OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

This document has been produced without formal United Nations editing. The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations Industrial Development Organization (UNIDO) concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries, or its economic system or degree of development. Designations such as "developed", "industrialized" and "developing" are intended for statistical convenience and do not necessarily express a judgment about the stage reached by a particular country or area in the development process. Mention of firm names or commercial products does not constitute an endorsement by UNIDO.

FAIR USE POLICY

Any part of this publication may be quoted and referenced for educational and research purposes without additional permission from UNIDO. However, those who make use of quoting and referencing this publication are requested to follow the Fair Use Policy of giving due credit to UNIDO.

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

RESTRICTED

DP/ID/SER.A/1390
18 September 1990
ORIGINAL: ENGLISH

18605

HANDICRAFT AND SMALL INDUSTRIES DEVELOPMENT
PHASE III

DP/ETH/86/027

ETHIOPIA

Technical Report: Pilot Demonstration Foundry*

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

Based on the work of Brian Barrett, Foundry Expert

Backstopping Officer: V. Gregor
Institutional Infrastructure Branch

United Nations Industrial Development Organization
Vienna

* This document has not been edited.

V.90-87807

Report Contents.

Executive Summary.

For the past seven years the Ministry of Industry via the Handicraft and Small Industries Development Agency has attempted to establish a Pilot Demonstration Foundry being one of the projects in TEED (Technical and Engineering Extension Department financed by UNDP and the government of the people's Republic of Ethiopia.

The rate of progress has been largely affected by shortages of working capital and also shortages of materials. To a much lesser degree the rate of progress has been affected by the lack of skilled labour and basic equipment for constructing a foundry. In these circumstances the small team of technicians at HASIDA have performed well and competently.

From an assessment of the present situation there is much work still to be done before commissioning can take place and everything depends on the allocation of funds to complete the project. Some of the plant and equipment has not yet been delivered to site and may be held up in Customs at the port of entry.

This report attempts to list the work to done section by section and also lists the additional equipment and materials needed for a successful foundry operation.

The report offers suggestions for a change in status for the foundry, mechanical workshops and the woodworking shop so that they can become self sufficient and profitable and thus remove the financial burden upon government.

Given that all monies are available from the forthcoming budget allocations and that there are few material shortages then the foundry could be commissioned within a period of 44-46 weeks from September 1990.

Recommendations.

The plant and equipment supplied for the foundry is somewhat limited for a successful enterprise and therefore consideration should be given to supplying additional items particularly those related to mould production, casting finishing and health and safety as listed in the text.

The local currency funding for this project should be maximised to ensure a successful commissioning in 1991.

The foundry, machineshop and the woodworking shop should be combined under one separate management and whilst it would remain wholely owned by the Government it would operate as a 'private' Company and thus help reduce the current financial burden.

Introduction.

For the past seven years HASIDA has been in the process of establishing a Pilot Demonstration Foundry (PDF), being one of the projects in TEED (Technical and Engineering Extension Department) financed by UNDP and the people's Democratic Republic of Ethiopia.

There are several reasons for the delay in completing this project not the least a lack of funds for the local purchase of raw materials and some difficulty in the supply of such materials. Despite such setbacks the engineering team of HASIDA have made significant progress during the past 12 months in the installation of the sand handling plant and the electric furnaces and the electric overhead travelling crane which required some ingenuity to erect.

HASIDA meaning Handicraft and Small Scale Industries Development Agency is an unlikely situation for a foundry and machine shop and whilst the original project design might have justified a corelation between handicraft skills and the production of castings, in today's world it may seem rather incongruous.

The foundry building exists next to a woodworking shop and a machine shop and metal working shop within the compound of HASIDA which contains textiles, carpet making, bamboo cane furniture making, horn carving and other similar light craft activities. Outside the compound but immediately adjacent to the foundry are the offices of the Ministry of Tea and Coffee and on the other side of the main road is a large Hotel.

The original project document for the foundry placed emphasis on development, training, centre of excellence, research and development, laboratory testing services and materials analysis. The present economic climate of Ethiopia is such that the need to produce saleable cast products which would lead to financial self

sufficiency would receive greater approbation than a training centre constantly demanding support funding.

If this assessment is a true reflection of government thinking then the future objectives of the HASIDA foundry are likely to be as follows;-

1. To produce cast products at a consistant level of activity to generate a business-like environment which will ultimately become financially self reliant and self funding to relieve government of the burden. Such cast products would be priced and be of a quality to generate cash surpluses or profit.

2. To provide a technical and quality service to industry in the manufacture of components, spare parts and other cast and machined products.

3. To meet any market demand for cast products and indeed to help generate or develop a market for castings where none now exists, for example cast iron to replace concrete manhole covers and rainwater down pipes currently made from steel sheet.

4. To train foundry personnel under production conditions rather than in a non-incentive semi-academic environment

To provide a technical consulting facility to private foundrieswhere the current level of technology is low. Since private businesses are in current financial difficulties this service may have to be offered free of charge.

In respect of being a production unit and a training centre the project is rather short on essential plant and equipment as it now stands. For example the foundry will be able to melt at a rate of 750 gross tonnes ie. 500 tonnes nett good castings per year but it is doubtful whether the moulding and the sand handling plant could match this and certainly the casting finishing equipment is not adequate. If the foundry is to be self sufficient then aspirations to produce must relate to not only green sand castings but also to larger floor moulded castings up to a cast weight of 200 - 300 kg In this context however, the foundry space is very limited and it would be prudent to place all casting finishing activities in the planned extension of the foundry building (which is designed to house scrap and other raw materials.) If the machine shop is combined with the foundry then storage space for ferro alloys and other expensive items is already available with fork lift truck

access.

The combining of the foundry, machine shop. metal working shop and the woodworking shop under one management and separate from the handcraft industries of HASIDA should be given detailed consideration for the following reasons;-

a. the foundry requires a machining facility and the two departments are entirely compatible.

b. woodworking and patternmaking are closely related and essential machinery could be more fully utilised.

c. in terms of land, these units could be separated from the craft sections of HASIDA with separate access and security.

d. by making the combined units a wholely owned but 'private' Company it would be legally possible to circumvent government regulations regarding wage norms and allow incentive pay structures to exist which would relate to productivity, quality and sales. In this environment the Company could readily survive provided that adequate working capital was injected at the outset and that the foundry was fully commissioned and able to make its substantial contribution.

e. if the above suggestions were possible then the benefit to government would be considerable in terms of industrial development on the site and a lessening of the financial burdens that HASIDA now incurs.

f. there is at least one other project for a PDF in Ethiopia, ie. a training foundry to be sited near the AKAKI Spare Parts factory. It should be noted that the market for cast products is at present rather limited and that the AKAKI Spare Parts foundry is under-utilised to a substantial degree. To create a second PDF may in the short term add to the problems of AKAKI and HASIDA by way of competition . It has been stated that government opinions on this matter favour HASIDA catering for private industry requirements and the new PDF at Akaki would look afterpublic sector interests. In the long term both PDF's will be able to survive in a growing industrial base. What may be needed to give assurance to this premise is a funding of the market end to create the demand.

Due to the rather lengthy delays in completing this project as mentioned previously in the text, the one month mission to Addis Ababa has been almost confined to a diagnostic survey of the situation at HASIDA foundry. This report therefore identifies the work still to be done and the equipment yet to be received and/or installed. The capital expenditure budgets for the new financial year have not yet been divulged by the government treasury and therefore it has not been possible to ascertain whether the project will be fully funded to ensure completion within the next twelve months.

Materials, Handling and Storage.

1. The foundry layout drawing designed by HASIDA shows a possible building extention to accommodate raw materials under cover and secure. Unless there is provision in this years budget it is unlikely that the extention will be built before 1992. It has already been suggested that this extention should be put to more productive use as acasting fettling and finishing shop including despatch area. If this is approved then the scrap pens could be erected outside the end retaining wall of the extension. On the basis of a combined foundry and mechanical workshop there would be ample provision for storage of consumables.

2. There is an identified need for other consumable items than those already requested from UNIDO funding. These items are listed in Annexe .C. to this report, but in particular such items as mould and core coating, Alphset resin and catylist, carburiser are required.

3. The local availability of scrap is limited as evidenced from the fact that the AKAKI foundry is obliged to import scrap even though its current output level is only 30% of its design capacity. It would therefore be prudent for HASIDA to start accumulating small quantities of selected scrap to provide an ample stock when the foundry is commissioned. However, this suggestion requires funding and requires stock pens preferably under cover.

4. A highly suitable silica sand has already been identified for foundry use by the AKAKI foundry. It is strongly recommended that in the future, washed, dried and classified sand sand should be purchased, by agreement directly from AKAKI foundry and not from the quarry. This would avoid the necessity of providing a sand conditioning plant at HASIDA. Ideally, such plant should be at the quarry so that the entire foundry industry could benefit.

5. No consideration has yet been given to waste and rubbish disposal. Whilst many of the spent materials of a foundry may be considered non-toxic their dumping in bulk can cause long term contamination of underground water and adjacent land. This should be of concern to the Ministry of Industry.

6. The fork lift truck purchased by UNIDO and not yet officially handed over is apparently being used for all the workshops of HASIDA, not just the foundry and it is presently stored outside. It is feared that this vehicle will not be servicable at the time of commissioning. Already there are distinct signs of degradation and therefore the fork lift truck should be stored within the foundry and the keys secured.

7. No consideration has yet been given to the design and manufacture of various types of skips and stillages which can be handled by the fork lift for the transportation of castings, scrap, rubbish, sand etc. Again these items must be included in the budget provision.

Melting Plant.

The Inductotherm 500 kg Induction furnaces are superficially, substantially installed. However, there are major items still to be erected, connected or fitted. These include ;-

1. the water pump and furnace water closed cooling system is yet to be installed and the necessary connecting copper pipework and rubber hoses fitted. This is a major task which cannot be accomplished until part of the woodwork shop has been demolished and a new foundation concrete pad constructed for the radiator unit. The evacuation of the woodwork shop to its new building is some 6 months from action because of current shortages of building materials. As a temporary measure to expedite matters it has been suggested that the woodwork shop tool store be rehoused either in the foundry store room or better still at the top end of the shop which is the designated area for woodwork training. This would allow partial demolition of the old building to accommodate the water cooling system. However, this apparently requires a ministry of industry approval, permission to proceed and allocated funds.

2. the provision of an emergancy water supply tank and tower and the necessary pipework connections to the closed water system together with suitable valves.

3. the installation of the main power cable from the transformer house (not yet built) to the furnace panel so that the panel can be positioned and the bus bar connectors fitted.

4. the flexible hose leads to the furnace coil lack the special connectors to the busbars. These are requested from the furnace supplier via UNIDO.

5. the guard rails to the furnace platform though manufactured await fitting due to lack of cement or petty cash to buy cement. It is suggested that part of the rail be movable or hinged to allow access to the platform by the fork lift truck.

6. it has been previously discribed that in the vicinity of the foundry there are several important buildings which could be

poluted by foundry dust and fume unless some provision is made for dust and fume collection. This requirement is absolutely necessary for recarburising additions to cast iron. It should be noted that there is no ventilation in the foundry roof and the side vents in the walls will not provide adequate natural extraction .
This problem should be recognised and the funds made available so that an extraction unit can be supplied and the ducting fitted before commissioning the foundry.

7. the purchase of a rapid Carbon, Silicon, CE value determinator with combined temperature check apparatus complete with pouring cups and thermal tips as specified in the Annexe .. is absolutely necessary for prompt resolution of the elements which can be adjusted in the furnace bath, without which analysis of melts would be purely historic.

8. the manufacture by HASIDA of tools for deslagging the furnace bath and the provision of slag and rubbish trays.

9. the manufacture by HASIDA of wedge chill test apparatus to standard design.

Sand Plant and green sand Moulding.

The green sand preparation and handling plant is substantially erected, but requires much work to complete the installation.

1. the main support girder structure requires substantial reinforcement with diagonal and cross members to make the entire structure rigid and able to withstand the loads to be imposed upon it.
2. siting the Kunkel Wagner jolt squeeze moulding machine and grouting in the bolt fixtures with rubber pads between the base and the concrete floor.
3. provision of a monorail air hoist to transfer mould parts from

the moulding machine to the roller track. The hoist mechanism to incorporate a box part turn over device.

4. provision of a flexible sand distibution chute from the moulding machine sand hopper so that sand can be directed into the moulding box (because the hopper is set too high above the machine)

5. the roller track layout designed by HASIDA should be studied before completion to ensure that there is a coring up and mould closing station, a pouring station, a mould cooling station (representing 45 minutes production) and a method of box return after knock out. This equipment also needs urgent funding if it is to be completed on time.

6.. the bucket elevators to the sand plant need to be secured to the upper deck structure and also insulated to prevent vibration and noise tranference.

7. the locally produced parts of the sand plant require priming and painting after a thorough check of all weldments.

8. the magnetic separator geared motor missing from the original consignment and reordered has not yet been delivered .

9. the provision of secondary lighting circuits to essential parts of the sand plant including water proof lights and switches in the basement areas.

10.. completion of the installation of electrical cables to all motors and connectors and the operating panel of the sand plant. All cables are to be clipped to the structure and made safe. Each motor is to be test run using a temporary power supply. Provision should also be made for emergency stop buttons at the sand mill and in the basement.

11. provision of scrap metal collection bins(two) for the magnetic separator and also sand collection bins for the basement area.

12. manufacture of sand muller bottom wear plates missing from the consignment. HASIDA to make the pattern and the castings to be made at AKAKI foundry in high chrome iron. This requires funding.

13. installation of compressed air and water services to the sand plant.

14. production of wooden mould boards for roller track layout.

15. purchase of sets of moulding boxes (see below).

16. purchase of one Kunkel Wagner moulding machine (see below).

General comments concerning the moulding and sand plant.

It has been roughly estimated that the likely av erage weight of metal poured into a green sand mould will range from 12 kg - 22 kg. With a furnace melt of 500kg, the number of moulds required to absorb the melt will be approximately 25 per hour. Even assuming that half of the metal will be poured into floor moulds, 24 half moulds per hour would be required from the Kunkel Wagner moulding machine ie. twelve bottoms and then after a pattern change - twelve mould tops. With only one moulding machine this production rate would be very difficult to achieve and maintain thoroughout a shift. If the metal melted is held for long periods because of a shortage of moulds then the cost of electrical power could become alarming and furnace lining life could be seriously affected.
What is needed therefore is a second moulding machine so that cope and drag part moulds can be made simultaneously.

A second factor yet to be resolved is the amount of sand in the system and the design features to cool the sand after shake out. Moulds cannot be produced satisfactorily if the sand is above 35°Centigrade. This will only be established at the commissioning stage but the present view is that the plant may not cope with a sustained productive activity unless additional sand cooling equipment is provided. This could be in the form of dust

extraction equipment with ducting at the sand aerator and at the bucket elevator.

It should also be noted that twelve moulds per hour cannot be attained with only five sets of boxes (as supplied) each of two sizes ie. ten boxes. Allowing for mould storage prior to pouring, mouldcooling after pouring and a supply of box parts to the moulding machine an estimated 45 sets of boxes of a given size are necessary.

Further to the question of dust and fume extraction there is a strong likelihood that dust polution will not be controllable unless a dust collector is installed. Simply cutting the rate of productive activity will not stop the rate of polution.

Coremaking.

The plant layout shows a core room as part of the services and laboratory block. It is strongly advised to have all coremaking activities in the main foundry building near to the mould making stations. Apart from the sand laboratory which should have a direct access to the foundry the other labs should be isolated from sand. These laboratory rooms should also be free from dust and fume and preferably be air conditioned if sensitive equipment is to be protected.

Apart from a coresand mill no other facilities have been provided. The following items of equipment are considered necessary ;-

- one Coreblower 1.5 litre capacity.
- coremaking bench to be made in the woodwork shop with 2m x 1m x 0.1m thick work surface.
- CO_2 gassing equipment (pulse gassing type)
- Alpha set resin binder with catylist (100 litres binder)
- Additive weigh scale 0 - 10 kg x 250 grm.

- CO_2 Gas Cylinders (six)

- Core Coating Slurry mixer 25 lt capacity.

- Zircon Core and Mould Coating mixture 250 lt.

Casting Finishing Operations.

There appears to have been less attention given to the processes and problems of casting finishing than to melting and moulding. In fact the least capital has been spent in this area, which is a pity, since casting firishing is labour intensive with little or no job satisfaction. It is therefore seen as important to provide the necessary basic tools, a double ended pedestal grinder, fettling booths, dust extraction equipment and safety protection for operators.

It has been suggested that the fettling shop be transferred from its planned site inside the foundry to the building extension This proposal makes sensible use of the available space.

In order to transfer casting stillages in and out of the foundry there is a requirement to have a vehicle accesss at the front of the foundry building.

The sand blasting cabinet as supplied is of limited use for iron casting cleaning. The cabinet is of very light construction and has very limited loading capacity. It is therefore necessary to compliment this equipment with a rotary barrel type shot blaster.

The largest double ended grinder available in the local market is not suitable for casting cleaning and fettling. A double ended grinder with 600mm dia. x 80mm thick abrasive wheel and dust

extraction is necessary, plus a supply of wheels.

The provision of fettling booths and possibly of work positioners for ease of casting handling and fettling are requirements for the fettling department.

Utilities.

The supply of water to the plant is essential before commissioning, with a delivery capacity sufficient not to delay the sand preparation cycle. It may be necessary to provide a small header tank with ball cock if the supply pressure is low.

Compressed air at a minimum outlet pressure of 10 Bar is required. However, the compressor as supplied does not have the capacity to meet all the needs of the foundry and the air reservoir is too small. It has been suggested that a 100mm dia pipe ring main system be installed to increase the storage capacity for compressed air. The lack of compressed air capacity may prove to be a decisive limiting factor to both mould production and casting finishing.

Electrical Power Supply.

The lack of electrical power supply to the foundry is the major cause for not completing the installation of the plant and equipment. If electrical power had been available then the motivation to complete the installation would have been positive.

The Electrical Power Authority are required to supply some 600m of HT cable to a transformer 1000KVA which is to be housed in a building to be erected by HASIDA (civil contracted).
It is essential that sufficient funds are now made available to pay for the cable laying operations, the transformer, the transformer house and the cable to be connected from the transformer to the electric furnaces and other equipment through a

distribution board. Providing that funds are made available there is no reason why the lighting circuits should not be installed in preparation for the completion of the power supply.

Patternmaking.

It has been realised by HASIDA that without suitable pattern equipmentbeing available at the time of commissioning then it will not be possible to demonstrate the potential of the foundry nor prove the plant and equipment. It is therefore essential to have a patternmaking facility now even though it is temporary and even if the machinery of the woodworking shop has to be used .
The pattern tools and machinery have not yet been delivered but this should not prevent progress being made in providing master patterns. It is noted that the woodworking shop is under separate management but this should not be the cause of non action to provide a patternmaking facility.

Since the equipment has not yet arrived on site it is not possible to judge its suitability, but two items appear to be missing from the procurement list ;-

- patternmakers contraction rules for iron, steel, aluminium and copper alloys.

- pattern copy miller for reproduction of wooden patterns.

Laboratory Facilities.

The project has provided a range of sand testing equipment and chemical laboratory apparatus. Since this equipment is still in packing cases or not yet delivered to site no assessment has been made. It has however been proposed to re-design the layout of the laboratory rooms and to make better provision for maintenance.

Marketing.

Although this subject does not directly affect the commissioning of the supplied plant and equipment the future success of the project does demand consideration of what type of casting will be made in the foundry. Activity levels will be very low if the foundry waits for a customer who may require only a one off spare part. Firm guidance is therefore necessary from the ministry of industry in this matter. To be fair to HASIDA some consideration has already been given to this problem and to making alternative products to AKAKI foundry so that HASIDA does not become a competitor. Several ideas are currently being evaluated.

Management and Training.

HASIDA foundry has a small select team who will form the nucleous of the management and supervision. Since the date of commissioning is not imminent the presence of this team at some time in the future is not certain. For example the senior engineer is shortly to go to University in England to complete a Masters Degree course. He will not therefore be involved in the final stages of the installation of the plant. His successor was also abroad during this mission and it was not clear whether he would return in time for a formal hand over of duties.

The team have all received some training in foundry related subjects during the period 1987 -1989. There is always the danger that such training will be largely forgotten by the time of commissioning, however, some 'in plant' refresher courses can be held when the time is opportune.

With regard to manpower for the various founding operations some recruitment policy will have to be adopted when the date of commissioning is clear. Until that time there is no point in offering training programmes.

Time to Commission the Foundry.

The time required to complete the instaliation ready for commissioning is very difficult to assess without knowing the financial provisions in the forthcoming budget and the manpower available for each element of work shown in Annexe... For example HASIDA has one qualified electrician and without help the installation of the power cables , lighting circuits, distribution boards etc would take many months. Given that money and labour are available and that jobs are worked simultaneously in a planned fashion then it is estimated that the commissioning of the foundry could take place in 46 weeks if the programme commenced say September lst 1990. This estimate is for the foundry only and not for the laboratories but if the same premise is made regarding labour and funds then all the ancillary items could be completed with a twelve month period.

The main problem will continue to be the installation of the power supply particularly if the electrical authority will not start laying the HT cable before the transformer house is complete and will not allow the cable to the furnace before they have tested and passed their power input and transformer.

Work Plan Elements.

The following lists details the work still to be carried out in order to be able to commission the foundry. The estimate of time for each element is based on Ethiopian values which takes into account the lack of infrastructure and the time taken to requisition materials etc. The nett time estimated in the work plan assumes that all necessary funds will be available this coming financial year and that extra to budget funds will be available should the need arise.

A. Furnace Water.	Estimate of time to complete. weeks.
1. Build temporary accomodation for the woodwork shop tool stores, transfer stores and vacate the old store.	9
2. Demolish the old store building.	1
3. Design and manufacture girder frame support for radiator	9
4. Provide a concrete base for radiator framework	8
5. Erect water cooling radiator and connect all pipework	16
6. Fill system with soft water, check out pumpscheck for leaks	2
7. Supply and erect emergency water tank and connect piping via isolator valves to closed circuit system	10

B. Electrical Power.	
1. Confirm agreement that the civil contract will re-commence work on the foundations for the transformer	2
2. Build foundations and transformer house	15
3. Install the transformer (by EELPA)	3
4. Supply HT power to transformer (trenched 600 m cable)	20
5. Supply power cable from transformer to furnace (overhead 150m)	10
6. Provide secondary power line to distribution boards	10

7.	Provide complete lighting curcuits to the foundry	10
8.	Provide emergency buttons to sand plant	4
9.	Complete all electrical curcuits to motors and panels	8
10.	Supply and install SDB for sand plant	4

C. Utilities.

1.	Provide an insulated building for the compressor and engineer a ring main system for compressed air including shut off valves and water separation filters	16
2.	Provide connectors and pipework to all plant items using air.	4
3.	Repair compressor damaged in transit.	1
4.	Check system for leaks	1
5.	Provide water mains piping to sand plant and foundry sink	8

D. Buildings

1.	Build extension to foundry to accommodate casting finishing section and despatch area.	18
2.	Erect scrap pens .	4
3.	Prepare and install pattern shop facilities (temporary)	12
4.	Complete sand testing laboratory	32
5	Complete metallurgical/analytical laboratory	42
6.	Complete mechanical testing laboratory	42

E. In House activities to be completed.

1.	Sand plant elevators to be secured to the main frame	4
2.	Sand plant mainframe to be reinforced with cross members	8
3.	Access door hinge pins to be fitted where missing	1
4.	All locally fabricated parts to be painted.	16
5.	The overhead crane hook safety clip to be remove and heat reflector plate fitted below pulley block	4
6.	Moulding machine to be correctly sited and fixed	2
7.	Sand fall chute to be designed and fitted for mouldfing m/c	4
8.	Pneumatic hand operated dosing panel to be fitted	2
9.	Positioning of furnace control panel when power cables are provided from the transformer, connection of busbars completing hydraulic pipework,	2
10.	Provide furnace tools for slagging off, slag trays, rubbish containers, scrap loading bins,	8
11.	Provision of roller track layout for green sand moulding	20
12.	Provision of monorail air hoist for box transfer	12
13.	Manufacture of 60 mould boards in wood	6
14.	Manufacture of various wooden moulding boxes for flaskless moulding.	12
15.	Manufacture of wooden stairways for sand plant and foremans office	8

Annexe B.

Items of Plant and Equipment Required.

1. 45 sets of moulding boxes for Kunkel Wagner machine
2. Gas cutting equipment for scrapyard.
3. Manufactured by HASIDA or purchased -two fettling booths
4. One Kunkel Wagner moulding machine
5. one shot blast barrel machine
6. one swing frame grinder/cut off machine
7. Dust and Fume extraction equipment
8. Bar casting machine for cast iron bar/
9. Pour down moulds for spare metal (to be produced inhouse)
10. Patterns various to be ready by commissioning date.
11. Core shooter machine
12. Coreshop additive weigh scale
13. Spare furnace coil
14. Safety equipment including safety shoes, goggles, aprons etc.
15. Patternmakers contraction rules.
16. Pattern miller.
17. Carbon/Silicon/CE Value determinator and combined pyrometer
18. CO_2 Pulse Gassing Equipment
19. Kilowatt Hour meter for furnace power consumption control
20. Foundry 3 tonne truck for sand and scrap collection.
21. Project vehicle (toyota land cruiser type)

Annexe C.

Materials Required.

1. 50 tonnes silica sand from AKAKI.
2. 5 tonnes carburiser.
3. 2 tonnes Silicon Carbide
4. 1 tonne Aluminium Ingot
5. 0,5 tonne Copper ingot.
6. 2 tonnes slag coagulant for iron and steel
7. Alpha set resin and catylist for cores and floor moulds
8. Zircon mould and core coating
9. Cut off wheels and grinding wheels
10. Shot blast media.

DIAGRAMATIC — FETTLING BOOTH

METAL GRID
8mm THICK PLATE STRIP
75mm X 75mm X 75mm