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REPUBLIC OF MALAWI

Technical report: Market Survey of Ferrous and Non-Ferrous Foundry and Forged Products*

Prepared for the Government of Malawi
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

Based on the work of G. Lamb, marketing consultant for foundry and forged products

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Vienna

* This document has not been edited.

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EXPLANATORY NOTES

(a) Currency

- the local currency unit is the Malawi Kwacha (K)
- UN operational rate of exchange Feb 1990.. 1 US$ = 2.66K

(b) Technical Abbreviations

- SG	Spheroidal graphite iron (simple cast iron treated with magnesium to produce characteristics akin to steel)
- EOT (CRANE)	electric overhead travelling (CRANE)
- CO_2 (gas)	carbon dioxide (gas)
- OEM	original equipment Manufacturer
- tpa	tonnes per annum
- BHN	brinell hardness number
- Cu base	copper based (alloys) e.g brass, bronze

(c) Acronyms

MISCOR	Malawi Iron & Steel Corporation
MDC	Malawi Development Corporation
SUCOMA	Sugar Corporation of Malawi
BAT	British Africa Tea Estates
UTM	United Transport of Malawi
PTC	People's Trading Centre
LESCO	Lilongwe Engineering Supply Company

(d) Acknowledgements.

The Mission has benefitted greatly from preliminary information provided in the briefing discussion with the Res.Rep. Dr. K. Leitner; from talks with Dr. Paul de Roover of Animal Power Utilisation Project and from the continuous support of Mr.A. Jacob of UNIDO Industrial Consulting Service in Blantyre.

MISCOR has provided support of counterpart Mr. R. Oosthuizen and the Technical Sales Representative Mr. B.R. Kaphuka.

Dr. A. Moshe of Tanzania Food & Nutrition Centre was visiting on a separate Mission and provided contacts and background information on Tea Estates and related agricultural matters.

Transport for the extensive travelling involved was organised Mr. Kari Kohtamaki JPO.

(d) Technical terms used in Foundry & Forge Production Technology

cupola	: cylindrical vertical shaft furnace using coke fuel
ladle	: refractory lined steel vessel carrying liquid metal
floor moulding	: manual compaction of sand moulds
machine moulding	: pneumatically powered machine for compaction of sand moulds
snap-flask	: cheap machine moulding method using a hinged mould box
mould box	: (flask in USA) steel container for moulding sand
drag	: bottom half of mould
cope	: top half of mould
core	: hardened compact of sand used to form hollow castings
sprue	: canal for introducing liquid metal into the mould cavity
fettling	: (Old English meaning:to correct) All the operations which go to finishing a casting to a sufficient quality for commercial sale.
shotblast	: cleaning castings surfaces by means of bombardment with steel or hard iron shot
metal flashes	: thin fins of metal which arise accidentally when closing together cope and drag moulds
chipping	: use of special hard hammers to remove metal fins
induction furnace	: furnace having refractory vessel surrounded by a coil of copper wire such that by application of electrical current the electro-magnetic forces melt the contents of the vessel
crucible	: refractory vessel containing liquid metal
Pecking (hammer)	: a special form of chipping hammer (see above)
tramp metal	: unwanted metallic particles contained in moulding sand
knock-out	: removal of castings and sand from mould box after cooling
paddle mixer	: sand mixer using concept like ship's propellors
Izod	: mechanical test for metal to measure shock resistance
centrifugal casting	: pouring liquid metal into steel die rotating at high speed to produce superior quality cylindrical components
sweep moulding	: cheap moulding method using a single wooden board swept in a circle around a fixed axle
die casting	: pouring of liquid metal into a metal mould to achieve high accuracy
use	: pre-form for forging
log	: cylindrical cast for machining
tooling	: generic term for patterns, models, dies, jigs and fixtures.

ABSTRACT.

(a) Project Details

- Title: Marketing Consultant for Foundry and Forged Products
- Number: DP/MLW/88/11-51
- Objective: i) conduct a detailed and comprehensive market survey for MISCOR
  ii) draw up a draft Proposal for future expansion and modernisation of the Company based on the Survey.
- Duration: 2-months commencing February 1990

(b) Conclusions

The present market for cast metal products is approximately 450-tonnes p.a. cast iron, 38-tonnes p.a. brass/bronze and 35-tpa of aluminium.
An immediate additional market exists for special (SG) cast irons mainly in automotive sectors of 250-tonnes p.a., also for steel castings in heavy engineering sectors of 150-tonnes p.a. and wrought steel (forgings and rolled) of 1000-tonnes p.a.

Industry technical knowledge of materials specifications is very poor.
Heat-treatment facilities do not exist as a service.
Certain essential machine tool capacity is insufficient: for example gear cutting, dynamic balancing, internal and external splining, precision internal grinding.

De-regulation of metal scraps export is considered damaging to the National Economy: once scrap supply is exhausted alternatives will have to be imported.

(c) Recommendations

Important expansion of the Engineering Sector would result from the availability of SG iron and steel castings, leading to increased employment and import substitution.
MISCOR would be justified in investing in small-scale facilities to meet SG iron and steel castings production and the same facilities would additionally be able to manufacture - 800-tonnes p.a. steel billets for forging and rolling.

MISCOR is advised to expand its machine shop capability to increase added value. A major Training Programme will be required to raise MISCOR technical standards. A marketing strategy is proposed in the Report.
A Project Proposal for future expansion and modernisation is included

CONTENTS Page No.

INTRODUCTION

This Report has been prepared by G.C.B. Lamb on behalf of United Nations Industrial Development Organisation and specifically relates to an investigation of the extent and profile of castings and forgings demand in Malawi. It also proposes the contribution which could be made by MISCOR in meeting those demands.

MISCOR is the only exclusive ferrous and non-ferrous foundry in Malawi, and is an Associate Company of Malawi Development Corporation. Previous missions from UNIDO and SADCC have emphasised the importance of development of the foundry sector in Malawi. These Reports include:

- Project Concept, August 1986 prepared by a UNIDO Staff Member
- Industrial Advisory Services, April 1987 prepared by Adidas Jacob (SM/MLW/034/11-02)
- Project Formulation, October 1988 prepared by A.K. Mitra (DP/MLW/88/-/A/01/37).
- SADCC Study of Foundries Sector in SADCC Countries, February 1988 prepared by ADK. Project number 5604. 12. 94. 333.

The Market Survey has formed the basis of a Project Proposal for future expansion and modernisation to enable MISCOR to draw up its future corporate and development plans, and thereby support the general industrial growth of the Country

The investigation commenced following the Consultant reporting for duty in Lilongwe on 5 February 1990. The Mission duration has been 2-months.

The original objectives were directed to the assessment of the existing demand and likely future change in demand pattern for the range of castings currently manufactured by MISCOR. Further, MISCOR had proposed an expansion programme for increasingly large grey iron castings together with steel castings up to 2-tonnes weight. There was also the aim to introduce forged products into MISCOR's production plans.

Early evaluation of MISCOR's aims revealed the incompatability between existing skills and facilities,and the original concept of expansion. The skills level is particularly low in all departments, and technical control is quite insufficient to sustain an advance into large-scale castings production. Accordingly, the first recommendation of the Consultant was to entirely scale down the proposed scope. MISCOR immediately agreed to this revision.

Following preliminary assessment of Company capability and early contact with the Country situation, the Consultant proposed that SG iron castings should be introduced to the scope of future production, with the specific aim of addressing the spare parts market for transport and other vehicles, and also serve to supply light-weight fittings for animal-drawn trailers and implements.. MISCOR also agreed with this revision..

Acting on the revised Terms of Reference, it has been possible to achieve all of the objectives set down with regard to Market Assessment for cast and forged products, and it has further emerged that a major sector opportunity exists in the production of small rolled steel section, the raw material of which could be produced by MISCOR as an incidental and without prejudice to the main stream production activities of the Company. In this respect, it has been possible to expand the Scope, although still remaining within the strict interpretation of the objectives.

The extension to include rolled steel products feed stock offers the possibility of supporting the growth of small-scale industry, with particular emphasis on entrepreneural development, since it will remove the need for importation of the more commonly-used steel sections. High performance steel i.e. tool steels can also be manufactured within the revised concept, and thereby help to alleviate constraints of material quality and availability referred to by Mitra (DP/MLW/88/-/A/01/37) and promote small-scale manufacture in the rural areas of selected agricultural tools implements and equipment identified by the UNIDO staff member and referred to in the Project Concept 13 August 1986. Jacob in the Report on Industrial Advisory Services SM/MLW/034/11-02 points out that there is hardly any local industry for the manufacture of automobile spart parts in Malawi, and goes on to point out that local manufacture could prove to be an attractive prospect. The availability of indigenous raw materials of adequate quality would enable certain levels of technology to be achieved, and some part at least of the spare parts supply could be addressed.

Since identifying the prospect for simple rolled steel products, 3-potential investors have come forward to offer installation of 2-high, single-pass roll stands.

Raw material in the form of random scrap metals is freely available in the Country although the actual quantities could not be assessed. Some Manufacturers are storing metal scraps, and the amounts identified approximate 12,000-tonnes.

Other Manufacturers are exporting copper-based and aluminium scraps and there is a distinct possibility that Country supplies will be sufficiently depleted in coming years to require import of replacem ent raw materials. MISCOR's senior Management is currently active in seeking to redress this situation, in consultation with the appropriate Ministries and other Government Departments.

The pricing of castings has been causing some concern, and the Trade Tariffs applicable over the range of components within the scope of cast and forged products leaves a complex picture when attempting to determine the viability of indigenous manufacture compared with imports. The weakness of MISCOR'S cost estimating processes has made it more difficult to reach conclusions in the area.

There is evidence that Users are prepared to face a premium price for the convenience of local purchases, and the avoidance of delays in obtaining Import Licences and currency allocations.

I. PRESENT SITUATION.

A. Country Situation.

By reason of its land-locked location, transport is a major consideration in Malawi, which in turn reflects on the delivered price of imported raw materials and manufactured goods.

Most of the Companies visited manufacture at batch level production, in the case of agricultural implements, some manufacturers have longer running product lines but this is exceptional.

Outside of the engineering scope, competitive manufacture of building roofing tiles was set up for continuous high volume production, but the facilities when seen were under utilised.

(a) Product Range: the scope found during visits may be grouped as follows:

- light steel fabrication e.g. wire products, sheet metal
- agricultural tools and trailers involving forging, welded fabrication and machine shop work.
- machinery repairs and rebuilding.

(b) Engineering Approach :. Due to non-availability of replacement components, a strong sector has emerged dedicated to reclamation of worn parts by the process of metal spraying or by weld build-up. Major modifications are carried out to worn components and often other materials are substituted; generally speaking an equivalent life expectation results, with the exception that in reclaim and rebuild of certain agricultural tractors, the refurbished item is of substantially higher performance standards than the original.

A siege mentality has developed similar in engineering terms to that of UDI period in Zimbabwe and as was the case in that country, has brought out strikingly good entrepreneural skills which have resulted in enhanced Country standards

A flourishing trade now exists in metal spraying and welding of worn components which will materially affect the market for MISCOR products

(c) Constraints on Engineering Sector Expansion.

A summary of reported problems has the following profile:

(i) limited domestic market

(ii) high cost of raw materials inhibits export possibilities

(iii) shortage of certain specialised machinery:

- centreless grinding
- precision internal grinding
- gear cutting
- heat treatment
- cam shaft lobe grinding

(iv) technology- poor design capability

- poor understanding of materials application (Appendix VII)
- insufficient understanding of special techniques such as welding
- insufficient grasp of heat treatment significance

(v) skills level:

- large dependence on expatriates (usually associated with management)
- limited Malawian capability at shop floor level

(vi) education and training:

- poor match between training facilities and industry needs

(vii) indigenous raw materials availability:

- no indigenous extraction or processing of metals
- complete dependence upon recycled scrap
- no capability to produce specialised material:
  . carbon steels
  . wrought steels such as UK EN series and DIN
  . SG irons
  . abrasion-resistant steels

(d) Metal Products in Immediate Demand.

List restricted to the capability of proposed MISCOR modernisation (Appendix V) and its linkages :

(i) earth-moving ground engagement tools:

- bucket teeth
- bucket and blade corners
- front end lips
- scraper blades

(i) tractor:

- transmission spacers
- front suspension supports
- front axle beams
- hydraulic lift covers
- tool bar lifting screws (adjusters)
- wheel weights and front weights

(iii) transport:

- brake drums and brake discs
- wheel hubs
- spring hanger brackets
- steering components
- gear carriers, differential carriers
- exhaust manifolds
- water pump bodies and impellors
- pulleys

(iv) agricultural:

- plough beams and shares
- trailer running gear
- cultivator tines
- harrow discs

(v) cement:

- grinding media (balls)
- kiln liners and segments
- firebars and grate sections
- diaphragm segments

(vi) railway:

- couplers
- knuckles and knuckle pins
- bogie side frames and bolsters
- axle boxes

(vii) domestic:

- cooking stoves
- manhole covers and frames
- window frame furniture

(e) Raw Materials Availability.

In order to expand the industrial sector in Malawi, it is necessary to consider the sources and availability of raw materials.

In the absence of indigenously arising metal supplies, total reliance has to be placed on imports or local scrap from redundant or worn-out equipment and vehicles.

The forward prospect of a successful foundry operation is critically dependent on a sufficient supply of correct grade scrap material.

Whilst such scrap is obtainable, it can be re-processed profitably to supply local demand and reduce Foreign Exchange outflow.

Once local scrap material has been consumed, replacement raw materials will have to be imported. Caution is necessary since the price margin between imported raw material and new finished parts is relatively small, and could result in users preferring to purchase new parts by direct import. In such event, the local industries will decay, and may even fail, so allowing the skills and employment opportunities to be lost.

B. MISCOR Situation

MISCOR started from a complex series of events and was set up in 1983 and came to an immediate close-down. It appears that electric arc melting equipment was supplied and installed but upon the first commissioning operation produced unacceptable electrical supply problems for the city of Blantyre. That arc furnace less some critical parts which have been sold off now lies redundant in the Works yard. The Company was reopened in 1983 using simple cupola melting furnaces and imported coke as a fuel

Although the foundry building shows appropriate foundry knowledge in its size, layout and construction, it can only be supposed that there was insufficient foundry experience available at the time of reopening and subsequently. The name of MISCOR has been found to be universally associated with poor quality of raw material, dimensional accuracy and unreliable delivery.

Despite the foregoing the Company now operates at a profit.

(a) Installed Equipment: all elements of the equipment are conventional and well-known in modern practice:

(i) melting. Simple cupola furnace formerly hand charged and recently equipped with a simple home-made mechanical charger. No instrumentation.

(ii) moulding: two large machines and one small machine are of most modern design and in good condition although improperly connected to the air supply and all elements badly adjusted.

(iii) sand preparation: modern type of mill with charging devices. Generally in good condition.

(iv) coremaking: process is manual only, a form of core-drying oven is used: completely unsatisfactory, no controls.

(v) fettling : all the critical elements are broken down or not working correctly. A shotblasting unit of modern design is non-functional by reason of spare parts (which are castings and could be made in MISCOR). Grinding machines whilst being modern are not appropriate for the present class of work.

(vi) handling: One 5-ton EOT crane serves moulding and metal distribution. Two swing jib cranes are installed, by reason of wrong location and bad lifting tackle, their effectiveness is slight.

(b) Technology of Production.

(i) raw materials control:

- metallics : simple manual system, completely effective
- melting fuel : coke, imported. Company obliged to accept "as delivered
- sand : own quarry. Quality unsatisfactory
- sand binders : molasses. Used in the "as purchased" condition, bentonite and dextrin imported
- refractory : purchased locally and milled. Control satisfactory

(ii) moulding:

- mould making: very poor at all levels
- mould and core assembly: very bad, incurs high rectification charges
- handling equipment: badly conceived, badly constructed and in need of extensive maintenance

(iii) coremaking:

- all manual: resultant quality very poor
- sand control requirements not understood
- quality of compaction variable and invariably bad
- dimensional accuracy very poor
- core drying virtually out of control and most probably the origin of many blow-hole type defects.

(iv) melting:

- seriously constrained by the simple design of the furnace added to use of Zimbabwe coke which is notoriously poor. It is probable that the current procedures are the best which may be expected in the circumstances.
- selection of raw materials as part of melt could be improved:
  . rigorously separate high phosphorus material
  . discriminate between automotive returns and broken heavy machinery
  . strictly limit steel charged by avoiding chromium-bearing elements

(v) metal pouring:

- probably the weakest element in the factory. Complete absence of understanding of thermal radiation losses, heat transfer, metal and slag viscosity. Artisan skills extremely poor in metal flow control as evidenced in castings seen at Sparctacus.

(vi) fettling:

- thoroughly bad, almost out of control
- sprue knock-off hampered by bad pattern design
- shotblast machine not used therefore surface finish very poor.
- lack of definition (including complete absence) of moulded holes
- serious overgrinding
- castings delivered to customer with adhering sand (thereby causing the purchaser to carry out rectification fettling to avoid destruction of cutting tools).

(c) Overall quality of finished product

(i) function:

. generally disregarded at all stages of manufacture
. lack of feed-back via sales
. careless customer liaison in discharging technical queries
. much material wasted and consequent customer costs in removal by virtue of past MISCOR poor reputation (customers assume bad quality and add extra machining metal based on previous experience)
. almost total absence of engineering grasp of product application

(ii) appearance:

. generally poor.
. surface blisters which evidence hard spot are ignored (there should be feed-back to pattern design)
. cross joint and mis-match evident everywhere
. adhering sand lowers good appearance
. burnt-in sand (partially fused glass) not removed
. metal flashes not properly removed

(iii) dimensional accuracy:

. virtually non-existent
. some influence towards improvement as mentioned below in Item (j)

(d) Tooling, Patterns and Models

(i) design:

- overall very poor
- currently subject to upgrading programme
- core/mould relationship not understood
- castings manufacturing technology very poor
  . ingates for metal
  . slag control in gating systems
  . shrinkage compensation

(ii) quality of execution:

- surface finish poor
- accuracy of taper very poor
- failure to compensate for predictable wear areas
- absence of metal facing in wear zones
- patternmaking convenience takes priority over resultant casting quality

(iii) accuracy:

- really very poor
- failure to ally with product function
- low levels give rise to metal flashes requiring extensive fettling rectification
- corebox dimensional accuracy extremely poor

(iv) artisan skills:

- hand working operations sufficient
- use of machine tools inadequate
- attention to dimensions is not enough

(e) General Artisan Skills Foundry and Fettling.

In the broad field affecting finished product quality, the skills are insufficient, but in the judgement of UNIDO Consultant is caused by inadequate training. Contact with the workforce indicates that levels of intelligence, literacy and preparedness to learn are adequate. Hands-on training will be necessary. (Note Item (d) (iv) above)

(f) Sales and Customer Liaison

(i) appointees not technically experienced in foundry and castings production

(ii) no member of the staff has sufficient general engineering knowledge to give an adequate service to customers' needs

(iii) good and courteous relationships obtain with all customers, and MISCOR staff make serious efforts to comply with their customers' requests.

(g) Marketing.

(i) a weak element in the Company structure

(ii) unadventurous, lacking in direction

(iii) addresses customers at too low a level

(iv) no contact with local business community

(v) lack of knowledge of product function or customer downstream processes

(g) (vi) some limited serious efforts have been made to introduce new market penetration, but have not been followed up to realize the potential advantage, see Appendix VIII, H165 - 02002 and H165 - 02003.

(h) Administration.

(i) not functioning smoothly
(ii) quality consciousness lacking
(iii) costing and production cost estimating not correctly set up
(iv) management information is insufficient
(v) production planning is unrealistic

(j) Recent Trends.

(i) appointment of a new General Manager early in 1989 has produced favorable customer reaction. Frequent unsolicited references were made to better quality and improved control during past months.
(ii) a sense of supplier/customer relationship is beginning to emerge, to replace the former "market place" attitude complained of by certain former users of MISCOR products.

II. INVESTIGATION OF MARKET.

A. Methodology.

(a) Visits were made to 70 Organisations and Companies in Malawi.

(i) Programme of visits was based on information from:

- UNDP Staff members
- various official reports
- MISCOR
- Government of Malawi Development Programme 1987/91
- Government of Malawi Statement of Development Policies 1987/96
- local business contacts

(ii) Visit activities included:

- simple discussion
- detailed inspection and study of Company activities
- analysis of stores and materials stocks.

(b) Distribution of Visits by Organisational Category:

- Central Government bodies:	10
- Municipal Administration:	3
- District Supply Services	5
- Foreign Embassies	3
- Manufacturers	21
- Agricultural Producers	9
- Traders	13

Some visits to Organisations were repeated when new perspectives emerged in order to further explore the basis of data obtained.

(c) Geographical Distribution of Visits by area:

- Mzuzu	5
- Kasungu	5
- Lilongwe	19
- Blantyre and Limbe	21
- Zomba	2
- Thyolo and Mulanje	9
- Nchalo	3

(d) Official Statistics.

The data at the Statistical Department has been studied. It gives an adequate explanation of the number and types of vehicles and confirms the very wide Country proliferation of passenger and transport vehicles.

It is not possible to apply these statistics to establish market size relating to MISCOR'S production range because of the high level of salvage practised by repairers. This takes the form of machining oversize components such as brake drums and then fitting oversize brake shoes or, where appropriate,the metal spraying to build up the surfaces after wear.

From MISCOR'S standpoint, the vehicle proliferation has further hidden problems: where a vehicle type is recorded, statistics from about 1984 cover the population but do not specify the Mark. Some vehicles have undergone 3-styling changed during the period, but these have included a conversion from cast iron cylinder block to aluminium cylinder block, and from pulley driven fans to electric fans.

Having regard to the foregoing, it is the actual situation on the ground which has to be addressed in assessing the market in respect of MISCOR's share.

(e) Visits to Manufacturers.

The response varied widely:

(i) full collaboration where previous purchasing records were made available for analysis by the Consultant

(ii) refusal to respond or to allow an inspection of products.

Judgement was necessary in certain cases in order to asses the likely inputs and outputs.

III. PRESENT MARKET SIZE.

A. General Position.

No clear indications emerged to permit precise market size to be stated.

Many engineering organisations did not know enough about the nature of materials involved and questions as to material specifications were often negatively answered, and it became necessary to discuss particular components in order to assess the actual use.

Components are frequently converted into an alternative material or alternative manufacturing methods when supply problems arise. Sensitivity to cost variations was generally very low, so that few materials were chosen on the basis of manufacturing economy, and most usually were based on supplying the immediate market demand.

B. Castings Manufacturers.

(a) MISCOR is the only independent ferrous and non-ferrous foundry in the Country.

(b) Foundry & Engineering Limited were the only other ferrous founders identified. This Works claims to be the oldest foundry in Malawi and is a captive unit engaged in the manufacture of components for maize milling machines. The foundry also produces necessary bearing bushes in brass and bronze. Malawi Railway has a tied foundry.

(c) Aluminium Casters.

The Mission identified a number of producers, some of whom were not known to MISCOR, but which it transpires have successfully eroded MISCOR'S market.

(i) Tools & Dies Engineering Limited started up about 2-years ago as contract toolmakers to the Trade, and in April 1988 commenced diversification into aluminium die casting manufacture. The Company has made rapid strides, particularly in the field of charcoal smoothing irons, washbasin support brackets and cooking pots.

(ii) Agason Motors are general traders who commenced aluminium manufacture round about March 1988 because of the difficulty in obtaining good quality machining stock from MISCOR. The investigation showed that they are now the biggest manufacturer in Malawi of aluminium "logs" (Trade term for stock cylindrical pieces).

(iii) MISCOR produces a range of aluminium "logs" and shaped castings, and has declined from the only producer up to about 1988 to a minor supplier at the present time. Large or complex aluminium castings may still only be supplied locally from MISCOR.

(d) Copper-based Alloy Casters.

The term embraces brass and bronze, also leaded bronze, all of which are alloys of copper, having zinc, tin or lead in varying proportions.

(i) Argasan has emerged as the largest brass caster identified, a position which has been achieved since entering this alloy market in mid 1988. The products are limited to brass solid and hollow bar, the quality is very high indeed.

(ii) Petroleum Services produces brass on bronze bar, also shaped castings, and is currently the largest regular producer of brass castings.

(iii) MISCOR produces all of the alloys in copper in the form of bar and shaped castings, and is the only producer of large or highly-complex castings within the range. MISCOR, however, is now a minor producer.

C. Forgings Manufacturers.

Forgings fall into two categories, open die and closed die respectively. Open die is a form of hammering with a power press, and produces only general rough shapes. Closed die produces finished shapes which may or may not require subsequent machining.

(i) Agrimal is a Company with extensive captive capability and is not known to offer a contract service to the Trade outside of their range of agricultural and hand tools.

(ii) Petroleum Services has contract open die (hammer) capacity which is offered to the Trade.

(iii) No other manufacturer of forged products has been identified.

D. Present Volume Identified.

With the exception of a small number of major Users of iron castings, it is not easy to identify all Users of cast products, so that it is necessary to assess the manufacturers' volumes as a means to estimate the current market.

(a) Ferrous Castings Production.

Is currently limited to grey iron corresponding to BSS 1452 grades 12, 14 and 17.

(i) MISCOR 1989 output	: 306-tonnes
(ii) Foundry & Engineering Ltd (estimated)	: 120-tonnes
(iii) Railway	: 30-tonnes

(b) Aluminium Castings & Logs Production.

(i) Tools & Dies Engineering	: 12-tonnes (rapidly rising)
(ii) Argasan Motors (logs only)	: 12-tonnes
(iii) MISCOR	: 11-tonnes

(c) Copper-based Alloy Production

(i) Petroleum Services (estimated)	: 20-tonnes
(ii) Agasan Motors	: 12-tonnes
(iii) MISCOR	: 6-tonnes

E. Observations on Current Technology.

The acceptability of castings of all types across the broad spectrum of manufacturers visited is quite low. The bad image of casting stems from a history of poor dimensional quality and indeterminate metallurgical quality.

In the case of cast iron the problem often relate to the temperature of pouring the liquid metal because metal which is cast at too low a temperature will be hard (up to 800 BHN) and therefore unmachinable. On the other hand the iron may be melted from carelessly chosen raw material including scrap drain pipes and gutters which, being a high phosphorous material will cause leaking from a component intended to carry liquids. These faults and many others of a similar nature mean that users of casting have in the past been disappointed by the quality and serviceability of the offered product.

Similar problems are found in aluminium alloys due to lack of technical understanding on the part of secondary metals (scrap) collectors or merchants. Frequently the only criterion is the colour of the metal so that aluminium, zinc and proprietary alloys used in automotive construction (Mazak) will be mixed together with disastrous results for strength and machinability. Such experiences bring the notion of casting into disrepute.

F. Current Trends in Malawi

(a) Ferrous Production

Declining standards from MISCOR are steadily bringing local production into disrepute and a number of users have informed the consultant (sometimes in writing) of their intention to discontinue purchases from MISCOR. Foundry & Engineering have intimated that they are now commencing production of iron castings for the Trade.

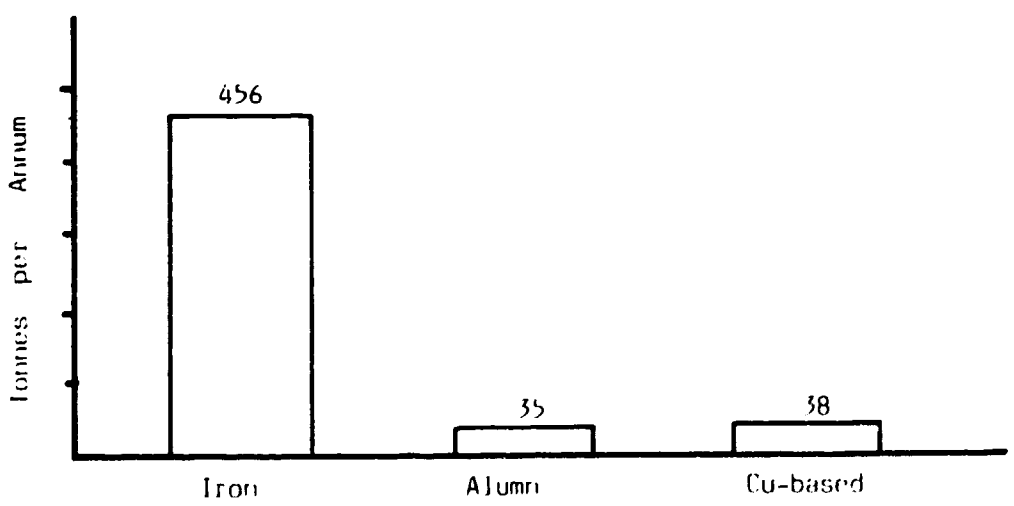
(b) Aluminium Castings

Agason Motors has recently employed an expatriate metullurgist and proposes a large expansion in both aluminium and brass "logs" production. Tools & Dies is currently expanding their die casting capability.

(c) Copper-bassed Alloys.

Petroleum Services have informed of their intention to expand in production of shaped castings. As mentioned before Agason Motors is proposing a production expansion.

G. Indication of Present Market.



IV FORECAST MARKET SIZE

A. Official Policies.

The Malawi Government Statement of Development Policies 1987 - 96 published by Dept. of Economic Planning & Development indicates a reasonably stable position for the share of manufacturing as a proportion of GDP. There is an indicated variation ranging only from 12.1% in 1987 through 11.9% in 1991 and a forecast 12% in 1996. This however, is carried on the basic surmise of an expected rise in GDP which predicts a manufacturing out turn from KM 285.7 in year 1986 to KM 413 in year. 1996

In real terms these preditions imply a growth rate of 3.9% per annum through the period 1987 - 96 and may be expected, if realised, to indicate an increase in manufacturing activity of 41%.

A concerted effort is being made to improve the teaching of technology in Technical Institutions, Secondary Schools and at the artisan level. Numerous Aid Agencies are contributing for example UNDP in promoting scholarships for Secondary education and ILO participation in enhancement of craft skills. It seems, therefore, that some effort is being made to address the need for skilled technicians and artisans to match the predicted industrial expansion.

B. Influence of Transport.

Major public expenditure frequently associated with bi-lateral agreements is now being directed to improvement of communications for which there are two major thrusts designed to reduce the problems of Malawi's land-locked communications:

- opening of a Northern Corridor to link with the TANZAN railway link to Dar-es-Salaam.
- re-opening of the Nacala railway

There will be major increase in the heavy truck population which in turn will produce a demand for spares, and EEC funding is being applied to the purchase of 30-articulated trucks to expand the domestic capacity previously carried by rail.

The UTM Transport Company which operates passenger buses and coaches has scheduled an increase of its present fleet of 250-heavy vehicles to a figure of over 350-vehicles by June 1990 with corresponding prospects for spares.

An existing concrete railways sleeper plant at Selima was recently reactivated and is now operational, and a prospect of introducing the pandrol method of rail securing could be a further source of expansion. A project is under consideration for refurbishment of 180-railway goods wagons, together with passenger coaches and vans, and this in turn should yield scope for steel castings.

C. Influence of Water Resources Upgrading.

A number of water improvement programmes are at various stages of completion, and carry a significant proportion of asbestos cement pipes which in turn yield a market for cast iron collars and sockets. Exhaustive enquiries have been made from major City Water Boards and pursued through Project & Implementation Offices to confirm that the asbestos cement pipe will retain its market share against the expanding use of plastics and polymers. It seems that the asbestos pipe continues to be well-favoured and has an extensive future.

Irrigation is being expanded in many fields of agriculture and likely to be accelerated on account of recent droughts. Aluminium valves are preferred and the butterfly type seems to be commanding an increasing proportion of the market, thereby offering substantial new business for the metalworking industry.

Village level hand water pumps feature quite large in projects for rural development, and there is a detectable strong demand for power pumps involving both iron and bronze components.

Various Authorities contacted consider there to be a modest demand for small-scale hydro power units, but the Mission was quite unable to identify any firm indication of practical implementation.

D. Water-borne Transport.

The Mission has failed to identify any substantial public or private development in water-borne transport or leisure activities which is likely to attract significant commercial interest.

E. Electrical Power Transmission.

A project for 132KV power line between Nkula- Limbe was identified but this would not normally provide significant work for the scope of metalworking activity in Malawi. If SG iron insulator caps were considered there could be a prospect.

F. Confidence in Local Market.

In order to forecast the likely market size, it is important to consider the degree to which castings will be acceptable to prospective local Users. In the course of investigations, the Consultant was made aware of strong opposition to local products based on past experience. There are two components to this namely faulty materials and faulty application. (see Appendix VII)

User confidence in grey iron, aluminium and copper-based alloys from MISCOR is shaken, so that other have emerged to take over certain of the market share, but it still leaves MISCOR as the only significant supplier of iron castings to the Trade.

Aside from the considerations of MISCOR, many Users have changed their product specifications to steel, or even to import, and there may be a delay in persuading the market as to the acceptability of the local product even after the necessary improvements in quality have been established.

It must not be expected that transport safety-critical items will be purchased from the local market until satisfactory performance has been demonstrated for a number of years.

A specific instance has been identified where a major manufacturer has stated that approximately 300-tonnes per year of potential iron castings market has been converted to steel fabrication.

G. Estimate of Underlying Scope for Cast & Forged Products.

Based on the investigations carried out during the Mission, consultations with existing and potential Users and a survey of existing manufacturers, the following scope is apparent:

- grey iron castings current production is about 450-tpa and specific opportunities for a further nominal 300-tpa have been identified. Total 750-tpa
- special irons particularly SG to serve the motor trade spares will aggregate approximately 250-tpa and will rise as the unique performance of the material is appreciated.
- steel castings which are particularly appropriate in earth-moving equipment will find an immediate outlet of 50-tpa and quickly expand as potential Users become aware of the local capacity. A market of 150-tpa is expected.
- aluminium is steadily expanding and currently achieving 40-tpa and upon establishment of satisfactory quality will achieve 80-tpa.
- copper-based alloys are currently achieving 45-tpa and the potential including pump casings and impellors is considered to be 70-tpa.

(b) There is no significant forging in the general market. The Agrimal operation is regarded as an in-house manufacturing arrangement and the free market demand is considered to be about 20-tpa. This figure could increase once Insurers of Malawi Railways could be satisfied as to the quality and reliability of indigenous manufactures.

H. Forecast Market Allocated by Sector.

	Grey iron	SG iron	Steel castings	Aluminium	Copper based	Steel forging	Tin solder
Textile	-	5	-	20	-	-	-
Automotive	100	115	20	20	3	6	
General Engineering	420	60	5	10	25	2	2
Replacements	65	10	10	5	8	2	-
Agricultural incl tractors	40	30	10	-	15	4	
Electrical	5	-	-	-	2	-	1
Railways	30	5	25	3	2	2	
Earthmoving	-	15	80	-	-	4	
Municipal	70	10	-	2	-	-	-
Domestic	20	-	-	20	15	-	1

V MISCOR STATUS

A. MISCOR Image in the Market Place.

(a) Only one User expressed satisfaction with MISCOR castings, no doubt on account of the fact that his requirements were metal quality only. MISCOR certainly has achieved an internationally acceptable metallurgical standard during the past year. There is universal condemnation of MISCOR quality and this is mainly associated with three features:
- unreliability of the metallurgical standards
- gross casting internal defects due to absence of quality control
- poor dimensional accuracy and bad appearance.

(b) Sales and customer liaison is not strong enough to accurately report the customer problems. Absence of a machineshop capability deprives MISCOR of the in-house opportunity to monitor certain defects.

B. Security of MISCOR Present Market Share.

(a) The poor quality noted above has allowed the introduction to the market of competition all of which is self-taught. Without exception the competitive product is entirely superior in quality to MISCOR and is sold at lower prices. So far this encroachment has been limited to the non-ferrous materials; but there is a serious prospect that Foundry & Engineering with a well-established foundry operation and a large machine shop will penetrate MISCOR grey iron production.

(b) Specific items lost by MISCOR to competition:
- domestic aluminium smoothing irons
- aluminium smoothing iron sole plates
- basin brackets
- aluminium "logs" of all sizes
- bronze bar and stick and hollow bar
- brass bar and stick

(c) Component material changes :
- generally throughout developing countries manhole covers are now produced in concrete because of the problem of theft of the heavy cast iron pieces which are broken up and sold by the thieves as scrap iron.

  This condition already obtains in Malawi and is the subject of discussion between Blantyre Municipal Council and MISCOR. The overall profitability of MISCOR is considered by the executives to depend heavily upon manhole covers.

(d) Competitiveness .

- Certain stable lines in the MISCOR range are being sold only to Government bodies or their Operating Agencies, particularly:
  (i) domestic cooking stoves (Dover No. 6. and No. 8.)
  (ii) Post Office manhole covers (heavy duty road type)

These two items are regularly produced and sold at prices which are higher than the competition, and therefore represent a hidden form of subsidy. There is a danger that another manufacturer may enter the market at more competitive prices, or that Government purchasing policy giving preference to local manufacture may be varied at some future time.

(e) Forward Orders.

In pursuance of investigations into costing, production cost estimating and management information (referred to on Page 16) it was discovered that forward orders as at 20th March 1990 represented approximately 4-weeks work at the budgeted rate..

(f) Order Completion.

In spite of the poor forward position outlined in (e) above, the Consultant's investigation showed certain numbers of outstanding orders uncompleted and apparently without a documented position. In the course of visits to MISCOR customers, complaints along these lines had been made, and it was not possible to discover an internal MISCOR mechanism to monitor outstanding or delayed deliveries.

It is necessary that this situation be redressed before MISCOR contemplates expanded output into more demanding markets such as automotive production and steel products.

VI CONCLUSIONS.

1. There is an existing market for castings: grey iron 450-tpa; aluminium 35-tpa; copper-based 38-tpa.
2. There is no call for castings over 500-Kg mass
3. MISCOR is losing market share due to poor quality and the share being retained is de-grading into low quality cheap products
4. MISCOR is losing added value by not machining castings.
5. There is an unserved demand for SG iron for automotive use
6. From investigations there is a forward market : grey iron 750-tpa; SG iron 250-tpa; steel castings 150-tpa; steel forgings 20-tpa; aluminium 80-tpa; Cu-based 70-tpa.
7. Lack of some manufacturing facilities is inhibiting market expansion e.g. heat-treatment and certain specialist machining operations.
8. De-regulation of scrap exports places in jeopardy the supply of secondary metals relied upon in Malawi as raw materials in foundry.
9. Management information at MISCOR is not sufficient to enable analysis to be made of Company performance and current position.
10. MISCOR is benefiting from the hidden subsidy of higher-than-market place prices paid by Government Departments for indigenous manufactures of cooking stoves and street furniture.
11. Business is being lost to MISCOR due to ineffective sales and marketing stemming largely from lack of materials knowledge and application.
12. Extensive training is necessary in most Departments of MISCOR.
13. There is not enough market in iron castings to support a modernization programme.
14. Diversification is essential to support any programme of modernization and expansion, and should include SG iron and steel castings.
15. After steel manufacturing capability is established the facility could be used to supply billets and pre-forms for rolled and forged products
16. The immediate market for simple small size (76mm downwards) rolled steel sections is estimated at 1000-tpa and the potential is about 3000-tpa.

VII. RECOMMENDATIONS TO MISCOR.

A. Operational Upgrading.

1. Immediately commence machining of castings offered for sale.
2. Change Management structure to overcome poor product quality.
3. Concentrate technical resources on the raw materials of moulding and coremaking.
4. Bring shotblast machine into use to improve surface finish quality in order to enhance customer appeal. (Improve Quality Control is a spin-off).
5. Seek consultant assistance to instal management information and control systems
6. Devise and instal an effective costing system (could be included in .5. above)
7. Upgrade the mechanical status of existing foundry shop EOT crane and complete erection of second EOT crane to increase output.
8. Appoint an experienced and fully qualified patternmaking specialist.
9. Establish a formal Quality Control and Inspection Department to give permanent effect to the urgent measures 2., 3., and 4. above.

B. Modernization.

10. Consider a modernization programme along the lines of Appendix V the principal feature of which is to maximise existing assets.
11. Set up necessary training courses, Fellowships etc., to support the modernized methods.
12. Appoint a metallurgical Graduate to take over control of the more advanced melting, also a mechanical engineering Graduate in the capacity of Development Engineer to provide a combined service to maintenance and Sales.
13. Embark on a co-ordinated Sales and Marketing upgrading programme using the in-house capabilities of the new Graduate appointments.

C. Marketing Strategy.

14. Improve standard of iron castings as an emergency programme.
15. Only sell machined brass, bronze and aluminium bars and sticks.
16. Consider items under .15. above as a secondary consideration and instead concentrate on complex bronze pump casings and impellors to establish MISCOR up-market image.
17. Encourage field trials as a means to re-introduce MISCOR products into lost markets and effectively monitor progress.
18. Maximise concentration on vehicle spares particularly UTM and the military.
19. Following introduction of electric melting, construct a campaign directed towards two principal fields:
    - SG iron in automotive transmission components
    - steel castings for ground engagement tools (earth moving equipment)
20. Commence a programme of Seminars and advertisement to bring to the notice of the trade in general the important advantages of SG iron.
21. Introduce and advertise a heat-treatment service relating to MISCOR products and offer a Contract heat-treatment service to the Trade.
22. Progressively investigate the practicability of collaborating with an Investor for setting up steel rolling facilities. Commence casting steel billets to supply the Investor requirements.
23. Investigate practicability of offering cast preforms to Agrimal for forging.

APPENDIX I. Job Description.

Post Number : DP/MLW/88/018/11-51

Post Title : Marketing Consultant for Foundry and Forged Products

Duration : 2-months

Duty Station : Blantyre, Malawi with travel within the country

Purpose of Project : Conduct a detailed and comprehensive market survey for Messrs Malawi Iron and Steel Corporation (MISCOR) Limited, Blantyre, for Grey Iron, Non-ferrous, Aluminium and Steel castings in Malawi.

Draw up a draft project proposal for future expansion and modernisation for the company based on the above market survey and in co-operation with the General manager and other concerned people at the MISCOR factory.

Duties : In conjunction with MISCOR the Consultant will:

1. Make himself conversant with present production capabilities and capacities of MISCOR.

2. Become familiar with the production capabilities and capacities available for foundry and forging work in the country and the neighbouring region.

3. Assess demand in Malawi for:
   - grey iron castings up to 3-tons
   - non-ferrous castings up to 120-Kg
   - aluminium castings up to 60Kg
   - steel castings up to 2-tons
   - demand profile for general industrial forged products

4. Analyse and recommend:
   - product yields and costs
   - raw materials
   - sector allocations
   - pricing policies and market promotion.

5. Draw up a Project Proposal for future expansion and modernisation for the Company.

APPENDIX II. Senior Staff.

1. UNIDO Staff.

Dr. Kerstin Leitner	Resident Representative	Lilongwe
Ms Cheryl Ann Hairston	Administrative Officer	Lilongwe
Mr Kari Kohtamaki	JPO	Lilongwe
Mr Adidas Jacob	Chief Technical Adviser.	Blantyre

2. Counterpart Staff

R. Oosthuizen	General Manager	MISCOR
C.G. Chipinda Phiri	Company Secretary	MISCOR
L.B. Sayenda	Factory Manager	MISCOR
B.R. Kaphuka	Technical Sales Rep.	MISCOR

3. UNIDO Contributing Staff

Paul S. De Roover	Chief Technical Adviser to Animal Power Utilisation Project Lilongwe
Dr. Alex C. Mosha	Tanzania Food & Nutrition Centre (UNDP Expert on MIssion)

4. MDC Counterpart Staff

Kingsley N. Kalonda	Senior Technical Consultant Industrial Consultancy Services Blantyre

APPENDIX III TRAINING PROGRAMME.

1. Assessment of Needs.

1.1. Overall position

With the possible exception of administrative financial staff, the levels of training and performance in every department, and at every level, will need to be reinforced in order to sustain the projected modernization programme.

1.2. Bias of skills.

The Modernization Plan will shift the emphasis of skills away from hand-moulding and coremaking by introducing superior equipment and tooling. Consequently tooling-related skills of construction and application assume more significance.

1.3. Quality.

Traditional foundry work methods place most of the responsibility for quality on the skilled worker, whereas more modern concepts introduce quality achievement into the supervisory grades. Training in quality-consciousness is necessary.

1.4. Technology of Production.

A great emphasis will have to be laid on the upgrading of technological standards.

1.5. Equipment and Machining Maintenance

Fundamental instruction will be required in all elements of machinery operation, planned maintenance, store-keeping procedures, budgeting and supervisory responsibilities.

1.6. Production Control and Planning.

Fundamental training will be required for:

- the elements, tools, implementation and practice.

1.7. Costing.

The altered production methods will create a need for complete revision of procedures.

2. Recruitment of Specialists.

2.1. Some necessary special skills are not represented in the existing staff complement, principally:

- metallurgy
- mechanical engineering design
- patternmaking technology

2.2. By recruitment of the skills in 2.1. above a valuable part of training may be accomplished in-house.

2.3. Within the organization chart, Appendix VI, the metallurgical and mechanical engineering appointments would be at Graduate level, and the patternmaking post filled by an expatriate on Contract.

2.4. It is felt that the present patternmaking foreman, together with the new mechanical engineer will acquire sufficient knowledge from the expatriate's experience for the post to be dissolved after (representatively) 5-years.

3. Estimated Training Profile.

3.1. International Experts:

Machine moulding technology	: 3-man months
Coremaking technology	: 6-man months
Heat treatment specialist	: 2-man months

3.2 External Industrial Consulting Service.

(on-going service over 2-years, equivalent man-months identified)

Organization and Methods in Quality Control including reject analysis	2-man months
Production records as a Management tool	1-man month
Preparation of a job costing method	1-man month

3.3 Study Tours.

Mechanised moulding practice	1-man month
Coremaking techniques	1-man month
Equipment maintenance	1-man month
Quality Control	1-man month

3.4 Country-based Courses arranged with local resources in conjunction with I.L.O. or similar assistance and in collaboration with the local Trade Testing Centre.

- patternmaking
- foundry practice
- machine shop practice

APPENDIX IV . Summary of Visits.

Legend.

MF	Manufacturer
GV	Government
TR	Trader
E	Educational
MA	Municipal Authority
AP	Agricultural Products
EM	Embassy

REFERENCE	ORGANISATION	PERSONS MET	CLASSIFICATION	PRODUCTS	MISCOR PROSPECTS							
					GI	SG	NON-FERROUS	STEEL	WROUGHT	CYLINDERS	SOLDER	
1	Ministry of Agriculture	K.Kohtamaki UNDP Dr.A.C.Mosha UNDP.	GV	Statutory Body								
2.	Ministry of Industry	K.Kohtmaki UNDP Dr.A.C.Mosha	GV	Statutory Body								
3.	Malawi Development Corporation	Reiner I.Eich James Naphambo A Jacob K.K Kalonda	GV	Statutory Body								
4	Pope Pius XII Seminary	Father Scorten	E	Theological College	*							
5.	City of Blantyre Engineer Private Bag 67. Blantyre	Mrs Kalima Mr Mkandawire Mr Kantuwela Mr Jumbe	MA	Municipal Statutory Body	*	*	*		*		*	
6.	BLANTYRE WATER BOARD PO Box 30369 Chichiri. Blantyre	Mr Barnet Chirwa Mr Jali	MA									

REFERENCE	ORGANISATION	PERSONS MET	CLASSIFICATION	PRODUCTS	MISCOR PROSPECTS							
					GI	SG	NON-FERROUS	STEEL	WROUGHT	CYLINDERS	SOLDER	
7.	J D Hardware Box 397 Blantyre	Mr kotecha	IR	General Hardware Merchants and Domestic supplies	*	*	*		*		*	
8.	AGRIMAL (Chillington Agrimal) PO Box 134. Blantyre	Mr. John R. Batson	MF	Manufacturers of Agricultural Equipment	*	*		*	*			
9.	Automotive Products	Mr Glauser	IR	Automotive spare parts Agents	*	*		*	*	*		
10.	David Whitehead	Mr. Sheekhay	MF	Textile Manufacturer	*	*	*		*		*	
11	Northern Engineering	Ken Webb	MF	Agricultural Equip. and roofing tile manufacturers	*	*	*	*	*			
12.	Conforzia Tea Estate	Mr. Laurie Chappell	AP	Raising and Processing Tea	*	*	*		*		*	

REFERENCE	ORGANISATION	PERSONS MET	CLASSIFICATION	PRODUCTS	MISCOR PROSPECTS							
					GI	SG	NON-FERROUS	SHEET	WROUGHT	CYLINDERS	SOLDER	
13	P I C (Mulanji)	Visit only	IR	Gen. hardware Merchants & Domestic Suppliers	*	*	*				*	
14.	British AFrica Tea Estate	Mr. Tilley Mr. Kelley	AP	Raising & Processing Tea	*	*	*		*		*	
15.	Lugeri Tea Estate	Mr. Sondhi	AP	Raising & Processing Tea	*	*	*		*		*	
16.	SUCOMA	Mr. M. O'Leary	AP	Sugar Producers	*	*	*	*	*		*	
17.	Salima Cement Works	Visit only	MF	Concrete Railway Sleepers		*						
18.	UNDP/FAO Animal Power Utilisation Project	Mr Paul de Roover Dr Mosha										
19.	Constantini	Mr A Capellini										

REFERENCE	ORGANISATION	PERSONS MET	CLASSIFICATION	PRODUCTS	MISCOR PROSPECTS							
					GI	SG	NON-FERROUS	STEEL	WROUGHT	CYLINDERS	SOLDER	
20.	MOTOR SUPPLIES	Mussa Patel	IR	Automotive Spare Parts	*	*	*		*	*	*	
21.	Ministry of Agriculture Research Divsn Chidetze PO Box	Dr. Mosha Mr. K. Kumwenda	GV	Field Trials & Farm Equipment								
22	Naming'ombe IEa Estate Thyolo	Mr. Quinn	AP	Raising & Processing lea	*	*	*		*		*	
23.	British African Iea Estate. Gothe	Mr. Rick Tilley	AP	Raising & Processing lea	*	*	*		*		*	
24.	Mandalla Estates. Mulanje	Mr. Cumming	AP	Raising & Processing lea	*	*	*		*		*	
25.	Rural Water Supplies Project Office. Palombe Office	Mr. P.G. Kanaventi	AP	Water Supply Services	*	*	*		*			

REFERENCE	ORGANISATION	PERSONS MET	CLASSIFICATION	PRODUCTS	MISCOR PROSPECTS							
					GI	SG	NON-FERROUS	STEEL	WROUGHT	CYLINDERS	SOLDER	
26	Blantyre Water Irrigation		GV	Water Resources	**						*	
27.	PIC Blantyre Peoples Trading Centre Limited. PO Box 30402 CHICHIRI	Mr. R. Burgell Mr. K. Chiwaya	TR	Gen.Hardware Merchant and domestic supplies	*	*	*		*		*	
28.	Malawi Railways	Mr. Takomana	MF	Transportation	*	*	*	*	*		*	
29.	SUCOMA (Sugar Corporation of Malawi Limited) Private Bag 50 Nchalo	Mr. M O'Leary Mr. J.P. Calisse	MF	Raising and processing sugar	*	*	*	*	*	*	*	
30.	SUCOMA (Sugar Corporation of Malawi Limited	Mr. M. O'Leary	MF	Sugar machinery								
31.	David Whitehead, Blantyre	John Sheekhay	MF	Textile Manufacturing	*	*	*	*	*	*	*	
32.	Shire Limited Blanture	Mr Ganizani	TR	General Hardware Merchants and domestic suppliers	*	*	*		*		*	

REFERENCE	ORGANISATION	PERSONS MET	CLASSIFICATION	PRODUCTS	MISCOR PROSPECTS							
					GI	SG	NON-FERROUS	STEEL	WROUGHT	CYLINDERS	SOLDER	
33	Press Steel & Wire Limited Press Steel Industries Limited PO Box 5651, Limbe	Arvind Rajani	MF	Steel Wire				*	*			
34	City of Blantyre	Mr R.Mitchinson Mr Chavurla	MA	Statory Body	*	*	*		*		*	
35.	EXCEL Hardware		IR	Maize flails	*	*		*	*			
36.	Portland Cement (1974) Limited. Changalume	Mr. Roy Kapesi Barton Kachinjika (ex Blantyre Wks)	MF	Clinker for Cement	*	*	*	*	*	*	*	
37.	Railway Rehabilitation, Salima. Cement Works (concrete sleepers)	Visit only	MF	Concrete railway sleepers		*						
38.	Wheelhouse, Salima	Jan Junger	IR	Deutz engines scrap rly clips						*	*	

REFERENCE	ORGANISATION	PERSONS MET	CLASSIFICATION	PRODUCTS	MISCOR PROSPECTS							
					GI	SG	NON-FERROUS	SHEET	WROUGHT	CYLINDERS	SOLDER	
39.	British High Commission	Mr. Michael Claughton	EM	Diplomatic								
40.	Steelworks Limited. Lilongwe	Mr.Rudolfo A.P.Mendes	MF	Steel fabrications and structural					*		*	
41.	Zimbabwe High Commission	Visit to identify Suppliers	EM	Diplomatic								
42.	Spartacus Lilongwe	Mr. Bessone Mr. Jagot	MF	Automotive Repairs and Precision Engineering	*	*	*	*	*		*	
43.	Agricultural Trading Company	Makina Nyoni Mr. Malunga	IR	General Agricultural Suppliers	*	*	*	*	*	*	*	
44.	Limbe Tobacco Lilongwe	Mr. Palmer	AP	Tobacco Growers	*	*	*	*	*	*	*	

REFERENCE	ORGANISATION	PERSONS MET	CLASSIFICATION	PRODUCTS	MISCOR PROSPECTS							
					GI	SG	NON-FERROUS	STEEL	WROUGHT	CYLINDERS	SOLDER	
45.	Malawi Post Office Stores	I.J.M. M'Neusa M'Nensa	GV	Govt stores for Malawi Post Office	*	*	*		*		*	
46.	Water Authority	N.A.MacDougall Simon Lapper	MA	Water Resources	*				*		*	
47.	Maltracko	Mr. Kapezi	MF	Off-highway Automotive refurbishment	*	*	*	*	*	*	*	
48.	Stancom Tobacco Packers	Mr.K.M.J. Tembo	MF	Raising and Processing Tobacco	*	*	*		*		*	
49.	Water											
50.	Ministry of Agriculture Research Chedetse	Mr. Balaka	GV	Field Trials and Farm Equipment								

REFERENCE	ORGANISATION	PERSONS MET	CLASSIFICATION	PRODUCTS	MISCOR PROSPECTS							
					GI	SG	NON-FERROUS	SHEET	WROUGHT	CYLINDERS	SOLDER	
51.	Planning Office . Mzuzu	Mr.B.L.D.Chingwende	GV	REgional Planning								
52.	Agricultural Development Unit Mzuzu	J.F. Mwenechanya	GV	Research Station								
53	LESCO Mzuzu	S.R.Kanyalika	IR	Agricultural & General Hardware	*	*	*	*	*		*	
54.	Hardware & General				*	*	*		*		*	
55.	Kawalazi Tea Estate	P.R. Verster	AP	Tea & Coffee Growers and Processors	*	*	*		*		*	
56.	Kandodos Superette Manyani Garage Kusuhgo Auto McConnel Trade Centre Kamputi Estate	Group Inspection visits	IR	Domestic Suppliers Traders								

REFERENCE	ORGANISATION	PERSONS MET	CLASSIFICATION	PRODUCTS	MISCOR PROSPECTS							
					GI	SG	NON-FERROUS	STEEL	WROUGHT	CYLINDERS	SOLDER	
57	UIM	Mr B Baxter	MF	Transportation	*	*	*	*	*	*	*	
58	Government Central Stores	Mr Murimo	GV	Government Central Purchasing and Stores House	*		*		*		*	
59.	Malawi Railways Foundry	Mr S.L.Jakomana Mr J.A.M.Mwemifumbo	MF	Transportation	*	*	*	*	*	*	*	
60.	Engineering & Foundry	Mr. Farook.	MF	Maize milling machines		*		*	*		*	
61.	Tools & Dies Engineering Ltd	Mr. A. Legey Mrs Legay	MF	Toolmakers. Aluminium diecasters	*	*		*	*		*	
62.	Agason Motors	Ismail Pangwani Mr. Patel - metallurgist	MF	Automotive spare parts traders & non-ferrous foundry	*	*		*	*	*	*	

REFERENCE	ORGANISATION	PERSONS MET	CLASSIFICATION	PRODUCTS	MISCOR PROSPECTS							
					GI	SG	NON-FERROUS	STEEL	WROUGHT	CYLINDERS	SOLDER	
63.	Petroleum Services Ltd.	Mr. J. Hewson	MF	Brass castings, fabrications and forged components	*	*		*	*		*	
64.	ESCOM (Electricity Supply Commission of Malawi)		MA	Electricity supply								
65	Customs & Excise		GV	Government Administration								

APPENDIX. V.

RECOMMENDED MODERNISATION.

CONTENTS

APPENDIX V . Recommended Modernisation.

1. Strategy.

Commencing from the position at MISCOR March 1990

1.1. Concentrate on metal and sand controls to improve product quality.

1.2. Upgrade pattern design to increase quality and productivity.

1.3. Introduce snap-flask moulding to reduce pattern costs and increase productivity.

1.4. Develop large moulding machine practice in accordance with Consultant's proposal H 165 - 01001 (Appendix VI Section .3.). to increase productivity and raise quality. These facilities exist and when realised, make possible production in ex cess of 400-tons per year without other additions.

1.5. Instal 500Kg electric induction melting furnace to make possible the manufacture of SG iron and steel in addition to international grades of grey iron.

1.6. Progressively expand market scope and penetration using the new facilities under 1.5. to include automotive components of a wide range, off-highway vehicles and ground engagement tools.

1.7. Develop laboratory facilities and offer high performance steels for forging and heat-treated parts.

1.8. Develop heat treatment facilities to upgrade MISCOR manufacturing capability and offer a contract service to industry.

1.9. The existing facility to manufacture tin and lead solder sticks to be developed as convenient. No significant investment involved.

1.10. Develop bronze pump casings of high complexity to establish a technical reputation for MISCOR and afterwards re-address the brass and bronze bar market lost to competitors.

1.11. Aluminium components to be developed as market opportunities are identified. The facilities 1.4. are applicable to aluminium and can therefore accept high volume if this should materialise.

APPENDIX V (Continued) Recommended Modernisation

2. Description of Facilities.

1. Melting Raw Materials.

1.1. Incoming

Provision of reinforced concrete apron accessed by main EOT crane is for receiving and inspection of raw materials which normally comprise cast iron and steel scraps. Automobile scrap frequently includes complete motors and transmission sub-assemblies which would be dismantled on the apron.

1.2. Storage

Concrete or brick bunkers are located between the apron and induction melting furnaces. Different qualities of metals are placed in separate bunkers so simplifying the charge make-up procedure.

A secure storage area is provided for high-value metallurgical additives (e.g. nickel = US$ 11,000 per tonne). A wire cage or brick enclosure is usual.

1.3. Charge Make-up

At a level of 500-Kg per hour the charge make-up is a manual operation. A 500-Kg platform weigh scale is used to weigh all charge materials, which are then transferred to a wheeled barrow and pushed close to the furnace operating platform. When convenient the barrow may be hoisted by EOT crane alternatively the barrow is emptied by hand and the materials placed on to the platform.

1.4. Furnace Charging.

All charging is manual. For a 500-Kg furnace this is mandatory in order to prevent damage to the linings. Cast iron and steel borings and swarf may be shovelled.

1.5. Existing Cupola Melting Furnace.

The out of doors metal storage would remain, also the mechanical skip charger to raise the furnace charges to high level.

APPENDIX V (Continued)

2. Melting Process.

2.1. Existing Cupola Furnace

The existing cupola furnace is retained without modification, but its role changes. Following completion of the planned up-grading this furnace will not normally be used, and all production will be achieved by the new induction furnace. In the event of increased production demand, the cupola can be employed to melt metal for transfer to the induction furnace for superheating or analysis correction, thereby increasing the total metal output. Such operation is termed duplexing.

2.2. New Electric Induction Furnace Installation.

A twin-crucible coreless induction furnace is proposed, operating at 750Hz nominal with frequency band correction. Melt capacity 500Kg, electrical rating 350KW. One electrical control console is used, capable of melting with either of the crucibles. The furnace is complete with hydraulic tilting gear, water circulation.

Output from the recommended furnace is 500Kg per hour, or when duplexing with the cupola, is 1,000Kg per hour. The furnace will operate continuously or intermittently as required.
The whole installation is placed in a concrete enclosure providing a working platform on top and housing the hydraulic electrical and water circulating plant underneath.

Contiguous with the furnace installation is the metallurgical control laboratory for testing metal analysis and treatment. Lifting capability for periodic furnace crucible maintenance is available from the main workshop EOT crane.

3. Moulding.

Two principal moulding processes are proposed; within each process a number of variations exists but does not affect the overall concept or provisior of facilities.

3.1. Machine Moulding.

3.1.1. Moulding machine

The two existing simultaneous jolt-squeeze machines are retained, together with the jib cranes serving them.
The moulding machine jib cranes should be re-located to improve the utilization of floor space, and permit setting of cores without additional handling.

3.1.2. Mould Handling

Following completion of the drag (bottom half) mould it is lifted by special carrying bail swung into position over the roller conveyor, turned over whilst being set down and placed on a wooden bottom board on the roller conveyor.

New lifting equipment is proposed (in the category of loose tools) as a means of raising productivity.

The cope (top half) mould is handled identically and set down on top of the drag mould.

3.1.3. Mould Clamping.

Conventional double-tapered knock-on cramps are envisaged ; positioning, tightening and removal to be manual.

3.1.4. Mould Circulation.

To process moulds through the cycle of operations, 2-strands of roller conveyor each 20 Metres long are positioned relative to the mould machine, To form a closed loop a simple transfer trolley is located at each end.
After completion of moulding, the cope and drag halves are set down on the roller conveyor, cramped together and pushed away into a waiting section, then transferred by the transfer trolley to the second strand of roller conveyor to await metal pouring.

After pouring, moulds are pushed along the conveyor for a cooling period of 40 - 70-minutes as may be required, then lifted by pneumatic hoist for knock-out.
All movement around the circuit is manual and in fact is continuous since every 3-minutes (representatively) one new mould is made and one cooled mould is knocked-out.

3.1.5. Mould Knock-out

Cooled moulds are lifted by pneumatic hoist suspended from a simple monorail. The complete mould is placed on the floor, the lifting bail re-positioned to lift the cope only, sand is knocked out of the cope box and falls on the floor, the empty box being replaced on the transfer trolley. The hoist is returned to lift the drag mould which will invert since the casting produces an out-of balance*, remaining sand is knocked out and the drag box placed on top of the cope box.

The whole assembly of empty boxes sitting on the wooden bottom board is pushed back on the transfer trolley, aligned with the roller conveyor and pushed toward the mould machines.

3.1.6. Castings Removal.

Once dumped on to the floor after knock-out the casting has to be separated from sand and removed to a cooling location. Actual separation of sand is a critical function relating to casting quality and may require to take place between (say) 3-minutes of knock-out and (say) 4-hours after knock-out. In either event, after sand separation the casting may be lifted manually using suitable tools, or by the knock-out hoist in the case of heavy pieces for deposit in the castings cooling area.

3.2. Floor Moulding

3.2.1. Mould Making.

The basic principles of floor moulding are foreseen to apply. Loose pattern and mounted patterns are expected to be used. Manual and pneumatic rammers are currently utilized.

* a slightly different procedure is used when the casting remains in the cope half mould.

3.2.2. Mould Handling

Two EOT cranes service the main moulding bay and apart from small duty in the heavy fettling bay and metal pouring, are normally fully available for floor moulding. Some effort will be made to standardize mould box sizes so that specialized lifting equipment can be brought into use.

3.2.3. Mould Clamping.

Where mould boxes are fitted with taper lugs, the same cramps will be used as in the machine moulding section, otherwise "C" cramps or simple weighting will be employed.

3.2.4. Mould Movement

All movement of moulds and mould boxes will be by the EOT crane.

3.2.5. Mould Knock-out

Primary knock-out may be done on the moulding floor and the sand shovelled into containers (typically 2,000Kg) or complete mould with casting mv be transported to the knock-out monorail at the moulding machines.
To facilitate this the mould transfer trolley floor rails are extended across the full width of the main moulding workshop. Sand containers would be transported in the same manner.

3.2.6. Castings Removal

Those castings of a size too large for the shotblast machine will be transported by EOT crane directly to the heavy fettling section for manual sand removal and grinding.

Castings for shotblast are transferred via the extended floor rails to the knock-out area and processed as machine moulded work.

3.3. Snap-flask Moulding

3.3.1. Mould Making

The existing HPLI moulding machine will be modified by removing the stripping mechanism. A conventional snap-flask operation method is proposed using double-side pattern plates and hinged mould flasks.

Sand will be manually shovelled, a one-man operation is envisaged.

3.3.2. Operating Procedure.

The moulding operator will place moulds on the working floor.

Sand will be provided daily as a working "heap". AFter pouring moulds will be broken in situ on the floor and castings removed by steel hook into container, the sand will be watered down and shovelled back to the heap, thereby providing a measure of reconstitution.

The original heap sand would be used as a facing.

3.3.3. Metal Pouring

Hand pouring by the moulding operator is proposed.

The major influence in choosing the location of the snap-flask unit has been proximity to the electric furnace, so that the operator may collect metal directly from the furnace.

A 20Kg hand ladle is proposed.

3.3.4. Organization of the Unit.

Since liquid metal is to be available every 1-hour, the snap-flask operator may collect metal hourly, therefore the floor area allocated may be restricted.

By this means, a casting can always be moulded and poured within the 1-hour period, thus providing a same-day service for urgent (i.e. breakdown) delivery.

4. Mould Sand Preparation.

4.1. Sand Cooling

After castings removal the sand is allowed to cool in situ, sometimes water may be sprayed on by hosepipe when the casting metal to sand ratio permits, thus obtaining cooling by evaporation.

4.2. Separation of Tramp Elements.

A specialized conveyor unit with proprietory name "Royer" is provided. A Royer is 1500mm long, inclined at 45° and its conveyor belt runs at 180m/minute. Sand thrown on to the conveyor belt is centrifuged off the end: dense metal particles are flung 5m away, less dense core sand lumps are flung 4m away and small sand grains deposited as a heap within 3m of the Royer machine. Thus a separatio n of these elements is conveniently achieved.

4.3. Sand Reconstitution

From the heap produced by the Royer, sand is manually shovelled into the skip loader (hoist) of the existing sand mill. Additives of coal-dust, clay, water and starch are made according to the technology. Alternatively, sugar-based additives can be used.

After milling, sand is discharged to fall on to floor adjacent to the mould machines.
There are differing practices such as 1-component (unit) sand or 2-component (facing and backing) sands. The described facilities and process are equally applicable.

4.4. Sand Transfer to Moulding

The relocated existing sand mill will discharge processed sand between the two moulding machines for manual shovelling into mould boxes on the machines. A greater productivity will result if half of the processed sand is transported by special 2-wheel barrow and deposited in equal portions alongside each moulding machine on the side opposite to the sand mill.

APPENDIX V (contd)

4.5. Floor Moulding

Knock-out sand is transported to the knock-out facility (3.2.5.) and processed as 4.3. above.
After reconstitution, the sand will be discharged from the sand mill into the 2-wheeled barrow (4.4.) and moved alongside the machine moulding conveyor for hoisting by EOT crane which will deposit the sand where required on the iron-or steel-moulding floor.

4.6. Snap-flask Moulding.

Moulding sand for snap-flask work differs from machine moulding or floor-moulding sand.

Daily the sand from this unit will be whovelled into the 2-wheeled barrow, removed to the sand mill, re-milled, returned to the barrow and returned to the snap-flask area.

APPENDIX V (contd)

5. Coreshop.

5.1. Raw Materials Storage.

An area of $20m^2$ is arranged adjacent to an outside wall to receive and store new sand. Six variations of base core-sand have been assumed.
Handling will be manual.
Various sand binders are kept in the designated mould and core materials store alongside the coreshop.

5.2. Tooling Store.

Coreboxes, jigs, assembly fixtures and gauges in immediate use are placed in racks alongside the work benches.

5.3. Sand Preparation.

One 250kg paddle mixer is located near to the new sand storage bunker and alongside the coreshooting machine which will be the biggest sand consumer. Raw materials additives measurement is volumetric, using individual measuring cylinders for liquids and solids. This approach will avoid problems of calibration of pumps over the variation of temperature and humidity encountered, which would attend the choice of a continuous screw mixer.

5.4. Coremaking.

5.4.1. Hand methods will predominate for the first 3 - 5 years of the Project, if only by reason of the patternmaking capacity shortage. 3-wooden benches with compressed air supply are located between sand mixing and corebox storage. 2-operators per bench is anticipated.

5.4.2. Machine production by compressed air shooting is provided by a 16-litre horizontal strip manually controlled sequential cycle machine. Sand feed from the mixer will be manual: a mezzanine floor may be constructed at a later stage if the machine production rises above the predicted level. Such development would be a normal "internal improvement" carried out by the maintenance department.

5.5. Core Processing.

Following the core manufacture a hardening process is required: carbon dioxide gas is used for sodium silicate binders and heating is applied for most naturally occuring oils and sugars e.g. linseed oil or molasses.

APPENDIX V (contd)

The CO_2 gas is applied automatically by the core shooter.
Hardening by heat (curing) is provided for by two drying ovens built with an outside wall to facilitate fuel delivery and reduce heat within the workshop
The type of curing oven may be to suit local preference: sliding racks may be employed or a simple "walk in" oven may be used.
Heating is suitable by any cheap fuel method.

5.6. Core Coating.

It will be necessary to coat the surface of cores for use with steel; in iron it will often be preferred to use coating. Compounds of carbon, graphite,silica and zircon are usual; water or alcohol is normally used as a carrier.
To facilitate coating, 3-work benches are envisaged: cores would be withdrawn from the curing oven, allowed to cool for 1 - 10 minutes then coated by dipping or painting. Proprietory spraying has been deliberately omitted in order to avoid maintenance problems; simple bent pipe spray cans may be constructed by the maintenance department.
Normally drying of water-based coating is achieved by residual heat in the core; alcohol-based coatings are fired by naked flame.

5.7. Storage of Finished Cores.

Due to prevailing humidity levels, the storage of cores is attended by difficulties. As a desirable approach, cores should be manufactured on a production programme which ensures their consumption with short delay only. Practical circumstances dictate that some storage is inevitable, therefore 4-steel racks are provided, which may be placed inside the core-drying ovens for overnight storage so that the residual heat of the furnace structure maintains the cores above dew-point to inhibit moisture pick-up.

5.8. Core Transport.

The transfer trolley rails for machine mould handling are extended into the coreshop and a second transfer trolley supplied for the coreshop. The second trolley provides transport within the coreshop and together with the dedicated mould trolley is used to transfer cores into the main moulding bay for distribution by EOT crane.
Supplementary carrying plates and trays in wood or metal would be produced by the foundry as a revenue item.

APPENDIX V (Contd)

6. Metal Pouring.

6.1. General

3-basically different systems will be used for the ferrous production. Non-ferrous pouring systems are integral with their melting, Sections .8. and .9.

6. 2. Machine Moulding.

A 250kg covered ladle is proposed, suspended by hoist from a single monorail. One-man operation is the aim.

The hoist should be a rack-and-pinion hand-wheel type although a simple chain hoist will suffice and may be preferred since they are already in use elsewhere in the factory: the chain hoist is 2-man operation.

Metal is collected from either cupola or electric furnace and the ladle pushed manually to the roller conveyor pouring section.

6. 3. Floor Moulding.

Because floor moulds occupy an area and have different pouring requirements, the 2- EOT cranes will be utilized to transport ladles from both cupola and electric melting furnaces.

6. 4. Snap-flask Moulding.

In the snap-flask operation, pouring is an intrinsic part of the moulding function. A hand-ladle is used as described under 3. 3.3.

7 . Fettling.

7 . 1. Process Concept.

The detailed fettling process route is special to each individual casting, and further varied by different metal specifications. Accordingly a general-purpose workshop facility must be provided which is capable of many variations without incurring unreasonable capital costs.

The basic fettling plant comprises:
- shot blasting machine
- floor-mounted pedestal grinders
- swing-frame grinders (German: pendulum grinder)
- hand-held small grinding machines
- simple hammer and chisel.

The most important process aim is to avoid castings being collected in batches (such as dumping on the floor). After shotblasting, the castings must be continually processed, a function which is normally accomplished in under 2-minutes.

7. 2. Castings Cooling.

Following knock-out,castings need to be cooled in accordance with the technical requirements of the alloy from which they are made, and the function to which they will be applied.

Control is a matter of foundry shop-floor management, no special facilities are necessary.

7. 3. Sprue Removal.

At the correct time, metal sprues, feed metal heads and other technical appurtenances are removed. In grey iron castings by hand-hammer, in SG iron by hammer or band-saw and in steel by oxygen-gas burner.

The pieces removed are returned to the metal raw materials stockyard area.

7. 4. Core Removal.

Core sand is different from moulding sand and it is a matter of technological determination as to whether the broken-down cores shall be integrated with the moulding sand or removed and discarded.

No equipment is necessary, the control is a function of foundry shop-floor management. Adequate space has been allocated for the purpose.

7.5. Shotblasting.

7.5.1. Process

In order to remove sand adhering to the casting surface, it is subjected to bombardment by steel or iron particles, projected at high speed from a revolving wheel with impellor vanes.
Processes using sand are injurious to health and are prohibited in most countries.

7.5.2. Existing Plant

A perfectly satisfactory modern shot-blasting unit manufactured by Spenstead of UK is installed and in working order in MISCOR works. Consumable spares are required. However, the unit is too small for practical purposes to support the proposed expansion, and a larger shot-blast machine is proposed.
All metals can be processed in the same machine, the limitation is of physical size only.

7.5.3. Proposed New Shotblast Machine.

It is proposed to include a simple rotary table machine, 2.5m diameter, with 2-shot throwing wheels, complete with all filtering and dust-collection equipment.

7.5.4. Operating Procedure.

Castings, after core removal and cooling, will be lifted by 500Kg jib-crane from the floor on to the shotblast machine table. The table rotates continually and at each revolution the operator turns each casting to expose new areas to be cleaned, after which the component is removed. Two revolutions of the table are normally required for satisfactory cleaning.

At the end of the shotblast cycle, the castings are disposed to a roller conveyor, usually on wooden bottom boards. One operator is able to carry cut all the functions of shotblast loading, turning over and disposal.

7.6. Grinding.

Shotblasted castings are lifted from the wood bottom boards by inspector and good castings placed on boards or in containers on roller conveyor feeding the pedestal grinding machines.

Reject castings are disposed to a container for analysis and recording.
At the grinding machines, an operator picks up each casting performs the required work and disposes the casting into a chute for subsequent work.
In certain cases the subsequent work may involve hand-held grinder operations.
Large size or heavy castings are ground by swing-frame grinder in an acoustically damped booth. Castings after shotblasting may be fed by roller conveyor or when not shotblasted by reason of size, will be transported by main EOT crane.

7.7. Chipping.

Some operations in finishing a casting are most suitable carried out by hammer and chisel or by using a specially shaped (pecking) hammer. These operations may precede or follow pedestal grinding: in the layout H165-01003 one grinding conveyor line allows for chipping before grinding and one line is set out for chipping after grinding.

8. Inspection, Quality Control, Despatch.

8.1. Inspection.

In-process inspection is a part of quality control applied at numerous stages:

- raw material receipt
- completed cores
- completed moulds
- after shotblasting
- after grinding
- on completion of all operations (final inspection),

Mostly the inspection is by process operators whost payment includes for this responsibility.
Incoming raw materials inspection is a management function; inspection after shotblasting and final inspection is a quality control function reporting directly to the General Manager.
Tools of inspection are usually manufactured in the pattern shop, sometimes customers supply measurement gauges.

8.2. Quality Control

Commencing with laboratory analysis of melted metal, the quality control function is continuous throughout the manufacturing process:

- liquid metal (bath) samples
- ladle samples
- micro structure examination (SG iron)
- test bars
- sand control:
  - . core sand
  - . moulding sand
- mould hardness
- core surface hardness
- visual inspection after shotblast
- dimensional accuracy
- hardness
- microstructure of heat-treated castings

Provision is made for all the above tests in the Schedule of Equipment

Mechanical testing is presumed to be an external contract function mainly provided by the Bureau of Standards, B lantyre and will include:

- tensile testing
- rupture test
- Izod (or Charpy) tests

Appropriate internal documentation is applied for the effective logging and control of technical specifications.

8.3. Despatch

An area is disignated for assembly of components comprising specific orders, prior to despatch to customers.

Whilst this is primarily a paperwork function, the area is located within the EOT crane coverage to facilitate handling of heavy castings.

A weigh scale is included for checking materials despatched.

9. Aluminium.

9.1. Scope

The foreseen demand for aluminium is as a service rather than a principal material supply, therefore minimum facilities are provided. Any future expansion is fully catered for as follows:

- increase in moulding capacity: utilize snap-flask machine and carry moulds to the aluminium section
- major increase in mould capacity: use the two BQ3 moulding machines (sands are compatible).
- major increase in metal demand: use one of the 500Kg induction furnaces.

9.2. Melting

Existing 60Kg pit furnace relocated at an outside wall to simplify flue construction.

9.3. Pouring

Monorail 2-man bridle and lift-out tongs

9.4. Moulding - hand

9.5. Cores - from main coreshop alongside.

9.6. Knock-out - manual in situ

9.7. Sprue cut-off - band saw located inside section

9.8. Fettling - fettling shop area

9.9. Sand preparation - periodic re-milling in the main sand mill, say weekly. Facing sand may be produced on demand in the core sand mixer

10. Bronze.

10.1. Scope

A service only level is forecast in sand moulds. Greater output is expected from die-cast bar and hollow bar.

10.2. Melting

Existing 60Kg pit furnace relocated at an outside wall to simplify flue construction.

10.3. Pouring

Manual 2-man bridle and lift-out tongs

10.4. Moulding - hand and permanent mould

10.5. Cores - from main coreshop alongside

10.6. Knock-out - manual in situ

10.7. Sprue cut-off - band saw located inside section

10.8. Fettling - fettling shop area

10.9. Sand preparation - batches prepared in main sand mixer and reconstituted in workshop by moulders

11. Special Processes.

11.1. Pit Moulding

To accommodate certain large or heavy castings, a floor pit is proposed:

- diameter = 2.5m
- depth = 4.0m
- construction = 400mm brick wall
  300mm concrete base
- drainage = (according to need) pump well
- cope clamping = 6-off, diam 100 floor rings

11.2. Centrifugal Casting

A single variable speed horizontal machine is proposed, complete with protective casing and die handling
Capacity: 75 - 200 diameter x 400 long

11.3. Sweep Moulding

A single spindle unit is included:

spindle diameter	75mm
base plate size	1500 x 1500

11.4. Die Casting

11.4.1. Iron

Certain chilled iron work may be attracted e.g. railway wagon brake blocks. No special equipment would be required: simple die clamping rigs would be made as part of the tooling (pattern equipment)

11.4.2. Aluminium

Gravity die-cast work will always arise in aluminium. A wholly manual operation is foreseen, and clamping rigs would form part of the tooling.

11.4.3. Bronze

Gravity casting of bar and stick, also hollow bar may form a major part of the copper-base demand. Hinged dies of cast iron will be sufficient.
No specific facilities are required.

11.5. Tin Alloys

Because of the small scale of these alloys, coupled with low metal melting temperature, the operation can be carried out as an occasional function in the aluminium or bronze section. Metal would be melted in a small "spoon" ladle held over one of the pit furnaces and use waste heat.

Diecasting is the principal form of casting, but the most profitable outlet for tin alloys is in re-metalling of automotive connecting rods and crankshaft bearings.

12. Heat Treatment.

12.1. Scope

General purpose heat treatment facilities are proposed which can accommodate all normal treatment in each of the metals to be cast:

Two levels of facility are included:

- large size and bulk quantity
- small size and special treatment

Quenching by water and oil is included.

12.2. Location

An area in the finishing section is chosen, adjacent to an external wall to facilitate burner flue exhaust and quench vapour extraction.

12.3. Large Size Work

Furnace type construction	Bogie hearth Brick or low density board
Firing	Oil
Working dimensions	2000 x 2000 x 1500 high
Bogie construction	Steel fabrication
Charging method	Double flanged wheels on flat bottom rail
Motive power	EOT crane/floor pulley

12.4. Small Size Work

Furnace type construction	Muffle Low density board
Firing	Electric
Working dimensions	400 wide x 800 long x 400 high

12.5. Quenching

Two steel baths are proposed:

- oil bath	2000 x 2000 x 2000
. circulation	electric pump
. complete with basket for removal	
- water bath	2000 x 2000 x 2000
. circulation	header tank to waste (pumped into sand plant water header)
. complete with basket for removal	

12.6. Process Control

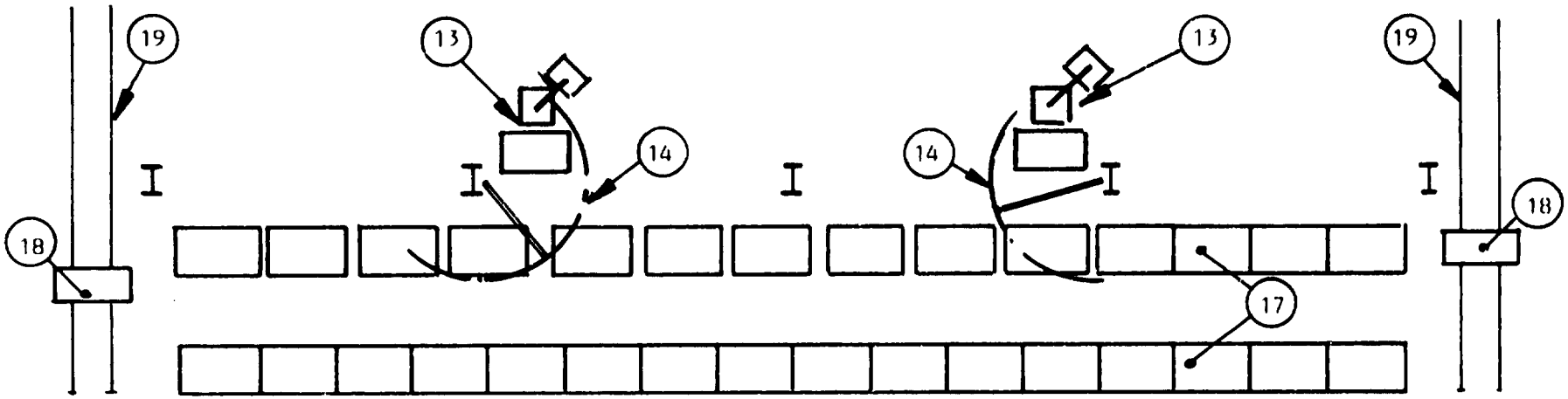
Each furnace to have independent indicating pyrometer with continuous chart recorder.

Burner automatically controlled from PLC fed from pyrometer.

APPENDIX V . (Continued) Recommendated Modernisation

3. Drawings.

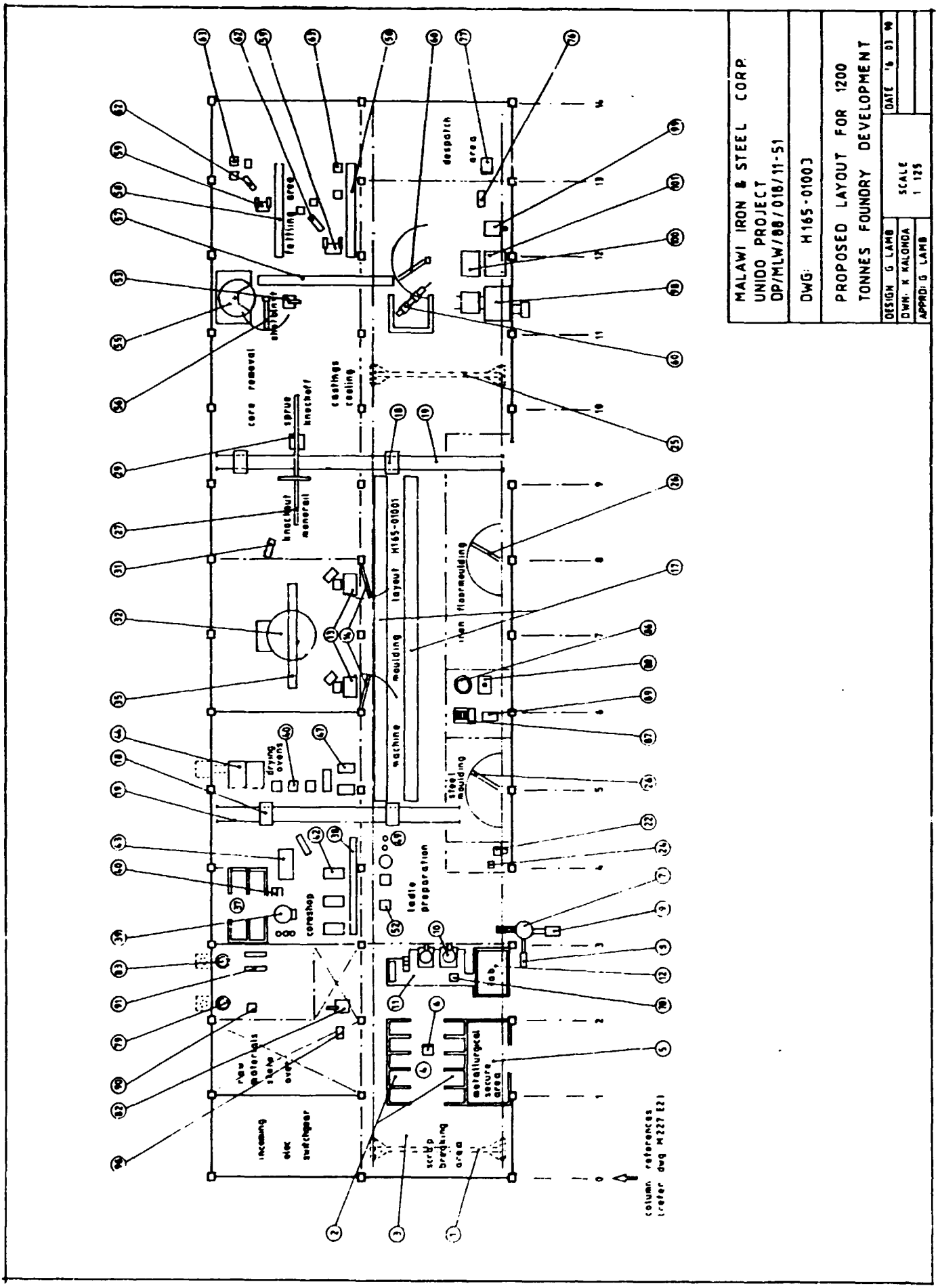
3.1. Drawing H 165 - 01001	Large Moulding Machine Development
3.2. Drawing H 165 - 01003	Proposed Layout for 1200-tonnes Foundry Development.



LAYOUT OF MOULDING MACHINES
BASED ON DRG. H 165 - 01001

Scale 1 : 100

Item numbers related to Appendix V, Section 4.


MALAWI IRON & STEEL CORP
UNIDO PROJECT
DP/MLW/88/018/11-51
DWG: H165-01003
PROPOSED LAYOUT FOR 1200 TONNES FOUNDRY DEVELOPMENT
DESIGN G LAMB
DWN: K KALONDA
APPRD: G LAMB
SCALE 1:125
DATE '6 03 90
despatch area
fettling area
core removal
sprue knockoff
castings cooling
knockout monorail
machine moulding layout H165-01001
iron floormoulding
steel moulding
drying ovens
coreshop
ladle preparation
job.
metallurgical secure area
raw materials store
incoming elec switchgear
scrap breaking area
column references (refer dwg H227 E2)

APPENDIX V . (Continued) Recommendated Modernisation

4. Schedule of Plant & Equipment.

Melting Raw Materials

1. E.O.T. Crane	Span 8.0 metres capacity ; 5000 Kg control : pendant	1-off
2. Storage bunkers	concrete or brick steel reinforced 1000 wide x 1600 deep x 1000 high retainer walls in sets of 5-off	2-sets
3. Receiving apron	concrete, steel reinforced 10 M x 5M x 400 thick	1
4. Working floor	concrete, steel reinforced 8 M x 7M x 250 thick	1

5. Secure Melting Store 1

5.5M x 2.0m enclosure, 1000 high x 300 thk concrete dwarfwall embedded BRC fabric 100 pitch to 3000 high, roofed in BRC supported on I section bearers. Complete with 2-personnel access doors.

6. Platform Scale 1

Steel platform knife-edge scale, beam or dial.
Capacity 500 Kg * 0.5Kg with wheels

Melting Plant

7. Cupola Melting Furnace 1

Diam 30" conventional shaft furnace, with wind belt, tuyeres, blast main, tapping spout, slag spout and drop bottom doors

8. Cupola Fan 1

600 diam x 10kw centrifugal fan with mains starter and overload protection.

9. Cupola Charging Skip 1

Inclined skip charger, self tipping, electric motor drive 4KW winch drum, gearing and controls with safety over-run switch

10. Electric Induction Furnace

Coreless induction furnace plant 1

melting crucibles 2

electric power pack with correction 1

cooling water pack 1

hydraulic tilt mechanism 2

11. Furnace Platform 1

Steel reinforced concrete construction, 5M x 2M plan size x 1200 high to furnace makers' specification integral with floor spillage pit and access stairways.

12. Laboratory Building 1

3.5M x 7.0m plan size independent reinforced concrete floor slab with brick enclosure to 3000 height, concreted load-bearing roof, double-glazed windows to 3-sides, access door with sealed vestibule. Lighting to office standards, air-conditioned

Moulding

13. Moulding machines (sequence production) 2

Simultaneous Jolt-squeeze pinlift machines with table to suit 1000 x 750 patterns.

14. Jib Cranes 2

250Kg electric hoist x 2000 radius, column mounted for 90° swing. Pendant control and catenary wire supply

15. Mould Lifting Bail 4

Purpose-designed one-piece lifting bail for each mould-box size to be used, complete with link chain suspension, ring eye for lifting by Item 14 and steel pocket for pendant control of Item.14.

16. Moulding Boxes 60-pairs

24 x 20 fabricated steel with closing pin lugs and turnover trunnions, machined joint faces, hardened steel round and elongated bushes. Cope 250deep, drag 180 deep

17. Mould Conveyor Track 2

Angle steel framed roller track, 20M length side support angles 76 x 50 x 6.

Roller: diam 60. length 500. pitch 100.

18. Transfer Trolley 2

Roller track 1500 length to specification Item 17 mounted on 150 x 76 'C' section steel x 900 long complete with axles and ball-bearing double flange cast iron wheels

19. Transfer Trolley Rails 4

50 x 25 black steel bar 18M long with welded steel bolting spaces (ties) 60 x 10 black flat. Quantity specified serves coreshop and mould knock-out.

20. Mould Bottom Boards. 80

1000 x 640 x 2-ply natural timber boards 50 thick cross laid and nailed. (Artificial wood compounds such as plywood, chipboard or blockboard will not prove suitable)

21. Mould Box Cramps 300

Cast SG iron double taper or spring steel 'C' clips, to suit mould boxes Item 16.

22. Snap-flask Moulding Machine 1

Simultaneous Jolt-squeeze machine with table to suit 400 x 300 patterns.
(Existing HPL 1 machine with pin-lift mechanism removed)

23. Snap flasks for Moulding

Hinged or snap action; wood or aluminium with triangular location pins with adjustment.

sizes:	500 x 400 x 200/150	1
	450 x 350 x 200/150	1
	450 x 350 x 150/100	1

24. Mould Closing Table 1

600 x 400 table x 750 high of sawn timber construction; 4-legs support; pattern support rest at rear.

25. General Foundry Shop Crane 1

E.O.T. crane span 8.0 metres
capacity: 5000 Kg
control: pendant

26. Wall Jib Crane 2

250Kg electric hoist x 2000 radius, column mounted for 180° swing. Pendant control and catenary wire supply.

Moulding Sand Preparation

27. Knock-out Monorail 1

200 x 100 x 25Kg 'I' Section monorail beam 10M long supported by 200 x 100 end pillars and intermediate bridge giving clear 2M work space between flanges

SWL 5000Kg, height to underside of flange - 3500.

28. Monorail Trolley 1

8-wheel fully articulated trolley with load-bar. 120 diam flanged ball-bearing wheels.

SWL 2000 Kg. height to load-bar eye 3200.

29. Knockout Hoist. 1

2 x pneumatic cylinders, coupled at head and nose ends.

SWL of unit 1000Kg. cyl diam 120; stroke 1000.

Manual valve, single acting, exhaust speed control.

30. Knock-out Lifting Bail 1

Purpose-designed double 'C' section beam with twin support eyes to suit pitch of cylinder Item 29. and eyebolt suspensions at each lower end to suit forged closed elongated lifting loops. Length of beam 1400, lifting loops 30 Diam. bar. SWL 1000 Kg.

31. Sand Conditioning Belt.

No. 2. Royer by Pneulec Limited (UK) 1

Provide ½" air hose for electric cable protection.

32. Sand Mill 1

Simpson type mixer complete with skip charger and rotary discharge aerator

capacity per batch: 500 kg

drive: 37 KW

33. Sand Transport Barrow 2

Steel fabricated, single axle, 2-wheel barrow with steel tubular handle, pneumatic tyres and tipping body section

capacity, dry sand 500 Kg

34. Sack Truck 1

Conventional hand-pushed 2-wheel truck for transport of granular raw materials in hessian or paper sacks.

Capacity: 100Kg

35. Maintenance Gantry for Sand Mill 1

Simple 300 x 120 x 45Kg I-section monorail beam 6M long supported by 300 x 120 end pillars.

SWL 2000Kg

36. Maintenance Gantry Trolley 1

4-wheel plate sided ungeared trolley to suit 120 flange, complete with closed lifting eye.

SWL 5000 Kg.

Coreshop.

37. New Sand Storage 1

Concrete or brick; steel reinforced walls in sets of 3-off:

1200 wide x 1500 deep x 1000 high.

Floor: concrete, steel reinforced, 5M x 4M x 200 thick

38. Tooling Storage Rack 1

Steel or wood construction comprising horizontal shelving with vertical supports to floor. Each shelf to have rear retaining upstand and diagonal bracings.

No. of shelves:	4; vertical spacing 400
Width of each shelf:	400mm
Specific loading:	100Kg per metre run
Length of rack:	7M

39. Coresand Mixer. 1

Steel crib with hardened side liner plates sliding discharge door with safety cover, electrically interlocked top wire mesh cover complete with motor, vee-belt drive and gearbox.

Capacity 250Kg per batch

40. Additives Local Storage. 2

Steel, wood or brick retainer walls 600 high to enclose 500 x 500 floor area for granular materials

Steel or polymer containers made from cut-down suppliers delivery drums fitted with suitable lids oe loose covers: for resins, silicates or molasses 4

41. Measuring Vessels. 6

Discarded containers (typically from food packaging) cut down or calibrated to required columetric capacity

42. Hand Coremaking Benches. 3

Work bench of exceptionally heavy construction, typically wood, with diagonally opposite tool storage cupboards to permit 2-operators to use the bench.

Size: 1800 x 1200; top construction: 100mm thick.

height: 850 ; support legs: 6-off, 100 x 100

complete with $\frac{1}{2}$BSP steel pipe and 2-off hose connexions for compressed air, water filter and cut-off valve.

43. Coreshooter or Coreblower 1

Capacity:	16-litre
Strip:	Horizontal, stroke 180mm
Controls:	Manual, auto sequence.
Corebox size:	500 x 700 x 400 through the parting line

fitted with CO_2 gassing head

Preference should be given to a non-electrical machine. A second-hand machine should be considered if proper certification is available.

44. Core Drying Ovens 2

Simplest form is a bricked enclosure with steel roof insulated by sand 200 deep, having underfloor flue for hot gasses from a coal or coke fire box.

Internal dimensions: 3000 x 2000 x 2000 high

Access: hinged doors

Loading: manual

Core support: steel racks or brick

Operating temperature: 160 - 180^{o} C

Temperature control: indicating pyrometer and manual flue damper

Fuel: not important, but is a convenient means to use reject coke (breeze) from cupola.

45. Core Plates. 200

Cast iron or aluminium ribbed plates with machined top face

size range: 200 x 200 - 600 x 400

indicative rib depth : 60 (provides hand hold)

Plate to have cast-in holes, diam16 spaced at 60 x 60 pitch.

NB steel plate may not be used.

46. Core Finishing Benches 3

Steel fabricated work bench size 500 x 500 x 750 high, 6mm steel plate top and angle section construction, with low level shelf, 6mm steel plate 400mm above working floor. Usually 1-leg is kept short for M16 steel hexagon bolt levelling screw.

47. Core Storage Racks 4

Wood or fabricated steel comprising horizontal shelving with vertical supports to floor, shelves to be free of obstruction bracing should not be used, rigidity to be obtained by hauncheon joints if wood, or welding if steel.

number of shelves: 4, vertical spacing 400

width of each shelf: 600

specific loading : 200Kg per Metre run

length of rack : 1.5M

Metal Pouring.

48. Pouring Ladle (machine moulding) 4
Barrel-type with geared handwheel operating , hinged filling lid, single spout.
capacity : 250 Kg
diameter of shell : 500
length of shell : 540
refractory lining : brick or monolithic

49. Pouring Ladle (floor moulding) 1
Bucket-type with geared handwheel, double spout,
capacity: 1000 Kg

50. Pouring Ladle (floor moulding) 4
Bucket-type with geared handwheel, double spout
capacity: 500 Kg

51. Hand Ladle (snap-flask moulding) 4
Bucket-type with single handle and straight cross bar
capacity 25 Kg
handle length 1600

52. Ladle Drying Hearth 2
Simple grey cast iron hearth enclosure suitable for coal, coke or wood having support bracket for $\frac{1}{4}$" BSP steel pipe for compressed air.

Fettling.

53. Metal Bandsaw. 1
Continuous loop power-driven conventional bandsaw.
table size 750 x 750
capacity in steel 80mm
complete with blade welding attachment.

54. Oxy Gas Burning-off Torch. 1
Hand-held level feed burner, 2.6diam nozzle, powder dispensing cup and needle control. Complete with hoses 10M long. Gas/oxygen pressure gauge sets and flow regulators with anti-blowback valves. Gas bottle cart with solid tyres.

55. Shotblast Machine. 1

Rotary table type, totally enclosed

2-shot throwing wheels

Complete with shot recirculation, elevator, mechanical sieve, air "wash", sand separator, dust extraction, bag filter and dust removal bins.

Electrical cycle control, safety interlocks.

NB. Screw shot recovery system should not be used; it is preferable to excavate foundations for steel hopper recovery system.

56. Jib Crane 1

250 Kg electric hoist x 3000 radius, column-mounted for 270^{o} swing.

Pendant control and catenary wire supply.

57. Roller Conveyor 1

Angle steel framed roller track, length 9M, side support angles 76 x 50 x 6.

Roller: diam 60, length 500, pitch 100.

58. Roller Conveyor 2

Angle steel framed roller track, 6M. Side support angles 76 x 50 x 6.

Roller diam: 60. length 500. pitch 100

59. Pedestal Grinder . 2

Floor-mounted internally driven variable speed drive (ie constant wheel surface speed).

speed : 2600 surface M per minute.

wheel size : 600 x 50 x 128

number of wheels : 2

complete with approved dust extraction guards, adjustable work rest

60. Swing Frame Grinder (Pendulum Grinder) 1

Single wheel shaft drive

speed : 2600 SMP/Minute

wheel size : 600 x 50 x 128

complete with screw balance adjustment and approved dust extraction guard.

61. Jib Crane. 1

250Kg electric hoist x 3000 radius column-mounted for 270^{o} swing.

Pendant control and catenary wire supply.

62. Work Disposal Chute. 3

Inclined and flat low-sided chute, fabricated steel construction length 1600, width 750.

63. Chipping/Inspection Bench 6

Steel fabricated work bench, 25mm steel top plate and angle section construction, with low level shelf, 6mm steel plate 400mm above working floor. Usually 1-leg is kept short for M16 steel hexagon bolt levelling screw.

Inspection, Quality Control, Despatch.

64. Carbon Equivalent Meter 1

Digital indicating direct reading bench-mounted instrument, complete with electric leads to pouring stand, plug-in pouring cup stand.

65. Polishing Disc 1

Twin-disc bench-mounted selvit cloth polisher with water feed.

66. Microscope. 1

Bench type monocular instrument with light. Magnification x 100

67. Steel Determination Analysis Instrument 1

Proprietory integrating instrument e.g LECO or Electronite

68. Sand Test Equipment 1-set

- laboratory weighing balance
- nest of sieves
- permeability tester
- green compression tester
- shatter test rig
- AFS 3-ram unit
- moisture test (speedy or ultra-violet)
- core surface hardness tester.
- mould hardness tester, scale 'B'

69. Electrical Voltage Stabilizer 1

For protection of Items 64 and 67 according to Makers' specification.

Temperature Measurement Instruments.

70. Radiation Pyrometer, hand held. 1
range 750 - 1000°C (bronze) and 1100 - 1650° C (steel).
Single instrument with change over scale OR two separate instruments (Fe - Con and Pt - PtRh)

71. Immersion Pyrometer, hand held 1
direct reading or fixed readout with compensating cables.
Digital pre ferred but not essential. Range 1000 - 1650° C.

72. Immersion Pyrometer, hand-held 1
direct reading, digital, range 750 - 1000° C

73. Stick-type Immersion Pyrometer 1
direct indicating with steel sheath 0 - 500° C

74. Fixed Insertion Thermocouple for Heat-treatment Furnaces 4
Fe - Con, steel sheath, screw connexion, range 200 - 1100° C
with indicating dial (integral or coupled) with chart recorder.

75. Mercury-in Glass Thermometers for Sand Additive and Core Drying Ovens 4
Range 0 - 260° C with wood carrying box.

76. Brinell Hardness Tester 1
Floor-mounted pedestal type. 3000 Kg x 10mm ball.
Hydraulic loading. Measuring scale swing head

77. Despatch Weigh scale 1
Floor platform dial scale
capacity : 500 Kg x 0.5Kg
platform size: 500mm x 500mm

78. Furnace Additions Scale 1
Bench platform dial scale
capacity : 120Kg x 0.2Kg
platform size : 500 x 500

Aluminium

79. Crucible -type Pit Furnace 1
with support stand, including burner with feed and controls, flue duct and stack

80. Pouring Bridle 3
2-man single handle and pram ends. Forged steel construction

81. Lift-out Tongs 2
Forged steel 2-piece scissors with hinge pin

82. Band saw for Sprue Cut-off 1
continuous loop power-driven conventional bandsaw
table size: 400 x 400
capacity in steel 50mm
complete with blade welding attachment

Bronze.

83. Crucible-type Pit Furnace 1
with support stand, including burner with feed and controls, flue duct and stack.

84. Pouring Bridle 3
2-man single handle and pram ends. Forged steel construction

85. Lift-out Tongs 2
Forged steel 2-piece scissors with hinge pin.

Special Processes.

86. Moulding Pit for Heavy Castings 1
brick and mortar side wall construction and concrete base with drainage facility to suit local conditions
Diam 2.5M ; depth 4.0M
Wall 400mm ; base 300mm with pump well

87. Centrifugal Casting Machine 1
comprising die head mounting, drive motor, speed control, protective casing, pouring spout.
capacity: diam 75 - 200mm
length 400mm
Die and mould handling to be included.
Selection of moulds to be purchased with machine

88. Sweep Moulding Baseplate and Spindle
swing head, slotted clamp arms, depth gauges and spirit levels
spindle diameter 75mm
base plate 1500mm x 1500mm

89. Die Clamping Rigs for Iron Chill Casting 1
Steel section base with fixed head and sliding die mounting clamped by screw

90. Die Table with Clamping Heads for Aluminium Diecasting. 1

91. Support Rack for Bronze Stick Moulds 2
fabricated steel frame with bottom sand tray, screw clamps for moulds

92. Melting Pot for Tin Alloys 1
cast iron flanged crucible-type suitable for use with Item 83.

93. Top Frame for Items 92. and 83. 1
cast iron support for tin melting pot to locate over bronze furnace

94. Ladle for Tin Alloys 3
cast iron spoon ladle, capacity 16Kg with cast-in steel handle

95. Solder Stick Moulds 6
cast iron plain moulds, 10-gang closed die halves with logo and grade inserts, fitted with clamps

96. Guillotine. 1

simple vertical hand shear with measuring stop

97. Balance 1

Simple knife-edge domestic kitchen scale for product final weight check . Capacity 0 - 250 grm x 0.5 grm.

98. Heat Treatment Furnace 1

Type	: Bogie hearth
Construction	: brick or low density board
Fuel	: oil
Internal dimensions	: 2000 x 2000 x 1500 high
Bogie	: steel fabrication
Charging	: double flange wheels
Track	: flat bottom rail
Motive power	: E O T crane/floor pulley

complete with sealed door, atmosphere control dampers, pyrometric connexions, P L C burner control

99. Heat Treatment Furnace 1

Type	: muffle
Construction	: low density board
Fuel	: electric
Internal dimensions	: 400 wide x 800 long x 400 high
Charging	: manual

complete with sealed door, atmosphere control damper, pyrometer connexions, P L C temperature regulation

100. Quenching Tank (oil) 1

Fabricated steel tank with drain and plug.

Dimensions: 2000 x 2000 x 2000

Facilities: stool for basket

Unloading : reinforced basket

Loading : sling chains with base hooks

Circulation: electric pump

Fire protection to suit local availability

Fume hood with extractor fan

101. Quenching Tank (water) 1

Fabricated steel tank with drain and plug.

Dimensions:	2000 x 2000 x 2000
Facilities:	support stool for basket
Unloading :	reinforced steel basket
Loading :	sling chain with loose hooks
Circulation:	electric pump to header tank (pumped into sand plant water header)

Services.

Following final determination of each constituent machine, specific requirements for services are to be determined:

102. Compressed Air

103. Process Water

104. Cooling Water

105. Drains

106. Electrical supply - low tension

107. Electrical supply - high tension.

Loose Tools and Equipment

108. Various hand tools and special items including:

- paint brushes
- hand brushes
- floor brooms
- shovels
- rakes and scrapers
- chipping hammers
- chisels and drifts
- crowbars, core knock-out bars, hooks and wire pullers
- special shape cranked hooks for sprue and shotblast
- work pans

APPENDIX V . Continued) Recommended Modernisation

5. Estimated Costs.

Import items are quoted ex-Works Suppliers' premises	Local K	Import US$
Melting Raw Materials		
1. EOT crane	existing	
2. Storage bunkers	civils	
3. Receiving apron	civils	
4. Working floor	civils	
5. Secure melting store	civils	
6. Platform scale	existing	
Melting Plant		
7. Cupola melting furnace	existing	
8. Cupola fan	existing	
9. Cupola charging skip	existing	
10. Electric induction furnace		160,000
11. Furnace platform	civils	
12. Laboratory building	civils	
Moulding		160,000
13. Moulding machines	existing	
14. Jib cranes	existing	
15. Mould lifting bail	500	
16. Moulding boxes	existing	
17. Mould conveyor track	3000	
18. Transfer trolley	1200	
19. Transfer trolley rails	800	
20. Mould bottom boards	200	
21. Mould box cramps	in-house	
22. Snap-flask moulding machine	existing	
23. Snap flasks for moulding		2,000
24. Mould closing table	in-house	
25. General foundry shop crane	existing	
26. Wall jib crane	2000	
	7,700	2,000

Moulding Sand Preparation	Local K	Import US$
27. Knock-out monorail	400	
28. Monorail trolley	300	
29. Knock-out hoist		2600
30. Knock-out lifting bail	150	
31. Sand conditioning belt		5500
32. Sand mill	existing	
33. Sand transport barrow	700	
34. Sack truck	200	
35. Maintenance gantry for sand mill	2000	
36. Maintenance gantry trolley	150	
	3,900	8,100
Coreshop		
37. New sand storage	civils	
38. Tooling storage rack	400	
39. Core sand mixer		6000
40. Additives local storage	civils	
41. Measuring vessels	in-house	
42. Hand coremaking benches	1200	
43. Coreshooter or Coreblower		60,000
44. Core drying stoves	civils	
45. Core plates	in-house	
46. Core finishing benches	200	
47. Core storage racks	400	
	2,200	66,000
Metal Pouring		
48. Pouring ladle (machine moulding) 250Kg		3000
49. Pouring ladle (floor moulding) 1000Kg	existing	
50. Pouring ladle (floor moulding) 500Kg	existing	
51. Hand ladle (snapflask moulding) 25Kg	in-house	
52 Ladle drying hearth	in-house	
		3,000

Fettling		Local K	Import US$
53.	Metal bandsaw		3600
54.	Oxy gas burning-off torch	1800	
55.	Shotblast machine		95,000
56.	Jib crane	2600	2600
57.	Roller conveyor 9M	1500	
58.	Roller conveyor] 6M	2000	
59.	Pedestal grinder		11,000
60.	Swing frame grinder	existing	
61.	Jib crane	2600	2600
62.	Work disposal chute	600	
63.	Chipping /inspection bench	900	
...	Inspection, Quality Control, Despatch.	12,000	114,800
64.	Carbon equivalent meter		6000
65.	Polishing disc		500
66.	Microscope		2000
67.	Steel determination analysis instrument		62000
68.	Sand test equipment		28000
69.	Electrical voltage stabilizer		700
Temperature measurement Instruments			99,200
70.	Radiation pyrometer, hand held		1000
71.	Immersion pyrometer, hand held (100C - 1650)		1200
72.	Immersion pyrometer hand held (750 - 1000)		1200
73.	Stick-type immersion pyrometer		350
74.	Fixed insertion thermocouple (Heat-treat furn)		2200
75.	Mercury in glass thermometers		300
76.	Brinell hardness tester	60,000	
77	Despatch weigh scale	22,000	
78	Furnace additions scale	10,000	
		92,000	6,250

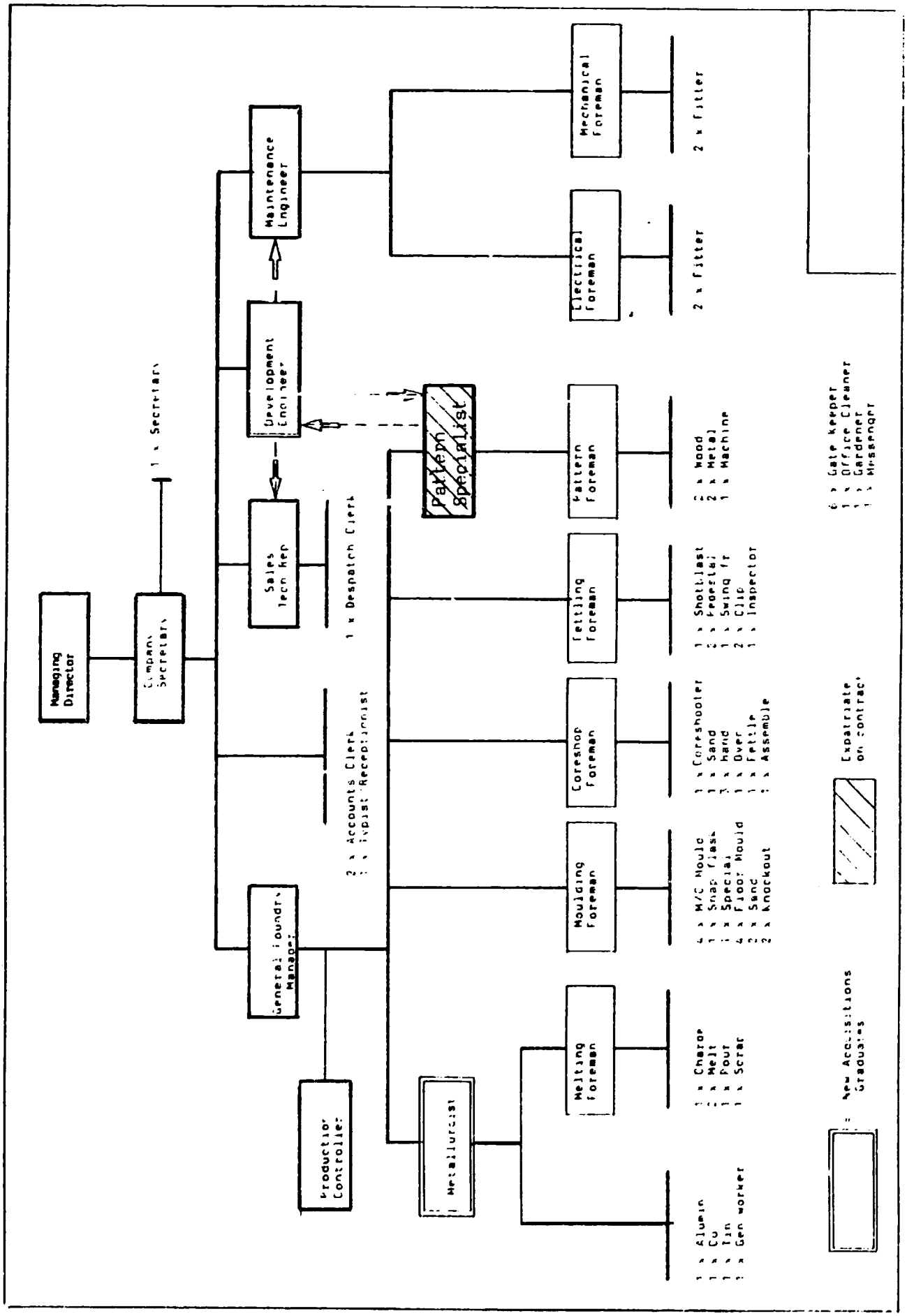
		Local K	Import US$
Aluminium			
79.	Crucible-type pit furnace	existing	
80.	Pouring bridle	existing	
81.	Lift-out tongs	existing	
82.	Band saw for Sprue cut-off		3600
Bronze			3,600
83.	Crucible-type pit furnace	existing	
84.	Pouring bridle	existing	
85.	Lift-out tongs	existing	
Spcial Processes			
86.	Moulding pit for heavy castings	civils	
87.	Centrifugal casting machine		48000
88.	Sweep moulding baseplate and spindle	existing	
89.	Die clamping rigs for Iron chill casting	2000	
90.	Die table with clamping heads for Al diecasting	2400	
91.	Support rack for bronze stick moulds	600	
92.	Melting pot for tin alloys	400	
93.	Top frame for Items 92. 83	150	
94.	Ladle for tin alloys	100	
95.	Solder stick moulds	1000	
96.	Guillotine	900	
97.	Balance	3000	
98.	Heat treatment furnace - bogie hearth	40,000	
99.	Heat treatment furnace - muffle		15,000
100.	Oil quenching tank	2700	
101	Quenching tank (water)	2500	
		55,750	63,000

Services.		Local K	Import US$
102.	Compressed air	40,000	
103.	Process water	11,000	
104.	Cooling water	4,000	
105.	Drains	9,000	
106.	Electrical supply - low tension	29,000	
107.	Electrical supply - high tension		
		93,000	
Loose tools and equipment			
108.	Various hand tools and special items including:	10,000	
-	paint brushes		
-	hand brushes		
-	floor brooms		
-	shovels		
-	rakes and scrapers		
-	chipping hammers		
-	chisels and drifts		
-	crowbars, core knock-out bars, hooks and wire pullers		
-	special shape cranked hooks for sprue and shotblast		
-	work pans.		
		10,000	
	GRAND TOTAL:	K 276,550	$ 525, 950

Civils and buildings excluded.

APPENDIX VI

SUGGESTED FOUNDRY ORGANISATION



APPENDIX VII. Faulty Design Concepts.

During visits to manufacturers and users of MISCOR products, certain complaints were presented as shortcomings of MISCOR'S supply. More seriously, the report "Study Concerning Equipment Manufacture Supply and Distribution for Draft Animal Power in Malawi (DP/MLW/88/002)" illustrates broken trailer hubs of MISCOR supply.

Some items have been investigated in depth and a series of incorrect accusations and statements and other misinformation were progressively pursued until finally an actual case of failure was uncovered .

Case 1. Tractor-drawn Trailer Hub.

Drawing H165 -03004 indicates the general idea of trailer hub construction in which a special hardened steel bolt (called a wheel stud) is forced into a hole with the object of cutting into the material of the hub so that the bolt is secured in position and prevented from rotation.
The practice is in common use worldwide, but cannot be applied to a cast iron hub. Special grades of iron which are elastic eg malleable iron or SG iron are ideally suited for the application.
Diagnosis of failed components further showed that the special wheel studs had been welded with nickel welding rods. The drilled holes in the hub were oversize from which it is deduced that breakages had occurred during assembly in the Makers' works and the larger holes gave rise to fewer breakages, but in turn failed to secure the wheel stub against rotation when the wheel nut was tightened.
It is to be supposed that welding was introduced to avoid rotation, but cast iron will not tolerate welding unless a process of pre-heating is applied, and after the welding operation, a stress relief heat-treatment is necessary.

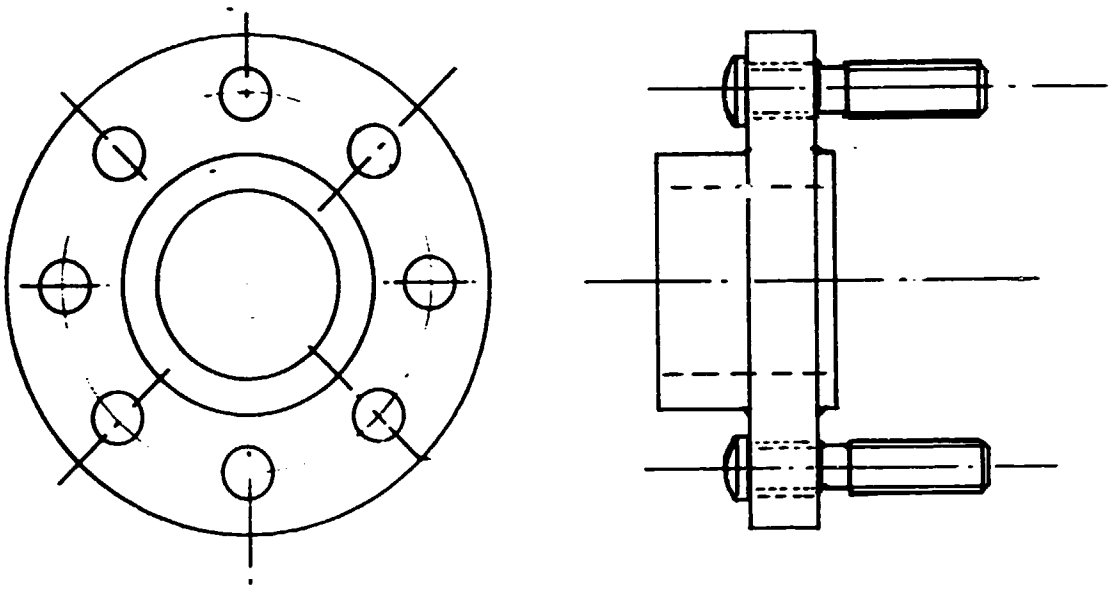
Conclusion.
Failure of the MISCOR hub was caused by mis-application on the part of the machinist and assembler who is also the supplier to the Trade, by reason of well-known engineering factors

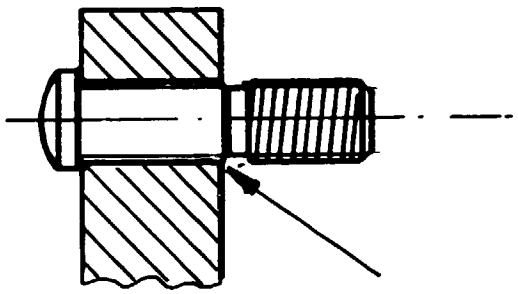
i) cast iron is not elastic and cannot accept a pressed-in component

ii) simple welding is not practicable with cast iron

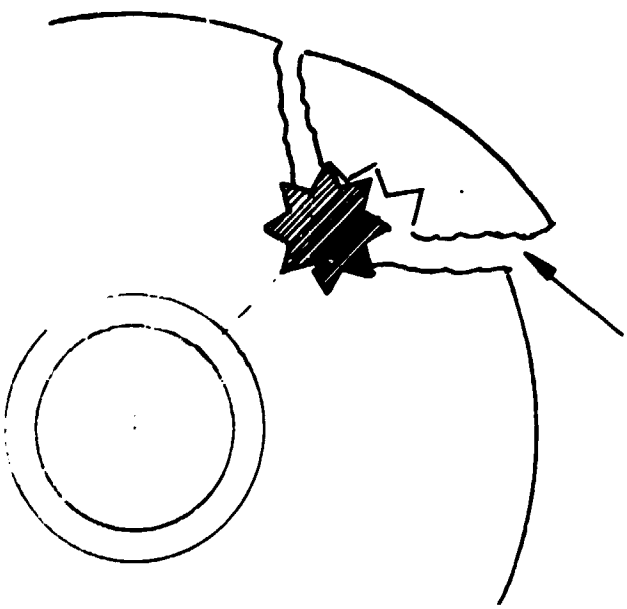
CASE 1. Tractor-drawn Trailer Hub.

GENERAL IDEA OF TRAILER HUB





THIS PART OF SPECIAL BOLT HAS "TEETH" FORCED INTO DRILLED HOLE



Cast iron is not elastic and cannot deflect to accept the bolt forced into the hole.

Result is breaking by tensile fracture.

DWG H 165 03004

Case 2. Industrial Gears.

Cast iron is a convenient material for drive gears in certain applications. A standard procedure is for a cast iron gear blank to be prepared by the foundry and afterwards machined to exact sizes prior to the cutting of the gear profiles. The centre hole in the gear has some drive facility cut in, usually a rectangular slot called a keyway.

An unusual procedure is current in Malawi which the UNIDO Consultant has never before experienced in that potential users of gears purchase from MISCOR a large circular block of metal which they (wrongly) described as "billets" and from these large pieces a number of gear wheel shapes are cut.

The practice is totally wrong and can only produce unacceptable result in terms of material texture, surface finish of the resulting gear and the life of the gear in service.

It is a known fundamental of cast iron metallurgy that the thickness of a cast iron casting is directly related to the quality of metal. Even when the same metal is poured into pieces of different thickness, there is a completely different metallurgical result.

The "billet" is indicated on drawing H165 - 03005 and the method of cutting gear blanks is indicated. It may thus be observed that all the metal of the gear is from the coarse grained large section the"billet". The drawing also illustrates how very small or fine grains result in thin metal sections, and indicates that the gear blank should be purchased from MISCOR in the approximately finished profile in order to obtain the maximum benefit from fine grain, with attendant longer life and service.

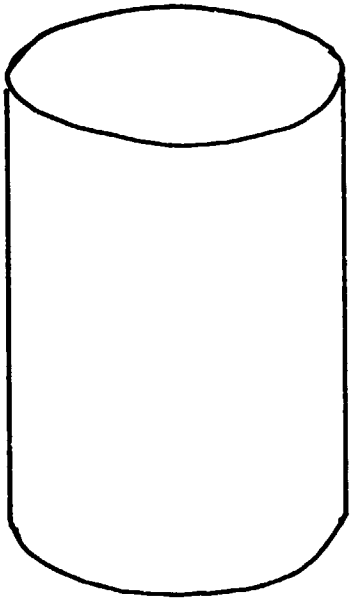
Conclusion.

MISCOR must undertake a Sales Promotion activity to publicise these characteristics of cast iron, and provide a service to the user which identifies the most suitable method of manufacture for the gear.

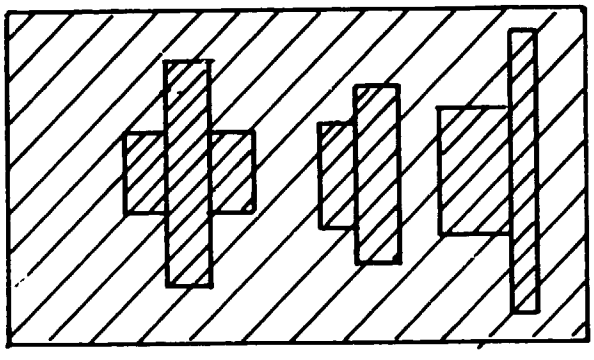
By such action, a better application of the material will result with corresponding user improved satisfaction.

Note. The word "billet" in standard English usage is applied only to a steel section of exactly 4-inches (approx 100mm) square regardless of length.

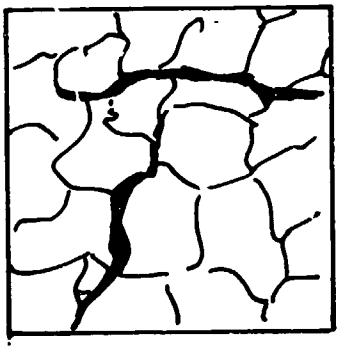
CASE 2. Industrial Gears.



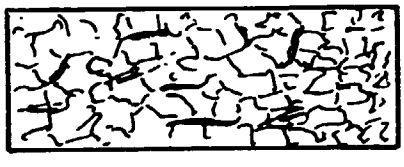
CAST 'BILLET'



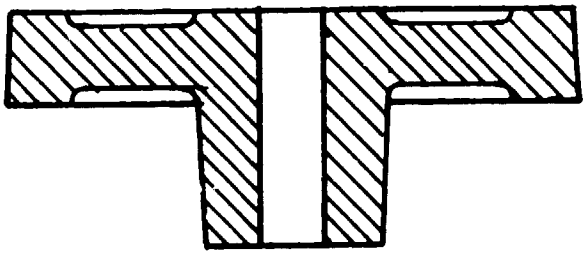
DIFFERENT SIZE GEARS
CUT FROM 'BILLET'



COARSE GRAIN IN
THICK SECTION



FINE GRAIN IN
THIN SECTION



RECOMMENDED PATTERN PROFILE FOR
GOOD RESULTS

DWG: H 165 - 03005

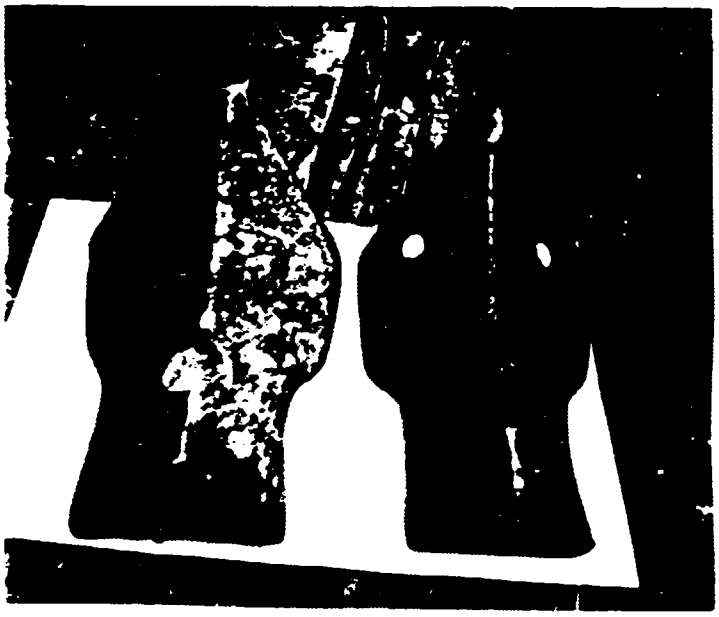
APPENDIX VIII. MISCOR Projects Initiated.

During the Mission certain production constraints were identified and market opportunities discovered. A series of Field Reports has been issued for information and guidance of MISCOR:

- H 165 - 02001	Maize Sheller Disc	Demonstrate MISCOR capability for manufacture.
- H 165 - 02002	Powered Water Pump	Monitor field trials of MISCOR products.
- H 165 - 02003	Vehicle Brake Disc	Monitor field trials of MISCOR products
- H165 - 02004	Agrimal Plough Frog	Change manufacturing method to improve product quality and reduce customer rectification work.
- H 165 - 02005	Machining of Product	Advise early commissioning of second-hand lathe machine.
- H 165 - 02006	Machine Shop Layout	Recommend employment of UNIDO Industrial Consultancy Services to propose a suitable layout for machinery and patternshop.
- H 165 - 02007	Recommended Modernisation	Advise MISCOR to utilise UNIDO Industrial Consultancy Services to develop detailed implementation of UNIDO Consultant's proposal.
- H 165 - 02008	Mould Quality	Advise on technology and implementation of increased air pipe sizes for moulding machine compressed air supply leading to improved mould hardness

APPENDIX IX Illustrations

A. Indication of MISCOR quality problems



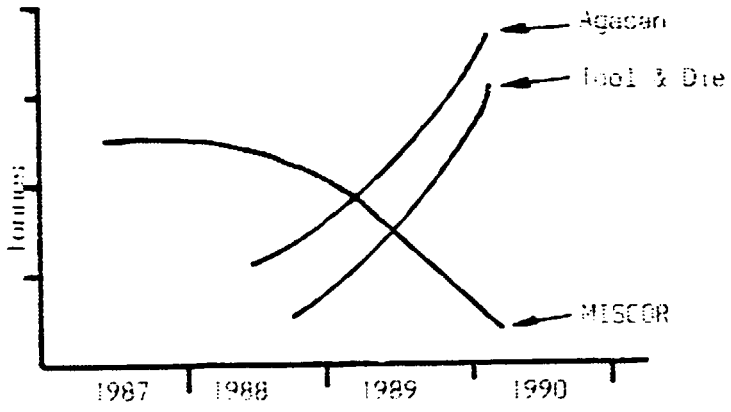
Delivery of castings
to local customer
Items found on transport
vehicle leaving works

Wrong component supplied

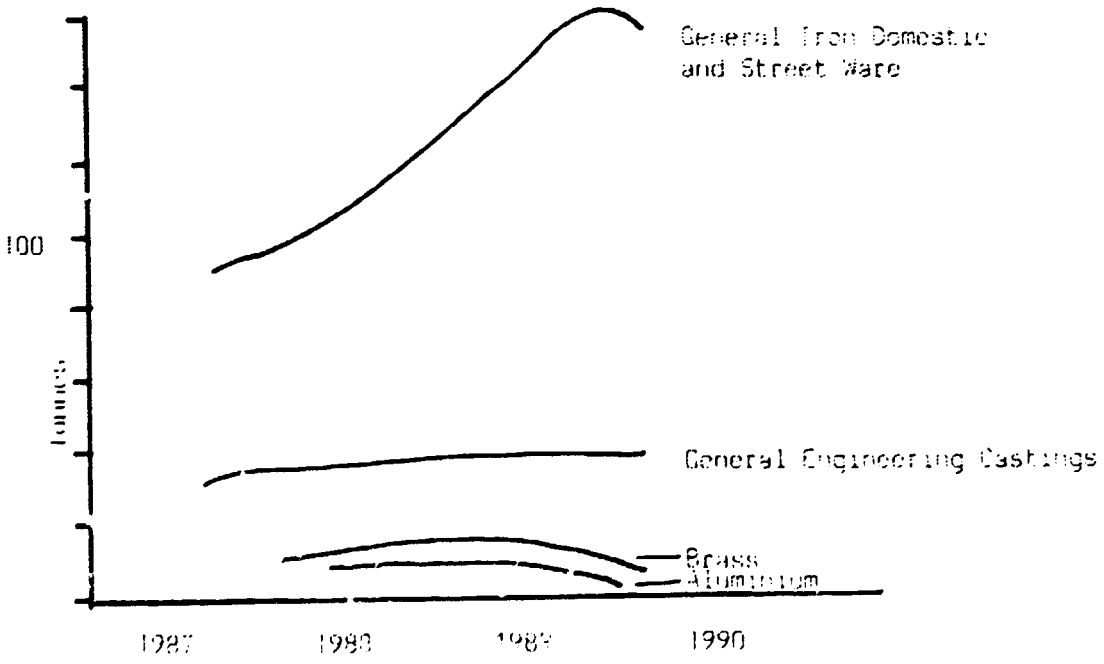
Broken component
supplied

B. Hardware Items Suitable for MISCOR Manufacture

C. Comparison of Outputs of Aluminium



D. MISCOR Output Profile.



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