydraulic shears was recommended.

Quality control. There is little quality control except for dimensional checking of bars and rods. The rolling mills rely on the billet suppliers' certificates. A range of simple measuring devices were put on the list of UNIDO supplied equipment, together with the optical pyrometer which also is a tool of quality control.

Maintenance. The maintenance workshop has problems with electric welding and cannot take electrical measurements. The equipment and instrumentation recommended include a universal hydraulic puller/pusher set, an insulation meter, a digital multimeter, an ammeter/voltmeter, and an electric welder.

Buildings are in considerable disrepair; consider putting the shop crew on the job of repairing them while the mill is idle. Also, these people could cut the scrap heaped up outside.

Roofs are leaky; there were repeated cases of damage to the main drive motors because of rainfall combined with irregular operation. This put the shop out of operation for several months. The insulation meter was ordered by UNIDO specifically for checking the insulation resistance of the electric motors to prevent serious damage. Uncontrolled ingress of water appears to be a general problem, because water was also detected in the finishing block oil tank of the wire rod mill.

High contents of chlorides and mechanical impurities (scale) in cooling water are responsible for the low service life of slide bearings. Many parts of the mill are badly corroded.

It has also been recommended that
- the reconditioning of crane wheels could be done locally;
- the instruments supplied by UNIDO be used to measure the insulation resistance of electric motors;
- the same instruments and tools be also employed to increase the low utilization at the mechanical workshop;
- the range of farming machinery produced at the mechanical workshop be expanded; this would enhance the over-all capacity utilization;
- an engineering designer should be consulted to assist in the design of farming and other implements.

Training. As already mentioned above in Section C.1.1, there is a high share of unskilled labor and only one graduate engineer at CIFEL. At the managerial level, training is required in the following specific areas: (i) utilization of computer assisted steelworks modeling (preferably with the rolling mill manager or the finance manager participating) because of the need to assess and reassess, under serious and changing external constraints, the development and rehabilitation plans; (ii) participation in an exchange program where a CIFEL development manager should visit SRM (mainly to exchange experience relating to developments such as the wire mill and secondary products section) and a maintenance manager should visit ZISCO (to take part in the ZISCO maintenance training program); (iii) on-the-job training overseas for a shop manager in a well run mill of comparable size; and (iv) the GM should attend a regional rehabilitation workshop.

Recapitulation of capacity utilization. Present capacity utilization figures at the bar mill and the wire mill are abysmal: 18.7 and 10.5%, respectively. Conservative target figures that can be achieved without major investment, through implementation of the less demanding recommendations and measures outlined above, are of the order of 5-10%. An over-all improvement of maintenance and production practice would be the chief components. However, external factors outside company control play a dominant role here; chronic shortages of billets and power are dominant.

C.1.4 Future expansion and rehabilitation

CIFEL's modernization and rehabilitation plans include major projects such as revamping of the existing wire and bar mill, erection of mini-steel shop with a CC caster, revamping and modernization of foundry and mechanical workshops, and installation of new drawing machines, but also relatively modest projects such as installation of an induction furnace and the establishment of a training center.

It has been estimated that after implementing the ambitious rehabilitation and modernization program, CIFEL will be in a position to produce

- 80,000 tpy of finished hot rolled products
- 8,000 tpy of cold drawn wire
- 4,500 tpy of steel, iron, and non-ferrous castings
- 2,500 tpy of machined parts and steel structures.

The low production of steel in Mozambique is a pressing problem which is aggravated by the generally low capacity utilization at CIFEL. All long term development is contingent on the country overcoming the generally unfavorable economic situation.

After implementing the ambitious rehabilitation and modernization program, CIFEL would be in a position to produce

- 80,000 tpy of finished hot rolled products
- 8,000 tpy of cold drawn wire
- 4,500 tpy of steel, iron, and non-ferrous castings
- 2,500 tpy of machined parts and steel structures.

CIFEL management's own view of the rehabilitation and expansion needs is as follows:

Foundry:
- To reach the molding shop capacity.
- To increase the sand preparation capacity.
- To mechanize the sand transport system.
- To improve the quality of castings through modification of the casting system.
- To install an induction furnace of 1.5 to 3 tons capacity.
- To secure instruments for the laboratory.

Rolling mill:
- To modify the bar mill so as to allow for the production of sections.
- To modify the rod mill technology so as to increase the finishing speed from 14 to 23 m/s, to boost productivity.
- To install two drawing machines at the drawing mill to reach a capacity target of 8,000 tpy (producing wire 8 mm and up).

Machine shop:
- To increase the capacity of machining to boost the output of mill rolls from nodular iron, to upgrade repair work and manufacture of spares.
- To secure instruments and apparatus for quality control.

General:
- To establish a training center to provide training in foundry, rolling mill, drawing mill, and machining technology.
- To establish a social center for the workers.

Suggested implementation:

The major problem of development is the thwarted long-term development plans and uncertainty about further development due to shortage of funding and of foreign currency, and also due to external constraints of the country which are outside company control.

CIFEL's rehabilitation plans are now being given a chance at success, with a foreign aid package coming from Spain which should also address the problems of the steel industry.

The modernization and rehabilitation of CIFEL has already been the subject of numerous studies and consultations. The major projects planned include revamping of the existing wire and bar mill, erection of mini-steel shop with a CC caster, revamping and modernization of foundry and mechanical workshops, and installation of new drawing machines, but also relatively modest projects such as installation of an induction furnace and the establishment of a training center. One project which would be of considerable importance to the plant's future is the installation of a closed loop water circulation system; the chloride contaminated water presently used throughout the plant has very damaging effects.

It appears to be necessary to reassess the projects aimed at erection of mini-steel plant, rolling mill revamping and modernization (both bar mill and wire rod mill); modernization, revamping, and overhaul of foundry and mechanical workshop, rehabilitation and modernization of wire drawing shop, and erection of new, closed cooling water circulation system, in view of the foreign aid package of which CIFEL should be one of the beneficiaries. The reassessment should take into consideration a realistic estimate of the trends to be followed by the external constraints. Availability of raw materials and power is essential for otherwise the effectiveness of all development work and rehabilitation would be uncertain.

D. MAURITIUS

D.1 DESBRO International Limited

Address: Plaine Lauzun, Port Louis, Mauritius

D.1.1 Company background and performance

Background. DESBRO International is a Group of companies involved in steel rolling, production of plastic piping, and other commercial and production activities. The Rolling Mill Section of Desbro International Ltd. is the largest of the four steel bar producers in Mauritius. Established in 1966, Desbro rolling mills is a privately owned company linked to a number of other Mauritian enterprises of the Rogers & Co. Group. The capital is MUR 25 mln (1989).

The 300-mm rolling mill is a seven-stand, cross country repeating mill turning out reinforcement bars. This mill is operated since 1979. Another, older mill (200 mm) is out of operation.

Range of products. Mild and high tensile reinforcement bars 8, 10, and 12 mm dia. are produced, with the 8-mm bars dominating (78.5 % of all production).

Company performance. The production figures for 1987, 1988, and 1989 reflect the current boom of the construction industry in Mauritius:

Production, tpy:	1987	1988	1989
	9,316	10,867	17,584

Major products:

	Capacity (tpy)
Hot rolled products	20,000

Principal production units:

Plant/unit name	Supplier	Operated since	Capacity (tpy)
Rolling mill (12")	Shekhar, India	1979	20,000
Rolling mill (8", dismantled)	Brightside, UK	1965	6,000

Basic product mix

Product	Description
Rolled bars	8 to 12 mm high yield deformed rebars; straightened wire 6 mm dia. from imported coils

Mode of operation:
2 (3) shifts

Employees:

	total	ca 300 (also employed in non-metallurgical operations)
	rolling mill	43 per shift

For specific mill data, see Annex G.

D.1.2 **Findings**

Condition of production equipment. The general condition of the plant equipment is good. In fact, the plant is relatively new and is being relatively well maintained.

Except for the roughing stand the rolling mill train is fully mechanized, with front and back repeaters. Mill guides are in good condition. Roller outlet guides are used. Cooling of the rolls is adequate. Reconditioned roll passes are normally used.

There are stands in the bay which originate from one of two dismantled mills (the other having been sold to Madagascar).

There are no controls and no temperature measurement at the heating furnace. The furnace damper is kept in a fixed position. Furnace skids are made of steel, giving a relatively good service life of two years. Furnace billet charging conveyor is out of operation and billets are manually positioned front of the pusher.

Raw materials and power. DESBRO is fully dependent on imports of billets. While 60 by 60 mm billets are the chief feeding stock, 80 by 80 mm can also be processed. The billets are imported from ISCOR R S.A. Imports from ZISCO were discontinued on account of poor surface quality, scattered chemical composition, and irregular delivery.

The problem of electric power rationing is not acute in Mauritius.

Process and operation. With the present production mix where 8 mm bars are dominant, the major constraint is that the speed of the finishing stands is too low lagging behind the furnace capacity; this results in a limitation of output.

Manually operated roughing mill involves hard physical labor. Cooling bed operation is rather labor intensive (manual handling of rolled bars). Transport of billets from the furnace outlet door to the roughing mill is also manual.

When rolling heavier billets (80 by 80 mm), an additional 10 crew members are needed.

Otherwise the process is all right sofar but in the near future, small-size billets (60 by 60 and 80 by 80 mm) are expected to be no longer available (within about two years) so the mill faces the necessity to modify the process so as to accommodate 100 by 100 mm billets.

The product mix of DESBRO is specialized and this is advantageous because the whole range of sizes can be rolled using the same set of rolls. This is beneficial for time utilization. The roll pass design suits the present product mix well but will require modification as soon as the technology of rolling bigger billets is adopted.

Fuel oil consumption at the heating furnace is estimated at 65 liters per ton of production. Heating controls are inferior; the setting of furnace burners is done by experience only.

Scaling is heavy but the furnace bottom is being regularly cleansed of scale, and preventative maintenance is being applied. Thanks to regularity of operation (22 hours a day) the furnace refractories are not exposed to excessive thermal shocks. However, the furnace is being overheated and the plastified scale is readily soaked by the magnesite lining; this causes sticking of billets.

Excessive sticking of billets to the heating furnace hearth results in severe wear of the hearth and consequently, loss of production.

The cutting shears downstream of the finishing stand must be actuated manually as there are no reliable hot metal detectors.

As a matter of fact, the detector previously installed was responsible for a fatal injury. The hot metal detectors initiating the end cutting shears downstream of #3 stand are running out.

The absence of any apparatus which would count and/or record the volume of production is felt. Of course, this is a problem of all the rolling mills covered.

Roll pass reconditioning (by overlaying) is an established practice for the roughing mill rolls.

Volume and efficiency of production. As the demand grew over the years, DESBRO kept gradually increasing the time utilization of the mill by switching to two-shift operation and by extending shift duration to 11.5 hours. A system of output-related premiums is being practiced with success.

The time utilization of the mill is rather good. The production of rebars was over 17,500 tons in 1989; all was high-tensile grade.

The product mix of DESBRO includes 8, 10, and 12 mm dia. rebars, with 8 mm dominating. This is so because an agreement on the production mix split was concluded with another company, the Sections Rolling Limited of Port Louis which specializes in heavier bars (over 12 mm dia.).

MILL UTILIZATION

Calendar time: 365 x 24 hours		8,760
Working hours: hours/shift	11.5	
shifts/day	2	
days/week	5	
weeks/year	48	
overtime	permanent (3.5 hours per shift, occasionally incl. Saturdays)	
Total working hours available, CPT		5,556
Breakdown of mill stoppages	not recorded	
Net production time	3,600	

[illegible]
Working hours available/calendar time. %
Net production time/working hours available

Mill output (1989):		tph	pieces
	per gross hour	2.75	70
	per net hour	4.25	10[illegible]
Mill output targets:			
	8 mm dia	3.7	9[illegible]
	10-12 mm dia	6-7	12[illegible]
Nominal maximum mill capacity, tpy:		1 shift	3 [illegible]
	calculated		
	at 70 % utilization	7,260	21,[illegible]
	at 80 % utilization	8,290	24,[illegible]

(calculation based on 8 hours per shift, 6 days [illegible] a year. 4.5 tph mill output at given product mix)

Status of maintenance and servicing

Production bays:
The rolling mill bay roof is in good technical [illegible]. [illegible] maintenance shop has very limited floor area, the [illegible] are improperly located, there is not enough space [illegible] handling. A forge shop is part of the general [illegible] workshop. The available machinery is adequate for the [illegible] the mill but the machines are old so modern machining [illegible] cannot be used.

Technical level:
In spite of the constraints mentioned above, [illegible] mainly from inappropriate dislocation of [illegible] and maintenance workshop, the technical [illegible] relatively good.

[illegible] maintenance complexity:
[illegible] complexity. [illegible] intric[illegible] [illegible] are contracted out. Rout[illegible] maintenance [illegible] done by company staff [illegible] motors and electric wiring are also [illegible]

Failure rates of critical subassemblies and units:

Failures are not very frequent but there is no file-keeping.

Maintenance routine:

The production equipment working in batches, the routine repairs are done as planned mainly on Sundays or are continued on the Monday morning shift. Medium repairs are done twice a year depending on the condition of the pusher furnace and the duration of its repair.

Maintenance prevention:

Preventative maintenance is done according to recommendations of a technical inspector. As a rule, this is part of the maintenance routine engaged in on Sundays.

Staffing in maintenance and servicing:

Total number of staff	40
technical personnel	2
engineers	1
technicians	1
laborers	
mech. workshop & fitters	20
electricians	3
furnace bricklayers	1 + 4 helpers
others incl. building maint.	10

Skills and experience of maintenance staff:

The professional level of maintenance staff is good. Most of the staff have the necessary basic skills obtained by previous formal training (apprenticeship) as well as the necessary experience for work in their respective professions. Those working the machine tools can turn out medium complexity components.

Maintenance and servicing equipment:

The available machine tools are outdated, many operations are done manually. However, the machine park still is almost adequate for the jobs required. Additional machinery would not fit in because of lack of space; replacements are the only possibility given the workshop building.

Maintenance and servicing technology:

Most of the procedures employed are as per simple, standard practice. Management are making efforts to become self-sufficient in mechanical maintenance at the rolling mill and in the manufacture of spares.

Spare parts:
There is a good supply of spares, maintenance tools, and working aids.

Refractories and consumables:
Refractories are imported from South Africa. These are high and medium alumina firebrick for sidewall and roof linings of the pusher furnace, chromomagnesite material and insulation bricks to protect the furnace jacket. Consumables (e.g., lubricants) are available locally.

D.1.3 Problems and remedies

The following problems were identified, and recommendations were made:

1. Change of inputs. Small-size billets (60 by 60 and 80 by 80 mm) are expected to be no longer available. Remedy consists in adapting future development so that the mill could accept 100 by 100 mm billets (cf. "Future expansion and rehabilitation").

2. Output constraints. The speeds of the intermediate and finishing stands are too low resulting in a limitation of output when rolling 8 mm dia. rebars (which is dominant product). Again, this is a matter to be handled by future development.

3. Furnace overheating; temperature measurement and controls missing at the heating furnace. A reheating furnace temperature measuring system and an optical pyrometer were recommended. The chief benefits are reduced fuel oil consumption (estimated at 5 liters/ton), reduced loss of steel due to scaling (by min. 10 kg/ton), and longer service life of refractories.

4. Excessive sticking of billets to the heating furnace hearth resulting in severe wear of the hearth (also see item 3). Electromelted refractory for relining the bottom of the pusher furnace was recommended and its supplier was identified.

5. Hard labor and labor intensive operations. Manually operated roughing mill and manual billet transport from the furnace involve hard and dangerous physical labor, and so does the cooling bed operation. This again can only be remedied by future

development.

6. Hot metal detectors. Cutting shears downstream of the finishing stand must be actuated manually as there are no reliable hot metal detectors to re-activate this cutting shears and also to keep operating the shears downstream of #3 stand. This has been remedied by the recommendation to UNIDO to purchase new hot metal detectors for the mill. Modern heavy duty detectors were purchased, and their assembly was demonstrated on site.

7. Filekeeping problem. There is no apparatus which would count and/or record the volume of production. To avoid disputes regarding the number of billets rolled, it has been recommended that the signal from a hot metal detector be employed for automatic counting of the pieces passed through the rolling mill so that exact filekeeping is introduced. This is an effective solution in conjunction with a Kienzle recorder from Germany, also recommended (for keeping permanent records).

It has also been recommended that files be kept on the yield of steel, the specific consumption of fuel, and the frequency and types of mill breakdowns, to raise the utilization of the mill.

8. Cutting of cobbles. There is no shears to cut scrap and rejects effectively. Scrap generated at the company is sold (exported). A portable hydraulic shears was put on the list of UNIDO supplied equipment (to be shared with Ship Breaking & Rolling Industries).

9. Alternative product mix. It is worth considering the production of channels and angles (which now are imported as-rolled) by cold forming from strip. More intricate shapes could be introduced later.

Quality control. Attention is paid to quality control, to a degree sufficient for the present product mix. There is a laboratory with a tensile tester. Complaints were voiced as to the quality of ZISCO billets (variability of mechanical properties and chemical composition).

Maintenance. The mechanical workshop is equipped with machines which are rather old. As in most mini-mills of the area, the ribs in roll grooves are manually ground. There is little room in the workshop and poor lighting. The gases from the forge shop affect the working environment in the workshop (the workshop serves not only the rolling mill but also the PVC pipes production plant).

For improvement of maintenance, essential electric measuring instruments were supplied, as well as a universal hydraulic puller/pusher set to ease dismantling of equipment and mill changes (cf. Annex D).

There is little room in the mechanical workshop, and poor lighting. The gases from the forge shop affect the working environment in the workshop. It has been recommended that efforts be made to remedy the situation in future development.

Training. The managers are quite good, with sufficient experience and with enough of an understanding of the present and future needs. The rolling mill manager has had foreign experience. The following training is recommended: (i) participation in a subregional exchange program where a DESBRO manager should visit KUSCO to share technical as well as managerial experience in the areas of maintenance organization and rolling practice, and also to learn the operations of a wire products section to germinate ideas on future development; (ii) on-the-job training for a DESBRO executive in a well run overseas rolling mill of comparable size; and (iii) possibly participation in a modeling workshop. If the Subregional mill rehabilitation workshop is held in Mauritius as proposed by the field mission, an active participation by DESBRO would be desirable. Also, DESBRO should be prepared to receive two visitors (from KUSCO and ZISCO) within the framework of the proposed exchange program.

Recapitulation of capacity utilization. Present capacity utilization at the rolling mill is 64.7%. Inasmuch as the 8 mm bars are the dominant product size, it is essential to speed up the mill in order to remove the main output constraint. Also, improved filekeeping should be able to analyze mill stoppages and to identify sources of potential improvement. Comparisons of hourly rolling rates indicate reserves because with the labor intensive operations, the rolling cadences tend to be irregular. Taking the positive aspects of the present operations into account, DESBRO should be able to aim at a target figure of 70%; this can be achieved without major investment.

5.1.4 Future expansion and rehabilitation

At DESBRO as a private company, the present high rate of demand for rebars is encouraging for a stepwise implementation of expansion projects.

he short term projects aiming at speeding up the train and nstalling a new roughing stand are already in progress and both he drives and the roughing stand can possibly be installed efore the end of 1990.

he present layout of the mill constrains the location of the new oughing stand.

ong term expansion plans involve considerations to install a elting capacity.

ecommended implementation:

1. Go ahead with installation of new roughing mill so as to speed up the mill train (1990-1991). The roughing stand must be so designed as to accommodate 100 by 100 mm billets and to eliminate hard labor. New pass design must be elaborated.

2. Having increased the speed of the mill by about 40%, pay ttention to modernization of the cooling bed which otherwise ould become the bottleneck and would keep labor costs high. A echanized rack-type cooling bed should be installed (1991). Make se of KUSCO and possibly SRM experience.

3. There being no producer of sections (channels and the like) n Mauritius, give serious consideration to the project aimed at ntroduction of a cold rolling/forming capacity where steel ections would be produced from imported strip.

4. DESBRO being an exporter of own as well as collected scrap, he installation of an induction furnace should be considered. his could be a low-cost, small furnace (1 ton capacity) easy to nstall. Scrap could be remelted in this furnace which would turn ut castings: this would require a marketing study.

5. This would be a viable alternative to the installation of an EAF for the production of feedstock for the Mauritius rolling ills; the sources of scrap being limited and there being no hipbreaking operations at present, an EAF appears to be a more istant possible development.

6. In every case, consult and possibly coordinate development ith Sections Rolling Limited, to avoid overcapacity in Mauritius nd to maintain a reasonably high capacity utilization. Export ossibilities, preferably to the continental PTA countries where olled stock is in short supply, should always be borne in mind.

D.2 Ship Breaking & Rolling Industries Limited

Address. Plaine Lauzun, Port Louis, Mauritius

D.2.1 Company background and performance

Background. The company is owned by the Lam Po Tang Group of companies which is active in steel rolling (The Ship Breaking and Rolling Industries Ltd. and Sections Rolling Limited) and also in galvanizing, the aluminum industry, production of corrugated sheets, and manufacture of cooking utensils. The Ship Breaking and Rolling Industries Ltd., Plaine Lauzun was established in 1974 and was active in bar rolling from material obtained locally by shipbreaking.

Later in 1980. a new bar rolling mill was commissioned where the starting material is billets 60 by 60 mm, mostly imported from R.S.A.

This is a private company where the owners are also engaged in distributorship.

Range of products.

1. Mild steel round bars for reinforcement of concrete made to M.S. 10-1980 and BS 4449-1978; 8-25 mm dia. in 6-12 m lengths.

2. High tensile deformed rebars (BS 4449-1978, Cr 460/425, M.S. 10-1980 high yield deformed; ASTM A-615 grade 60); 10-25 mm dia. in 6-12 m lengths

3. Mild steel square bars 8-25 mm, flat bars 4 by 18 to 12.5 by 50 mm and angles 25 by 25 by min 6.

Mild steel is produced to min 250 MPA YS, min 450 MPa UTS, and min 22% relative elongation.

High tensile bars are produced to min 400 MPa YS and to UTS [illegible] 15% as against YS. The minimum relative elongation is [illegible] 14% for bars up to 16 and over 16 mm dia., respectively.

Company performance. The old rolling mill has been out of operation for some 10 years and the mill bay serves as dispatch storeroom and provides shelter to the maintenance workshop.

The original capacity of the old mill had been 2,500 tpy based on single-shift operation

As for the new rolling mill, its capacity in single-shift operation (which however involves frequent extended shifts) is [illegible].000-[illegible].200 tpy.

The performance of the new mill since 1982 is shown below:

Year	Production (tpy)
1982	2,241
1983	3,403
1984	3,682
1985	3,262
1986	2,560
1987	3,614
1988	3,500
1989	4,275

A production of 20 tons of rolled stock in an 8-hour shift represents the break-even point; this amounts to somewhere near 6,000 tpy, i.e., more that the current production figures.

Major products:

	Capacity (tpy)
Hot rolled products	ca 6,500

Principal production units:

Plant/unit name	Supplier	Operated since	Capacity (tpy)
Old bar mill	Hong Kong	inac ive	2,500
New bar mill	Shekhar India	1981	6,500

Product mix breakdown.

Product	Description
Reinforcement bars	(a) mild steel round and square bars (b) high tensile deformed rebars
Flat bars and angles	

Production by products, 1989:

Rebars	tons
8 mm dia.	2,990
10 mm dia.	450
12 mm dia	420
16 - 25 mm dia.	415
TOTAL	4,275

Production costs MUR/ton (1989).

material and energy	6,603.0
capital investment	267.8
tools and expendables	41.4
maintenance and repairs	109.1
workforce	96.3
other	968.2
TOTAL	8,085.8

Total maintenance and repair costs (1989): MUR 466,402.5

Sales (1989): domestic sales worth MUR 35,500,000

Imports of billets 60 by 60 mm from R.S.A.:
3,850 tons worth MUR 24,255,000

Price of
8-mm rebar: MUR 9,770/ton (incl. sales tax)

Mode of operation:
1 shift with overtime

Employees: total 73

There is a premium bonus system making it possible to work in overtime. The mill management is capable but without much metallurgical expertise. Interest in UNIDO training has been expressed.

For specific mill data, see Annex G.

[illegible].2.2 Findings

Condition of production equipment. During the two UNIDO field missions the field team were able to witness regular production at the bar mill, as well as mill repair and setting.
The general condition of the plant equipment is commensurate with age. Much of the bar mill equipment is locally overhauled.

The reheating furnace lacks instrumentation. Temperature measurement and controls at the furnace are missing.

The furnace has only two skids spaced at 700 mm from one another; consequently, short billets cannot be processed.

Except for the roughing stand the rolling mill train is semi-mechanized with back repeaters only (used up to 16 mm diameter). Mill guides are in good condition. Cooling of the rolls is adequate. Reconditioned roll es are normally used.

There are specialized shipbreaking tools at the mill (two crankshaft cutting shears for heavy plate).

The idle 9" rolling mill, formerly used for rerolling bars from shipbreaking, has not been operated since 1980. This appears to be in poor condition.

Specifically, the mill was running since 1973 till 1979, and processed scrap from shipbreaking. Plates up to 1" thick were cut on two crankshaft shears to pieces 0.5 m long. Alternatively, billets 55 by 55 by 600 mm were used. The mill output was approx.

7 tpd (2500-3000 tpy). Mill consists of five 3-high stands (cast enclosed frame) and one finishing 2-high stand driven by a 260 kW/984 rpm a.c. motor with flywheel. The furnace, equipped with a screw driven mechanical pusher, is fired by two front wall burners and the billets are manually discharged using tongs. The whole mill including a simple cooling bed (30 by 2 m) is manually operated.

<u>Raw materials and power.</u> The Company is fully dependent on imports of 60 by 60 mm billets. These are imported from ISCOR, R.S.A. Imports from ZISCO were almost completely discontinued; only small quantities of mild steel grade billets from ZISCO are being used.

Fuel oil consumption is estimated at as high as 120 liters per ton of production depending on size.

Electric power is available.

<u>Process and operation</u> The process and operation at the plant are rather straightforward and can be considered adequate for the present [illegible] of production.

[illegible], the company faces the problem of having to modify the [illegible] because the small-size billets (60 by 60 mm) may become unavailable in the near future. At present, no billets bigger than 60 by 60 can be accommodated.

Excessive sticking of billets to the heating furnace hearth was [illegible] resulting in severe wear of the hearth.

[illegible] additional [illegible] is required when rolling [illegible] [illegible] roughing stand).

[illegible] rolling mill involves hard physical labor; [illegible] manually operated.

Cooling [illegible] operation is very much labor intensive (manual handling of rolled bars).

[illegible] cooling bed is a welment not attached to any foundation and [illegible] the last mill stand is not used; the rolls [illegible] above ground so the cooling bed cannot have [illegible] collecting bin.

The mill [illegible] housed in a bay of light construction, with no overhead crane, the dismantling of stands is assisted by a hoist suspended from a beam running over the stands; it is very difficult and unwieldy to haul the rolled stock away from the cooling bed and from the rolling mill area.

[illegible] storage area within the bay is [illegible] is usually used for mill change.

General maintenance is adequate but in furnace lining work and in [illegible] maintenance the mill depends on outside help.

Maintenance at the rolling mill proper is regular; maintenance [illegible] are done on the weekends, to keep time utilization [illegible] possible. The overhauls are undertaken by the mill crew [illegible] is motivated to keep the failure rates low.

Due to lack of instrumentation the furnace is being overheated; [illegible] of billets is a problem. Fuel oil consumption is high as [illegible] operated with frequent interruptions.

[illegible] conditioning is an established practice (by overlaying).

[illegible] insufficiently equipped, the machines [illegible] there [illegible] little room in the workshop. Only [illegible]

[illegible]

[illegible] production. The present [illegible] (8 hours) plus frequent overtime (4 [illegible] demand grew the Company [illegible] the time utilization of the [illegible]. In spite of this, the production [illegible] in 1983.

At [illegible] tpy rated capacity, this amounted to a capacity utilization of [illegible] but in previous years, because of much lower production, it had been about [illegible] or even lower.

In any case, at the present level of expenditures and prices, the Ship Breaking & Rolling Industries will continue operating in the red unless they raise production to beyond 6,000 tpy.

The product mix of the Company includes 8, 10, 12, 16, 20, and 25 mm dia. deformed rebars, with 8 mm dominating.

The joint marketing agreement the Company had with DESBRO International was discontinued in 1990.

MILL UTILIZATION

Calendar time: 365 x 24 hours		8,760	
Working hours: hours/shift		9 (+ 4)	
shifts/day		1	
days/week		6	
weeks/year		48	
overtime		almost every day	
Total working hours available, CWA		3,744	
Mill delays		not recorded	
Net production time, hours:		ca 1,[illegible]0	
Time utilization, %:			
working hours available/calendar time			42.7
net production time/working hours available			41.3
Mill rate of output:	tph	pcs/h	
per gross mill hour	1.15	40	
per net mill hour	2.76	96	
Design rate:	3.45	120	
[illegible]			
[illegible] per 8-hour shift	20.0	696	

[illegible]

[illegible]		[illegible] shift
Calculated		
	[illegible] utilization	[illegible],84[illegible]
	[illegible] utilization	5,53[illegible]

[illegible] calculation is based on 8 hours per [illegible] [illegible] weeks a year, and mill output of 3 tph.

[illegible] MAINTENANCE AND [illegible]

[illegible]
[illegible] unsatisfactory. It suffers from lack of skilled staff and lack of machines and adequate tools. Full-scale and medium repairs are done with all the rolling mill [illegible] participating, under supervision of the maintenance foremen.

[illegible] maintenance complexity: not high

[illegible] subassemblies and units.
[illegible] critical item of equipment.

[illegible] failure rates: kept but not evaluated

[illegible] routine:
The [illegible] involved in a beam production [illegible] of the medium repairs is governed [illegible] of the reheating furnace. It takes [illegible] the reheating furnace lining

[illegible]
[illegible] inspection, [illegible] work as may be needed [illegible] hours

[illegible]

[illegible]

[illegible] can [illegible]

Maintenance [illegible]:
[illegible] are old and worn.
[illegible] instrumentation is limited.

Spare parts:

[illegible]	Good; spares are imported.
[illegible]	Average.
[illegible]	Exceptionally.

[illegible] and consum[illegible]:
[illegible] supplied from India. [illegible] quality [illegible] satisfactory. Other [illegible] safety aids) are available [illegible]

[illegible]

The [illegible] can be broken down as follows:

[illegible] financially unless production is [illegible] utilization at the mill can in [illegible] the route of extending the working [illegible] constraints (cf. paragraph 3), [illegible] streamlining the operations which faced [illegible] insurmountable without major investment (or [illegible]. Moreover, the [illegible] situation has become more [illegible] of a product mix specialization [illegible], and is bound to be even more constrained [illegible] the short term rehabilitation projects [illegible] felt.

[illegible] bay or light construction, with [illegible] only [illegible] it is [illegible] stock [illegible] production [illegible] full. An [illegible] change and maintenance [illegible] by recommending to UNIDO the purchase of [illegible] pusher set for the mill, [illegible]

[illegible] their attempts to switch to two [illegible] problems. This relates to the labor [illegible] and also to differences in pay [illegible] to compete with wages offered [illegible]

[illegible] temperature measurement and controls missing at the heating [illegible] associated high fuel [illegible] liters/ton (in case of 8 mm rebar), [illegible] as high as those of DESRO. [illegible] when the rolling mill is idling represents [illegible] heat. The prerequisite of real improvement [illegible] measuring system on the furnace [illegible] down production costs thus [illegible] to approach the break-even point [illegible] increase production because the [illegible] not at the reheating [illegible] very useful in improving [illegible] furnace overheating thanks to [illegible] furnace control and [illegible] liters/ton. Reduction of the [illegible] is estimated to be no less than 10 [illegible]

[illegible] billets to the heating furnace hearth [illegible] hearth. This is yet another [illegible] On-the-spot assistance [illegible] on comprehensive information.

[illegible] These are necessary because of [illegible] the blanks along the rolling mill [illegible] has only two skids spaced at 700 [illegible] ly, short billets cannot be [illegible] installation of one or two more [illegible]

[illegible] is required after the #3 [illegible] side of the roughing [illegible]

[illegible] mill involves hard physical [illegible] roughing mill is manual, [illegible] labor intensive [illegible] All this contributes to manpower problems (cf item #3 above).

9. The cooling bed is a weldment not attached to any foundation and must be moved when the last mill stand is not used; the rolls have little clearance above ground so the cooling bed cannot have any bundle collecting bin.

10. Electric motor failures. An insulation meter, digital multimeter, and ammeter/voltmeter were recommended for preventative maintenance.

11. Small-size billets (60 by 60 mm) may become unavailable in the near future and the mill as it stands cannot accommodate bigger billets.

12. There is shipbreaking equipment but no shipbreaking activity. It has been recommended to consider reestablishing the shipbreaking operations discontinued 10 years ago. The first key to this problem is to try regaining access to a shipbreaking jetty. If this is not viable the company should get rid of specialized shipbreaking machinery.

13. Useless old mill. Again, if there is to be no more shipbreaking the idle 9" rolling mill (formerly used for rerolling bars from shipbreaking; not operated since 1980) should be scrapped or sold. As a matter of fact, scrapping it may prove to be the only possibility. This will give the Company a bay equipped with rails for overhead crane, for effective rolling mill operation or some other activity.

14. Tidiness of the workplace suffers from heaps of entangled discards outside the bays. This also is a safety hazard. The portable hydraulic cutting shears supplied by UNIDO can be used to clear this away effectively. Joint usage with DESBRO was recommended.

Priorities. From the point of view of the company future, items 2, and 3 represent the main constraints responsible for the unfavorable situation outlined in 1. Mauritius being a small island, it represents a highly competitive environment in the area of steel rebar production.

Quality control. There is no laboratory. The mill relies on the billet manufacturers' certificates. Documentation for roll groove machining is in poor condition. Ribs in the finishing pass grooves are manually ground. Samples are takes twice a week and sent to the Mauritius Bureau of Standards for tensile testing. All this however does not present a very serious constraint to marketing the present product mix.

Maintenance. The mill change taking three days, the universal puller/pusher set supplied by UNIDO should cut down the stoppages considerably, because of easier dismantling and assembling.

Training. The mill manager is an excellent organizer but lacks technical education. This manager would greatly benefit from (i) participation in a subregional exchange program where he would best visit KUSCO to gain a deeper technical understanding in the areas of maintenance and rolling practice; and (ii) on-the-job training in a well run overseas rolling mill of comparable size. An executive from the head office of the Lam Po Tang group (owners of Ship Breaking & Rolling Industries as well as of its sister company the Sections Rolling Limited) could benefit from participation in a steel mill modeling workshop. If the mill rehabilitation workshop is held in Mauritius as proposed by the field mission, an active participation would be desirable.

Recapitulation of capacity utilization. Present capacity utilization at the rolling mill is 41.3%. Calendar time utilization is low, too. Mill layout and related material handling and maintenance problems are source of constraints insurmountable without a major revamping. Mill delays involved in clearing the rolled stock from the production area are considerable, too. Expiry of the product mix split agreement also is having an adverse effect. Nonetheless, implementation of the recommendations made should bring the mill to a level of about 50% capacity utilization. Keeping the working rhythm is the greatest single opportunity to raise capacity utilization but of course, this is difficult to do because of the labor intensiveness involved.

D.2.4 Future expansion and rehabilitation

At Ship Breaking & Rolling Industries there are no major expansion plans. The old, inactive rolling mill is not likely ever to be recommissioned. Re-activation of shipbreaking is contingent upon re-allocation of a jetty by the Government, and would also require some melting capacity to be effective.

Bottlenecks described above cannot be fully removed unless a major redesigning and revamping of the mill takes place. This is unlikely, in the light of the present financial situation.[5]

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[5]According to information received three months after the field mission, the Company suspended operations.

D.3 Sections Rolling Limited

Address: Plaine Lauzun, Port Louis, Mauritius

D.3.1 Company background and performance

Background. Sections Rolling Limited of Plaine Lauzun is member of the Lam Po Tang Group of companies of Port Louis, together with another producer of rolled bars the Ship Breaking & Rolling Industries Ltd.

Sections Rolling Ltd. started production in 1975. Equipment was purchased in India but only some of it was installed (originally, four rolling stands). In 1985 a roughing train incorporating two stands was added and commissioned.

Range of products. In spite of the name of the company being suggestive of the originally intended production which was hot rolled sections, the chief and only product of the company is high tensile and mild steel deformed rebars made from imported billets (60 by 60 mm).

Within the production specialization and joint marketing agreement with Desbro International Ltd., Sections Rolling Ltd. has been concentrating on rebars in the 12 to 25 mm dia. range. In fact, there has been an agreement that Desbro would sell the production of Sections Rolling Ltd.

Company performance. The scope of production is given by the size of the Mauritius market and the aforementioned production specialization, In spite of the construction boom of recent years the rolling mill, given the range of products, can handle the required volume in one-shift operation accounting for 21 - 23% of the local steel demand (including the demand for wire which is imported).

An internal constraint is represented by the heating capacity of the mill and by the high share of manual labor.

The actual over-capacity of the mill, in relation to the present demand cannot be fully utilized even if some of the production range handled till early 1990 by Ship Breaking & Rolling Industries Ltd. were to be transferred to Sections Rolling Ltd.

The company is run by mixed expatriate and local management. There are two experienced engineers, with practice from Indian iron and steel industry. Total employment is about 60.

For specific mill data, see Annex G.

D.3.2 **Findings**

Condition of production equipment. The technical condition of the production equipment is commensurate with age and degree of usage. Owing to low level of mechanization the mill is very flexible and does not impose very high demands in setting and resetting when switching from one size to another, at variance with fully mechanized mill trains.

The modernization of the mill, of which the installation of the new reheating furnace and the completion of the series of mill stands are the essential components, provides all prerequisites for a successful solution of all present technical and quality constraints. In comparison to the other mills visited, the major problems which revolve around the reheating furnace are already being tackled in a determined, well defined manner. As concerns universal maintenance tools and equipment, this can be shared with Ship Breaking & Rolling Industries Ltd. because of joint ownership and small physical distance of the two facilities.

Raw materials. Quality billets are available from R.S.A. Mild steel billets from ZISCO find it hard to compete, because of quality and dimensional accuracy but mainly, because of less regular deliveries. Larger billets will have to be imported in the future.

Process and operation. The process is straightforward, the mill crew is skilled. Past participation in ZISCO, Zimbabwe training program was regarded as generally useful but was geared to a different production program and mill size. The management are interested no longer in a purely maintenance oriented training but rather, in on-the-job training in mill operations proper, in a small rolling mill (not in a big steelmaking facility).

Volume and efficiency of production. As already mentioned, the volume of production is the result of the market situation and the product mix split. One-shift operation (with extended shifts) affects capacity utilization.

MILL UTILIZATION

Calendar time: 365 x 24 hours		8,760
Working hours: hours/shift	9	
shifts/day	1	
days/week	5	
weeks/year	48	
overtime	if required	
total working hours available,		2,160

Time utilization, %:

working hours available/calendar time	24.6
net prod. time/working hours available	72.0

Mill output (1989): 3.6 tph

Mill output target ca 4.0 tph (furnace limitation)
36.0 tons per shift

Mill capacity, tpy: 1 shift
calculated for 70 % utilization 9,070

Above capacity calculation is based on 9 hours per shift, 6 days a week, 48 weeks a year, and mill output of 5 tph (with the new furnace operating).

Status of maintenance and servicing:
Technical level:
The technical level of maintenance is adequate. The mill crews take part in maintenance and repair operations.

Degree of maintenance complexity: Low complexity.

Failures of critical subassemblies and units:
Mainly in furnace area.

Filekeeping of failure rates: in daily production reports.

Maintenance routine:
Usual procedure is followed in repair and maintenance work. Single-shift operation provides sufficient scope for repairs and maintenance prevention.

Staffing in maintenance and servicing:
not available

Skills and experience of maintenance staff:
The maintenance men have had considerable practical experience, sufficient for routine practice.

Maintenance and servicing equipment:
The condition of machinery and tools is commensurate with usage and age.

Maintenance and servicing technology: Standard practice.

Spare parts:

availability	imported from India and R.S.A.
quality	adequate
production of spares	occasional, guides
reconditioning of spares	roughing mill rolls

Tools: Maintenance tools and equipment are adequate; much of this can be obtained locally, including electric measuring instruments.

Refractories and consumables:
Imports from India and R.S.A.; sufficient quality and quantity. Consumables (lubricants etc.) are obtained locally.

D.3.3 Problems and remedies

The problems of the mill were discussed with management and the stages of the ongoing rehabilitation and upgrading program were reviewed.

The specific problems faced by Sections Rolling Ltd. include:

1. Low demand on local market for given product mix; consequently, the necessity of operating one shift only, even if at a high time utilization. The recommendation is to re-check the supply and demand situation in Mauritius with a view to the development plans of Desbro focused on small sizes of rolled stock, also taking into account that the sister company the Ship Breaking & Rolling Industries suspending operation.

2. Low throughput of standing reheating furnace. This is being taken care of by the mill upgrading program (to commission the new reheating furnace).

3. Absence/poor condition of temperature and combustion controls on the furnace. The company should put to best possible use the instrumentation and auxiliary equipment originally intended for the weaker sister company the Ship Breaking & Rolling Industries Ltd. Especially, use the temperature measurement system supplied by UNIDO until the old furnace is replaced.

4. Billet length constraint. The necessity of charging different billet lengths because of the length of the cooling bed and because of mill design constraints imposes a limitation on the mill. This will improve as soon as the present stage of the upgrading program is completed.

5. Billet size constraint. Small size billets (60 by 60 mm) will be difficult to obtain. This is a situation faced by all the Mauritius rolling mills.

6. New stands waiting. The obvious recommendation is to increase mill output and to expand product mix by installing new stands already on site.

7. Hard physical labor (mainly, in material handling and hauling) due to low degree of mill mechanization (especially, labor intensive operations around the cooling bed). Again, this will improve as per item 4. The universal puller supplied by UNIDO should facilitate the assembling and dismantling operations during mill changes and repairs.

8. It is imperative to look into the export potential, particularly within the PTA to justify long range development plans (80,000 tpy produced in two-shift operation cannot realistically be sold within Mauritius).

Quality control. As in the other rolling mills in Mauritius, the level of quality control is commensurate with the market requirements and relies to a high degree on the billet manufacturers' certificates and a stabilized rolling practice. There is no laboratory. Random tensile testing is done by sending samples to the Mauritius Bureau of Standards.

Maintenance. The production specialization of the mill facilitates maintenance. The mill has a high share of manual operations - there are no repeaters etc. so that maintenance is not complex. The new stands and reheating furnace about to be installed will be a decided advantage.

Training. While the mixed expatriate and local management is at a high technical level with foreign experience and with clear ideas about mill possibilities and future development plans, it would be beneficial for the company to be take part in (i) a subregional exchange program involving KUSCO and (ii) on-the-job training overseas, preferably in a rolling mill of which the product mix would include bars, flats, and sections. As concerns the other two forms of training proposed, i.e., participation in the steel mill modeling workshop and the regional workshop on mill rehabilitation, the same recommendation applies as has been made to Ship Breaking & Rolling Industries.

Recapitulation of capacity utilization. Present utilization of the working hours available at the rolling mill is 72.0% but it must be borne in mind that this is only one-shift utilization. With a single shift, calendar time utilization of course is low. However, the market for given product mix is limited and switching to two-shift operation would require product mix expansion. This is why, after completing the short term development program (see below), it will become feasible for the first time for Sections Rolling Limited to introduce the production of sections, as the only mill in Mauritius, thereby greatly enhancing the over-all capacity utilization.

6.3.4 Future expansion and rehabilitation

The current selling price of 9,500 to 10,000 MUR (Mauritius Rupees) per ton of rebar provides a good margin encouraging expansion plans.

After the second stage of mill upgrading in 1985, the third phase is underway: this will consist in the commissioning of a new reheating furnace (already on site) equipped with adequate temperature controls and measurement, and the installation of a two-stand finishing train giving a higher exit speed.

Implementation of this, already on-going mill upgrading project will considerably enhance heating accuracy and thus, product quality; it will reduce fuel consumption and billet scaling. There will be no problem switching to larger size billets (as soon as the 60 by 60 mm billets cease to be available, or even before that). Also, it will increase the company's chances to enter the small sections market.

Long range plans focus on possible installation of a hot rolling mill having a capacity of 80,000 tpy assuming two-shift operation. A proposal by Danieli of Italy for a new facility is being examined.

Suggested implementation:

In the short term, the obvious course to take is to implement the instrumentation and equipment taken over from the sister company. This will mainly serve to alleviate the reheating furnace bottleneck.

In the longer term, the mill expansion program is technically well conceived and developed. The UNIDO team approves of the plan. However, the implementation schedule of stage 3 upgrading clearly depends on market development. All necessary equipment has been on site for considerable time. (The new reheating furnace was yet to be put into operation during the second field mission.)

The implementation of the long range scheme (new hot rolling mill) could also take the route of securing reconditioned equipment, either a complete line or a complete section such as roughing mill, mechanized cooling bed, etc., to decrease the capital outlays.

Clearly, an activity in exports is one of the prerequisites for implementing this large project.

V. PROPOSED TRAINING

The UNIDO team had an opportunity to examine the shops and units (rolling mills, EAF, maintenance workshops, and fabrication shops) in the small scale steel plants covered under the present project and make observations regarding staff qualifications. Many discussions with management of these mills focused on training. Without exception, it has been found by the team (and confirmed by local management) that in order to raise the effectiveness and productivity at most of the plants visited, it is of great importance to upgrade the professional level of personnel in all the managerial and supervisory positions.

It has also been found that generally, the training programs of UNIDO are very much welcome and held in high esteem. Specifically, the management of the individual steel plants (including ZISCO where training was the only aspect covered by the present project) were enthusiastic about the participation of their personnel in the training programs listed hereunder.

ZISCOSTEEL deserves a more detailed consideration in this respect. There is an extensive, well equipped and staffed training facility where apprentices of all steelmaking trades as well as junior staff are receiving their training in a variety of specialized courses. However, the range of operations of ZISCOSTEEL proper is entirely outside the scope of all the small steel mills covered under the present project. Hence, it has been pointed out that practical training at ZISCO has little relevance to the training requirements for the small scale melting and bar/wire rolling operations of the mini-mills. Also, ZISCO right now is having to cope with problems of their own which are also reflected in ZISCO's relations with the mini-mills of the subregion, and must concentrate on production, product quality, logistics, and market orientation problems. Even the expansion projects at ZISCO, ongoing or planned (such as the sheet mill project), while beneficial for the whole subregion, are unrelated to the immediate and long term needs of the mini-mills.

A. Identification of training requirements

In connection to the above, the suggestions and/or requirements of individual steel plants regarding training of their personnel were collected, analyzed, and cross-checked against the background of the field team's own steelmaking and managerial experience. Of particular importance in this process was the fact that the team were able to confront their experience from all the mills covered under the present project, in a situation where very few of the individual steel plant managers and executives have ever had an opportunity to confront their own experience with that of their neighbors within the PTA. The analysis of the over-all training needs resulted in training and training-related proposals regarded as most useful for all the countries and plants covered. The facts concerning ZISCOSTEEL also had their influence on the formulation of the training projects and on situating them outside ZISCOSTEEL. The proposals are summarized in the following four training projects. These projects, albeit in unfinished form, were already discussed and found support in all the mills without exception, including ZISCOSTEEL.

B. Formulation of training projects

A brief formulation of the four training projects envisaged is given below. Full particulars on each of these draft projects can be found in Annex H.

B.1. On-the-job training

On-the-job training at a well-operated steel mill provides the greatest immediate benefit if the mill selected for training features a type and scale of operations similar to those of the trainees' own mills. Efficient mills of this kind are operating in Czechoslovakia, and provide the additional advantage of combining all the operations encountered at the different trainees' mills (that is, EAF, continuous caster, bar and wire rolling, and maintenance) even under the roof of a single plant.

Indeed, this kind of training is a logical, inseparable part of the UNIDO technical assistance projects.

This is a three-week on-the-job training for steel plant shop supervisors and/or production/maintenance managers

B.2 Workshop on steelworks modeling

A workshop on building and using corporate models in steelworks is a logical extension to the UNIDO technical assistance projects. Specifically, the workshop will address cost, production, and financial models as applicable to steelworks. This is a workshop which the Subcontractor proposes to organize by arrangement with W. S. Atkins Management Consultants, England.

The workshop will assemble a multi-disciplinary group of senior steel mill managers for the purpose of undertaking corporate planning within their respective companies.

This is a six-day training workshop where the multi-disciplinary group alluded to above would be composed of individuals representing a cross-section from management to technology to accounting and financing. Consequently, each country would send out as trainee either an engineer or a sales oriented manager.

B.3. PTA steel plant rehabilitation workshop

There are 23 steel mills in the subregion. As confirmed by recent missions, most of them suffer acutely from poor capacity utilization and are in sore need of rehabilitation. Isolated efforts to enhance capacity utilization were often fruitless and rehabilitation plans face difficulties at implementation. Rehabilitation is also thwarted by the general condition of the national economies involved and by the shortage of foreign exchange, making it increasingly necessary to rely on foreign aid. The optimal rehabilitation technologies are yet to be defined.

The principal issues that need to be addressed jointly include mill rehabilitation, upgrading of technology, maintenance of equipment, and subregional cooperation within the steelmaking industry.

All this information is needed by PTA and by individual Governments to update and, if necessary, reformulate their policies for the steelmaking industry.

This is an international workshop on the rehabilitation of steel mills in the PTA countries, to be held in Mauritius. Attendance is recommended not only to PTA countries covered by the present project (DP/RAF/88/072) but actually, to all PTA countries where steel plants are operated.

B.4 Subregional steel plant exchange program

Surveys have shown that in the steelmaking industry within the PTA subregion, there is practically no partnership oriented cooperation which would be based on the principle of exchange of experience.

Recognizing that considerable experience can be gained through personal contacts among professionals of similar orientation and having ascertained that each of the steel plants visited under the project DP/RAF/88/072 has something at least to offer which is not known at the other plants in the way of technology, innovation, and/or organization, a subregional exchange program for steel plant managers and operators is proposed.

VI. ACHIEVEMENT OF IMMEDIATE OBJECTIVES

Actual results are compared with schedules, targets, and objectives.

A. Comparison of results with schedules and targets

The schedules were constructed by UNIDO and fully adhered to. Detailed schedule of field work and other activities was updated in a January, 1990 "Tentative revised implementation schedule" which is confronted with actual activities in Annex E.

Equipment specification for the project area steel plants was prepared ahead of schedule at an urgent request by UNIDO.

The targets of the project were met in full This issue of training was addressed to an extent considerably wider than required by the Terms of Reference.

B. Comparison of results with objectives

Efforts were made by the UNIDO team to meet the project objectives in spirit as well as by the letter of the formal terms of reference.

The field team visited the project area steel mills and probed into questions of production, technology, maintenance, and costs.

This resulted in on-the-spot assistance the team were able to provide to the mills.

On the basis of discussions and results of the first mission, the field team drew a list of equipment and instrumentation to be purchased by UNIDO and supplied to the mills within this technical assistance project.

On-the-spot assistance and the supplies of equipment represent improvements already implemented.

The two missions and their subsequent analysis yielded a number of improvement suggestions for each of the steel plants. These actually are recommendations to the management; because of their detailed and specific nature, they are always listed with the steel mill in question.

The objectives are best classified as (i) integration of lacking critical equipment, (ii) trained plant personnel; (iii) improved capacity utilization, productivity/production, and product quality; and (iv) well-substantiated expansion and rehabilitation projects.

The immediate objectives, as spelled out in the Introduction, have been achieved. As already mentioned, the components of the present project - mainly, on-the-spot assistance, measuring and control equipment provided by UNIDO, review of development programs, and training - have been and will be of help to the steel plants in the areas of process upgrading, technology modification, and product improvement but cannot be expected, at the level of funding provided, to achieve much in the area of capacity utilization and plant rehabilitation. Improved capacity utilization of the plants, together with trouble-free operation as can only be provided by adequate maintenance, is the development objective. Training schemes and follow-up activities conducive to this aim were proposed.

VII. UTILIZATION OF PROJECT RESULTS

The UNIDO project DP/RAF/88/072 produced many specific modes of results and suggestions. In the area of short term development, the most important item has been the instrumentation and equipment provided by UNIDO to the plants; this has alleviated a number of bottlenecks previously identified by the field mission.

On-the-spot assistance was another type of immediate help to the plants. Of course, this could only be compatible with the scope of the mission.

The medium term development should be well advised to follow the recommendations and to implement the suggested improvements as spelled out in the Chapters above.

Both medium and long term development are bound to benefit from follow-up training and workshops.

It has been ascertained by the field missions that an important factor which affects the level of utilization is the necessity to enhance plant-to-plant communication for the purpose of exchange of experience. This factor should be stressed in all subsequent activities in the interest of subregional integration.

VIII. CONCLUSIONS

The objectives of the project were attained in compliance with the Terms of Reference. As evidenced by this Report and its Annexes, this is the result of a full involvement of the subcontractor's team and also of the very good cooperation with the management at all the project area steel plants.

During the rather brief space of time available for the field mission to each of the project area countries, the team collected a large amount of information. The profile of the company interviews and plant visits had to be designed in a manner general enough to grasp the variegated aspects of the individual steel plants, and yet specific enough to capture the essentials at each steel mill.

The present document is the result of an honest analysis of the collected data, aimed at optimally exploiting the available potential of the steel plants in order to better satisfy the needs of the downstream industries.

The guidance of the Metallurgical Industries Branch of UNIDO and the cooperation of the UNIDO Country Directors is gratefully acknowledged.

The support of the PTA and of project area Governments is appreciated.

United Nations Industrial Development Organization
Vienna

18780
(2 of 3)

RESTRICTED
December 1990
English

DEVELOPMENT AND RATIONALIZATION OF SMALL SCALE STEEL PLANTS IN THE PTA REGION

DP/RAF/88/072

ANNEXES TO TERMINAL REPORT

(Annexes A through G)

Prepared for the P.T.A.
by the United Nations Industrial Development Organization
acting as executing agency
for the United Nations Development Programme

Based on the work of R. Stefec & team,
Polytechna Corp. subcontractors

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__**Polytechna Corp. subcontractors**__

ANNEX A. International staff

R. Stefec	team leader, Prague Institute of Chemistry & Technology; field & home work
J. Drbout	Research Institute of Steelmaking Technology & Economics, Prague; field & home work (rolling mills)
J. Roubal	Research Institute of Steelmaking Technology & Economics, Prague; field & home work (maintenance)
F. Prochaska	General Board of Ferrous Metallurgy, Prague; field & home work (EAF)
F. Flandera	SKODA Corp., Pilsen; field & home work (cost analysis & development)
A. Dusek	Polytechna Corp., Prague; home assistance
M. Zeminova (Ms)	Polytechna Corp., Prague; field assistance
M. Stockert	SKODA Corp., Pilsen; home work
Z. Cabrada	HUPRO Metallurgy Designers Bureau, Pilsen; home work
I. Pindur	New Metallurgical Plant, Ostrava; home work
M. Petrman	POLDI United Steelworks, Kladno; home work.

ANNEX B. Senior counterpart staff

Kenya

KWANT J.	Programme Officer, UNIDO, Nairobi
ODUOGI P.M.	Under-Secretary, PTA Coordinator, Ministry of Planning and National Development, Nairobi
OKELLO G.H.	Director of Industries, Ministry of Industry, Nairobi
RAJANI J.G.	Managing Director, KUSCO, Mombasa

Mauritius

MARCHAL J.-N.	Resident Representative, UNDP, Port Louis
LAM PO TANG L.K.C.	Managing Director, Lam Po Tang & Co. Ltd. (Shipbreaking and Rolling Industries Ltd. and Section Rolling Ltd.), Plaine Lauzun
SAMOUILHAN S.	Manager, Desbro International Ltd., Port Louis

Mozambique

GOULART C.A.	Country Director, UNIDO, Maputo
SENZANI-CHICOGO J.	General Director, Directorate of Metallurgy, Ministry of Industry and Energy, Maputo
TEMBA J.L.	General Manager, CIFEL, Maputo

Tanzania

DEMEKSA B.	Resident Representative, UNDP, Dar es Salaam
MAGEHI O.S.	Head, Metals and Engineering Sector, Ministry of Industries and Trade, Dar es Salaam
CHAMBAKA B.J.	General Manager, ALAF, Dar es Salaam
MKOKA L.J.	General Manager, SHM, Tanga

UNIDO Headquarters, Vienna

KROUZEK J.V.	Head, IO/T/MET
GROF T.	Programme Officer, IO/T/MET
ALIEV V.	Programme Officer, IO/T/MET
FIGUEIREDO F.	Area Officer

Zimbabwe

WILSON R.	Managing Director, ZISCOSTEEL, Redcliff

ANNEX C. List of persons met

AMBARI S.	Technical Manager, SRM Tanga, Tanzania
BAHL R.	Steelco Division Manager, ALAF, Dar es Salaam, Tanzania
BANDAWE C.	Marketing Manager, SRM, Tanga, Tanzania
CHAMBAKA B.J.	General Manager, ALAF, Dar es Salaam, Tanzania
CHESII I.K.	Directorate of Industries, Ministry of Industry, Nairobi, Kenya
CHONGO F.J.	Rolling Mill and Wire Drawing Manager, CIFEL, Maputo, Mozambique
CHOWRIAMAH M.	Public Relations Officer, Ministry of Industry, Port Louis, Mauritius
COROA M.J.	Finance and Economic Manager, CIFEL, Maputo, Mozambique
DEMEKSA B.	Resident Representative, UNDP, Dar es Salaam, Tanzania
[illegible] S.W.	Public Relations Officer, ZISCOSTEEL, Redcliff, Zimbabwe
[illegible]HLIN S.	Personnel Director, Desbro International Ltd., Port Louis, Mauritius
[illegible] J.	Technical Director, IMA, Maputo, Mozambique
[illegible]EIREDO F.	Area Officer, UNIDO, Vienna, Austria
[illegible] C.A.	Country Director, UNIDO, Maputo, Mozambique
GOWRISHANKAR S.	Steelcast Division Manager, ALAF, Dar es Salaam, Tanzania
[illegible] J.K.	Development Manager, KUSCO, Mombasa, Kenya
[illegible]OO R.	Deputy Manager, Sections Rolling Ltd., Plaine Lauzun, Mauritius
[illegible] V.	Programme Officer, IO/T/MET, UNIDO, Vienna, Austria
[illegible] A.N.	Works Manager, KUSCO, Mombasa, Kenya
[illegible]AKOV J.	JPO, UNIDO, Dar es Salaam, Tanzania
[illegible]	Works Manager, Shipbreaking and Rolling Industries Ltd., Port Louis, Mauritius
[illegible] J.	Programme Officer, UNIDO, Nairobi, Kenya
[illegible] C.	Electrical Engineer, SRM, Tanga, Tanzania
[illegible] TANG L.K.C.	Managing Director, Lam Po Tang & Co. Ltd. (Shipbreaking & Rolling Industries Ltd. and Section Rolling Ltd.), Port Louis, Mauritius
[illegible] A., Jr.	Metallurgical Division Manager, CIFEL, Maputo, Mozambique

[illegible] O.S.	Head, Metals and Engineering Sector, Ministry of Industries and Trade, Dar es Salaam, Tanzania
[illegible] P.M.	Dy General Manager, ALAF, Dar es Salaam, Tanzania
MARCHAL J.-N.	Resident Representative, UNDP, Port Louis, Mauritius
MKOPA L.J.	General Manager, SRM Tanga Tanzania
MHONYA L.	Procurement Manager, SRM, Tanga, Tanzania
MULAVA E.E.	Senior Operations Analyst, NDC, Dar es Salaam, Tanzania
MW'ABU [illegible].B. (Mrs.)	Directorate of Industries, Ministry of Industry, Nairobi, Kenya
MUSYANGI L.P.	Mechanical Engineer, SRM, Tanga, Tanzania
MWANKUSYE C.	Personnel Manager, SRM, Tanga, Tanzania
MWAURA Z.N.	Assistant to Under-Secretary, PTA Coord., Ministry of Planning and Nat. Development, Nairobi, Kenya
NCONYANI T.M.	Deputy Works Manager, Steelcast, ALAF, Dar es Salaam, Tanzania
NZOMO M.M.	Assistant Director of Industries, Ministry of Industry, Nairobi, Kenya
OBUOGI P.M.	Under-Secretary, PTA Coordinator, Ministry of Planning and National Development, Nairobi, Kenya
OKELLO G.H.	Director of Industries, Ministry of Industry, Nairobi, Kenya
PA[illegible] D.R.	Chief Engineer, Sections Rolling Ltd., Plaine Lauzun, Mauritius
[illegible] J.G.	Managing Director, KUSCO, Mombasa, Kenya
[illegible] B.G.	Training Manager, ZISCOSTEEL, Redcliff, Zimbabwe; PTA Coordinator, Steelmaking training
[illegible] N.J.	Director, KUSCO, Mombasa, Kenya
[illegible] S.G.	Director, KUSCO, Mombasa, Kenya
[illegible] J.	JPO, UNIDO, Dar es Salaam, Tanzania
[illegible]	Senior Production Engineer, PIPECO, ALAF, Dar es Salaam, Tanzania
[illegible] S.	Manager, Desbro International Ltd., Port Louis, Mauritius
[illegible]-CHICOGO J.	General Director, Directorate of Metallurgy, Ministry of Industry and Energy, Maputo, Mozambique
[illegible] M.C	Administrator, IMA, Maputo, Mozambique
[illegible] R.	Finance Manager, SRM, Tanga, Tanzania
[illegible] A. (Mrs.)	Deputy Resident Representative, UNDP, Port Louis, Mauritius

[illegible] A.A.	Senior Production Engineer, Steelcast, ALAF, Dar es Salaam, Tanzania
TEMBA J.L.	General Manager, CIFEL, Maputo, Mozambique
[illegible] F.M.T.	Director, Technical Division, Ministry of Industry and Energy, Maputo, Mozambique
WIRICH R.	Managing Director, ZISCOSTEEL, Redcliff, Zimbabwe
WONG S.	Quality Control Dept., Desbro International Ltd., Port Louis, Mauritius
[illegible] YIN SANG F.	Chief Engineer, Desbro International Ltd., Port Louis, Mauritius
[illegible] K.M.F.A. de	Maintenance and Work-shop Manager, CIFEL, Maputo, Mozambique

ANNEX D. Equipment provided by UNIDO

BREAKDOWN BY DESTINATIONS (steel plants in project area)

Item no.	Description	Destination and no. of pcs ALAF	TANGA	DESBR	SR/SB	CI[illegible]
1	Infrared pyrometer, portable CYCLOPS 52, range 600-3000 C complete with battery	1	1	1	1	1
2	Immersion temperature measuring system, microprocessor controlled, 1000 to 1750 C measuring range, complete with indicator lamp and buzzer, with 2,500 pcs disposable measuring tips	1	-	-	-	-
3	Reheating furnace temperature measuring system, complete with digital indicator for parallel measurement in three locations, with 6 spare sheathed thermocouples and 100 m cable	-	-	1	1	1
4	Thermocouples PtRh10%/Pt, Siemens type 7MC2002-2VE01, with 100 m screened cable	-	8	-	-	6
5	Reheating furnace offgas analyzer, portable, type Lancom 3400	-	-	-	-	-
6	[illegible] hydraulic puller set Lucas for steel plant maintenance (ref. [illegible] offer 5139)	1	1	1	1	1
7	[illegible] meter Siemens type [illegible]	1	1	1	1	1
8	Hot metal detector (infrared), [illegible]	-	4	4	-	4

9	Digital multimeter B 1002, Siemens type 7KB 1002-8AA	1	2	2	1	2
10	Electric welder - welding rectifier MEZ Brumov, type WTU 315, with two sets of protecting shields and gloves	-	-	-	-	1
11	Vernier caliper 1000/200, Mitutoyo type 534-108	-	1	1	1	1
12	Digital micrometer 0-25 Digimatic MDC, Mitutoyo type 293-601, with spare battery SR-44	-	3	3	3	3
13	Caliper 0-110 for tolerance measurements, Mitutoyo type 538-101	-	3	3	3	3
14	Filler gauge set 120 mm, metric	-	1	1	1	1
	same, imperial (inches)	-	1	1	1	1
15	Water level, 500 mm steel, prism type	-	1	1	1	1
16	Portable hydraulic shears PETIG type HC 530, for cobbles up to 50 mm, with spare cutting edges	-		1		1
17	Tongs type ampere/voltmeter Siemens, type 7KA 1400-8AE	1	1	1	1	1

DESTINATIONS:

Abbreviation	Full address
ALAF	Aluminium Africa Limited, Steelcast Division Attn.: P.M. Maheshwary, S. Gowrishankar P.O. Box 9032 Dar-es-Salaam, Tanzania Telex: 41265 ALAF TZ Cables: ALUMINIUM
TANGA	Steel Rolling Mills Limited Attn.: L.J. Mkoka, S. Ambari P.O. Box 5034 Tanga, Tanzania Telex: 45037 STEEL TZ

	Cables: STEEL ROL
DESBR	DESBRO International Limited Steel Rolling Mill Attn.: S. Samouilhan P.O. Box 60 Port Louis, Mauritius Telex: 4260 STEEL IW Cables: FINANCE
SR/SB	Sections Rolling Limited and Ship Breaking & Steel Rolling Industries Limited Attn.: A. Kwan Plaine Lauzun, Port Louis, Mauritius Telex: 4321 DONDON or see DESBRO Phone: 2-3728
CIFEL	CIFEL Foundry and Rolling Mill Company (Companhia Industrial de Fundicao e Laminagem S.A.R Attn.: F.J. Chongo, R.M.P.A. de Zaza P.O. Box 441, O. U. A. Avenue 485, Maputo, R.P.Moca
	Telex: 6-262 CIFEL MO
KUSCO	Kenya United Steel Company Limited Attn.: J.G. Rajani P.O. Box 90550 Miritini, Mombasa, Kenya Telex: 21197 Cables: KUSCO

BREAKDOWN BY ITEMS AND PROPOSED SUPPLIERS
(supplier codes are explained below)

Item no.	Description	No. of pcs.	Approx unit price	Approx total price	S co
1	Infrared pyrometer, portable CYCLOPS 52, range 600-3000 C complete with battery	6	2,500	15,000	A
2	Immersion temperature measuring system, microprocessor controlled, 1000 to 1750 C measuring range, complete with indicator lamp and buzzer, with 500 pcs disposable measuring tips	1	7,775	7,775	B
3	Reheating furnace temperature measuring system, complete with indicator/recorder for parallel measurement in two locations, with 6 spare sheathed thermocouples and 100 m cable	3	3,045	9,135	D
4	Thermocouples PtRh10%/Pt, Siemens type 7MC2002-2VE01, with 100 m screened cable	14	250	3,500	C
5	Reheating furnace offgas analyzer, portable, type Lancom 3400	1	5,112	5,112	I
6	Universal hydraulic puller set Lucas for steel plant maintenance	6	1,822	10,932	E
7	Insulation meter Siemens type 7KA1512-8AD	5	900	4,500	C
8	Hot metal detector (infrared), 600-1250°C	12	1,806	21,675	A
9	Digital multimeter. B 1002, Siemens type 7KB 1002-8AA	8	230	1,840	C

10	Electric welder - welding rectifier MEZ Brumov, type WTU 315, with two sets of protecting shields and gloves	1	3,131	3,131	D
11	Vernier caliper 1000/200. Mitutoyo type 534-108	4	450	1,800	G
12	Digital micrometer 0-25 Digimatic MDC, Mitutoyo type 293-601,with spare battery SR-44	15	140	2,100	G
13	Caliper 0-110 for tolerance measurements. Mitutoyo type 538-101	15	75	1,125	G
14	Filler gauge set 120 mm, metric	4	50	200	H
	same, imperial (inches)	4	50	200	H
15	Water level, 500 mm steel, prism type	4	50	200	H
16	Portable hydraulic shears PETIG type HC 530, for cobbles up to 50 mm, with spare cutting edges	2	8,125	16,250	F
17	Tongs type ampere/voltmetr Siemens, type 7KA 1400-8AE	5	230	1,150	C
TOTAL, US $				105,625	

IDENTIFICATION OF SUPPLIERS

Supplier code	Supplier identification	
	Dr. Georg Maurer GmbH, Optoelektronik Industriegebiet 10 D-7441 KOHLBERG, BRD	telex 7267734 tel. (07025)3031
B	KIMEX-ELECTRO-NITE Josef Raiss Strasse 6,7 A-6134 VOMP. AUSTRIA	

C	Siemens AG Siemensstrasse 88-92 Postfach 83 A-1211 WIEN, AUSTRIA	tel. 2501, 2543
D	MEZ Brumov CS-763 31 BRUMOV, CZECHOSLOVAKIA	
E	E. KANDT K.G. Robert Koch Strasse 36 D-2000 HAMBURG 20,BRD	telex 41-214164 kandt tel.(0049) 404710701
F	F.PETIG & SOHN GmbH Postfach 240 D-4048 GREVENBREUCH 2, BRD	telex 8517145 tel. (02107)73108
G	MITUTOYO-SAMPOH Messgereate Vertrieb GmbH Postfach 210565 Borsigstrasse 8-10 D-4040 NEUSS 31, BRD	
H	Schachermayer GmbH Industriezeile 86 Postfach 300 A-4020 LINZ, AUSTRIA	telex 022266
I	ABB Kent Europe Ltd. Zweigniederlassung Wien Jacquingasse 39 A-1030 WIEN, AUSTRIA	telex 132342 KENTWA tel. (0222)783153

ANNEX E. Adherence to schedules and targets

ORIGINAL TIME SCHEDULE FOR 1989/1990 AS PER TERMS OF REFERENCE

October 1989:
1. Briefing of the team leader in Vienna

October/December:
2. First field mission

December:
3. No. 1 draft report, immediately after completion of the first field trip; also contains a list of equipment required for the six plants under review

January/April 1990:
4. The equipment specified is ordered by UNIDO and air freighted to the plants

March/May:
5. Second field mission

July:
6. Draft final report

Late in 1990:
7. Final report - pending approval of the draft by UNIDO.

TENTATIVE REVISED IMPLEMENTATION SCHEDULE FOR 1990
Vienna, 30 January, 1990.

January/February:
1. Ascertain status of equipment orders and deliveries with Purchasing Section of UNIDO
2. Submit complete Kenyan visa applications for whole team through DA/GS/TRAV, in view of past difficulties

February:
3. Decide on project extension # 5 (substitutional first-mission coverage of Kenya)
4. Draft and send out telexes to project area UNDP/UNIDO offices informing of arrival dates and requesting usual visa on arrival facility
5. Decide on a tripartite meeting with PTA and project countries

February/March:
6. Cover first-mission Kenya pending positive decision as per 3).

March/April:
7. Pending a positive status of equipment deliveries,

undertake 2nd mission by field team to all project area countries (Mozambique, Kenya, Tanzania, Mauritius; also Zimbabwe in the case of T.L.), the sequence and timing to be determined as per the outcome of 2, 3, 4, and 5.

May/June:
8. Write draft final report
9. Implementation schedule update
10. Act on decisions about project extensions or, possibly, follow-up projects
   # 1 (Steelworks modeling workshop)
   # 3 (Training in EAF/caster/rolling mill practice)
   # 8 (Assistance to steel mills in Ethiopia and Madagascar)
   # 10 (Int. Workshop on the Rehabilitation of Steel Mills in PTA and SADCC Countries)
   # 11 (Int. Workshop on the Shipbreaking Industries in PTA Countries)

June/July:
11. Comments by UNIDO and PTA on the draft final report

September/October:
12. Tripartite meeting (pending decision on 5); submission of final report.

ACTUAL ACTIVITIES

October 1989:
1. Briefing of the team leader in Vienna, 15 October

October/December:
2. First field mission, 30 October through 2 December; Vienna consultation, 14 to 16 December

December:
3. No. 1 draft report - list of equipment required for the six plants under review, 16 December

January 1990:
4 Interim report incl. Technical annex, 30 January

February/April.
4. The equipment specified by team is ordered by UNIDO and air freighted to the plants

March/May:
5. Second field mission, 30 March through 10 May

July:
6. Draft final report, 16 July

September:
7. 2nd Draft final report.

December:
8. Final report.

FIELD ITINERARY

First field mission

	Team leader	Team
Mozambique	30 Oct- 7 Nov	30 Oct- 7 Nov
Tanzania	8 Nov-16 Nov	8 Nov-16 Nov[1]
Mauritius	17 Nov- 2 Dec	17 Nov- 2 Dec

[1]except for steelmaking expert:

Tanzania		8 Nov-23 Nov
Mauritius		24 Nov- 2 Dec

Second field mission

	Team leader	Team
Kenya	30 Mar-10 Apr	30 Mar-10 Apr
Tanzania	11 Apr-17 Apr	11 Apr-18 Apr
Zimbabwe	18 Apr-20 Apr	-
Mozambique	21 Apr-26 Apr	19 Apr-22 Apr
Mauritius	27 Apr-10 May	23 Apr-10 May

Above itinerary includes all travel and transits.

ANNEX F. List of references

1. A Survey of the Iron & Steel Sector in PTA and SADCC Countries, Vol.I, Main Study. UNIDO/IS/R44 (1986).

2. Preparatory Assistance and Advisory Services on the Techno-economic Appraisal of the Rehabilitation and Modernization of the Metallurgical Enterprise CIFEL in Maputo, Terminal Report UNIDO XA/MOZ/88/801, J. Gavlikowicz, Z. Dulewicz (1988).

3. Productivity Improvement of Steel Rolling Mills in Kenya Commonwealth Secretariat, Commonwealth Fund for Technical Co-operation Industrial Development Unit, (1985).

4. Productivity Improvement of Steel Rolling Mills in Mauritius and Tanzania Commonwealth Secretariat, Commonwealth Fund for Technical Co-operation Industrial Development Unit, (1986).

5. National Development Plan 1988-1990, Vol. 1, Ministry of Economic Planning and Development, Mauritius (1988).

6. Metal Working and Metal Forming Industries. Prospects and Opportunities, ALAF Ltd. (1989).

7. Views of the Kenyan Iron and Steel Industry, The Ministry of Industry, Kenya (1989).

ANNEX G. Specific mill data

COMPANY KENYA UNITED STEEL COMPANY LIMITED (KUSCO)

STEEL MELTING SHOP DATA

Melting shop staffing:	
total number of staff:	21
furnace crew:	12
pouring shop gang:	9
Electric arc furnace	
Manufacturer:	KGYV, Hungary
Year of installation:	1975 (#1 furnace) 1982 (#2 furnace)
Capacity:	4-5 tons each
Hearth diameter:	2.5 m
Dia. of electrodes:	200 mm
Transformer power:	2 MVA each
Water cooled units:	outside of roof shell, door arch, cooler rings around electrodes and electrode clamps
Nominal capacity:	13,500 ton each (based on 3 shift operation)
Associated facilities	
Charging system:	
Scrap buckets:	6 buckets; clamshell and orange peel types
Scrap transfer cars:	2 cars
Scrap weigh station:	1
Charging crane:	two 5-ton cranes
[illegible]	3 ladles with stopper rod teeming
Teeming cranes:	two 10-ton cranes
Ingots:	Bottom poured pencil ingots,

No. of ingots poured using a single runner: 48

CC billets: not yet being produced

Product mix

Only one grade of steel is produced; this is grade BS 4449 mild steel. The chemical composition is

C	0.15-0.26 %
Mn	0.45-0.60 %
Si	0.15-0.25 %
P, S	0.050 % max.

Production data

Year	Production of crude steel (tpy)	Specific consumption (per ton of crude steel) electric power (kWh)	electrodes (kg)
1987	19,531	648	6.4
1988	19,379	640	7.0
1989	18,547	668	7.2

Average tap-to-tap time: 150 min, split up into:
- repair time (fettling) 30 min
- charging time 15 min
- melting time 75 min
- refining time 30 min

Average casting time: 5 min

Average heat output: 88 - 89.5 %

[illegible] in casting : 1.9 %

[illegible] with defective [illegible] composition: 6.8 %

[illegible] of operation. Two EAFs can only be run simultaneously at [illegible]time and during the weekends, because of high cost of [illegible] power. Hence, the method adopted is sequence operation, [illegible] the one furnace switched on as soon as the other has tapped.

Average EAF's capacity utilization:

1988	71.77 %
1989	68.69 %

ROLLING MILL DATA

Mill type: 12", 7-stand, cross country repeating mill with a double tandem 2-high stand

Manufacturer: Danieli, Italy
Year: 1968

Mill layout: see drawing on next page

[illegible] range, mm: 8 (6) mm rounds and squares in coils
10 - 40 mm square and round bars

Product mix (1989):

size	tpy	%	grade
6	0	0	mild
8	9,940	47	steel
10	4,230	20	only
12	2,960	14	
16	1,905	9	
20	1,060	5	
25	423	2	
32	420	2	
40	210	1	

[illegible]: squares represent 75 % of total mill production

[illegible]nant size: 10 mm square

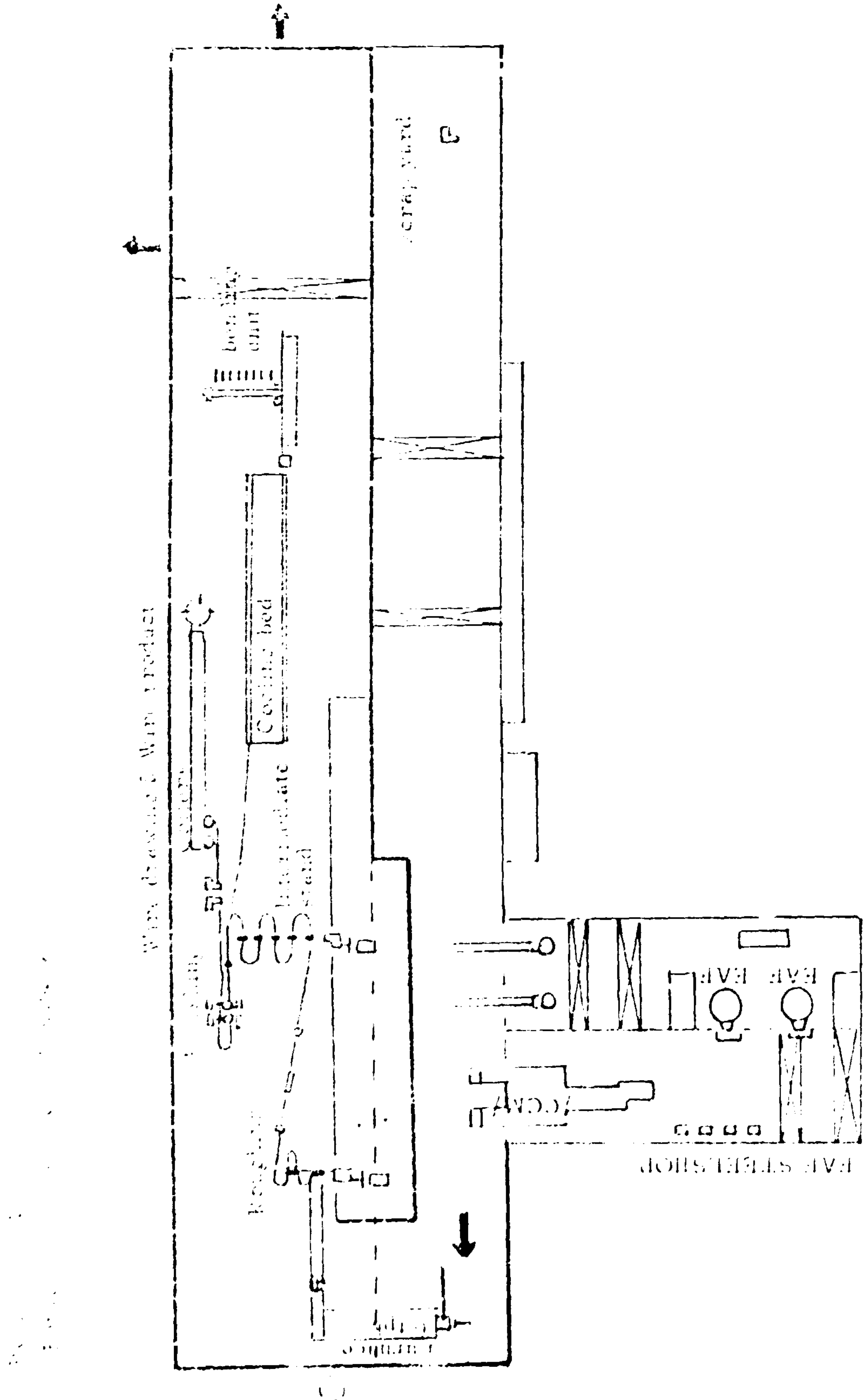
Feasible normal
[illegible] capacity, tpy: 20,000

[illegible] material: 75/100 mm pencil ingots
80 by 80 mm billets
length 1.5 m

[illegible] material: pencil ingots - own production
billets - imported (Europe, ZISCO Zimbabwe)

[illegible], kg/ton: 1,074 (1,065 - 1,081) Fuel oil
[illegible], l/ton: 60.5

[illegible]: no. per shift: 39
[illegible]ivity,
[illegible]: 180


Scrap yard
Cooling bed

[illegible]

[illegible] FURNACE

[illegible]	continuous pusher type with end drop-out
[illegible]:	Forni e Combustione, Italy
[illegible]:	Length 12.5 / width 1.8
[illegible]	5
	batch type
[illegible]	1.5 m water cooled skids, refractory
[illegible]	single row charging ingots reversed piece by piece to balance the taper and loaded onto the table in groups of ten (rail hoist) Charging operation is very slow, with approx. 2 minutes delay for every batch to be charged.
[illegible]	drop-out discharging onto roller conveyor equipped with a pneumatic turning device for pencil ingots
[illegible]	[illegible]
[illegible]	[illegible] (originally 2)
	[illegible] furnace face (originally 2 [illegible] for [illegible])
	[illegible] oil
	electric
	[illegible]
[illegible]	operated

Instrumentation: temperature measuring system with combustion ratio control

Furnace control: manual; furnace damper operable

ROLLING MILL

Mill trains/stands: 2 roughing, 5 intermediate, 2 x 2 finishing stands

stand #	type	roll dia. mm	roll length mm	roll speed rpm	stand drive kW
1+2	3-high	358	1,117	160	560
3-6	3-high	270	700	320	560
7	2-high	"	600	"	"
8	2-high	260	400	381	110
9	"	"	"	462	110
10	"	"	"	508	110
11	"	"	"	610	110

Speed ex finishing stand, meters/sec.: 4.5 stand # 7
6.3 stand # 9
8.3 stand # 11

Roll bearings: fiber bearings on 3-high stands (Germany)
roller bearings on 2-high stands except #7

Level of mechanization: fully mechanized

Supplier of rolls: imported from Belgium, Sweden, Germany, and Austria

Spare roll sets: ca 2

Roll cooling: adequate

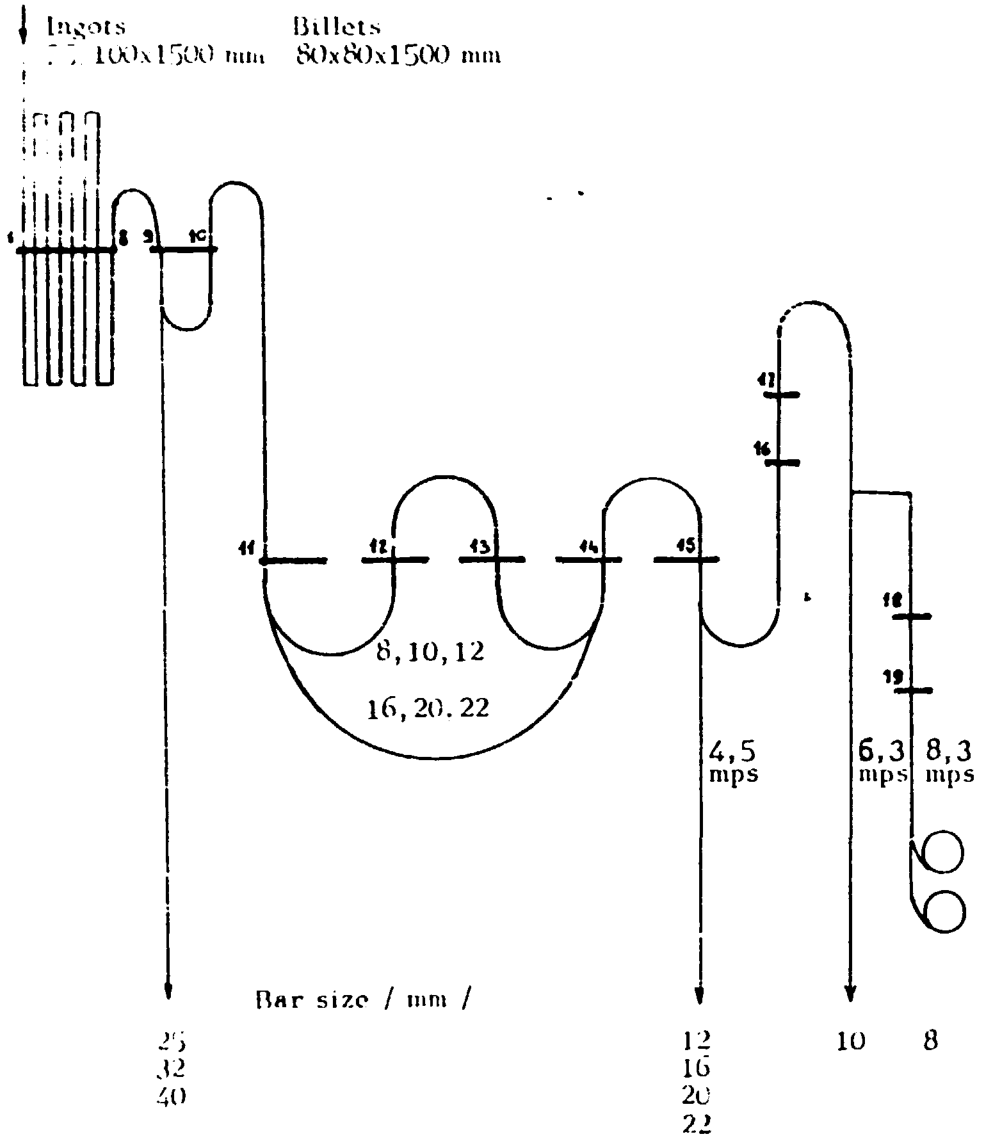
Roll pass design: Danieli design with some modification on roughing stands

Pass routine: see drawing overleaf

Reconditioning of rolls: no reconditioning on the roughing roll

ROLLING MILL PASS ROUTINE

/Kenya United Steel Company, Mombasa /



Roll pass life:	no data available
Shears:	automatic disc shears downstream of roughing mill and ahead of cooling bed
Cooling bed size:	30 by 6 m
Cooling bed type:	mechanical rake type
Coilers:	2 (max. speed 8.5 m/s, for 8 mm bars only)
Aux. equipment:	cold billet cutting shears
Downstream equipment:	twisting machines for rebars drawbench + straightening/polishing machine wire annealing/pickling line wire drawing shop wire galvanizing line machines for wire mesh barbed wire nails rivets chain link fencing reinforcing mesh

MAINTENANCE

Facilities requiring maintenance and servicing

Facility	Number	
EAF	2	KGYV, Hungary (4 tons)
Ladles	3	
Caster	1	not installed
Tundish	3	
Other melting furnaces	1	hot dip galvanizing tank
Reheating furnaces	1	5 tph pusher furnace, Forni, Genova, Italy
Rolling mill trains	2	320 mm (2 stands) 250 mm (5 stands)
Transport/handling		
cranes	3	two 10-ton, one 2-ton
vehicles	3	fork lifts
	3	trucks
	4	pickups
Workshop equipment	4 lathes. 3 drilling machines,	

1 roll turning machine, 1 milling machine, 2 power saws, 2 shaping machines, 1 surface grinder, 6 welders

Production bays:

Scrapyard is under roof but has low clearance which affects its capacity. This connects to the steelmaking shop and the other bays which all have sufficient floor area. Layout of production equipment is adequate, providing good access to maintenance. Maintenance of buildings is very good. The workplaces have adequate lighting. Areas not occupied by equipment are used for materials and spares storage. The EAFs operate without dust exhausts but the furnace bay roof is high enough the structure is open so that the offgases have good opportunity to scatter. The shops and workshops are kept tidy. The two maintenance workshops are sheltered by the rolling mill bay.

Staffing in maintenance and servicing:

Total number of staff	76
technical personnel	
engineers	2
technicians	3
others	-
laborers	
mech. workshop & fitters	33
electricians	13
furnace bricklayers	2
others	23

COMPANY ALUMINIUM AFRICA LIMITED (ALAF), STEELCAST DIVISION

STEEL MELTING SHOP DATA

Main production facilities

Electric arc furnace

Manufacturer:	G.E.C. India (model 11)
Year of installation:	1977
Capacity:	11 tons
Hearth diameter:	3.35 m
Dia. of electrodes:	305 mm
Transformer power:	5 MVA
Water cooled units:	outside of roof shell, door arch, cooler rings around electrodes and electrode clamps
Rated capacity:	18,600 tpy (three-shift operation)

Continuous casting machine

Type:	radial, two-strand
Manufacturer:	I.S.P.L. India (licence by Concast)
Year of installation:	1977
CC billet size range:	80 by 80 to 125 by 125 mm
Rated capacity:	25,000 tpy (three-shift operation)

Associated facilities

Charging system

Scrap buckets:	5 buckets; clamshell and orange peel types
Scrap transfer cars:	2 cars
Scrap weigh station:	1
Scrapyard crane:	two 5-ton cranes, one fitted with magnet
Charging crane:	one 20-ton crane
Ladles:	6 ladles with stopper rod teeming
Tundish:	4 tundishes
Pouring crane:	one 35/5-ton crane

Production and product mix

Two grades of steel are produced:

(i) Grade BS 4449 mild steel. The chemical composition is

C	0.20-0.30 %
Mn	0.50-0.90 %
Si	0.15-0.35 %
P, S	0.035 % max.

(ii) Grade BS 4449 high tensile steel. The chemical composition is

C	0.30-0.40 %
Mn	1.00-1.40 %
Si	0.15-0.35 %
P, S	0.035 % max.

Product mix (1989)

size	grade	%
CC billets 80 by 80 mm	mild steel	80
CC billets 80 by 80 mm	high tensile steel	20
Ingots	-	-

Production data (1989)

Production of crude steel:	11,035 tpy
Production of billets:	9,519 tpy
Yield of steel (1 ton of billets)	1,162 kg

Specific consumption (per ton of crude steel)

electric power	850 kWh
refractories (total with CC)	61.1 kg
electrodes	9.0 kg
scrap	1,150 kg
oxygen	8.0 cu m

Average tap-to-tap time: 4 hours 30 min, split up into:

repair time (fettling)	30 min
charging	20 min
melting	150 min
oxidation period	30 min
refining period	30 min
deoxidation and tapping	10 min

Average continuous casting time:	45 min
Average casting speed:	3.3 m/min

Rejects in CC: 1.9 %

Percentage of heats with defective chemical composition:	4.6 %	
Capacity utilization data in	1986	1989
Calendar time (hours)	8,760	8,760
GPT	5,314	5,314
Downtime	3,094	1,350
NPT	2,220	3,964
Breakdown of downtimes (%)		
shortage of scrap:	5	20
shortage of electrodes:	70	-
shortage of power:	10	55
defects (mech.+ elec.)	5	10
other	10	15
Average capacity utilization (%)		
EAF	33.4	59.6
Continuous caster	21.3	33.0

MAINTENANCE

Facilities requiring maintenance and servicing

Facility	Number	
EAF	1	
Ladles	6	
Caster	1	
Tundishes	4	
Transport/handling		
cranes	1	35/5 tons
	1	20 tons
	2	5 tons
vehicles	railway and fleet of trucks for scrap collection and billet transport	
Workshop equipment	2 lathes, 1 drilling machine, 1 power hacksaw	

Production bays

Roofless scrapyard connecting to the steelmaking shop bay wherein are located the electric arc furnace, the caster, and the ladle preparation section. The dislocation of the manufacturing units provides good access to repairmen. There is limited space though for ladle and tundish repairs. The maintenance workshop has only the barest minimum of equipment but the machine tools are in fairly good condition. Inasmuch as the steelmaking shop is only one of several shops of the company, some of the more intricate components can in fact be manufactured in the other shops' maintenance facilities.

Staffing in maintenance and servicing:

Total number of staff	42
technical personnel	
engineers	3
technicians	8
others	3
laborers	
mech. workshop & fitters	12
electricians	8
furnace bricklayers	5
others	3

COMPANY STEEL ROLLING MILLS Limited (SRM)

ROLLING MILL DATA

Mill type: 10", 3-stand, cross country semi-repeating mill with doubled 2-high finishing stand

Manufacturer: Danieli, Italy

Year: 1971

Mill layout: see drawing overleaf

Mill range, mm: 12 - 25 dia round and square bars/deformed rebars

Product mix (1989)

size	tpy	%	grade
12	5,180	35,7	low carbon/ high tensile
16	6.990	48,2	
20	1,550	10.6	
25	350	2,5	

Dominant size: 12/16 mm dia rebars

Feasible nominal mill capacity, tpy: 20,000

Charge material: 80 by 80 by 2000 mm concast/hot rolled billets

Supplier of charge material: ALAF-Steelco, Dar es Salaam; ZISCO, Zimbabwe

[illegible], kg/ton: 1,076.5

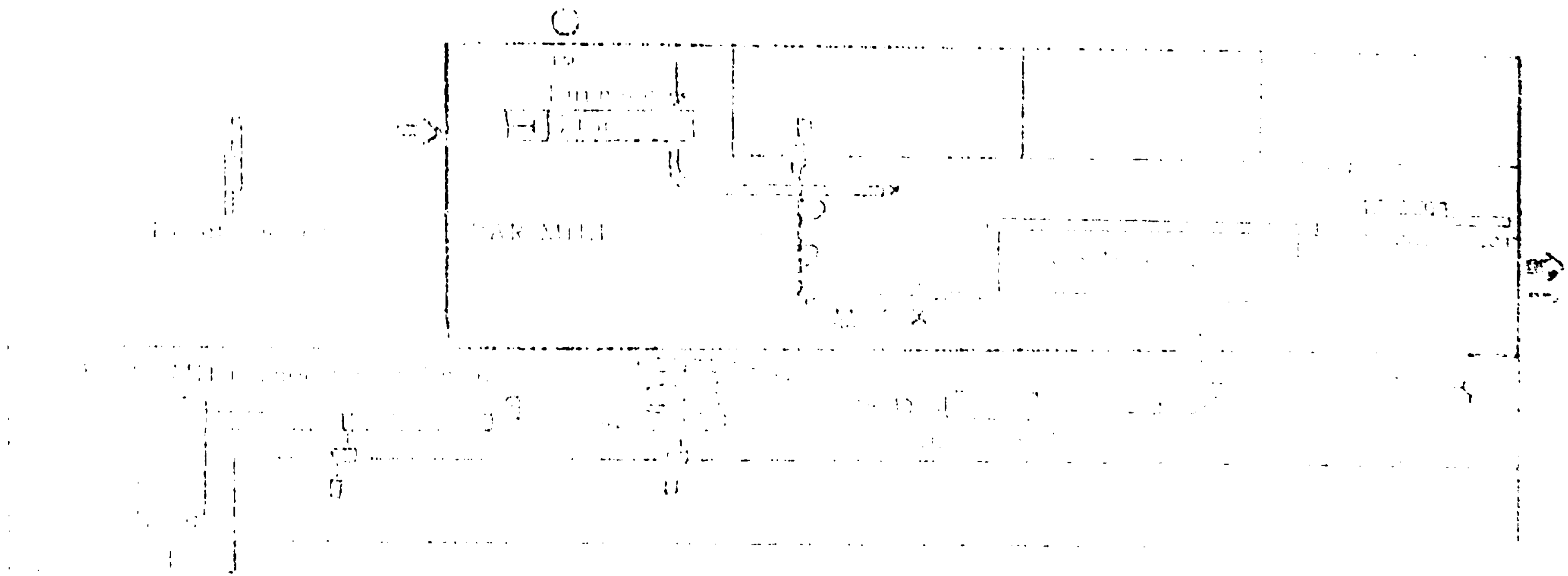
[illegible] consumption, l/ton: 99.2 (78-120)

[illegible] crew: crew size per shift: 50; total: 183

Productivity, [illegible]/man-year: 83.75

ROLLING MILL – LAYOUT

/Steel Rolling Mills, Tanga/



REHEATING FURNACE

Type:	continuous pusher type with mechanical side discharge	
Manufacturer:	Forni e Combustione, Italy	
Internal dimensions, m:	length 13.8	width 2.3
Furnace output, tph:	8	
Roof:	arch type	
Charging:	one row, by hydraulic pusher; transport onto the charging table by lifting truck	
Discharging:	mechanical chain discharging device (pusher)	
No. of billets in furnace:	170	
No. of zones:	1	
Burners:	5 (at furnace face: 2 at top, 3 at bottom)	
Fuel:	heavy oil	
Fuel heating system:	electric	
Recuperator:	none	
Flue gas damper:	kept set in one position, not used for routine control of furnace pressure	
Instrumentation:	temperature measuring system out of operation	
Furnace control:	manual, by experience	

ROLLING MILL EQUIPMENT

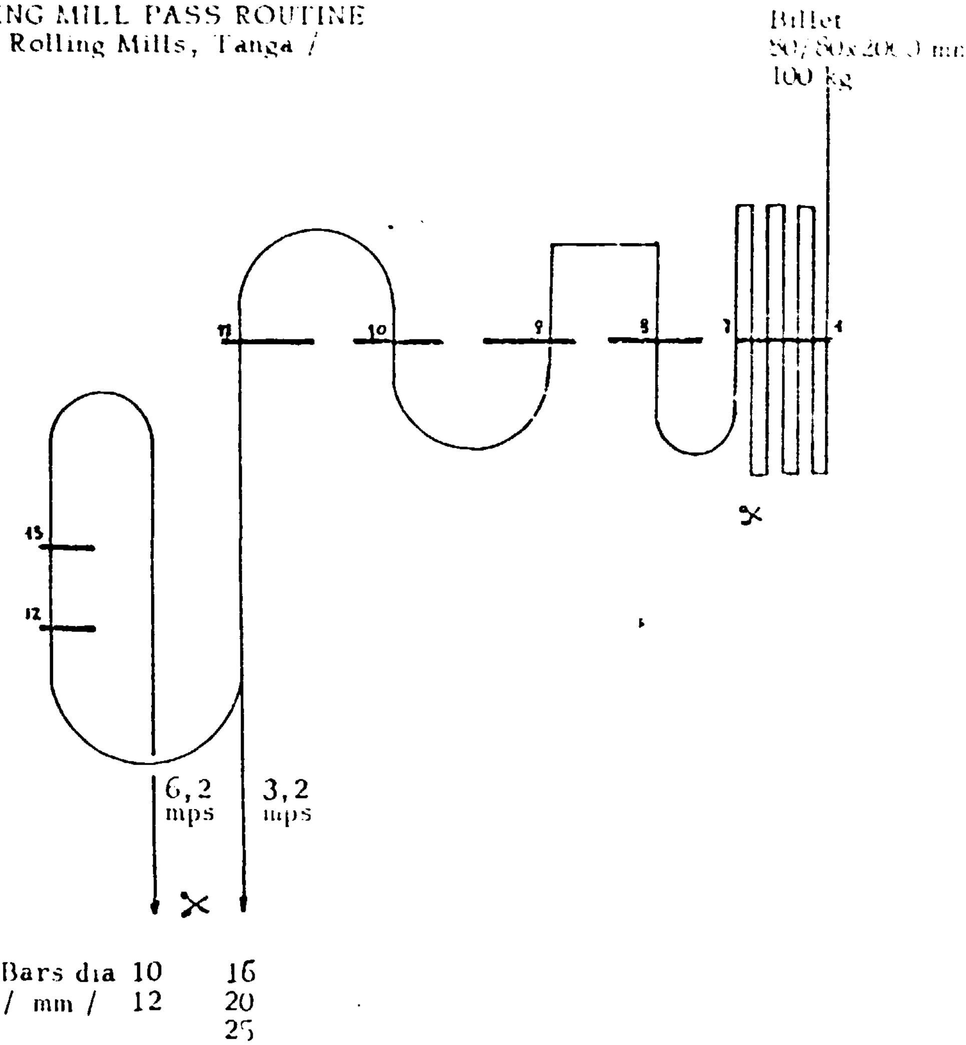
Mill trains/stands: 1 cross-country train with a 2-high tandem

No. of stands: 5 + 2

stand #	type	roll dia. mm	roll length mm	roll speed rpm
1	3-high	270	1,000	225
2-5	3-high	270	800	225
6+7	2-high	260	480	460

Mill drive:	850 kW A.C. motor with flywheel for #1-5 stands 2 x 110 kW A.C. motors for #6 and 7 stands
Speed ex finishing stand, meters/sec.:	3.2/6.2
Roll bearings:	fiber bearings on first five stands; roller bearings on 2-high stands
Level of mechanization:	fully mechanized roughing stand; semi-mechanized 3-high stands with tongsmen in front and repeaters in the rear
Roll material:	#1 stand: "SC" CrMo alloy #2-5 stands: TSp CrMo indefinite chill #7 & 8 stands: VML CrNiMoV hard guss
Supplier of rolls:	imported from Europe
Spare roll sets:	ca 2
Roll cooling:	adequate
Roll pass design:	Danieli roll pass design, modified on the first two stands
Pass routine:	see drawing overleaf
Reconditioning of rolls:	yes, on the roughing mill, using "armold" Cr20/Ni9/Mo3 electrodes without preheating (by British Oxygen Co., Tanzania)
Roll pass life:	60 tons per finishing roll groove; ca 4 years on roughing mill rolls (with re-conditioning)

ROLLING MILL PASS ROUTINE
/Steel Rolling Mills, Tanga /



Shears:	1 at outlet table of roughing mill 1 cut-to-length disk shears ahead of cooling bed 1 cropping shears alligator shears
Cooling bed size:	30 by 6 m
Cooling bed type:	mechanical rack type
Coilers:	2
Aux. equipment:	cold billet cutting shears
Downstream equipment:	drawing and secondary wire products section, inactive; installation was interrupted in 1982 and the shop has never been commissioned

MAINTENANCE

Facilities requiring maintenance and servicing:

Facility	Number	
Reheating furnaces	1	
Rolling mill trains	2	1 bar mill (active) 1 wire mill (inactive)
Wire products section	1	(inactive)
Billet cutting shears	1	
Transport/handling		
cranes	1	10-ton
vehicles	2	fork lifts
	3	mobile cranes
Workshop equipment	4 lathes 1 drilling machine, 1 milling machine, 1 shaping machine, 2 welders	

COMPANY COMPANHIA INDUSTRIAL DE FUNDICAO E LAMINAGEM S.A.R.L (CIFEL)

ROLLING MILL DATA - BAR MILL

Mill type: 5-stand, 16", 3-high cross country rolling mill

Manufacturer: Danieli, Italy

Year: 1961

Mill layout: see drawing overleaf

Mill range, mm: 10 - 50

Product mix (1989)

size	tpy	%	grade
10	390	15.7	low carbon
12	1,443	58.1	rebars only
16	495	19.9	
20	79	3.3	
25	60	2.4	
32	11	0.4	
50	5	0.2	

Dominant size: 12 mm round bars/rebars

Feasible normal mill capacity, tpy: 20,000

Charge material: 80 by 80 by 3000 mm billets
100 by 100 mm possible, for bars over 16 mm

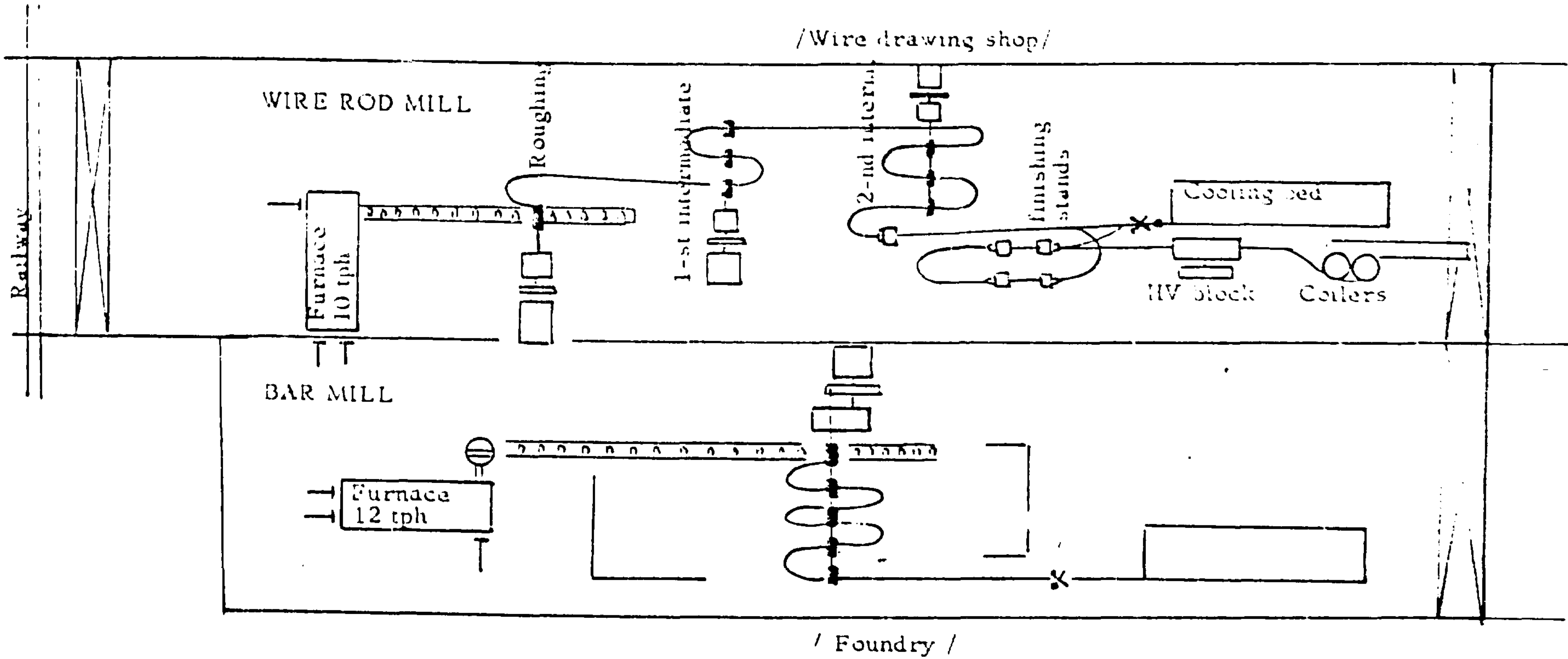
Supplier of charge material: imported from ZISCO, Zimbabwe

Production, tpy:	1987	1988	1989
	5,068	2,799	2,469

Yield, kg/ton: 1,217

Fuel oil consumption, l/ton: 195

ROLLING MILLS LAYOUT
/ CIFEL, Maputo /



Mill crew:	no. per shift:	25
	total:	97
Productivity, tons/man-year:	ca 25	

REHEATING FURNACE

Type:	Continuous pusher type furnace with side discharging
Manufacturer:	Wellman, UK
Internal dimensions, m:	length 12 width 3.5
Furnace output max., tph:	10 - 12
Roof:	arch type
Charging:	billets loaded by crane onto charging table and pushed by hydraulic pusher in one row through the furnace
Discharging:	by mechanical pusher onto the turning table and on roughing mill inlet conveyor
No. of billets in furnace:	150
No. of zones:	1
Burners:	5 in the front wall, 2 x 3 lateral burners are out of operation
Fuel:	heavy oil (imported)
Fuel heating system:	electric
Recuperator:	none
Flue gas damper:	due to complicated waste gas exhausting system (one stack for both furnaces - bar and rod mills) the furnace dampers are

	constantly open and furnace pressure control is practically impossible for both furnaces; one exhaust conduit can be shut separately but the other damper can only throttle both conduits
Instrumentation:	temperature measuring system has been out of operation since 1983
Furnace control:	manual, by experience

ROLLING MILL EQUIPMENT

Mill trains:	1
No. of stands:	5

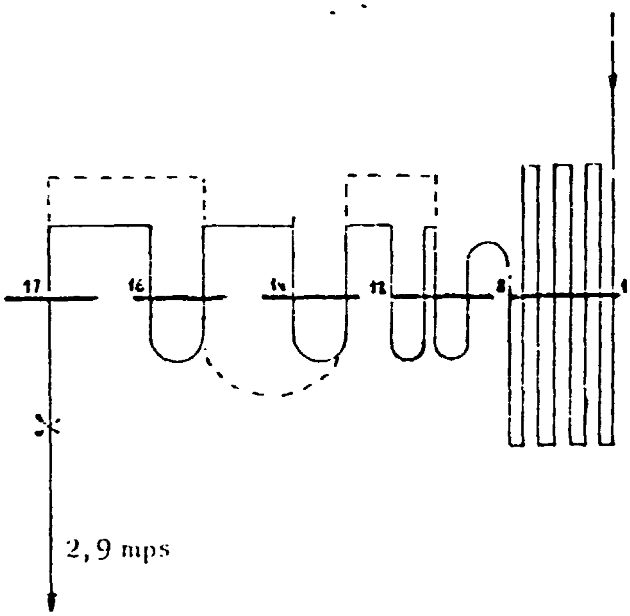
stand #	type	dia. mm	length mm
1	3-high	480	1500
2-4	3-high	480	1200
5	2-high	480	1000

Drive:	885 kW/985 rpm A.C. motor with flywheel
Speed ex finishing stand, meters/sec.:	2.9
Roll bearings:	synthetic fiber/phenolic resin type
Level of mechanization:	tilting table, roller conveyors, sliding plates on the roughing stand, repeaters, flying shear, mechanized cooling bed
Roll material:	forged steel rolls for roughing, cast iron rolls for remaining stands
Supplier of rolls:	imported
Spare roll sets:	2
Roll cooling:	insufficient; highly corrosive water
Roll pass design:	Danieli, Italy
Pass routine:	see drawing overleaf

ROLLING MILL PASS ROUTINE
/ CIFEL, Maputo /

BAR MILL

Billets
80x80x3000 mm
/100x100/



Bar size
/ mm /

10
12
16
20
25
32
50

Reconditioning of rolls: yes, roughing mill rolls

Roll pass life: no data available

Shears: 1 flying shear ahead of cooling bed
2 cut-to-length shears on the cooling bed

Cooling bed length: 20 m, rack type

ROLLING MILL DATA - WIRE ROD MILL

Mill type: hybrid cross country/continuous rolling mill

Manufacturer: 2 intermediate cross country trains - CIFEL
remaining stands - DANIELI

Year: 1955, upgraded in 1971 by Danieli

Mill layout: see drawing overleaf

Mill range, mm: 6 - 12

Product mix for sale (1989)

size	tpy	%	grade
6	435	40.8	mild steel
8	630	59.2	

(remaining volume is processed further in the wire drawing shop)

Dominant size: 8 mm dia

Rated mill capacity, tpy: 20,000

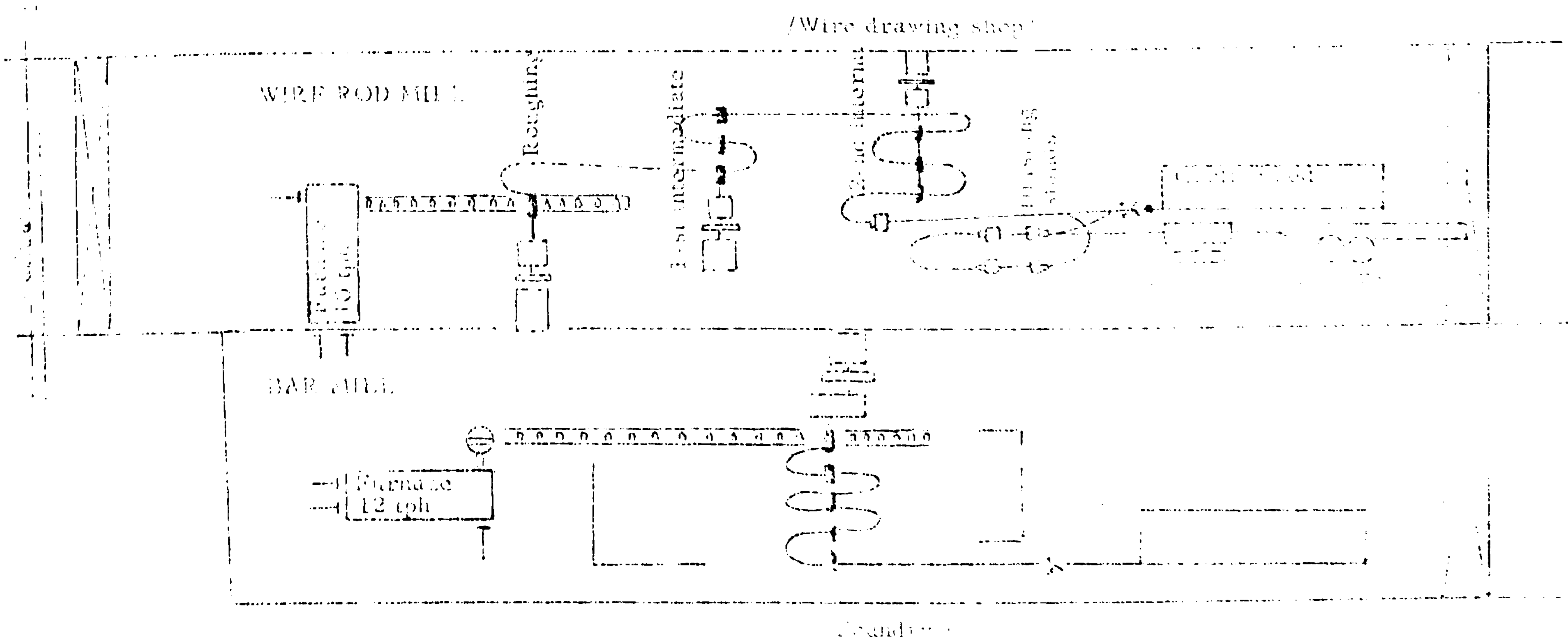
Charge material: billets 80 by 80 by 3000 mm

Supplier of charge material: imported from ZISCO, Zimbabwe

Production, tpy:	1987	1988	1989
	2,855	2,313	1,438

Yield, kg/ton: 1,525 (1,340 - 2,400)

ROLLING MILLS LAYOUT
/CIFEL, Maputo /



Fuel oil consumption, l/ton:	329.9
Mill crew:	89
Productivity, tons/man-year:	16.2

REHEATING FURNACE

Type:	continuous pusher type furnace with side discharging
Manufacturer:	Danieli, Italy
Internal dimensions, m:	length 9 / width 3.4
Furnace output max., tph:	10
Roof:	arch type
Charging:	single row charging billets loaded by overhead crane onto furnace side table and by roller conveyor transported to 2 hydraulic pushers
Discharging:	side discharging by mechanical pusher onto the roughing mill inlet conveyor
No. of billets in furnace:	110
No. of zones:	1
Burners:	[illegible]
[illegible]	heavy oil (imported)
Air heating system:	electric
Recuperator:	none
Flue gas damper:	same as for CIFEL bar mill furnace
Instrumentation:	temperature measuring system has been out of operation since 198[illegible]

operation since 1983

Furnace control: manual, by experience

ROLLING MILL EQUIPMENT

Mill stands/trains: reversing 3-high roughing mill, 2 separate 3-stand 2-high cross country mill trains (CIFEL 1958), a single 2-high stand, 2 pairs of 2-high stands, and a 4-stand non-twist finishing block (all DANIELI, 1971)

No. of stands: 12 + finishing block

stand #	type	roll dia. mm	roll length mm	roll speed rpm	stand drive kW
1	3-high	435	1,200	2.7	775
2-4	2-high	260	700	2.9	380
5-7	2-high	260	700	3.5	380
8	2-high	280	400	4.3	115
9-10	2-high	260	400	7.3	2x110
11-12	2-high	260	400	10.0	2x110
block	h/v	255	-	13.95	680

Roll bearings: fiber bearings on stands # 1 - 7
roller bearings on remaining stands

Level of mechanization: fully mechanized mill

Roll material: forged steel rolls for roughing, cast iron rolls for remaining stands

Supplier of rolls: imported

Spare roll sets: 2 approx.

Roll cooling: insufficient, highly corrosive cooling water

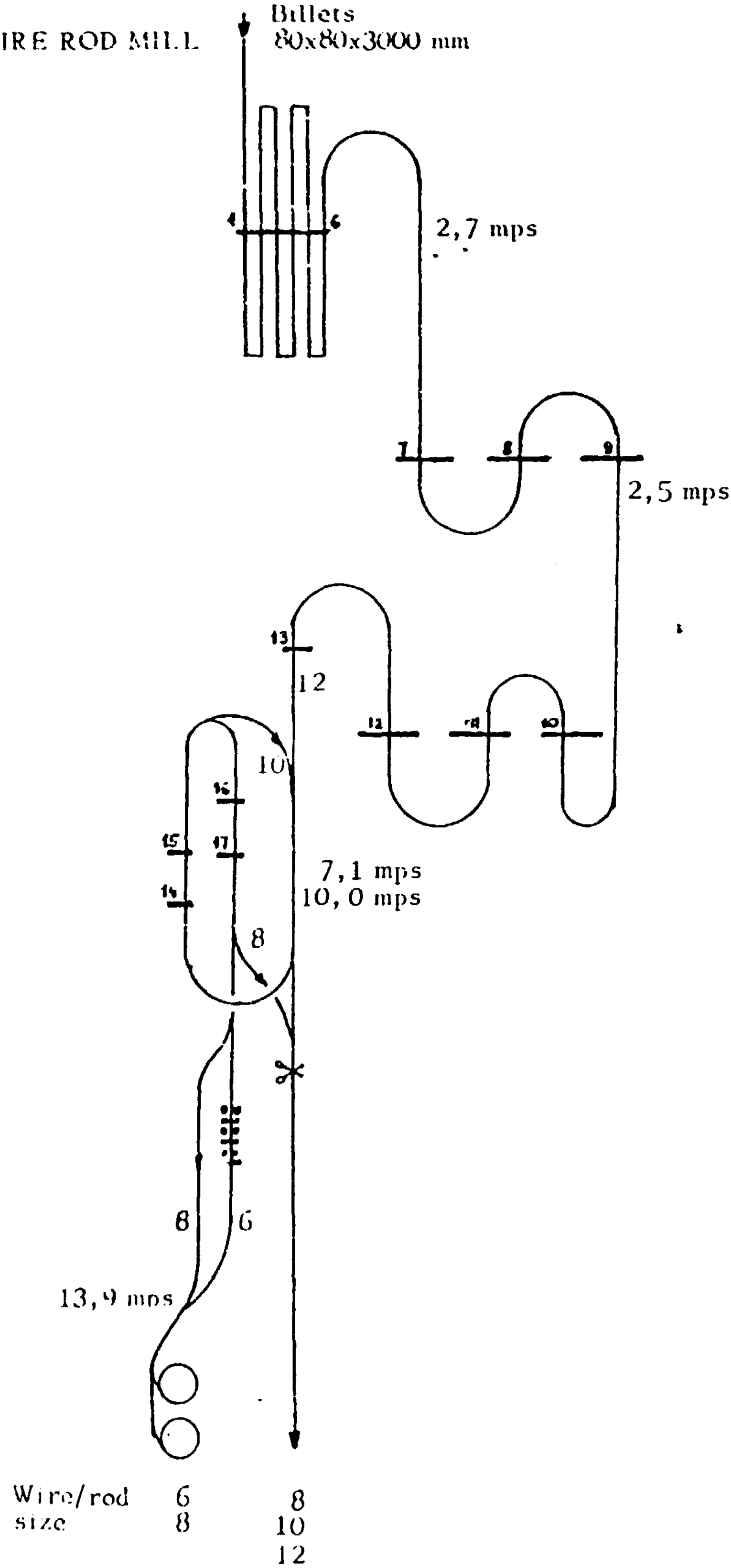
Roll pass design: Danieli

Pass routine: see drawing overleaf

Reconditioning of rolls: yes, roughing mill rolls

Shears: disc shears

WIRE ROD MILL



Cooling bed: ca. 30 m long, mechanical rack type

Coilers: 2 coilers, 14 mps, 2x35 kWDownstream
equipment: wire drawing shop with heat treatment and galvanizing facilities

MAINTENANCE

Facilities requiring maintenance and servicing:

Facility	Number
EAF	1
Ladles	5 (2 for cast steel, 3 for cast iron)
Other melting furnaces	2 cupolas (800 mm dia.)
	2 crucible furnaces (for nonferrous alloys)
	3 hood furnaces
	1 hot dip galvanizing tank
Reheating furnaces	2 pusher furnaces
Rolling mill trains	2
Transport/handling	
cranes	2 at bar mill (5 and 8 tons)
	2 at wire mill (5 and 8 tons)
	2 in mech. workshop (10 and 25 t)
	6 at foundry (2 to 10 tons)
vehicles	2 forklifts, 3 trucks
Workshop equipment	13 lathes, 5 milling machines, 4 facing machines, 10 drilling machines, 7 welders, 2 bending machines

Production bays

The two rolling mill bays are spacious enough but suffer from lack of maintenance. Roofing in particular is badly damaged offering inadequate protection against rainwater. The foundry bay has little clearance. The workplaces are poorly lit. Offgases from electric arc melting are not exhausted. There is no dust removing apparatus. The annealing bay is in very good condition and provides a satisfactory working environment. The mechanical workshop is good, of 4,000 sq.m. floor area (not fully used yet).

COMPANY DESBRO INTERNATIONAL LIMITED

ROLLING MILL DATA

Mill type: 12", 7-stand cross country repeating mill

Manufacturer: Shekhar Industries, Bombay, India

Year: 1979

Mill layout: see drawing overleaf

Mill range, mm: 8 - 12 mm round and deformed bars, high tensile (rebars) and mild steel grade

Product mix (1989)

size	tpy	%
8	14,000	78,5
10	2,640	16,0
12	944	5,5

Dominant size: 8 mm dia rebars

Feasible normal mill capacity, tpy: 20,000

Charge material: 60 by 60 by 1500 mm billets
80 by 80 by 1000 mm billets occasionally

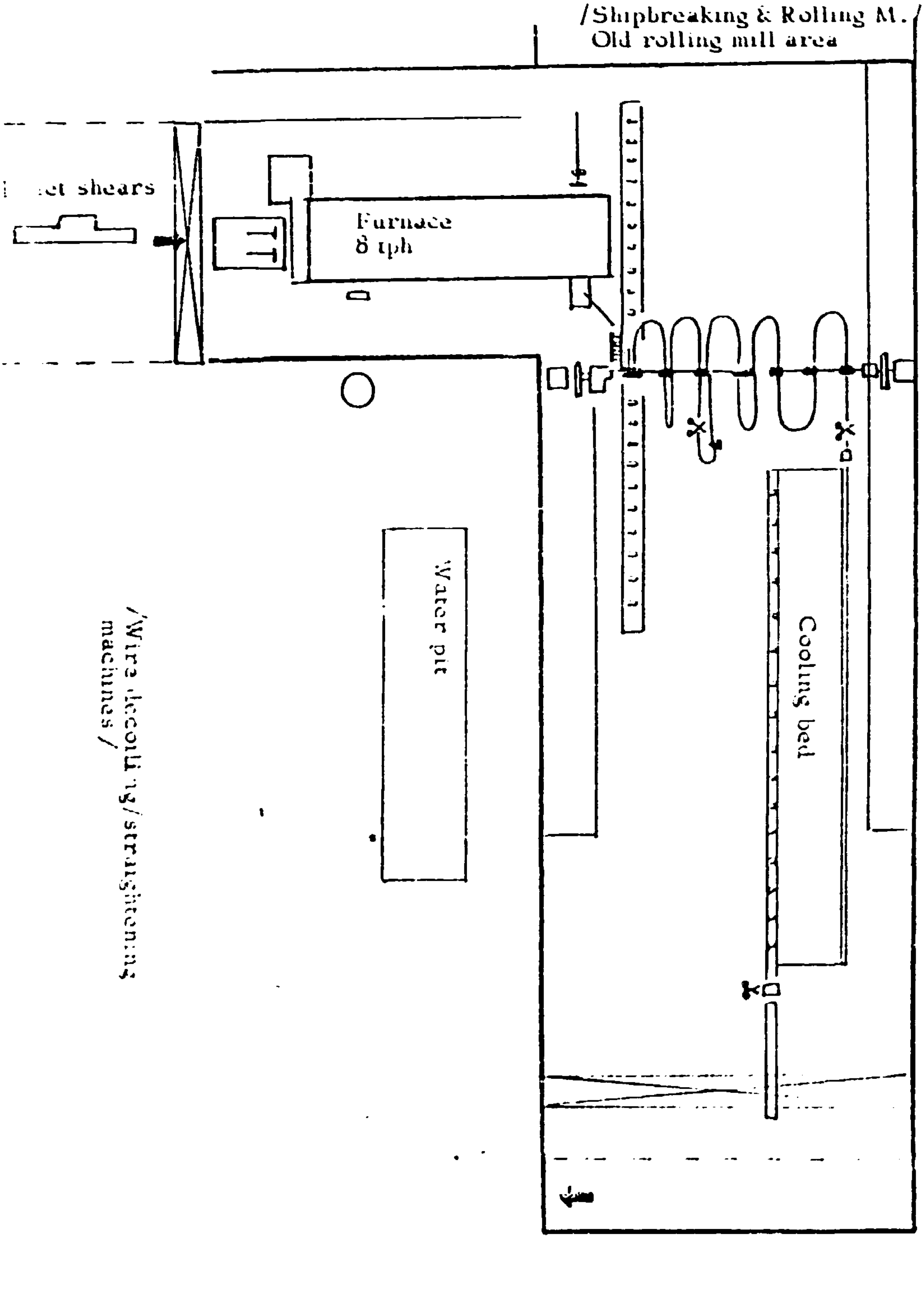
Supplier of charge material: ISCOR, R.S.A.
ZISCO, Zimbabwe (mild steel)

Yield, kg/ton: 1,086 (1,052 - 1,089)

Fuel oil consumption, l/ton: 60.5

Mill crew: no. per shift: 43

Productivity, tons/man-year: 204



ROLLING MILL LAYOUT
/ Desbro International, Port Louis/

REHEATING FURNACE

Type:	continuous pusher type with side discharging
Manufacturer:	Allied Consulting Engineering, India
Internal dimensions, m:	length 12 / width 2.4
Furnace output:	8 tph
Roof:	arch type
Hearth:	4 steel skids (billets), chromomagnesite refractory hearth
Charging:	loading onto furnace side table by overhead crane, and manual adjustment in front of two hydraulic pushers 2-row charging for 80 by 80 mm billets
Discharging:	pushed out of furnace by mechanical pusher and handled manually using tongs suspended from an overhead rail
No. of billets in furnace:	200 (400 in two-row arrangement)
No. of zones:	1
Burners:	3
Fuel:	heavy oil (imported)
Fuel heating system:	electric
Recuperator:	none
Flue gas control:	by damper
Instrumentation:	absent
Furnace control:	manual, by experience

ROLLING MILL EQUIPMENT

Mill stands/trains 1 roughing + 3 intermediate, 3 finishing

No. of stands: 4 + 3

stand #	type	roll dia. mm	roll length mm	roll speed rpm
1	3-high	300	800	225
2-4	3-high	300	700	"
5-7	2-high	300	600	269

Drive: 588 kW/720 rpm A.C. motor with flywheel
375 kW/720 rpm A.C. motor with flywheel

Speed ex finishing stand, meters/sec.: ca 4.2

Roll bearings: f[illegible] type (imported from FRG, India)

Level of mechanization: roller table and skid plates on inlet side of the roughing stand, no lifting table, front and back repeaters on remaining stands, front and rear end cropping disk shear with pinch roll after #3 stand, cut-to-length disk shear after last stand

Roll material: high carbon forged steel rolls on roughing, indefinite chill or SG iron on remaining stands

Supplier of rolls: imported from R.S.A., Italy, U.K.

Spare roll sets: 2

Roll cooling: adequate

Roll pass design: Shekhar

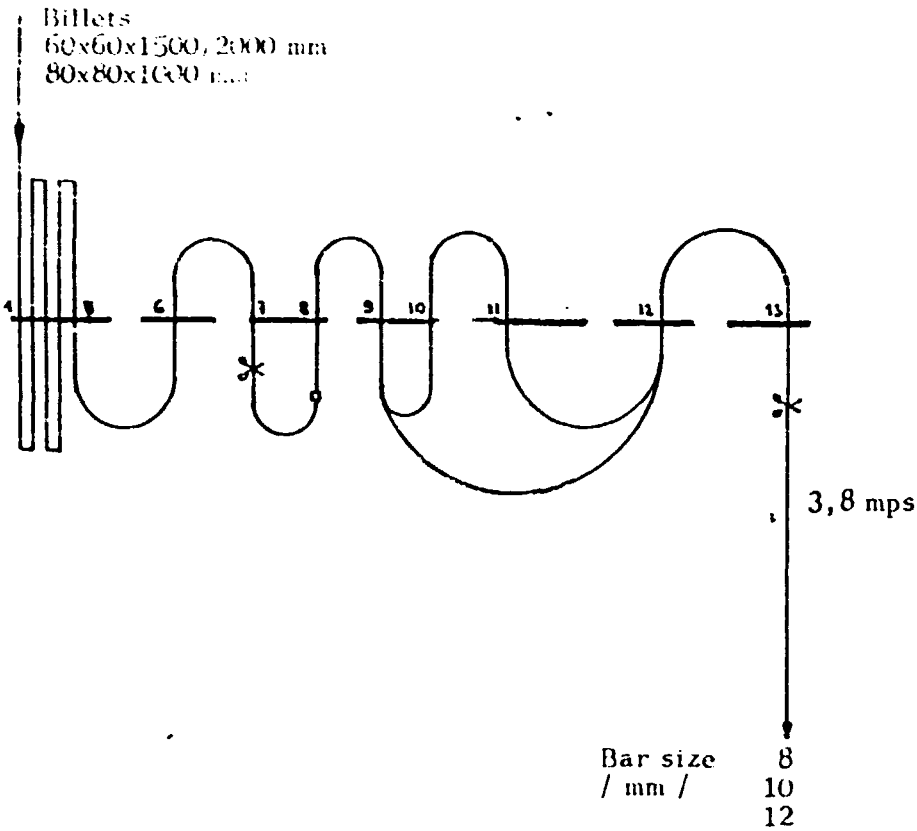
Pass routine: see drawing overleaf

Reconditioning of rolls: roughing mill rolls

Roll pass life: 60 tons per final pass

ROLLING MILL PASS ROUTINE

/ Desbro International, Port Louis /



Shears:	2 disk shears (cropping, cut-to-length) 1 crankshaft shears (Avery-Denison) downstream of cooling bed
Cooling bed size:	30 by 5 m
Cooling bed type:	manually operated with roller conveyor towards the cut-to-length shears
Coilers:	none
Auxiliary equipment:	1 billet cutting shears with capacity up to 100 mm sq
Downstream equipment:	twisting machine wire straightening machines (wire is imported in coils).

MAINTENANCE

<u>Facilities requiring maintenance and servicing</u>

Facility	Number	
Reheating furnaces	1	
Billet cutting shears	1	
Rolling mill trains	1	(7 stands)
Auxiliary equipment		water pumps, filters, hydraulic pumps, scales
Transport/handling equipment		
cranes	3	5/10 tons, controlled from shop floor
vehicles		trucks for rolled stock; "Bell truck" for handling and loading rolled bars onto trucks
Workshop equipment	2 lathes, 2 drilling machines, 1 knurling machine, 2 shaping machines, 2 welders; forge.	

COMPANY SHIP BREAKING & STEEL ROLLING INDUSTRIES LIMITED

ROLLING MILL DATA ("new" mill)

Mill type: 12", 7-stand, cross-country semirepeating mill

Manufacturer: Shekhar Industries Ltd., Bombay, India

Year: 1981

Mill layout: see drawing overleaf

Mill range, mm: 8 - 25 dia.

Nominal maximum mill capacity, tpy: 6,500

Product mix (1989):

size	tpy	%	grade
8	2,565	60	mostly high tensile
10	430	10.1	
12	640	15	
16	350	8	
20	225	5.3	
25	65	1.6	

Dominant size: 8 mm deformed rebars

Charge material: 60 by 60 mm billets, 900 - 1,290 mm long depending on bar size

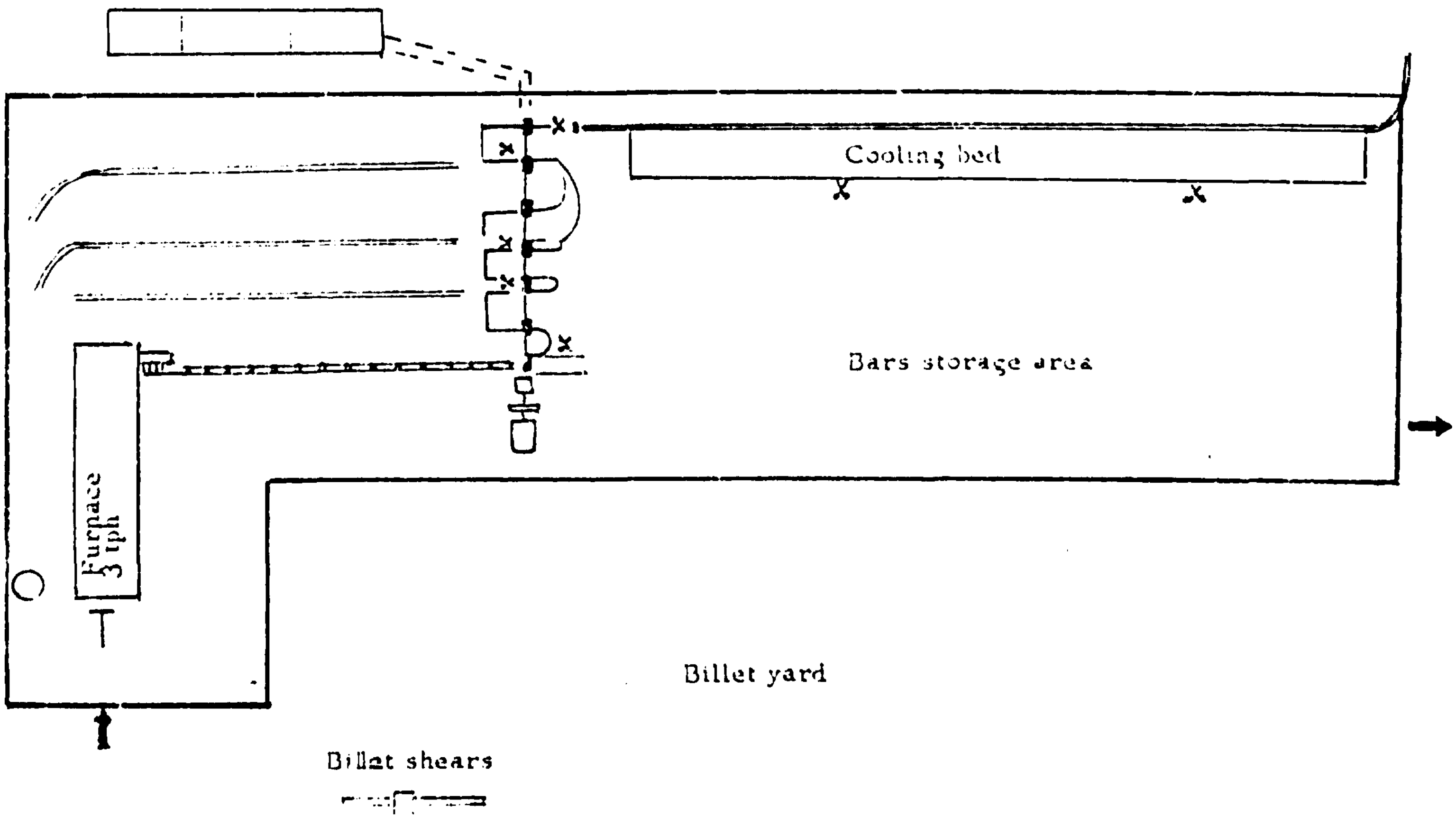
Supplier of charge material: imported from ISCOR, R.S.A. - high tensile
ZISCO, Zimbabwe - low carbon

Production, tpy:	1987	1988	1989
	3,614	3,500	4,275

Yield, kg/ton: 1,110

Fuel oil consumption, l/ton: 102 (70-120)

ROLLING MILL LAYOUT
/ Shipbreaking & Rolling Mills, Port Louis/



/ Old rolling mill/

Mill personnel,	
total:	73
shop floor:	62
Productivity, tons/man-year:	58.6

DETAILS OF EQUIPMENT

REHEATING FURNACE

Type:	continuous pusher type furnace with side discharging, 3 tph	
Manufacturer:	Allied Consulting Industries, India	
Internal dimensions, m:	length	width
	12.4	1.75
Roof:	arch type	
Hearth:	two 9-meter steel skids, chromomagnesite hearth	
Charging:	billets are loaded onto the furnace table b[y] lifting truck and manually placed in front o[f] a pusher head (1 row charging)	
Discharging:	side discharging, manually using tongs	
No. of billets in furnace:	180	
No. of zones:	1	
Burners:	3 Rotavac burners at furnace face	
Fuel:	heavy oil	
Fuel heating system:	electric	
Recuperator:	none	
Flue gas damper:	kept set in one position, never used for furnace pressure control	

Instrumentation: none

Furnace control: manual, by experience

ROLLING MILL EQUIPMENT

Mill stands/trains: 12", 7-stand cross-country semirepeating mill

No. of stands: 7

stand #	type	roll dia mm	roll length mm
1	3-high	300	800
2 - 4	3-high	300	700
5 - 7	3 high	300	600

Main drive: 597 kW/738 rpm A.C. motor with flywheel

Speed ex finishing stand, meters/sec.: ca 3.5

Roll bearings: fiber bearings

Level of mechanization: # 1 stand manually operated, no lifting table, roller conveyor on inlet side only, skid plates; remaining stands manually operated at inlet side, repeaters at outlet side up to 16 mm dia.

Roll material: #1 stand - steel; other stands - S.G. iron

Supplier of rolls: imported mostly from India (Gayson), Korea, and Hong Kong

Spare roll sets: ca 2

Roll cooling: adequate

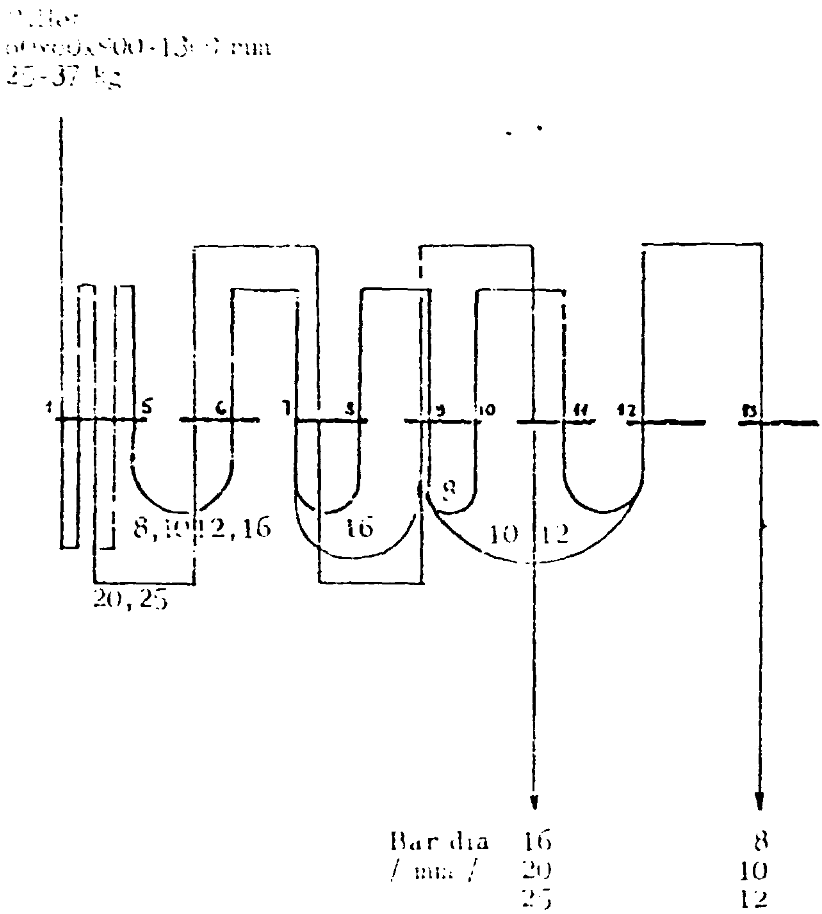
Roll pass design: Shekhar design, unchanged

Pass routine: see drawing overleaf

Reconditioning of rolls: yes, on roughing rolls, flame preheating

ROLLING MILL PASS ROUTINE

/ Shipbreaking & Rolling Mills, Port Louis /



Roll pass life: 100 tons per pass on final stand; [illegible] on roughing stand (with re-[illegible])

Shears: [illegible] on the outlet side of the finishing stand; [illegible] alligator shears along the cooling bed

Cooling bed size. ca [illegible] by [illegible]

Cooling bed type. manually operated, simple, low welded frame resting free on the floor

Aux. equipment: cold billet cutting shears; 2 crankshaft cutting shears for shipbreaking plate

Downstream equipment: none

MAINTENANCE

Facilities requiring maintenance and servicing

Facility	Number		
Reheating furnaces	1		
Ship plate cutting shears	[illegible]		
Billet cutting shears	[illegible]		
Rolling mill train	[illegible]	(bars)	7 stands
Transport/handling			
cranes	1	hoist	
other	1	fork lift	
Workshop equipment	[illegible] lathes, [illegible] shaping machines, [illegible] drilling machines, 1 milling machine, 2 welding machines		

Production bays

[illegible] two rolling mills: an old rolling mill [illegible] to roll bars from cut ship plate [illegible] operation and most of the bay where this [illegible] housed [illegible] rolled stock storage; the remaining part [illegible] a maintenance workshop, with [illegible]. The [illegible] rolling mill equipment, including [illegible] furnace, is still intact and [illegible]; it would serve no purpose to [illegible] it. The maintenance workshop is rather poorly equipped and the machinery shows considerable wear. The old rolling mill bay is not being maintained, and the physical condition of the building is deteriorating rapidly due to atmospheric corrosion.

The new bar rolling mill is in fairly good condition. However, the light structure of the building and low clearance make it impossible to install an overhead crane which in turn makes all maintenance and repairwork unwieldy because of constrained space.

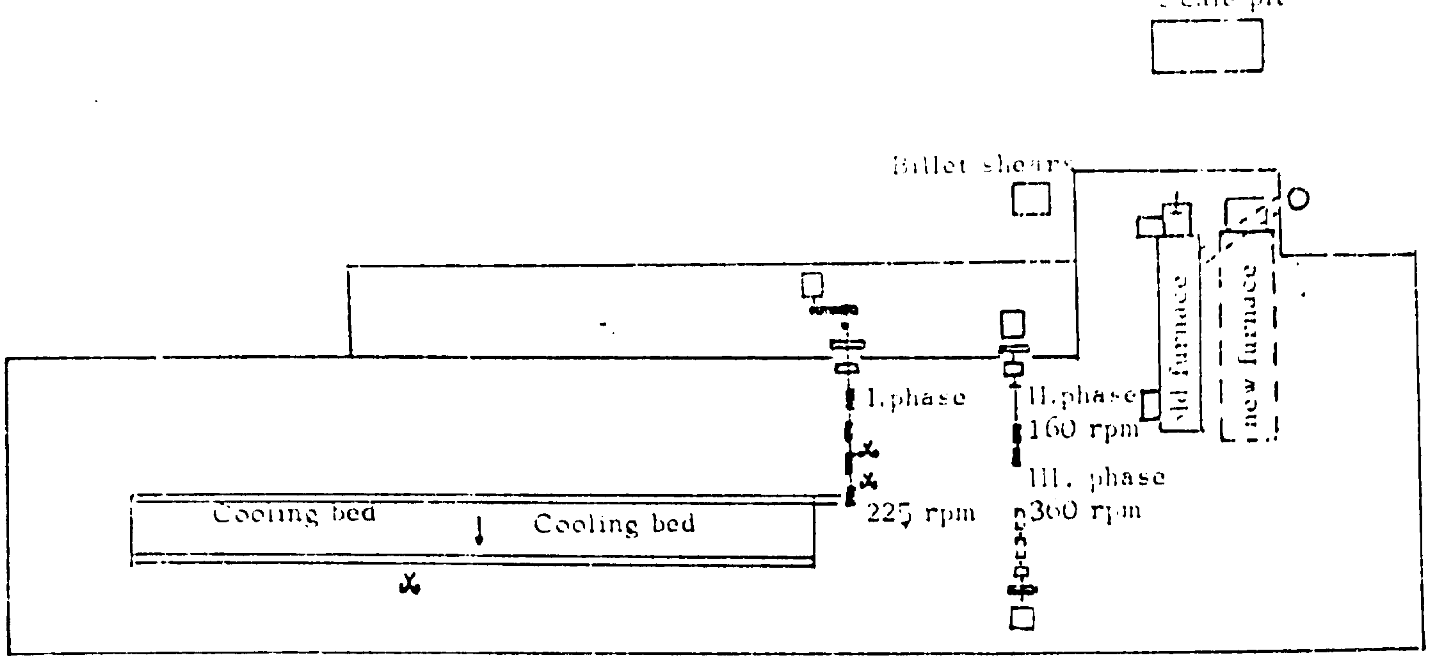
COMPANY SECTIONS ROLLING LIMITED

ROLLING MILL DATA

Mill type:	12", 6-stand, cross-country mill
Manufacturer:	Gayson & Co., Calcutta, India
Year:	1975
Mill layout:	see drawing overleaf
Mill range, mm:	8 - 25 dia. bars
Product mix (1989):	12, 16, 25 mm deformed rebars 40 % high tensile grade 60 % mild steel grade
Dominant size:	12/16 mm deformed rebars
Charge material:	60 by 60 mm billets, 860 - 1320 mm long depending on bar size
Supplier of charge material:	imported from ISCOR, R.S.A. - high tensile ZISCO, Zimbabwe - mild steel
Production (1989)	7,800 tpy
Yield, kg/ton:	ca 1,075
Fuel oil consumption, l/ton:	ca 70
Mill personnel, total:	ca 60
Productivity, tons/man-year:	ca 133
Quality control:	Samples sent regularly to Mauritius Standards Bureau in Reduit

ROLLING MILL LAYOUT

Sections Rolling, Port Louis /



REHEATING FURNACE

Type:	continuous pusher type furnace with side discharging
Manufacturer:	Bombay Furnace, India
Heating capacity:	4 tph
Internal dimensions, m:	length 12.0 / width 3.2
Roof:	arch type
Charging:	manually loaded, single row charging
Discharging:	side discharging (manual, using tongs)
No. of billets in furnace:	ca 200
No. of zones:	1
Burners:	3 burners at furnace face
Fuel:	heavy oil
Fuel heating system:	electric
Recuperator:	none
Instrumentation:	none
Furnace control:	manual, by experience

New heating furnace has been installed and is waiting for commissioning. This new furnace, also of pusher type, is equipped with temperature measurement and controls (using an on/off system of burner control). Higher heating capacity and more accurate control of heating will provide the benefits of lower scaling, lower fuel consumption, and higher product quality. Also, it will remove the capacity constraint represented by the standing, old furnace.

ROLLING MILL EQUIPMENT

Mill stands/trains: 12", 6-stand, cross-country rolling mill (2-stand roughing train, 4-stand intermediate/finishing train, separately driven)
two more stands with independent drive are ready to be installed in the next phase of mill upgrading

No. of stands : 6

stand #	type	roll dia. mm	roll length mm
1 - 2	3-high	300	800
3 - 4	3-high	300	800
5 - 6	2-high	325	1000

Main drive: 412 kW/735 rpm A.C. motors with flywheel

Roll speed: roughing train 160 rpm
finishing train 225 rpm (3.6 mps)

Roll bearings: fiber bearings

Level of mechanization: manually operated, back repeaters for small sizes

Supplier of rolls: imported

Spare roll sets: 2

Roll pass design: Gayson design

Roll pass routine: see drawing overleaf

Reconditioning of rolls: yes, roughing rolls

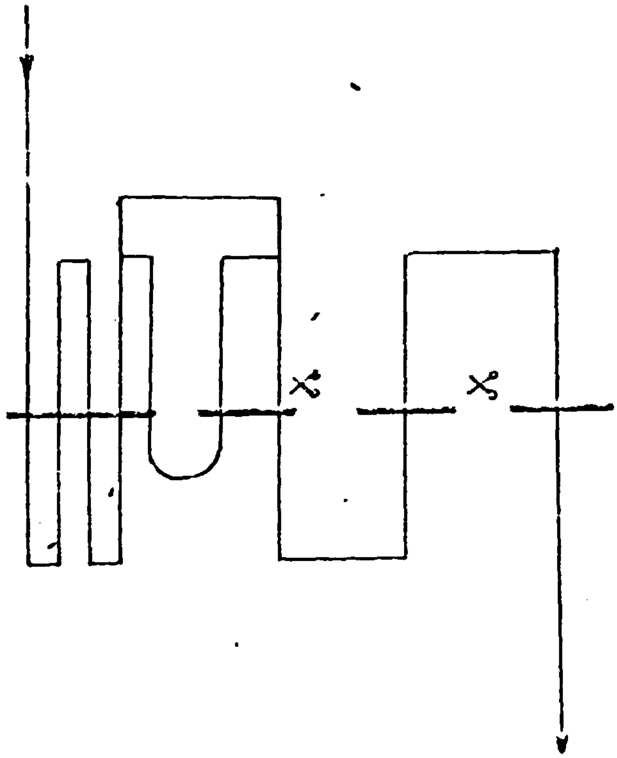
Shears: movable alligator shears
10-ton cut-to-length shears downstream of cooling bed

ROLLING MILL PASS ROUTINE

/ ... Rolling Ltd., Port Louis /

Billets
60x60x800-1350 mm

24-38 kg



Bar size/mm/ 12
16
25

Cooling bed :	ca 40 m long, manufactured from flat sections; bars are manually moved across the cooling bed by hookmen and transported by roller conveyor to the cut-to-length shears
Aux. equipment:	cold billet cutting shears

MAINTENANCE

Facilities requiring maintenance and servicing:

Facilities	Number
Reheating furnaces	2
Rolling mill trains	2
Billet cutting shears	1
Transport/handling	
cranes	1
vehicles	1
other	2 forklifts
Workshop equipment	3 lathes, 2 drilling machines, 1 power hacksaw, 1 shaping machine, 2 welders

Production bays

The mill is situated in an open bay, with the reheating furnace in an annex (cf. layout drawing). The condition of the two rolling trains is commensurate with their respective age. The old pusher furnace constitutes the chief problem and is to be replaced. Its throughput is low and its fuel consumption is rather high because of absence of controls and instrumentation. Maintenance is facilitated by the fact that this is a simple, straightforward operation with high workforce involvement.

United Nations Industrial Development Organization
Vienna

18780
(3 of 3)

RESTRICTED
December 1990
English

DEVELOPMENT AND RATIONALIZATION OF SMALL SCALE STEEL PLANTS IN THE PTA REGION

DP/RAF/88/072

ANNEXES TO TERMINAL REPORT

(Annex H)

Prepared for the P.T.A.
by the United Nations Industrial Development Organization
acting as executing agency
for the United Nations Development Programme

Based on the work of R. Stefec & team,
Polytechna Corp. subcontractors

United Nations Industrial Development Organization
Vienna

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UNIDO PROJECT DP/RAF/88/072
SUBCONTRACT EXTENSION PROPOSAL

ON-THE-JOB TRAINING IN CZECHOSLOVAK STEEL MILL

BACKGROUND

As confirmed by recent missions, most of the steel mills visited in the PTA countries covered by this project[1] suffer acutely from poor capacity utilization and are in sore need of rehabilitation.

Lack of adequate training ranks prominent among the factors which thwart the efforts to remedy the situation. Particularly at the middle level of management, there is a pronounced lack of metallurgical expertise in the EAF and casting shop, at the bar rolling mill, and in maintenance. Exposure to foreign (or even neighboring) mills of similar type and scale is entirely lacking, with the notable exception of participation by several mill staff members in the maintenance-oriented training project run at ZISCO, Zimbabwe.

Consequently, the idea of a training course which would allow the individual shop managers to develop in their particular line of specialization, was eagerly grasped at by the management of all the plants visited. Better trained operators and middle-level managers are a valuable asset to the mills in their efforts to upgrade production and product quality.

OBJECTIVES

On-the-job training at a well-operated steel mill provides the greatest immediate benefit if the mill selected for training features a type and scale of operations similar to those of the trainees' own mills. Efficient mills of this kind are operating in Czechoslovakia, and provide the additional advantage of combining all the operations encountered at the different trainees' mills (that is, EAF, continuous caster, bar and wire rolling, and maintenance) even under the roof of a single plant. Indeed, this kind of training is a logical, inseparable part of the UNIDO technical assistance projects.

The output of the training scheme is experienced, better trained steel mill shop managers and/or operators capable of supervising

[1]Kenya, Mauritius, Mozambique, and Tanzania.

more complicated jobs within the mill and of improving the mill operations, because of a deeper understanding of the underlying metallurgical issues.

ACTIVITIES

The Subcontractor shall

negotiate the detailed program and organization of the training course with the selected Czechoslovak steelworks;

organize the trainees' logistics and subsistence;

actively interact with the trainees throughout their stay, providing adequate instruction.

OUTLINE OF THE TRAINING COURSE

Timing: late 1990/early 1991
Duration: 3 weeks

The trainees[2] will take part in everyday operations of the Czechoslovak steel mill under supervision of Subcontractor and of qualified instructors. Proper attention will be paid both to the professional aspects and to the safety at work aspects. There will be room and board at the steelworks' facilities.

As explained above, the Subcontractor shall undertake all activities relating to the organization of the training course.

The trainees will essentially form a single team during the training but, depending on the professions involved, will be expected to split so that each of them can devote sufficient time to his own specialization.

A staff member of UNIDO, preferably from IO/T/MET, is invited to visit the Czechoslovak steelworks while the training will be in progress, at no extra charge to Subcontractor.

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[2]One trainee per steel mill for all the mills covered by the project, making up a total of six trainees.

SUBCONTRACT EXTENSION COST PROPOSAL ANALYSIS[3]

	Position/title	Man/months	Cost per m/m	Total cost
1.	PROFESSIONAL SERVICES			
A.	Project area			
	team leader	1.5	2,990	4,485
	team member/EAF	1.0	2,660	2,660
	team member/rolling	1.0	2,660	2,660
	Total project area	3.5		9,805
B.	Home office			N/A
2.	SUBSISTENCE			
A.	Project area (Czechoslovakia)			
	126 man/days @ 96 (6 trainees[4])			12,096
B.	Briefing & pickup of trainees			
	Austria: 2 man/days @ 129			258
C.	Other			N/A
	Total subsistence			12,354
3.	TRAVEL & TRANSPORTATION			
	air fares as follows:			
	1 air fare MPM-VIE-MPM		@ 1600	1,600
	1 air fare DAR-VIE-DAR		@ 1000	1,000
	1 air fare MBA-NBO-VIE-NBO-MBA		@ 1000	1,000
	1 air fare TGT-DAR-VIE-DAR-TGT		@ 1100	1,110
	2 air fares MRU-VIE-MRU		@ 1500	3,000
	1 air fare PRG-VIE-PRG		@ 350	350
	transportation from/to Vienna & within Czechoslovakia			2,400
	Total travel & transportation			10,460
4.	REPORTS			500
5.	OTHER DIRECT COSTS			
	telecommunications, postage, visas, charges & miscellaneous			1,500
6.	EQUIPMENT, MATERIAL & SUPPLIES			N/A
7.	SUBCONTRACTS			
	Fee charged for 3 weeks' training[5] at steelworks			6,720
8.	GRAND TOTAL			41,339

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[3]All figures are in US $.

[4]To cover the trainees' room & board expenses at the training site (steelworks) by subcontractor's arrangement, plus the trainees' pocket money.

[5]Based on a rate of $ 1,600 per month per trainee.

UNIDO PROJECT DP/RAF/88/072
SUBCONTRACT EXTENSION PROPOSAL
WORKSHOP ON BUILDING AND USING
COST, PRODUCTION AND FINANCIAL MODELS IN STEELWORKS

BACKGROUND

There are 23 steel mills in the various PTA countries. As confirmed by recent missions, most of them suffer acutely from poor capacity utilization and are in sore need of rehabilitation.

Lack of adequate training ranks prominent among the factors which thwart the efforts to remedy the situation. Even in the higher echelons of management, there is a pronounced lack of expertise in the areas of production and cost evaluation.

It is well recognized that a workshop which would allow the individual mill managers to properly assess their mills' situation and prospects would also be a valuable asset to the PTA, the respective Governments, and UNIDO in their efforts to upgrade, update, and put on a comparable basis their policies for the steelmaking industry.

OBJECTIVES

A workshop on building and using corporate models in steelworks is, therefore, a logical extension to the UNIDO technical assistance projects. This is a workshop which the Subcontractor will organize by arrangement with W. S. Atkins Management Consultants, England.

The workshop will assemble a multi-disciplinary group of senior steel mill managers for the purpose of undertaking corporate planning within their respective companies.

The major results include:

1. Senior professionals representing a cross-section of the steelmaking industry of the PTA subregion, well trained in the use of World Bank approved cost, production, and financial models as applied to their own steelworks.

2. Comparative evaluation by Subcontractor of the performance characteristics of the PTA steel mills covered within this project, done using World Bank approved corporate models in steelworks.

3. Data required to formulate updated, realistic, and concerted rehabilitation plans for the steel mills of the subregion.

4. Model software made available, on a permanent basis, to PTA steel mills.

5. Hence, amplification of the benefits derived from modeling due to multiple use of the models on site (i.e., in the PTA subregion) to examine all production, cost, and financial variants, and to potential use of these models by UNIDO as applied to other mills within future projects[6].

ACTIVITIES

The Subcontractor shall

negotiate the detailed program and organization of the workshop, provide necessary background on the project area steel mills, and cooperate with Consultant in setting up the workshop;

communicate the workshop content and structure to UNIDO and the Governments of the respective PTA countries[7], for them to be able to nominate the right personnel to attend[8];

organize the participants' subsistence and logistics, incl. an excursion to a British steel mill;

actively interact with the participants from PTA countries throughout the workshop[9];

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[6]Being more specifically tailored to suit the needs of the metallurgical industries, this production-cost-financial model compares favorably with the COMFAR model.

[7]Kenya, Mauritius, Mozambique, Tanzania, and Zimbabwe.

[8]The candidates should be senior management; should have fairly good English (Mozambique); and should not come from one single metallurgical or managerial discipline; a multi-disciplinary group is expected to achieve optimum results in the workshop.

[9]Participants from the PTA countries will mainly concentrate on the production model and on their own steel mills. Subcontractor will mainly concentrate on the full corporate model and on comparative evaluation.

record all workshop information and evaluate the project area steel mills' performances using the production-cost-financial combination model;

prepare a report for UNIDO covering the results of the workshop.

OUTLINE OF THE WORKSHOP

Timing: late in 1990
Venue: Epsom, England
Duration: 6 days (excl. travel)

The workshop will be held on the Consultant's premises and will last for six consecutive days. It will be fairly intensive and will include some evening work. The staff involved will have extensive experience in developing and using corporate models of steelworks.

The workshop will allow the participants to acquire an understanding on how to use a suite of computer models which have been designed to study the various issues involved in corporate planning:

* the Cost Model allows one to understand the existing cost structure of the company, hence its ability to compete with other producers;
* the Production Model allows one to make sensible projections of production, and the associated costs and revenues, given different investment plans;
* and the Financial Model allows one to estimate the future financial performance of the company and to experiment with different funding scenarios.

As mentioned above, the Subcontractor shall undertake all activities relating to the organization of the workshop.

The participants will form a single, multi-disciplinary team during the workshop. At the same time, the managers from the PTA countries[10] will concentrate on models of their own steel mills, while the Subcontractor (incl. UNIDO/IO/T/MET staff as may be required) will pay more attention to general issues of building these corporate models of steelworks, in order to undertake an in-depth comparative analysis of the project area steel mills.

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[10]One participant per steel mill from all mills covered by the project (i.e., seven participants including one from ZISCO).

Thus, the workshop participants will eventually represent the nucleus of a balanced group of professionals capable of taking responsibility for future planning and evaluation activities.

One or two UNIDO staff members, preferably from IO/T/MET, are invited to take part in the workshop, at no extra charge to Subcontractor.

SUBCONTRACT EXTENSION COST PROPOSAL ANALYSIS[11]

				Cost per m/m	Total cost
1.	PROFESSIONAL SERVICES	Position/title	Man/months		
	A.	Project area			
		team leader	0.7	2,990	2,093
		Total project area	0.7		2,093
	B.	Home office no charge			N/A
2.	SUBSISTENCE				
	A.	Project area			
		England: 21 man/days @ 190			3,990
	B.	Briefing/debriefing			
		Austria: 2 man/days @ 129			258
	C.	Other			
		England: 49 man/days (7 trainees) @ 190[12]			9,310
		Total subsistence			13,558
3.	TRAVEL & TRANSPORTATION				
	air fares as follows:				
		1 air fare MPM-LON-MPM		@ 2150	2,150
		1 air fare DAR-LON-DAR		@ 1900	1,900
		1 air fare MBA-NBO-LON-NBO-MBA		@ 1400	1,400
		1 air fare TGT-DAR-LON-DAR-TGT		@ 2000	2,000
		1 air fare HRE-LON-HRE		@ 2100	2,100
		2 air fares MRU-LON-MRU		@ 2550	5,100
		1 air fare PRG-LON-PRG		@ 850	850
		2 air fares PRG-VIE-PRG		@ 350	700
	transportation within England				800
	Total travel & transportation				17,000
4.	REPORTS				500
5.	OTHER DIRECT COSTS				
	telecommunications, postage, visas, charges etc.				700
6.	EQUIPMENT, MATERIAL & SUPPLIES				N/A
7.	CONSULTANT'S FEE[13]				14,636
8.	GRAND TOTAL				48,487

[11]All figures are in US $.

[12]To cover the participants' room & board expenses and pocket money.

[13]A staff member of UNIDO/IO/T/MET is invited to attend the workshop together with the PTA participants, at no extra charge.

FOLLOW-UP TO UNIDO PROJECT DP/RAF/88/072

INTERNATIONAL WORKSHOP ON THE REHABILITATION OF STEEL MILLS IN PTA COUNTRIES

Draft IDDA Project

BACKGROUND

There are 23 steel mills in the subregion. As confirmed by recent missions, most of them suffer acutely from poor capacity utilization and are in sore need of rehabilitation. Isolated efforts to enhance capacity utilization were often fruitless and rehabilitation plans face difficulties at implementation. Rehabilitation is also thwarted by the general condition of the national economies involved and by the shortage of foreign exchange, making it increasingly necessary to rely on foreign aid. The optimal rehabilitation technologies are yet to be defined.

The principal issues that need to be addressed jointly include mill rehabilitation, upgrading of technology, maintenance of equipment, and subregional cooperation within the steelmaking industry. The importance of the last-mentioned item calls for closer company-to-company as well as personal contacts at the executive level, but also at the technological level.

OBJECTIVE

Generation of data and links required for the formulation of updated, realistic, and concerted rehabilitation plans for the steel industry of the subregion.

All this information is needed by PTA and by individual Governments to update and, if necessary, reformulate their policies for the steelmaking industry.

ACTIVITIES

For the purpose of coordination, enhancement, and rationalization of steel plant rehabilitation efforts of the PTA subregion, organize and hold an international workshop where issues of steel mill revamping rehabilitation, and modernization are discussed informally between the countries of the subregion where steel mills are operated (possibly, with participation by potential donor countries) with a view to increasing the capacity utilization of the mills and to making the subregion more self-reliant in the area of the steel industry which is of crucial importance to the national economies of the countries involved.

The CTA shall work in closest cooperation with the Metallurgical Industries Branch and all other concerned units of UNIDO and, specifically, shall

1. define tentative agenda for the workshop and draft a CALL FOR PAPERS document

2. consult agenda, participation, and details with
   - the regional secretariat (PTA)
   - with Governments of the nine countries of the subregion where steel mills are operated
   - possibly, with Governments of potential donor countries
   - possibly, with individual experts specializing in the issues outlined above

3. collect papers for the workshop from nominated participants

4. finalize conference agenda and venue and help organize conference-related logistics

5. supervise a conference secretariat during the conference

6. prepare and edit a Volume of Proceedings.

OUTLINE OF WORKSHOP

Timing: late 1990/early 1991

Venue: island of Mauritius

Duration: 4-day conference (excl. travel)

Representation:
1. PTA Secretariat
2. countries of the subregion which qualify for assistance
   Angola, Ethiopia, Kenya, Madagascar, Mauritius, Mozambique, Tanzania, Uganda, Zimbabwe
3. possibly, potential donor countries
4. metallurgical expert(s) of the UNIDO
5. UNDP

JOB DESCRIPTION

Post number:	11-01
Post title:	Chief Technical Advisor
Duration of service:	2 months
Purpose of project activity:	To provide management and expert advice on issues of steel plant rehabilitation in the PTA subregion

Duties:

The expert will work as CTA specialized in metallurgical engineering, and will be expected to convene, coordinate, and supervise an International Workshop on the technology and methods of rehabilitation of steel mills.

Qualifications:

Project Manager in capacity of Chief Technical Advisor, with advanced academic background and extensive experience in the field of project preparation, management, and appraisal. Acquaintance with local conditions at the steel mills of the PTA is an asset.

INTERNATIONAL WORKSHOP
ON THE REHABILITATION OF STEEL MILLS IN PTA COUNTRIES

Draft IDDA Project

Project budget sheet[14]

B.L	Description	m/m	TOTAL @	US$
11.	INTERNATIONAL EXPERTS			
	11-01 CTA	2.0	9,500	19,000
	11-02 Secretary	2.0	1,100	2,200
SUB-TOTAL	INTERNATIONAL EXPERTS	4		21,200
	15-00 UNIDO staff mission	0.8		10,000
TOTAL	PERSONNEL COMPONENT	4.8		31,200
21.	SUBCONTRACT (workshop facility: Proceedings)			2,000
30.	TRAINING (participants from 10 countries)			14,000
40.	EQUIPMENT			none
50.	MISCELLANEOUS			
	50-00 Office equipment and consumables			1,500
	telecommunications, visas, charges			500
	local transportation			500
TOTAL	MISCELLANEOUS			2,500
PROJECT TOTAL				49,700

[14] All figures are in US $.

FOLLOW-UP TO UNIDO PROJECT DP/RAF/88/072

SUBREGIONAL STEEL PLANT EXCHANGE PROGRAM

Draft TCDC Project

BACKGROUND

There are 23 steel plants in the countries of the PTA subregion. With the only exception represented by ZISCO of Zimbabwe, these are small steel mills and/or rolling mills where production is focused onto reinforcement bars for concrete.

As confirmed by recent UNIDO and other missions, these steel plants, while essential similar to one another as concerns their production range and orientation, attain significantly different results in their production efficiency and effectiveness.

This is governed mainly by their capacity utilization and by the condition of their equipment. It has been ascertained that poor capacity utilization figures must be ascribed not to shortages of raw materials and energy alone but also, to an inferior condition of the production equipment and installations where frequent breakdowns are a constant plague and where inadequate maintenance [illegible] are sometimes employed.

Surveys have shown that in the steelmaking industry within the PTA subregion, there is practically no partnership oriented cooperation which would be based on the principle of exchange of experience.

Recognizing that considerable experience can be gained through personal contacts among professionals of similar orientation and having ascertained that each of the steel plants visited under the project DP/RAF/88/072 has something at least to offer which [illegible] known at the other plants in the way of technology, operation, and/or organization, a subregional exchange program for steel plant managers and operators is proposed. Advantage is taken of the fact that in this specific case of the PTA subregion, such an approach represents a rapid, effective. and low-cost method of upgrading the skills of steel plant personnel. As an TCDC project, the proposed exchange program should become a significant contribution to the South-South cooperation.

[illegible]

... [illegible] adopted and the technologies employed in the [illegible] management systems aimed at a better utilization of [illegible] equipment and the production capacity are of the [illegible] importance to any steel plant. This is why short-term [illegible] and consultation stays of executive personnel in [illegible] selected counterpart steel plants of the subregion are [illegible] principal objective of this technical exchange program.

[illegible] of this program is to be implemented under the guidance [illegible] with the assistance of UNIDO. Eventually, this activity [illegible] however develop into a permanent or rather, periodic [illegible] scheme administered and financed by the steel plants [illegible].

[illegible] outputs include:

[illegible] trained steel plant executives and managers/ [illegible].

[illegible] of direct personal contacts among the [illegible] staff of the steel plants upon which any effective and [illegible] technical, economic, and trade cooperation is [illegible].

[illegible] operating and maintenance practice based on [illegible] plant-to-plant assistance in selected areas of [illegible], technology, and maintenance.

[illegible], unified, and/or mutually better understood [illegible] guidelines and organization as employed in steel melting [illegible] and rolling mills.

[illegible]

[illegible] experts shall

[illegible] the basis of experience from the steel plants of the [illegible], set up the plan for the training program so as to [illegible] maximum benefit for each trainee (participant in the [illegible]

[illegible] prepare the schedules for the exchange program through negotiations with PTA Secretariat and the participating Governments and steel plants

[illegible] supervise the exchange program.

OUTLINE OF THE EXCHANGE PROGRAM

Timing of Phase 1: late 1990/early 1991
Duration of Phase 1: 4 months.

The participating steel plants are KUSCO[15] of Kenya, ALAF[16] and SRM[17] of Tanzania, ZISCO[18] of Zimbabwe. CIFEL[19] of Mozambique, and DEBBRO[20] and Sections Rolling/Ship Breaking[21] of Mauritius.

The number of potential participants per steel plant depends on how much the specific plant has to offer to its counterpart, and how much and in what areas it can learn from the counterpart. The professions preferably involved are shop managers, maintenance managers, development managers, and/or finance/cost managers.

Within the exchange program, each of these shall be received at the agreed counterpart steel plant by his professional counterpart for one week (including travel).

The tentative plan outlined below is based on UNIDO experience from the regional project DP/RAF/88/072 "Development and Rationalization of small scale steel plants in the PTA region". The final plan and schedule shall be worked out using this tentative plan as Terms of Reference.

---

[15] Kenya United Steel Company Limited, Mombasa

[16] Aluminium Africa Limited. Steelcast Division, Dar es Salaam

[17] Steel Rolling Mills Company Limited, Tanga

[18] The Zimbabwe Iron and Steel Company Limited, Redcliff

[19] Companhia Industrial de Fundicao e Laminagem, Maputo

[20] DEBBRO International Company Limited, Port Louis

[21] SR/SB = the two sister companies Sections Rolling Ltd. and Ship Breaking & Rolling Industries, Port Louis

Tentative plan of exchange program:

S .... shop manager
M .... maintenance manager
D .... development manager
F .... finance/cost manager
row ...... sending steel plant
column ... receiving steel plant

	KUSCO	ALAF	SRM	CIFEL	ZISCO	DESBRO	SR/SB
KUSCO		S	M			F	D
ALAF	S						
SRM	S						
CIFEL			D		M		
ZISCO				M		S	
DESBRO	S						
SR/SB	S						

Note: The specifications of profession (S, M, D, and F) are recommendations only.

JOB DESCRIPTIONS

Post number: 11-01
Post title: Chief Technical Advisor
Duration of service: 1 month
Purpose of project activity: To provide management and expert advice on issues of steel plant rehabilitation in the PTA subregion

Duties:
The expert will work as CTA specialized in metallurgical engineering, and will be expected to coordinate and supervise an International Personnel Exchange Program in the technology and methods of rehabilitation of steel mills.

Qualifications:
Project Manager in capacity of Chief Technical Advisor, with extensive experience in the field of project preparation, management, and appraisal. Metallurgical engineer. Acquaintance with local conditions at the steel mills of the PTA is an asset.

Post number: 11-02
Post title: Metallurgical Maintenance and Plant Rehabilitation Expert
Duration of service: 1 month
Purpose of project activity: To provide guidance, supervision, and organizatory skills to the management of an International Exchange Program for steel plant personnel from the PTA countries

Duties:
The expert will cooperate with the CTA and will set up a system of international exchange of steel plant shop managers, maintenance managers, development managers, and finance/cost managers so as to maximize the benefits derived from exchange training. Will negotiate training schedule and contents with management of participating project area steel plants.

Qualifications:
Technical University graduate, with wide experience in metallurgical plant maintenance and rehabilitation. Acquaintance with local conditions at the steel mills of the PTA is an asset.

SUBREGIONAL STEEL PLANT EXCHANGE PROGRAM

Draft TCDC Project

Project budget sheet[22]

Buli	Description	m/m	TOTAL @	US$
15.	INTERNATIONAL EXPERTS			
	11-01 CTA	1.0	9,500	9,500
	11-02 Maintenance/ Rehab. Expert	1.0	9.500	9,500
SUB-TOTAL	INTERNATIONAL EXPERTS	2.0		19,000
	16-00 UNIDO staff mission	0.4		5,000
TOTAL	PERSONNEL COMPONENT	2.4		24,000
21.	SUBCONTRACT			none
30.	TRAINING (12 participants from 5 countries)			12,000
40.	EQUIPMENT			none
50.	MISCELLANEOUS			
	50-00 Office equipment and consumables			500
	telecommunications, visas, charges			500
	local transportation			2,500
TOTAL	MISCELLANEOUS			3,500
PROJECT TOTAL				39,500

[22] All figures are in US $.