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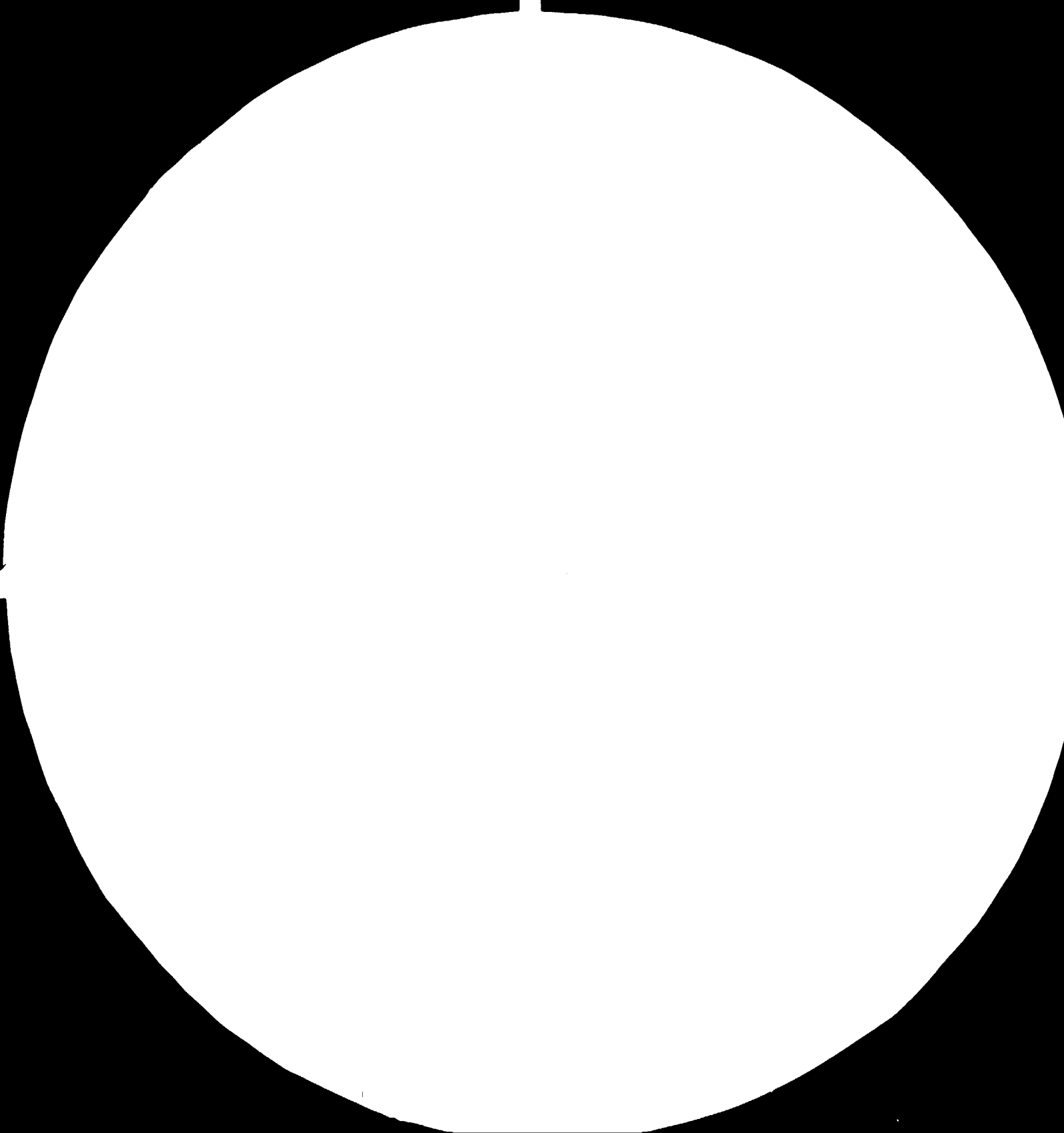
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MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS  
STANDARD REFERENCE MATERIAL 1010A  
ANSI AND ISO TEST CHART No. 2

13569

UNITED NATIONS INDUSTRIAL  
DEVELOPMENT ORGANIZATION

22 January 1983  
ENGLISH

Mozambique.

INDUSTRIAL SCALE RUN OF THE TECHNOLOGY OF BOTTOM  
POURING TO PRODUCE PENCIL-STEEL INGOTS, INGOT-MOULDS  
AND TECHNO-ECONOMIC APPRAISAL OF EXPANSION AND  
MODERNIZATION OF THE FOUNDRY AND STEEL MAKING SHOPS.

PROJECT: DP/MOZ/81/008/11-54/31.B.C.

TERMINAL REPORT

Prepared for COMPANHIA INDUSTRIAL DE FUNDIÇÃO  
E LAMINAGEM S.A.R.L. (CIFEL) in

THE PEOPLE'S REPUBLIC OF MOZAMBIQUE

BY

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UNITED NATIONS DEVELOPMENT ORGANIZATION  
VIENNA

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ABSTRACT

Under technical assistance programme of UNIDO/UNDP a team of three experts were deputed to CIFEL S.A.R.L. in the year 1981 to develop and introduce the production of bottom poured pencil steel ingots from their existing 1.5/2 Tonne Capacity Electric Arc Furnace and 2 Tonne Capacity Side Blown Converter with the sole object of stopping importation of steel billets now being used as the feedstock for their rolling mills for the production of steel bars, rods and wires. They successfully carried out the demonstration. But for lack of cast iron ingot moulds commercial production of Pencil Steel Ingots was held up. It was therefore essential to take up the manufacture of cast iron ingot moulds in their own foundry so that regular production of pencil steel ingots could be taken up to stop gradually the import of steel billets to save the country's foreign exchange.

The Expert arrived in Maputo on 30th October 1982 and commenced work on and from 1st November 1983. During the initial period it was necessary to examine the local conditions. The complete list of essential raw materials were sent to CIFEL in July 1982 as per UNIDO's instructions.

The pattern, core box, core pipe, mould boxes etc. were examined. It was found that the pattern needed extensive repairs and the wooden core box prepared last time was so much out of shape that it was rather impossible to produce a sand core correctly for ingot mould. In fact an Aluminium core box could have been prepared during the interim period since the last team of experts left CIFEL. The preparation of an aluminium core box

needed about 3 or 4 months time due to precision machining operations involved. However, a design for the same was taken up immediately and a set of drawings were prepared including cast iron core pipe, aluminium core carrier and handed over to the production manager during the middle of December 1982. The production manager indicated that the same would be ready for use at the latest by 15, February 1983. During the preparation of the design the position was further complicated as CIFEL Engineers wanted the length of the Pencil Steel Ingots to be 1600 mm as against 1400mm developed earlier. The question of length of Ingot was only solved after arrival of Mr. Sherwani, Co-Expert, who carried out extensive trials at the rolling mill and in fact rolled 32 mm dia bar for the first time with pencil steel ingots produced in CIFEL to justify the original length of ingot.

In view of the urgency and after a thorough discussion with Mr. Cudra Conrado, Head of the Laboratory, it was decided to prepare a few moulds after repairing the existing tackle and with available raw materials in Mozambique. With great difficulty at least two cores were made from the old core box which was cast on 6 December 1982, machined and put to trial and steel bottom poured successfully on 31, December 1982. To continue the exercise to prove metal, sand compositions for core and moulds and also paint for the core it was decided to cast a few more ingot moulds for which CIFEL Technicians are presently busy before the new Al. Core box and other facilities are ready during middle of February 1983. To enable CIFEL technicians to continue the manufacture of ingot moulds in the Foundry. CIFEL Engineers and Technicians namely Mr. Mateus (Design), Mr. Sombane (Foundry), Mr. Pedro (Melting Shop Chief), Mr. Carlos (Core Shop),

Mr. Mabunda (Moulding), Mr. Armando (Pattern Shop), Mr. Solomos (Sand Testing), Mr. Serafi (Laboratory) were closely associated during the demonstration period. I have every confidence that they would carry out the operations very successfully in future.

With regard to modernisation of the Foundry, where are enstalled 8 moulding machines (out of which only two are in actual operation) a plan of mechanisation has been prepared and given in annexure II. The Management has been advised to take up maintenance operation on rest of the moulding machines before taking up any modernisation work.

With regard to Bottom Pouring Practice Mr. Sherwani carried out severel demonstrations and a team of pitside workers have been trained for this purpose.

With regard to amalgamation of CFM with the operation of CIFEL, to boost-up further production of Pencil Steel Ingots, Mr. Sherwani in his report has dealt with the subject.

I sincerely believe CIFEL has not only the latent capacity of making pencil steel ingots about 15.000 tonnes in the first phase and 30.000 tonnes in the second phase after the amalgamation of CFM, but also foundry capacity both for Iron, Steel and Non-ferrous casting which can be utilised for the manufacture of spareparts for railways and other industries and also for export and thus contribute further to the foreign exchange conservation programme of the Country's Exchequer. But it would be necessary to put a lot of thoughts and efforts to



successfully exploit the situation. As the first step towards such efforts would be to take up on priority bases the following critical studies without any further delay:

- (a) Market survey to assess the demand of spareparts in ferrous and non-ferrous castings for the railway system and other industrial establishments in Mozambique to save foreign exchange.
- (b) Capacity evaluation of CIFEL Foundry Complex both for ferrous and non-ferrous castings after all the eight moulding machines have been thoroughly repaired and put into operation together with installation of other auxiliary equipment as shown on the attached drawing, in order that any surplus capacity for castings could be exported to neighbouring countries specially in Swaziland to earn foreign exchange.
- (c) Requirement of Cast Iron Ingot Moulds for the ultimate production of about 30.000 tonnes of Pencil Steel, should be set aside while evaluating foundry capacity.

INTRODUCTION

The potentiality of CIFEL, its latent unutilized capacity of the steel melting shops, foundry and rolling mills and its potentialities in the process of further industrialisation of Mozambique was first identified during the technical mission of Dr. E.T. Balazs, Chief of Metallurgical Section and Dr. B.R. Nijhawan, Senior Regional Field Adviser of UNIDO and subsequently approved by the Government of the People's Republic of Mozambique under cover of Project No. SI/MOZ/80/802/21-01/-31.3.C subsequent assistance was provided by UNIDO under Project No. DP/MOZ/81/008/11-54/31.8.C and duties of the experts were described as follows:

"The Consultant will be assigned to the management of S.A.R.L. -CIFEL to assist them both in the Industrial Scale Run of the newly introduced technology of bottom pouring to produce pencil steel ingots, and in the preparation and the techno-economic appraisal of the different variants of expansion and modernisations of the Foundry and steel making shop. More specifically the Expert will be expected to:

- 1) - Guide the bottom pouring practice of Steel Teeming to produce pencil steel ingots arranged in a cluster formation with a central bottom pouring channel;
- 2) Establish optimum mould preparation including refractory lining of the runners and channels for the feed of molten steel;
- 3) Undertake requisite mould preparation and steel teeming practice based on bottom pouring technology;

- 4). Review and identify quality problems carried at the production of ingot moulds such as preparation of cores related with mixed saucers, preparation of the patterns (painting and glue techniques) optimum chemical analysis of the iron for the moulds and the like.
- 5). Assist in the preparation of the technical documentation on the expansion of the melting bay, upgrading of the laboratory of chemical analysis.
- 6). Assist in the preparation of the programme of incorporation of the neighbouring CFM iron and steel foundry within the CIFEL Project.

The Consultant will also be expected to prepare a final report, setting out the findings of the mission and recommendations to the Government on further action which might be taken."

Accordingly the Expert arrived in Maputo on 30th October evening and reported to UNDP Office on 1 November 1982 where he had meetings with Mr. C.A. Goulart, Senior Industrial Development Field Adviser of UNIDO. After completing the administrative formalities Mr. Goulart introduced me to Mr. Cudra Conrado, an official of CIFEL who brought me to CIFEL and introduced me to the other senior officials of CIFEL such as Mr. Octavio Muthemba, The Chairman of CIFEL, Mr. Mota, The Technical Manager, Dr. Chicogo, The Head of Planning Section and others.

One Mr. Geraldo was named as my counterpart in CIFEL. As Mr. Geraldo went on leave after the first week of my arrival Mr. Cudra himself used to act for some time as my counterpart, but could not continue for long due to his other activities in the organisation. The Expert, however was introduced to the Heads of various sections of the shop, such as Mr. Mateus, Design Engineer, Mr. Sombane, the Foundry Supervisor, Mr. Carlos, Core Shop, Mr. Armando (Pattern Shop), Mr. Mabunda (Moulding Shop) Mr. Solomos (Sand Laboratory), Mrs. Amelia and Mr. Seraji of the Chemical and Mechanical Testing Section of the Laboratory. They all very well cooperated with the Expert in preparing a number of Engineering Drawings, for the mould box, Aluminium core box and core carriers, cast iron tube, preparation of various compositions of moulding and core sand, mould and core paint etc., necessary for the production of cast iron ingot moulds, needed for the production of Pencil Steel Ingots.

Mr. Otto Denes, the Resident Representative of UNDP, Maputo along with Mr. Goulart and Miss Petra Lantz visited CIFEL on the 9th December and had meetings with CIFEL officials named earlier and discussed further technical assistance sought by CIFEL.

Dr. I. Velev, ~~UNDP~~ Industrial Development Officer of UNIDO along with the Co-Expert, Mr. I.D. Sherwani arrived on the 15 December 1982 and also had meeting on 18 December/82 with all the members of the senior staff of CIFEL. Under the Chairmanship of Engineer Mr. Ussene Issuf Ibramogy, a number of problems connected with the project, its progress, shortfalls and

bottlenecks were discussed at length and many administrative problems were solved. In this meeting the question of ingot mould length was also decided which enabled the Expert to confidently go ahead with his work plan in CIFEL, within the short period available at his disposal to make an in-depth study on the manufacture of ingot moulds and connected problems.

However, with the help of all the Gentlemen named above the Expert was able to achieve the objectives with satisfaction.

Particular thanks are due to our able Resident Representative Mr. Oto Denes, Mr. Goulart, Miss Petra Lantz in UNDP/UNIDO Office and Mr. Octavio Muthemba, Dr. Chicago and Engineers Issuf and Mr. Cudro for their valuable support and cooperation.

FINDINGS

## 1. Plant and Machinery in CIFEL FOUNDRY COMPLEX

(a) Melting Shop :(i) For Iron and Steel Meeting

2 Nos - Cupolas with Blowers and other accessories

2 Tonne Capacity Side Blower Converter with Blower and an extra body and accessories

1 1/2 - 2 Tonne Capacity Direct Arc Electric Furnace with transformers and other accessories

10 Tonne Capacity E.O.T Crane floor operated

1 Emmersin type Pyrometer with Temperature Recorder

(ii) For Non-ferrous Melting

Tilting Crucible Furnace oil fired  
capacity 150 Kg 1-No  
100 Kg 1-No

(b) Moulding Shop

(i) 200 Kg Capacity BMD  
Sand Mixer Muller - One

(ii) 100 Kg Capacity - GUTMAN  
Sand Mixer Muller - One

(iii) 50 Kg Capacity Mixer - one

(iv) Sanddrier oil fired - one

(v) Jolt -squeeze pinlift type

Pneumatic Moulding Machine  
Model - BMM - BQ - 1 - Three

(vi) Jolt-squeeze pinlift type

Pneumatic Moulding Machines

GUSTAVZIMMERMAN  
Model UGR - 2 - Three

- (vii) Jolt-squeeze Turn Over type  
Pneumatic Moulding Machine  
GUSTAV ZIMMERMAN  
Model W-2 - Two
  - (viii) MOULD DRYING OVEN  
COKE FIRED - One  
E.O.T. Crane Floor operated  
5 Tonne Capacity - One  
3 Tonne Capacity - One  
Vibratory shake out - One  
(not installed)
- (c) Core Shop
- (i) Core Sand Mixers  
- 50 Kg Capacity - One
  - (ii) Core Drying Oven - Coke Fired - One
- (d) Fettling Shop
- (i) Chamber type Pneumatic shot blasting  
Machine - One
  - (ii) George Fischer  
Wheel abrator - One
  - (iii) Swing Frame Grinder - Two
  - (iv) Duplex stand Grinders - three
  - (v) Rumbling Barrel - One
  - (vi) Gas cutting and Welding Set - One
  - (vii) Electric Welding Set - One
- (e) Pattern Shop
- (i) Bandsaw Machines - Two
  - (ii) Planer & Surfacer - One
  - (iii) Planer & Thicknesser - One
  - (iv) Disc Type Sander - One
  - (v) Bobbin Sander - Two -
  - (vi) Wood Turning Lathe - Two
  - (vii) Piller Drilling Machine - One

- (f) Sand Testing Laboratory
- (i) Speedy moisture Tester - One
  - (ii) Permeability Apparatus - One
  - (iii) DIETART UNIVERSAL  
Green Strength Compression  
Apparatus - DIETART - One
  - (iv) A set of A.F.S. Siebes and  
Shaker - One
  - (v) Mould and core hardness - One  
Tester
- (g) Metal Testing Laboratory
- (i) Chemical  
C & S determinator for iron and  
steel  
  
Micro Balance - two  
Muffle Furnace - One  
Spekker Apparatus (Hielger) - One
  - (ii) Mechanical Testing See  
  
Universal Tensile Testing  
Machine - One  
Hardness Testin<sub>g</sub> - One  
IZOD & Charpy Tester - one
  - (iii) Metallography Section  
  
Belt Sander - one  
Disc polisher - one  
Table Microscope - one
- (h) Methods Design Section
- (1) Drafting Machines - 3
  - (2) Printing Machines - 1



2. Product Range
- i) Steel
    - Sugar Mill Scrapper and Trash Plates
    - Cast Steel Trolley Wheels and Misc.
    - Items such as Alloy Steel Grinding balls for Cement Mills
  - ii) Iron
    - Sugar Mill Rolls
    - White Iron Cylpebs and balls
    - Misc Castings
  - iii) Non-ferrous
    - Impellers
    - Bushes
    - Misc. castings of aluminium and copper alloy

3. Major Foundry Raw Materials of Mozambique
- (a) River Sand of the Incomati River

GRANULOMETRIA (A.F.S.)			
Crivos	Gr.		%
12	03,309	x 6 =	19.85
20	20,150	x 12 =	241.80
30	17,150	x 20 =	343.00
40	17,400	x 30 =	522.00
50	18,302	x 40 =	732.08
70	11,003	x 50 =	550.15
100	07,001	x 70 =	490.07
200	03,040	x100 =	304.00
270	00,430	x200 =	86.00
Fundo	00,906	x270 =	244.62
Total	98,691		= 3533.57

A.F.S. No. = 35.34

(b) Local White sand - Unwashed

Local Malhazine 12 Km

GRANULOMETRIA (A.F.S.)		
Crivos	Gr.	%
12	0,0280	x 6
20	0,7091	x 12
30	1,9632	x 20
40	4,8051	x 30
50	13,1465	x 40
70	25,5534	x 50
100	34,5594	x 70
200	11,4820	x100
270	1,8730	x200
Fundo	1,6827	x270
Total	95,8630	63,9272 (A.F.S.)

(c) Areia de Fundação de Marracuene (24 Kms)

GRANULOMETRIA (A.F.S.)				
Crivos	Gr.			%
12	00,122	x	6 =	0,73
20	01,166	x	12 =	13,99
30	02,745	x	20 =	54,90
40	06,827	x	30 =	204,81
50	17,200	x	40 =	688,00
70	28,000	x	50 =	1400,00
100	33,020	x	70 =	2311,40
200	00,090	x	100 =	09,00
270	00,674	x	200 =	134,90
Fundo	01,043	x	270 =	281,61
Total	98,707	x		5171,517

A.F.S. No. 51.73

(d) Local white sand - 30 Screened and washed

GRANULOMETRIA (A.F.S.)				
Crivos	Gr.			%
20	0,561	x	12 =	6.73
30	2,572	x	20 =	51,44
40	13,644	x	30 =	409,32
50	31,358	x	40 =	1254,32
70	29,675	x	50 =	1483,75
100	19,669	x	70 =	1376,83
200	1,934	x	100 =	193,40
270	0,018	x	200 =	3,60
Fundo	0,059	x	270	
Total	99,490	x		4795,32

A.F.S. No. = 48.20

(e) Redsand from Maracuene (16 Kms)

GRANULOMETRIA (A.F.S)			
Crivos	Gr.		%
20	0,2074	x	12
30	0,5852	x	20
40	3,9150	x	30
50	14,2062	x	40
70	28,2878	x	50
100	34,1982	x	70
200	6,6118	x	100
270	0,4170	x	200
Fundo	0,2978	x	270
Total	88,73		

Total A.F.S. = 53,40

(f) Bentonite

Analysis after activation with Soda Ash

SiO <sub>2</sub>	.....	68.8%	
Al <sub>2</sub> O <sub>3</sub>	.....	11.8%	
Fe <sub>2</sub> O <sub>3</sub>	.....	2.6%	
TiO <sub>2</sub>	.....	0.3%	
CaO	.....	3.8%	
MgO	.....	2.2%	
K <sub>2</sub> O	.....	0.1%	
Na <sub>2</sub> O	.....	1.1%	
S	.....	0.1%	
S <sub>103</sub>	.....	0.01%	
C <sub>02</sub>	.....	3.2%	
Loss on Ignition	.....	<u>7.8%</u>	
		100%	(approximately)

Mineral Contents

Montmorillonite	.....	50 - 60%
Crystobolite	.....	30 - 35%
Kaolinite	.....	5%
Calcite	.....	3%
Quartzite	.....	2%
Dolomite	.....	1%

Green Strength	....	7.2 Neutron
Dry Strength	....	18 Neutron
Refractories	....	1240°C

GRANULOMETRY - DRY

-100	...	0.4
+100	...	04
+200	...	2.5

- g) Cashew Shell Oil - Properties not known, viscosity not known, colour Black.
- h) All other materials such as Dextrine, graphites, silica flour, sodium silicate, refractory materials both acid and basic are imported.

#### 4. Foundry Management

Production management is under the care of foreign engineers such as Production Manager, Foundry Manager, Foundry Methods Engineer, Foundry Practice demonstrator assisted by Mozambican counterparts.

#### 5. Manufacture of Cast-Iron Ingot-moulds. requirement and characteristics

Cast Iron Ingot moulds are subjected to following service conditions

- (i) To withstand heat and washout when the liquid steel is poured in the ingot moulds;
- (ii) To withstand wear when the ingots are stripped out of the moulds;
- (iii) To withstand mechanical shocks when the ingots get stuck in the mould or cannot be stripped out easily;
- (iv) to withstand continuous thermal shocks.

The life of ingot mould is a subject of great concern to steel makers all over the world and as such continuous research and development activities are carried out in almost all steel plants and various compositions of the iron were tested. Quite sometime back Institution of Metallurgists in London indicated following metal composition with which ingot mould consumption was between 15 to 25kg per ton of steel produced.

% T.C.	Si	Mn	S	P
4	1.4/1.8	1-1.3	Less than 0.06	.15 Max.

In a British Steel Works some investigation was carried out when the consumption of ingot mould with particular reference to silicon and sulphur content of the ingot mould were recorded as follows.

SI - 1.8%	consumption	32lbs/ton
Si - 1.65%	consumption	26lbs/ton
S - 0.045	consumption	26lbs/ton
S - 0.05	consumption	27lbs/ton

The average metal composition of medium and large ingot moulds as per British practice was as follows:

	%T.C	SI	MN	S	P
Medium moulds	3.6	1.5	1	.06	.1Max
Large moulds	3.3	1.2	1	.05	.1Max

The consumption of ingot moulds as per American practice was given as 16-22kg and metal composition was given as follows:

T.C.	SI	Mn	S	P
3.5	1	0.90	07	2
		Max.		

The expert got good results in India and Egypt with pearlitic iron having the following composition:

% T.C	CC	SI	Mn	S	P
3.5-3.8	.6-.75	1.45-1.85	.85-1	.05	.1

The surface hardness was 200 BHN + 10%.

The pouring temperature of the metal was between ~~12500C~~ - ~~12750C~~ depending on metal thickness.

b) Production of Ingot mould in CIFEL

During the period of last UNIDO Mission consisting of M/s Shands, Sherwani, and Sen, a set of pattern, Corebox, Coreiron and mould boxes were made.

The details of such manufacture are given in the Report of Mr. Sherwani.

It was therefore necessary to examine the old tackles and results were as follows:

- (a) The ingot mould pattern cracked in number of places and the pattern needed substantial repairs and painting.
- (b) The core box made of wood was completely distorted.
- (c) The core bar was made from steel pipes.
- (d) Mould boxes were not quite upto the standard of good foundry practice.

Production of Ingot moulds needs a solid pattern. The pattern construction although in wood should therefore need metal inserts at critical places. The core boxes are invariably made of aluminium, machined and well finished for getting the straight internal surfaces. To prevent any distortion taking place during drying of cores, the standard practice is to have core bar of cast iron tubes with number of holes to allow gas to escape. The internal surface of the mould box must be well ribbed so that sand does not fall or get out of shape during handling. Manufacture of all the above tackles to current foundry practice could have taken easily more than a period of three months. In order therefore to organize some factual demonstration for producing moulds and cores, it was decided in consultation with the laboratory chief Mr. Coudra Conrado that manufacture of a few moulds for demonstration would be taken up by repairing the existing tackles.

However, in the meantime the management desired that the length of the ingot mould should be increased from 1400m/m to 1650m/m which necessitated a complete set of new pattern core box, core iron and mould boxes. However on arrival of Mr. Sherwani the



co-expert who carried out extensive trials including trial rolling to justify his original design of 1400m/m long moulds, the question of ingot mould length was resolved.

However, in the meantime after carrying out as much repairs as was possible on pattern and core box it was possible to make the first ingot mould with composition of moulding sand, core sand and core paint as follows:

Moulding sand as was used by CIFEL earlier having the following composition was used for moulding:

Mix n<sup>o</sup> 1    220kg River Sand  
                   220kg Red Sand  
                   220kg ready mixed sand with 6lt of molasses  
                   6 lt of water

The laboratory test was recorded as follows:

Humidity            4.1%  
 Permeability      100  
 Green compression 7.71b  
 strength  
 Green hardness n<sup>o</sup> 88

The core was made to the following sand mix composition:

50kg - 30 screened and washed silica sand  
 4kg      Red sand  
 2kg      Bentonite  
 0.6 litre Cashew shell oil  
 0.5 litre Dexil (Dextrine based)  
 0.5 litre Molasses  
 100 M.L. water

Laboratory results were reported as follows:

Humidity 2.5%

Permeability 90

Green Comp.strength 6.5lb/sq. inch

Green hardness 105

The graphite paint was prepared with:

100 parts of synthetic graphite powder in absence of natural graphite

10/12 parts Bentonite

20/25 litres water

viscosity 40/45

and well mixed in a mixer machine after keeping overnight.

The first casting with the above composition was poured at a temperature of 1275°C on 6 December 1982. The internal surface of the mould was perfect and after machining the bottom of the mould, ingots were successfully bottom poured by Mr. Sherwani on 31 December 1982. The ingot stripped very well which proved the composition of the sand and paint mix as perfect for the purpose.

This mould however, subsequently, developed cracks during subsequent use. The actual drillings were taken from the surface of this ingot mould and the chemical analysis was reported as follows:

%	C	Si	Mn	Cr
	2.80	2.45	1.79	0.08
	2.83	2.50	1.82	0.10

obviously this was not pearlitic Iron.

The laboratory chief Mr. Cudra subsequently confirmed that the composition of Cupola charge which he gave to the melting shop was used for some other casting due to a mistake and the ingot mould casting was poured in ordinary iron.

However, this position was quickly corrected by actually working to a fresh Cupola charge the expert worked out conforming to pearlitic iron and actually supervised its actual introduction in the Cupola as given below:

- (1) Pig Iron - 100kg
- (2) Foundry Return - 75kg
- (3) Cast Iron Scrap - 75kg
- (4) Steel Scrap - 50kg
- (5) Ferro Silicon 75% - 2kg
- (6) Ferro Manganese - 1.5kg
- (7) Broken Graphite Electrodes - 1.5kg
- (8) Normal coke and limestone

The liquid iron was inoculated with "INOCULIN" a special brand of FOSEGO and 3kg of Electro graphite powder was added in the ladle.

The chemical analysis was reported as follows:

%	C	Mn	Si	S	P	BHN
	3.50	.98	2.15	x	x	219

Due to lack of facilities combined carbon of the metal was not determined.

The CIFEL technicians were advised to follow the above noted practices when mass production of ingot moulds are taken up after the Aluminium metal core box and other accessories are ready by the 15th of February 1983 as have been indicated by the production manager of CIFEL Mr. Capriano Magalhaes.

### Modernisation and Expansion

#### (a) Modernisation

In the moulding shop there are 8 Pneumatic moulding machines but 6 of them are broken down for maintenance, also two major sand mixer muller i.e. BMD and Gutman are down for repairs for a considerable period of time. A new vibratory shakeout is lying in the packing case.

Unless the moulding machines and sand mills are repaired and put to commission there is no sense in talking about mechanisation. However, anticipating that some day the machines will be repaired and put to use, a plan to mechanise the sand handling and mould handling system have been developed and indicated on the attached drawing.

There is no doubt about the fact that once the moulding machines are repaired and put to commission and mechanisation system installed the foundry will have a tremendous production capacity for castings needed spare parts for railways and other Industrial Establishments.

#### (b) Expansion

The proposal for extending the melting shop has been dealt with by co-expert Mr. Sherwani which will provide additional space for producing bottom poured pencil steel ingots.

### MAJOR CONSTRAINTS

1. There is no facility in the Chemical Laboratory to determine combined carbon and phosphorus mostly due to shortage of glassware and chemicals.

2. In the Sand Laboratory there is no laboratory sand mixer for developing sand mix for different purposes.
3. There is no weigh bridge to weigh the steel scrap charge in the Electric Furnace.
4. Poor maintenance in the Foundry indications two major sand mixer mullers and 6 mould machines have broken down and no efforts are visible for their repairs and renovation. Pattern shop machines also are in broken down condition.
5. Mozambique is extremely short of Technical personnel for shop management.
6. There is no inplant training programme either for foundry supervisors or foundry technicians.
7. Material procurement is not properly scheduled to a time-bound programme in conformity with the production programme.
8. Lack of inventory control.
9. Communication gap between different levels of management.

g) Conclusions

It maybe seen from the foregoing findings that CIFEL Complex has the in-built capacity to produce p.a. at least 15,000 tonnes of pencil steel ingots from the existing premises, about 2,500 tonnes of steel castings and about 3,000 tonnes of iron castings per annum after the mechanisation system has been introduced. The exploitation of this latent capacity would help Mozambique to save enormous amount of foreign exchange if efficient management system is introduced.

The maintenance sector is extremely poor as may be evident from the fact that out of 8 moulding machines six are under break down and also both the major sand mixer mullers are broken down in addition to quite a few pattern shop machines.

#### Recommendations

1. Regular production of pencil steel ingots and ingot moulds must be taken up on a regular basis at the earliest opportunity as has been amply demonstrated during the last and present UNIDO mission experts.
2. Procurement of all raw materials both local and imported must be arranged well in advance to fit in with time-bound schedule of the production programme.
3. Laboratory chemicals needed to analyse combined carbon in iron and all the elements in iron and steel should be arranged and stocked for regular analytical work.
4. Laboratory Chemists should be further trained in other countries for gaining further experience and confidence.
5. Sand Laboratory needs a small Laboratory Sand mixer muller which should be purchased.
6. There should be greater co-ordination, co-operation and accountability between the various levels of management to fill up the communication gap between different levels of management.
7. To take up market survey for demand of spare parts as cast products in Mozambique.

8. Capacity evaluation of the foundry after mechanization of the foundry.
9. Mozambique Government should allocate a certain amount of foreign exchange to enable CIFEL to import essential spare parts to repair the machines. These machines can then be pressed into service for manufacturing import substitution items in the form of steel, grey iron and nonferrous castings for railways and other Industrial Establishments in Mozambique.

