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ESTABLISHMENT AND OPERATION OF SMALL CAST IRON FOUNDRIES
INDIAN EXPERIENCE 1/

by

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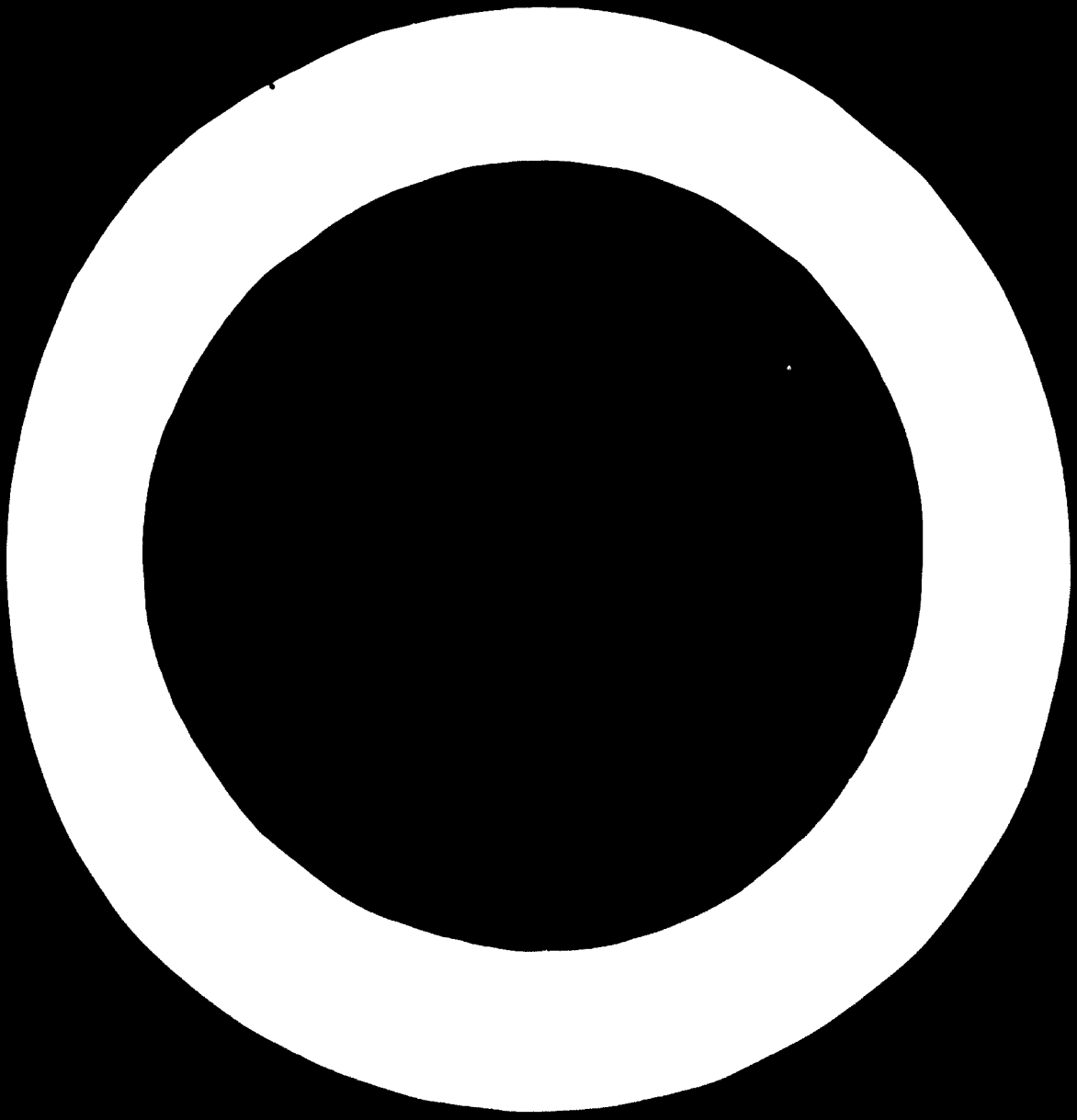

Preface

The growth pattern of industrialization, including foundry industry, frequently takes rather erratic shape for a developing country rapidly going through different phases of development. India is no exception in this type of spontaneous early development of its foundry industry. During the early stages of this industry it was based on elemental and temporary factors without proper planning on a regional or country basis. The individual initiative of the entrepreneurs crossed all barriers of scientific planning in this region. Nevertheless, production activities have been carried on and quality products are being turned out in this area, helping to save the country's valuable foreign exchange. During the last years this industry had to be synchronised and reorganized through better planning.

The selection of priorities between creating indigenous research and development and directly going in for tailor-made production units plays an important role in developing a sound foundry industry. Fortunately, in Indian conditions there was good co-ordination between the two types of creation and transfer of "know-how" in this branch of industry.

The development of the foundry industry in the Howrah area is a result of initiative, hard work and self discipline, supplemented by appropriate Government support and incentives. It is hoped that similar conditions exist in most of the countries of Asia and the Far East region or that such conditions can be created.

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Explanatory Notes

Reference to "tons" indicates metric tons, unless otherwise stated.

The following abbreviations and symbols are used:

c.f.m.	cubic feet per minute
C.I.	cast iron
M.S.	mild steel
M.T.	metric ton
p.a.	per annum
psi	pounds per square inch
Rs.	rupees
S.G.	spheroidal graphite
'	foot
"	inch

INTRODUCTION

Establishment of a small cast iron foundry may sound like a simple matter, but in fact it is not just installing a few items of equipment and producing a few castings. Setting up even a small cast iron foundry involves just as serious consideration of various aspects as for a large industrial complex. To set up the plant for a particular type of product and ensure its future growth as a successful industrial unit for ultimate good of the society needs strong foundations and industrial climate which can not be created single handed by one entrepreneur. It is a dynamic and continuing process. Realising this truth, the Government of India decided to create conditions under which those having the enterprising spirit and technical competence could actively participate in setting up small industrial plants, including small foundries. The task was by no means easy to solve particularly having in mind that the basic utilities and infrastructure such as electric power, steady supply of essential raw materials, communication facilities for the continuous procurement and movement of raw materials and finished products, plant and equipment and technological know-how and quality control methods, adequate finance, marketability of finished products etc. were not available before to the extent required. The Government of India had to take a series of urgent actions to provide the infrastructure in the country for an industrial base where both large and small industrial organisations could perform their respective functions in building an enlightened society bringing in its turn

maximum employment for its population and at the same time ensuring a product quality comparable with that anywhere in the world.

Foundry industry was only one of the major industries that came up in the country by taking advantage of the common service facilities provided by the Government both at the national and at the state level. Without these common services and basic infrastructures it would have been rather impossible to foster the growth of both large and small foundries in the country. The functions of various organisations which were catering the needs of small industries and with which the small grey iron foundries are closely interlinked have been briefly described, in order that the same pattern of organisation can eventually be set up by other developing countries. While it is extremely important for an entrepreneur to motivate himself for taking up a self-employment programme of setting up his own small foundry in his own country after making a careful study of local conditions prevailing in each respective case such as availability of basic raw materials, marketability of cast products and basic infrastructure needed to set up the plant, it is equally important that the common services facilities are made available to him in order to save valuable time and to avoid investing a substantial sum of money in providing the infrastructure. The phenomenal growth of small foundries in India has been due to the basic infrastructure provided by the various Government organisations as have been elaborately highlighted in this report.

Howrah, being the oldest industrial belt of India, where the roots of industrial growth took place as far back as the 18th century mainly due to the enterprising spirit of a handful of people, still plays an important role in the over-all industrial activity of the country. This paper deals with some of the salient features which were responsible for the growth of foundry industry in the area.

While old foundries are still functioning in the old way, new ones with modern technological practices are coming up fast to take up manufacture of more and more sophisticated items of castings needed for India's multifarious industrial complexes such as steel, cement, paper, chemicals and fertilisers, aircraft and defence hardware industry, railway system and automobile industry, agriculture and consumer goods such as sewing machines, electric fans, electric motor, machine tool industry etc.

The various case studies given as annexes of the paper with description of technological and financial data may serve as examples providing useful information to an entrepreneur or to organisations planning to establish foundries in their respective countries. Project reports of different types of foundries with details of equipment productivity, production cost etc. under Indian conditions may serve as a basic guide to entrepreneurs in developing countries who are desirous of taking advantage of Indian experience gained after several decades of trials and tribulations to set up small foundries on identical lines in the developing countries of Asia and the Far East.

The author wishes to place on record his sense of appreciation for the co-operation and assistance that has been extended to him by Mr. S.K. Ghose, Director, Small Industries Services Institute, Calcutta, Mr. B.L.N. Rao, President, Mr. R.M. Krishnan, Vice-President, Mr. V.S. Bhandary, Hon. Secretary, and staff of the Institute of Indian Foundrymen in preparing this report for submission to UNIDO.

1. HISTORICAL BACKGROUND OF FOUNDRY INDUSTRY

During the concluding session of the 40th International Foundry Congress held in Moscow in September, 1973, Mr. Kihl, President of the Congress, declared that the foundry industry has been judged to be the world's second largest industry not only from the point of view of employment orientation but also in order of importance for the role it is playing to sustain and improve human civilisation.

Mr. Howard Taylor of the Department of Metallurgy of the Massachusetts Institute of Technology traced the date of establishment of the first foundry centre during the days of Shang Dynasty (1766-1122 B.C.) in China. Mr. S.D. Joshi in his book entitled 'History of Metal Founding on the Indian Sub-Continent Since Ancient Times' in tracing the origin of foundry industry in India after examining various ancient cast products concluded that foundry industry was in existence in India even in 4000 B.C. Whatever may be the date of origin of the foundry industry either in China or in India one fact is certain that the technique of metal casting has traditionally been an art and a craft with secrets of the trade passing jealously from father to son in every country where foundries came into existence to meet the growing needs of human civilisation either in the form of domestic articles, work of art or military hardware until the industrial revolution in the 18th century. It was only during the beginning of the present century that the scientific community started taking active interest in the materials and the processes of the foundrymen. Today the foundrymen can feel confident that science and technology have made noticeable entry into the various critical aspects of foundry practices previously treated as top secrets.

2. SOME REMARKS ON THE PRESENT STAGE OF DEVELOPMENT OF FOUNDRY TECHNOLOGY

The modern means of quick transport, be it an automobile or a rail car, a ship or a submarine, an aircraft or a space craft, needs castings of high precision that cannot be made without the active help of modern science and technology.

Since the Second World War remarkable progress has taken place in the casting industry. The metal casting technology and foundry practices have been gradually developed to such an extent that it has been possible to guarantee the internal soundness and consistent solidity of the metal cast to various shapes and maintain the fine tolerances of dimensional accuracy sometime even eliminating costly machining operations. The invention of monocrystallic metal castings to overcome fatigue in modern long-range jet aircraft and space craft are only a few examples which can be cited in full confidence. This has been possible due to development of various melting techniques in vacuum, where no atmosphere can contaminate the metal. For dimensional accuracy the lost-wax method of moulding and casting in ceramic moulds has brought perfection to such an extent that even fine threads for which previously costly thread-rolling machines were employed are now being cast in various types of special alloys.

Concurrently phenomenal progress has been made even in conventional preparation of sand moulds which need no mould-boxes; even the cores are made of binders requiring no baking. The modern high-pressure boxless

moulding system is capable of producing as many as 300 moulds per hour with only one or two men working to press a few buttons producing castings of high precision and dimensional accuracy and interchangeability expected of a component for an automobile or agricultural tractor, etc. A typical example of an automatic high productive moulding line with sand preparation and reclamation system is shown in Fig. 1.

3. ROLE OF SMALL SCALE FOUNDRIES IN DEVELOPED COUNTRIES

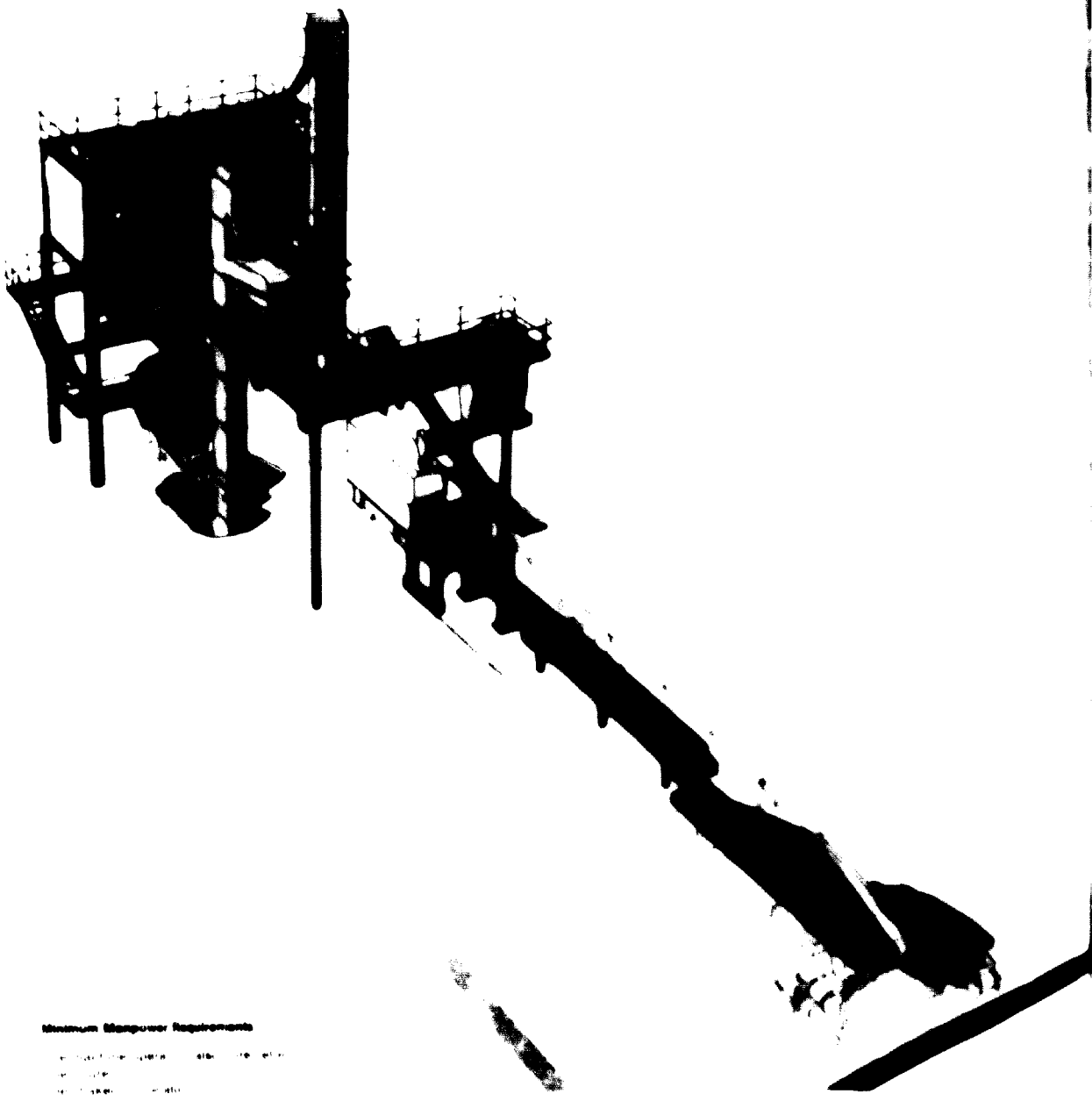
Simultaneously with the development of mass production technology of cast parts required in large quantity it is fascinating to note that the small foundries are still playing an important role in the economic activities of most developed countries.

It is interesting to note that in the USA in 1957, there were 2937 small foundries each employing less than 20 men out of a total of 5758 foundries.

In the same year, the following tonnage of castings was produced:

- Grey iron	12,664,504
- Steel	1,766,191
- Malleable iron	862,976
- Copper base	437,700
- Aluminium	375,878
- Zinc base	331,800
- Magnesium	15,161

It may be observed from the above figures that production of



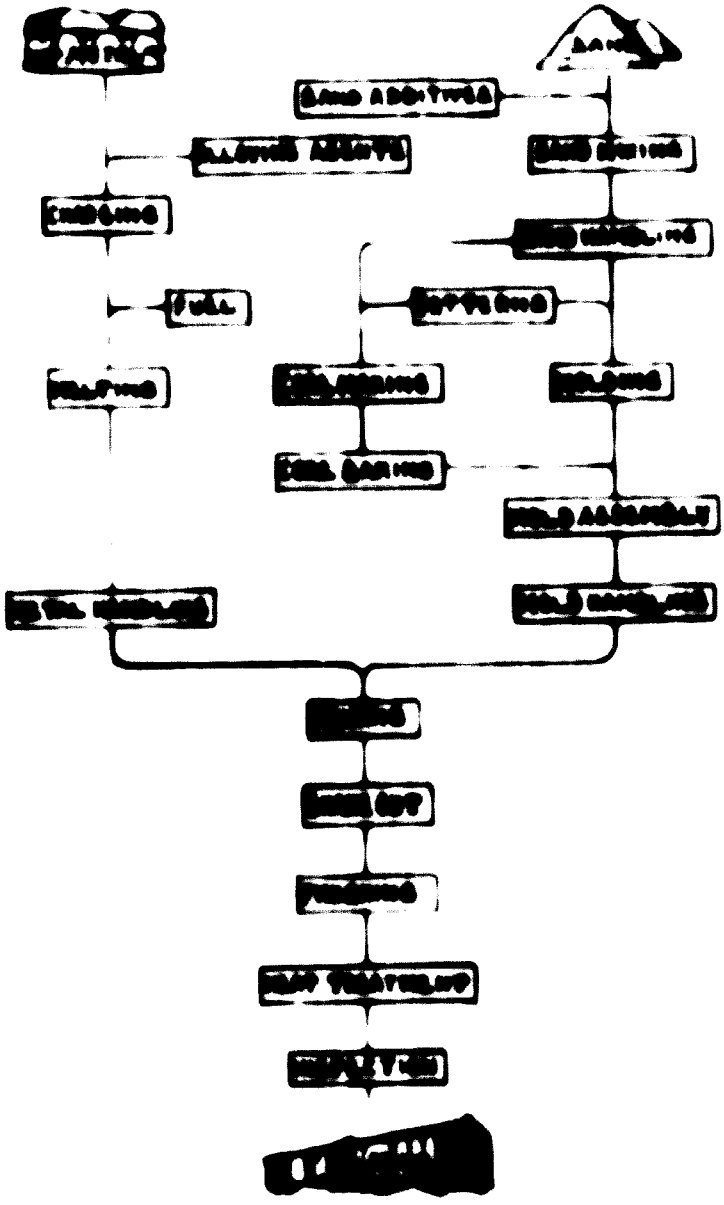
Minimum Manpower Requirements

Better Working Conditions

grey iron castings was almost eight times greater than steel and about twelve times greater than malleable iron casting production figures, respectively. This proves that greater attention must be given to creating and developing cast iron foundries.

It is a very healthy sign that attention is being seriously given to the development of grey cast iron foundry industry particularly in the small scale sector, not only by individual governments but also by the international organisations like United Nations Industrial Development Organisation. The scientific institutions and universities in almost all developed countries are providing appropriate facilities to enlighten the operations of small foundries, in addition to their efforts connected with the development of foundries for mass production. Since the basic technological steps in a large foundry or in a small foundry are fundamentally the same, the engineers and technicians responsible for carrying out the production activities should be intimately familiar with all the aspects of the various practices that must be implemented to produce a shaped casting. These basic steps are presented in the flow sheet shown in Fig... It may be noted from the flow sheet that the individual steps required to make a casting from raw materials are quite different from one another, each step involving a completely different type of technological treatment and method and having its own operational hazards which must be overcome for the purpose of producing a good quality casting.

Fig 2



FLOW SHEET OF TYPICAL METAL CASTING OPERATIONS

For example, the melting of metal to its predetermined composition involves thorough understanding of the metal characteristics from the stock yard to the mould and in each step adequate precautions must be taken so that only correct quantity and proper processing are used until the finished product gives the desired service life.

Similarly the preparation of the sand to make the cavity for the casting requires a quite different type of technology right from the selection of sand and its bonding materials so that it provides a stable shape for exact formation from the pattern around which the sand moulds or cores are formed.

The technology of pattern making is again a trade in itself quite different from metal-making or sand preparation and testing.

The job of a foundryman is therefore rather complex, involving control of multifarious factors which go towards formation of the castings from its liquid to solid state and its ultimate end use giving satisfactory service life in hazardous conditions.

A foundryman, therefore, has to prepare himself to accept the challenging task of producing a sound and solid casting by thoroughly understanding each of the basic steps.

4. FOUNDRY INDUSTRY OF INDIA

After many years of development through trials and tribulations, India has made a remarkable contribution towards the development of the foundry industry, the maximum noticeable growth taking place in the cast iron foundry industry, as may be seen from Table 1.

Table 1. Foundry Industry in India

State	Total number of foundries	Number of Small Scale Foundries	Production capacity of small scale foundries (tons)
Andhra Pradesh	286	131	10,000
Assam	18	12	3,000
Bihar	194	142	92,400
Delhi	154	142	51,000
Gujarat	348	309	97,600
Himachal Pradesh	5	5	
Jammu Kashmir	2	2	1,500
Kerala	100	88	8,000
Madhya Pradesh	78	56	17,000
Madras	288	183	78,00
Maharashtra	340	273	91,400
Mysore	164	147	28,000
Orissa	27	22	04,000
Pondichery	7	7	
Punjab	859	681	2,00,000
Rajasthan	46	33	27,000
Uttar Pradesh	650	621	3,70,000
West Bengal	409	270	1,90,000
Government Foundries	78	11	24,000
Total	4,197	3,466	1,37,8,400

Although the iron pillar [illegible], the [illegible] the Sun-temple of Konarak, the Delmada[illegible] bronze castings [illegible] West Bengal, the [illegible] cannot [illegible] known [illegible] Bijapur and many other old [illegible] the existence of a highly [illegible] o[illegible] times, the modern [illegible] country [illegible] [illegible] 19th. Already in [illegible] was clearly defined and multifarious [illegible] were taken up to meet the growing [illegible] process created avenues of employment for [illegible] Giant steel plants, heavy engineering [illegible] agricultural tractor plants, fertilizers and chemical plants, aircraft factories, locomotive and railway rolling stock factories, diesel engine and electrical machinery [illegible] plants were planned and constructed in addition to [illegible] textile and jute mills. Special emphasis was laid [illegible] small scale industries [illegible] which was the basic industry on which the growth of the engineering industry, large and small depended. The small scale sector thereafter was called to play its legitimate role in building up and developing foundry industry. The Ministry of Industrial Development of the Government of India announced their policy towards the growth small scale industries through the length and breadth of the country, for which a series of positive measures were taken as [illegible] in the descriptions that follow.

Since the problems of small grey iron foundries were interlinked with the problems of the small scale industry as a whole, the measures suggested were equally helpful for the countrywide growth of small grey iron foundries also.

ASSISTANCE PROPOSED BY THE MINISTRY OF INDUSTRIAL DEVELOPMENT OF THE GOVERNMENT OF INDIA

The international perspective planning team of the Ford Foundation, after visiting the country in 1964, arrived at the conclusion that a piecemeal approach for solving a multidimensional small foundries problems and that one is standing in the way of the growth of small scale industries and must be made first, so that an entrepreneur can effectively motivate himself to set up his own small scale industry based on his own technical preparation and aptitude for taking up the production of articles profitable which will fit in the overall economic activity in the country. The problems were:

Market research

Designing

New materials

Equipment and organisation of working

Technical guidance and research

Promotion and distribution

Finance

Organisation and co-operation.

To solve these problems the perspective planning team made certain suggestions and recommendations for implementation by the Government of India as enumerated below:

a) Establishment of a multi purpose institute of technology for rendering services to the industrial units to enable them to obtain scientific and practical knowledge which they cannot effectively obtain themselves.

development work;

information;

ity for small

ity from workshops

ment;

ate banks, state co-operative

ethod of

he type of assistance typified by schemes for setting up

which were established and distributed free with the

or engine would secure various types of

the State Government would

A scheme of this factory that is premises of any

industrial estate set up by the State Government;

A scheme for supply of power from the State Electricity

Board;

A scheme for supply of essential basic raw materials with

assistance in their procurement;

Provision of water and equipment on hire purchase

basis; and

Establishment of credit facilities for purchase of raw materials and discounting of bills.

The Industrial Service Institute of the Government

of the growth of small industries in the State. These small scale industrial units, assisted by the Industries Service Institute, have provided employment to about 50 lakh workers producing goods worth about Rs. 1,000 crores. Fixed capital investment in these units is about 40% of the gross industrial production in the

---

It will be

[illegible], cost of which came from a large number of small foundries. A [illegible] ago for setting up new cast iron foundries, as well as for the expansion and modernisation of foundries, are as follows:

1. Scheme for cast iron foundries

- Land and Buildings

[illegible] sq.ft. land	[illegible]
covered area [illegible] sq.ft.	
at Rs.10/- per sq.ft.	[illegible]
office building [illegible] sq.ft.	
at Rs. [illegible]/- per sq.ft.	[illegible]
	[illegible]

- Machinery and Equipment:

[illegible] per hr. cap. [illegible] No. 4" complete with [illegible] are sheet motor, including [illegible] fuging, clay, [illegible] and platform.	[illegible]
Core and mould drying oven 10' x 10' x 7' outside [illegible]	[illegible]
Sand Muller	[illegible]
Moulding box and [illegible] straight.	[illegible]
All [illegible] [illegible]	[illegible]
Molding power [illegible]	[illegible]
[illegible]-shaft grinder with [illegible]	[illegible]
Weighing scale [illegible]	[illegible]
Patterns	[illegible]
Miscellaneous	[illegible]
Office Equipment	Rs. [illegible]
Installation cost	[illegible]
	Rs.55,200/-

V. Recurring Expenditure:

Raw Materials & Consumable stores		(per month)
1. 17 M.T. Foundry Grade Pig Iron @ Rs.560/- M.T.		Rs. 9,520/-
2. 17 M.T. C.I. Scrap @ Rs.440/- M.T.		Rs. 7,480/-
3. Coke 9 M.T. @ Rs.260/- M.T.		Rs. 2,340/-
4. Coal 3 M.T. @ Rs. 100/- M.T.		Rs. 300/-
5. Plumbago, Bentonite, fire-clay etc.		Rs. 100/-
6. Mould & Core Sand		Rs. 200/-
7. Ferro Alloys		Rs. 100/-
8. Miscellaneous		Rs. 100/-
9. Limestone 2.5 M.T.		Rs. 250/-
		Rs. 20,390/-
	Rounded up	Rs. 20,400/-

Staff & Labour		(per month)
1. Foreman	1	Rs. 400/-
2. Skilled moulders	5 @ Rs.250/-	Rs. 1,250/-
3. Semi-skilled Moulder/ Core Maker	5 @ Rs.200/-	Rs. 1,000/-
4. Cupola attendant	2 @ Rs.200/-	Rs. 400/-
5. Unskilled worker	10 @ Rs.100/-	Rs. 1,000/-
6. Storekeeper/clerk	1	Rs. 300/-
		R. 4,350/-

Other items of expenditure	(per month)
1. Power, water charges	Rs. 250/-
2. Transport charges inward & outwards	Rs. 1,000/-
3. Repairs & renewals	Rs. 200/-
4. Stationery	Rs. 50/-
	Rs. 1,500/-

Recurring expenditure for 3 months	
1. Raw Materials & Consumable stores, 20,400 x 3	Rs.61,200/-
2. Staff & Labour, Rs.4,350 x 3	Rs.13,050/-
3. Other items of expenditure, Rs.1500/- x 3	Rs. 4,500/-
	Rs.79,350/-
Rounded up	Rs.79,300/-

D. Total Capital Investment :

1. Land & Building	Rs. 36,000.00
2. Machinery & Equipment	Rs. 55,200.00
3. Recurring Expenditure for 3 months	Rs. 79,300.00
	Rs. 1,70,500.00

E. Profit & Loss for one month:

1. Recurring Expenditure for one month	Rs.26,450/-	By sale of finished castings @ Rs.1050/- M.T.	Rs.31,500
2. Depreciation of Buildings @ 5% p.a.	142/-		
3. Depreciation of Plant & Machinery	460/-		
4. Interest on total capital investment @ 10% p.a.	1,420/-		
5. Gross profit before taxation	3,028/-		
	Rs.31,500		Rs.31,500

II. Scheme for the Manufacture of C.I. Pipe Fittings (Malleable Cast Iron):

A. Land & Building:

A covered area of 12000 sq. ft. taken on rental basis @ Rs. 0.30/sq.ft.	Rs. 3,600/-
Office Building - 1000 sq.ft. @ Rs.1/- per sq.ft.	Rs. 1,000/-
	Rs. 4,600/-

B. Machinery & Equipment:

I. Melting Section

a) One 1-ton oil-fired rotary furnace complete with accessories.	Rs. 75,000/-
b) Cupola - 24" dia. with all accessories	Rs. 24,000/-
c) Ladle Heating Equipment	Rs. 1,200/-
e) Geared Ladles and hand ladles	Rs. 3,800/-
f) Optical pyrometer	Rs. 1,800/-
g) One overhead Hoist 2-ton cap.	Rs. 10,000/-
	Rs.1,16,800/-

c. The Foundry:

a) Moulding boxes, 600 pairs, size 9" x 8" made of rolled steel plates	Rs. 18,000/-
b) Match plate pattern, 6 pairs	Rs. 6,000/-
c) Sand Mixer, 48" dia	Rs. 12,825/-
d) Sand riddle - 36" dia with striped stand	Rs. 3,500/-
e) Core ovens 6' x 3' coal-fired, 2	Rs. 9,000/-
f) Hand Moulding Machines, 5 pairs	Rs. 30,000/-
g) Pedestal Grinder- 12" dia x 1½"	Rs. 2,500/-
h) Pneumatic Grinder	Rs. 450/-
i) Air Compressor, double stroke, 100 c.f.m. displacement at 80-100 psi complete with tanks, motors etc.	Rs. 10,000/-
j) Foundry & Fitting tools	Rs. 3,500/-
k) Weighing Balance, 1-ton platform type	Rs. 5,000/-
	Rs.1,00,775/-

d. Annealing Section:

a) 2 Bogie-type oil-fired furnace, size 15' x 10' x 7', with burner, thermocouple pyrometer etc.	Rs. 80,000/-
b) 24 cast-iron annealing boxes 24" round x 15" high and each provided with detachable stools and covers, stool provided with legs	Rs. 2,400/-
c) Short Blast machine, rotary table type	Rs. 20,600/-
	Rs.1,03,000

e. Hot Dip Galvanizing :

a) Pickling tanks with pump	Rs. 5,000/-
b) Coal-fired oven for drying pipe fittings	Rs. 3,000/-
c) Coal-fired galvanizing bath made of either 1½"-thick cast-iron pot or 1/2-inch thick welded M.S. Plate, diameter 36 inches and depth 10 inches with initial 1 ton zinc	Rs. 10,000/-
	Rs. 13,000/-

F. Machine Shop:

a) Semi-automatic tapping machines, 2	Rs. 32,000/-
b) Vertical tapping machines (semi-automatic), 4	Rs. 32,000/-
c) General purpose machines: 1 lathe 6', 1 drill 3/4"	Rs. 10,000/-
d) Workshop tools & workers bench with vices	Rs. 6,000/-
	Rs. 80,000/-

G. Laboratory Testing:

Chemical testing:- Arrangement provided for regular determination of carbon, silicon, phosphorus, sulphur and manganese and periodical analysis of galvanizing bath solutions

a) Furnace & Fittings, work tables, shelves, cupboards, fume-closet etc.	Rs. 2,500/-
b) Necessary glass apparatus, chemical reagents, carbon and sulphur determinator.	Rs. 18,000/-
c) One chemical balance	Rs. 850/-
d) One Rockwell hardness tester	Rs. 4,000/-
e) 10-ton tensile testing machine (universal)	Rs. 70,000/-
f) Hydraulic testing machine for pipe fittings, 2	Rs. 5,000/-
g) Sand-testing equipment	Rs. 8,500/-
	Rs.1,08,850

Sum total of C to G	Rs. 5,27,725/-
Cost of electrical & Mechanical installation 10%	52,775/-
	Rs. 5,80,500

H. Office and Store Equipment:

a) Office furniture	Rs. 7,000/-
b) Racks	Rs. 3,000/-
c) Ceiling & Table fans	Rs. 3,000/-
d) Typewriters, 2	Rs. 2,500/-
e) Miscellaneous	Rs. 500/-
	Rs.16,000/-

I. REMUNERATION AND WAGES:

1. Metallurgist-cum-works manager	Rs. 1,200/-

		Rs. 1,200/-
2. Foundry:		
a) Furnace operator	2	Rs. 600/-
b) Skilled Moulders	5	Rs. 1,000/-
c) Semi-skilled moulders	8	Rs. 1,200/-
d) Labour	6	Rs. 600/-
3. Machine Shop:		
a) Machinists	8	Rs. 1,600/-
b) Workers	2	Rs. 200/-
4. Annealing Section:		
a) Furnace attendants	3	Rs. 600/-
b) Workers	4	Rs. 400/-
5. Galvanizing Shop:		
a) Skilled Workers	2	Rs. 400/-
b) Workers	3	Rs. 300/-
6. Laboratory Testing:		
a) Chemist	1	Rs. 700/-
b) Foreman	1	Rs. 600/-
c) Supervisor	3	Rs. 1,200/-
d) Storekeeper	1	Rs. 300/-
e) Accountant	1	Rs. 250/-
f) Clerk cum typist	2	Rs. 400/-
g) Unskilled labour	6	Rs. 750/-
		Rs.13,100/-

J. Raw Material & Stores Consumption: (per month)

a) Pig Iron & Scrap 60 tons @ 500 per ton	Rs.30,000/-
b) Steel scrap - 15 tons @ Rs.400 per ton	Rs. 6,000/-
c) Coke 12 tons @ Rs.200	Rs. 2,400/-
d) Furnace Oil 20,000 @ Rs.0.40/litre	Rs. 8,000/-
e) Foundry Sands, steam coal and wood	Rs. 1,200/-
f) Bentonite clays, graphite, soapstone linseed oil	Rs. 1,500/-
g) Chemicals	Rs. 350/-
h) Hydrochloric acid, Sulphuric acid, caustic soda, flux	Rs. 1,000/-
i) Refractory materials, ferro alloys	Rs. 900/-
j) Commercial zinc -3 tons @ Rs.500/- per ton	Rs.15,000/-
k) Other items	Rs. 1,500/-
	Rs.67,450/-

	per month
. Misc. items of expenditure for 1 month:	
a) Advertisement, postage etc.	Rs. 3,000/-
b) Power & Water	Rs. 2,250/-
c) Transport & Handling Charges.	Rs. 4,000/-
d) Maintenance, tax, insurance	Rs. 1,150/-
e) Travelling, contingencies	Rs. 1,700/-
	Rs.11,100/-
. Working Capital for 2 months:	
a) Raw Materials	Rs. 67,450/-
b) Expenditure	Rs. 12,000/-
c) Remuneration to [illegible]	Rs. 13,100/-
	Rs.92,550/- x 3
	Rs. 2,77,650/-
M. Total Investment (Capital Structure):	
a) Machine & Equipment	Rs.5,70,550/-
b) Working Capital investment	Rs.2,77,650/-
c) Office & Equipment	Rs. 16,000/-
	Rs.8,74,200/-
N. Expenditure per month (cost of manufacture):	
a) Working capital for 1 month	Rs. 92,550/-
b) Interest on total investment @ 12%	Rs. 8,742/-
c) Depreciation on machinery @ 12%	Rs. 4,838/-
d) Rent	Rs. 4,600/-
	Rs.1,10,730/-
O. Receipts per month:	
a) By returns from sales of 50 tons of fittings per month @ Rs.2500/- per ton	Rs. 1,25,000/-
b) by returns from foundry scrap, 18 tons @ Rs.500/- per ton	Rs. 9,000/-
	Rs.1,34,000/-
P. Profit & loss per month:	
a) Sales per month	Rs. 1,34,000/-
b) Expenditure per month	Rs. 1,10,730/-
	Rs. 23,270/-

Profit

Scheme for a non-ferrous foundry for manufacture of rough brass and non-metal castings.

1. Land & Building:

Rented shed, 1200 sq. ft., with provision for office — Rs. 300 per month

2. Plant & Machinery:

1. Coke-fired oil furnace complete with blower, motor & other related accessories	Rs. 2500/-
2. Core and mould drying oven size 6' x 4' x 3'	Rs. 2500/-
3. Moulding Tools	Rs. 1000/-
4. Moulding Boxes	Rs. 1500/-
5. Power hacksaw	Rs. 1500/-
6. Double-ended grinder 12" x 3"	Rs. 800/-
7. Moulding Sand	Rs. 500/-
8. Miscellaneous hand tools, work benches, vices, beam scale etc.	Rs. 2000/-
9. Erection & Installation of machines and electric fittings etc.	Rs. 2000/-
10. Office furniture, equipment etc.	Rs. 2000/-
11. Small chemical testing laboratory	Rs. 2000/-
	Rs.19,000/-

3. Raw Materials & consumable stores:

a) Copper mixed scrap, 1000 kg. @ Rs.13/- kg.	Rs.13,000/-
b) Zinc Ingots, @ Rs.5.75/kg.	Rs. 3,500/-
c) Gun-metal scrap, 1500 kg. Rs. 12.2 kg.	Rs.18,375/-
d) Balancing virgin metal	500/-
e) Graphite, bentonite, molasses, linseed oil, bucklings, firewood, crucibles, chemical reagents.	Rs. 8,700/-
f) Refractories, gunsteen, fire-clay, saw, steam coal, cotton waste, tools etc.	Rs. 2000/-
	Rs.36,075/-
	Rs.37,000/-

4. Staff & Labour per month:

a) Foreman	1		Rs. 500/-
b) Clerk/Accountant	1		Rs. 250/-
c) Store-keeper/typist	1		Rs. 250/-
d) Durman	2		Rs. 200/-
e) Core maker/moulder	4	@ Rs.200/-	Rs. 800/-
f) Helpers	6	@ Rs.100/-	Rs. 600/-
g) Furnace attendant	1		Rs. 250/-
h) Chemist	1		Rs. 250/-
			Rs. 3,100/-

5. **Other items of expenditure:**

a) Rent	Rs. 300/-
b) Electricity and water charges	Rs. 150/-
c) Postage & Stationery	Rs. 50/-
d) Sales expense	Rs. 200/-
e) Publicity	Rs. 100/-
f) Maintenance	Rs. 100/-
g) Transport charges inward & outward	Rs. 200/-
	Rs.1,100/-

6. **Working capital for one month:**

1) Raw materials & consumable stores	Rs. 37,000/-
2) Staff & Labour	Rs. 3,100/-
3) Other items of expenditure	Rs. 1,100/-
	Rs. 41,200/-

7. **Total capital investment:**

a) Non-recurring expenditure	Rs. 19,300/-
b) Recurring expenditure per 3 months	Rs.123,600/-
	Rs.142,900
	Rs.1,48,000/-

8. **Profit and loss account for one month:**

1) Recurring exp. for one month	Rs.1,41,200/-	
2) Depreciation of plant & Machinery		
a) for furnace & core oven & boils @ 20% p.a.	135/-	
b) for others @ 10% p.a.	65/-	
3) Interest on total capital investment @ 12% p.a.	1,430/-	
4) Gross profit before taxation	2,620/-	
	Rs. 45,450/-	

By sale

1) Brass casting 1500 kg. @ Rs.13.50 per kg.	Rs.20,250/-
2) Gun-metal casting @ 18/- per kg. for 1400 kg.	Rs.25,200/-
	Rs. 45,450/-

7. THE NATIONAL SMALL INDUSTRIES CORPORATION

The National Small Industries Corporation was set up as an autonomous body not only to act as a development bank but also to act as a motivator, modernisor and enlarger of small scale industries in the country by providing equipment on easy hire-purchase terms both for commencing a new small scale industrial unit and for replacement of outdated and obsolete machinery for an existing industrial unit as balancing equipment for increasing productivity and achieving quality. The hire-purchase

scheme of the National Small Industries Corporation popularly known as NSIC is quite liberal for an entrepreneur and has the following special features.

(i) Contrary to commercial practices the NSIC does not demand any collateral before giving plant and equipment on hire-purchase. Only the machines purchased with the help of the scheme are kept as security.

(ii) The earnest money asked for as down payment is a nominal percentage of the value of the plant and machinery acquired and the balance amount is repaid over a period of 7-8 years after an initial grace period of one year from the date of delivery of the respective machinery. The initial down payment required to be paid is only 5% of the total value of the machinery in case of imported equipment and 10% in the case of indigenous equipment. Thus a small scale entrepreneur does not have to find a lot of capital in the beginning to start up a small scale industrial unit.

(iii) Normally the interest charged on the hire-purchase amount is much lower than what is charged by commercial banks. [illegible] the interest was only 6% against 7% if the repayment of instalment is made on or before the due date of repayment.

Thus NSIC during the past two decades have helped about 12000 small scale industrial units in the country to procure equipment valued at about Rs.64 crores (Rupees 640 million) out of which imported equipment was worth about Rs.42 crores (Rupees 420 million) . As this figure was quite insignificant for a country the size of India many other financial institutions were also constituted.

9. OTHER FINANCIAL INSTITUTIONS HELPING DEVELOPMENT OF SMALL INDUSTRIES

The State Small Industries Corporation were formed in each of the 18 states of the country for the purpose of setting up industrial estates and providing factory sheds with all common services, such as roads, power, water etc. on hire-purchase basis to entrepreneurs setting up small industrial units as per schemes approved by the Small Industries

Services Institute. These state Small Industries Corporation also provide hire purchase facilities for the purchasing of plant and machinery and stock raw materials in bulk for supply in small daily, weekly or monthly lots to the small scale industrial units for cash so that the small scale industrial unit will not have to invest large sum of money in holding a large stock of materials.

(b) The State Financial Corporations:

The State Financial Corporation in each Indian State also advances money to purchase plant and machinery, land and building and also against installation cost. The initial down payment is normally 30% but in special cases can be relaxed at the discretion of the management board. No advance is made on working capital.

(c) Nationalized Banks :

The nationalized banks also provides finance against schemes which are cleared by the Small Industries Service Institute for the purchase of plant and machinery with 30% initial down payment and balance in half yearly instalment payments. Furthermore all the banks in India provide cash credit facilities with 30% marginal working capital and also bill discounting facility upto 75% of the value of the bill at 1% less than normal banking interest.

9. TAXATION RELIEF

Besides the facilities mentioned above the state governments do not charge sales tax on the plant and equipment and or raw materials purchased during the first five years from the date of installation of the factory. Furthermore small scale industrial establishment are exempted from payment of employees state insurance scheme and provident fund

e homes for the first 5 years thus eliminating a small scale
ndustrial unit's burden of taxation during the period of the
growth. Central Government also allows relief for the
irst years and depreciation at 10%, multiple shift work and
development stage. Thus a small scale industrial unit is not burdened
with taxes during the gestation period. It is normally expected that
the production stabilizes during this period, after which the norma
tax has come into force are established.

3. TRAINING FACILITIES FOR ARTISANS AND SUPERVISORS

The State Directorate of Industries in each state has a number
training centres for training artisans for various trades,
including foundry practice approximately one in each district. Most
of these training centres are well equipped to impart the necessary
practical training and theory so that the trainees receive a compre
hensive knowledge in the practical operations in a foundry, such as
pattern making, moulding, core making, melting, sand preparation et
c. The qualification for admission to these trade courses is
passing the final school examinations. The candidates are, however,
required to undergo an admission test before final acceptance. The
length of the course depending on the trade varies from 6 months to
one year. For foundry practice the course is normally 6 months.

There are three institutions imparting part time refresher
courses in foundry technology for the training of foundry supervisors.
They are: 1. The Institute of Foundrymen having four regional
centres in Calcutta, Madras, Bombay and New Delhi. (2) The Indian

...titute of Technology, Kharagpur (3) The National Institute of Foundry ...d Forge Technology, Ranchi.

The degree courses are conducted by the Indian Institute of Technology, Kharagpur, and the National Institute of Foundry and Forge Technology, Ranchi. Post graduate courses are also conducted by the same institutes for providing the engineering graduates with ... studies to take up responsibilities in the foundry industry. Furthermore the Ministry of ... of the Government of India operates (3) the grant from ... central Institutes in Calcutta, Madras, Delhi and Bombay. The central training Institutes have elaborate set ups of equipment for pattern making and foundry practice for dissemination of knowledge amongst the various grades of foundrymen in the country including supervisors and inspectors.

... RESEARCH AND DEVELOPMENT ACTIVITIES FOR FOUNDRY INDUSTRY

Before independence this was an unknown subject to Indian Foundry Industry. Only after establishment of the National Metallurgical Laboratory at Jamshedpur in 1947 were separate departments set up for research and development activities with the view to ... and other foundry technological practices. This National Metallurgical Laboratory for the first time took up a systematic study of foundry sands that are available in the country and nature of beneficiation needed to upgrade the SiO_2 content for high-temperature work. A nation-wide survey was made for the natural deposits of foundry sand in close co-operation with the geological survey of India, and several samples

were collected and processed in the laboratory and detailed results published in the form of a book 'Indian Foundry Sands'. This study helped the Indian Foundry Industry immensely to understand the value of quality control starting from the selection of good silica sand for foundry use.

Similar studies were also taken up to locate the deposits of bonding clays such as bentonite in various parts of the country in close co-operation with the geological survey of India, to collect samples and to carry out the necessary study to process the materials and upgrade them for foundry use. At the end of the study the results were published in the form of a book on Indian bentonite, both sodium and calcium base, which helped the Indian Foundries, particularly the small foundries, to introduce synthetic sand practice in a large majority of foundries for production of quality castings.

Studies on other foundry raw material are also taken up from time to time depending on the needs of the foundry industry. With regard to research and development activities the foundry section is well equipped with modern melting furnaces such as: (a) cold blast cupolas of various capacities, (b) hot blast cupola, (c) rotary oilfired furnaces, and (d) electric arc and induction furnaces and other foundry equipment. There is an elaborate [illegible] for processing and testing of basic sand and sand-mix required by various types of castings, and the results of such research work are made available to the foundry industry at either a nominal cost or no cost. The small foundries take full advantage of such research reports.

The National Metallurgical Laboratory has also set up 4 regional

stations to render services particularly to small scale foundries in Calcutta for Eastern Region, Ahmedabad for Western Region, Madras for Southern Region and Patala in the Northern Region. These regional foundry stations did a lot to disseminate the knowledge of modern foundry practices to small foundries who would not have had the opportunity of acquiring the knowledge otherwise.

12. STANDARDIZATION OF RAW MATERIALS AND FINISHED PRODUCTS OF INDIAN FOUNDRY INDUSTRY :

The Indian Standards Institution was constituted by the Government with its headquarters in New Delhi. The structurals and metals division of this institute have prepared with the active support of the foundry industry and the National Metallurgical Laboratory a number of national standards in conformity with other international standards for the benefit of the foundry industry, for finished products such as grey iron castings, malleable iron castings, S.G. iron castings and also essential raw materials for the foundry industry such as pig iron, foundry grade coke, silica sand, bentonite, dextrine, different types of core oils etc. The foundry sectional committee of the Indian Standards Institution is keeping a close watch on the development aspect, and accordingly essential items like mould boxes, chaplets, hand tools like trowels, cleaners, mallets and such other small tools have been standardized, which has brought in its turn a large number of factories manufacturing these items for the benefit and healthy growth of the Indian foundry industry in a systematic manner. These national standards helped the foundry industry to maintain a quality standard of its products both for home

consumption and export market. The foreign buyers of castings are satisfied with the various tests which have been prescribed in each standard to keep the quality of the product well within acceptable limits. To help the growth of large number of small iron foundries, standards for a rationalised size of cold blast cupola were framed and widely circulated. A few typical but useful examples of standards formulated by the Indian Standards Institution are reproduced below to elucidate how the national standards helped to bring about an understanding amongst the enterpreneurs about the type of finished products the type of basic raw materials and the types of foundry tools that should be used to organise a small scale grey iron foundry.

Example I. Pig Iron (Coke), IS.SP. No.224-1965 as per table 2.

Table 2. For Pig Iron (Cake), to IS.SP. No.226-1963

Grade	Sub-Grade	Code No.	Chemical Analysis % of Elements			
			Silicon	Manganese	Sulphur	Phosphorus
I	High Manganese	PG 30-Mn	2.75 -3.25	1.00 to 1.50	.05 max	0.40 max
	Low Manganese	PG 30	"	.5 to 1.00	"	"
	Low Mn. Int.P.	PG 30.P7	"	"	"	0.40 to 1
	Low Mn. High P.	PG 30.P12	"	"	"	1 to 1.30
II	High Manganese	PG 25 Mn	2.25 - 2.75	1 to 1.50	.05 max	.40 max
	Low Manganese	PG 25	"	.5 to 1	"	"
	Low Mn. Int. P	PG 25 P-7	"	"	"	4 to 1 max
	Low Mn. High.P	PG 25 P-12	"	"	"	1 to 1.30
III	High Manganese	PG 20 Mn	1.75 - 2.25	1 - 1.5	.05 max	0.40 max
	Low Manganese	PG 20	"	.5 - 1.00	"	"
	Low Mn. Int.P	PG 20 P-7	"	"	"	.4 to 1
	Low Mn. High.P	PG 20 P-12	"	"	"	1 to 1.30
IV	High Manganese	PG -15Mn	1.25 - 1.75	1 - 1.5	.05 max	0.40 max
	Low Manganese	PG -15	"	.5 - 1	"	"

Example 2. Extract from IS-4140-1967, Limestone

Table 3 - Chemical requirement of Limestone for foundry use a/

Characteristic	Requirement percentage by weight	
	Grade I	Grade II
Calcium oxide (CaO) min.	50	4.5
Insolubles in HCl, Max.	5.0	8.0
Total Impurities Including SiO_2 + Al_2O_3 + Fe_2 Max.	7.0	10.0
Sulphur and Phosphorus	Trace	Trace

a/ For use in cupola the size of limestone has been specified to 2" to 3"

Example 3: Extract from IS-1987 of 1962 for Silica Sand

Table 4 - Percentage of elements

Grade	Silica Max	Alumina Max	Iron oxide Max	Calcium & manganese oxide, Max	Alkalis Max
A	Over 98	1.0	1.0	1.0	0.5
B	95 to 98	1.5	1.0	1.0	0.5
C	90 to 95	5.0	1.5	2.0	1.5

ample 4. Extract from IS-3343 - 1966 for Natural Moulding Sand

Table 5.

ade	Clay%	'A'
A	5.10	1350 - 1450°C
B	10.15	1200 - 1350°C
C	15.20	1100 - 1200°C

ample 5: Extract from IS -3021 - 1966 for Bentonite

Table 6 Requirements of bentonite for use in foundries

.No.	Characteristic	Requirement	
		Type I	Type II
.	Moisture, percent, Max	12	12
.	pH value Min	7.5	7.5
.	Calcium oxide (replaceable Ca^{++}), percent Max.	0.7	3.0
.	Fineness - Dry	97 percent, Min To pass through IS Sieve 150-micron 90 percent, Min To pass through IS Sieve 75-micron	
.	Fineness-Wet	95 percent, Min To pass through IS Sieve 45-micron	
	Gel Index, Min	25 min	10 min

ample 6: Extract from IS 4269 for Dextrine

Table 7 Requirements of dextrins for use in foundries

Constituent	Yellow Grade I % by wt.	White Grade II % by wt.
isture, Max	10	10
h	1	0.5
soluble in cold water	10 max	22 max
luble or reducing	5	10
xtrine, Min	80	65

Example 7: Specification for Indian B.P. Hard Coke

Table - 8 - B.P. Hard Coke Properties

Constituent	Percentage by wt.
Moisture	1 to 1.5
Ash	20 to 24
Volatile matter	1
Fixed carbon	73 to 75
Sulphur	0.6 max
Phosphorus	1.5 max

Example 8 : Specification for Coal Dust

Table - 9 (a) Requirements of coal dust

Sl.No.	Characteristic	Requirement, Percent by Weight Grade 1	Grade 2	Grade 3
1)	Moisture, Max	3.0	3.0	3.0
2)	Proximate analysis on dry basis:			
	a) Volatile matter, Min	35	30	25
	b) Ash, Max	15	18	20
	c) Fixed Carbon (by difference), Min	to be reported		
3)	Sulphur on dry basis, Max	1.0	1.0	1.0
4)	Phosphorus on dry basis, Max	0.20	0.20	0.20

Table - 9 (b) Fineness of different grades of coal dust

Grade	Weight of material to pass through methods for sampling of coal and coke IS Sieve (Micron), percentage					
	600	300	212	106	75	53
F (Fine)	-	-	100	75	-	20
M (Medium)	-	100	80	-	30	-
C (Coarse)	100	80	-	-	20	-

Example 9: I.S.210 - Standards for Grey Iron Castings

TABLE 20 Mechanical test requirements of grey iron castings

Grade	Sectional Thickness of castings mm	Diameter of test bars as cast mm	Tensile strength, Min kgf/mm^2	Transverse Test Breaking Load, Min kgf	Transverse Test Corresponding Transverse Pupture Stress kgf/mm^2	Transverse Test Deflection Min mm	Brinell Hardness HB
15	4 up to 8	13	19	180	41.7	2.0	130 to 180
	Over 8 upto 15	20	17	400	38.2	2.5	
	Over 15 upto 30	30	15	800	34.0	4.0	
	Over 30 upto 50	45	13	1700	28.5	6.0	
20	4 up to 8	13	24	200	46.4	2.0	160 to 220
	Over 8 upto 15	20	22	450	43.0	3.0	
	Over 15 upto 30	30	20	900	38.2	4.5	
	Over 30 upto 50	45	17	2000	33.5	6.5	
0	4 up to 8	13	28	220	51.0	2.0	180 to 230
	Over 8 upto 15	20	26	500	47.8	3.0	
	Over 15 upto 30	30	25	1000	42.4	5.0	
	Over 30 upto 50	45	22	2300	38.6	7.00	
0	8 upto 15	20	31	550	52.5	3.5	180 to 230
	Over 15 upto 30	30	30	1100	46.7	5.5	
	Over 30 upto 50	45	27	2600	43.6	7.5	
0	15 upto 30	30	35	1350	57.3	5.5	207 to 241
	Over 30 upto 50	45	32	3300	55.3	7.5	
0	15 upto 30	80	40	1500	63.7	5.5	207 to 270
	Over 30 Upto 50	45	37	3700	62.7	7.5	

Note:- The properties given in the table are for sectional thickness upto 50 mm. For mechanical properties above 50 mm, the requirements shall be as agreed to between the purchaser and the manufacturer.

/Brinell hardness test is optional for all grades of castings.
/For grade 15, tensile, transverse and hardness tests are optional.

Table II Chemical analysis

Grade	T. Carbon	Silicon	Manganese	Phosphorus	Sulphur	Cr	Mo
15	3.5	2.2	0.70	0.45	0.12	Nil	Nil
20	3.5	1.9	0.70	0.45	0.12	Nil	Nil
25	3.35	1.7	0.70	0.25	0.11	Nil	Nil
30	3.20	1.40	0.70	0.15	0.11	Nil	Nil
35	3.10	1.30	0.80	0.15	0.11	0.2	Nil
40	3.05	1.30	0.80	0.15	0.11	0.2	0.6

Note: Depending on the section thickness of the casting the composition may also vary, particularly silicon content.

[Clauses 2.1 and 2.2]

CHARACTERISTIC	CUPOLA DESIGNATION			
	(A)	(B)	(C)	(D)
	450	600	750	900
1)				
Nominal capacity, t/h	0·5-0·75	1·25-1·90	2·2-3·75	3·5-5·75
Inner diameter of shell F, mm	690	840	1145	1295
Inner diameter after lining below the charging door G_1, mm	450	600	750	900
Inner diameter after lining above the charging door G_2, mm	540	690	995	1145
Diameter of wind chamber H, mm	1090	1240	1640	1870
Supporting column from ground level to base plate A, mm	750	1050	1650	1650
Height of centre line of tuyeres from base plate B, mm	700	750	800	850
Effective height D, mm	3500	3500	3600	3500
Height of shell from bell end to the top of cupola without the spark arrester C, mm	1250	2400	2400	3000
Height of the centre line of tap hole from base plate E, mm	150	150	150	150
Height of the centre line of slag hole from base plate J, mm	450	450	486	486
Height of wind chamber K, mm	600	650	750	800
Height of bottom of wind chamber from base plate L, mm	820	880	940	1005
Size of charging door M, mm	450×SA	480×SA	450×SA	450×SA
Thickness of the shell plate below the charging door T_1, mm	5	5	6	6
Thickness of the shell plate above the charging door T_2, mm	5	5	5	5
Air inlet pipe diameter, mm	150	200	225	275
Number of tuyeres	4	4	6	6
Air consumption :				
a) Volume, m^3/min	18-21	32-36	48-54	70-76
b) Pressure, mm water gauge	350	400	450	500

NOTE — The nominal capacity given is related to the production of grey cast iron with a coke-metal ratio of 1 : 6.

A Supporting column from ground level to the base plate
B Height of centre line of tuyeres from base plate
C Height of shell from bell end to the top of cupola without the spark arrester
D Effective height
E Height of centre line of tap hole from base plate
F Inner diameter of shell
G_1 Inner diameter after lining below the charging door
G_2 Inner diameter after lining above the charging door
H Diameter of wind chamber
J Height of centre line of slag hole from base plate
K Height of wind chamber
L Height of bottom of wind chamber from base plate
M Size of charging door
T_1 Thickness of shell plate below the charging door
T_2 Thickness of shell plate above the charging door

CONSTRUCTIONAL DETAILS FOR CUPOLA FURNACE

All dimensions in millimetres

Thus the standards prepared by the Indian Standards Institution are helping the entrepreneure to know exactly the technical details of finished products or raw materials.

13. SNOWBALL ACTION OF SPORADIC GROWTH OF SMALL CAST IRON FOUNDRIES AFTER INFRASTRUCTURES WERE PROVIDED BY GOVERNMENT:

The infrastructure thus provided by both central and state governments in India in multifarious shapes and forms did produce results and small scale cast iron foundry industry took fullest advantage of the facilities made available as a whole for the growth of small scale industrial units. The sporadic growth of consumer industries like sewing machines, electric fans, electric motors, agricultural implements, automobile spare parts, sanitary castings, irrigation pumps, diesel engines etc. brought in its turn huge demands on the foundry industry. Almost overnight small foundries sprang up throughout the country to meet the challenge, as may be seen from Table 13.

Table 13 - Regional specialisation in the manufacture of foundry products in India

Product		Principal Manufacturing Regions
1.	Agricultural machinery and equipment	Punjab - 37.1% U.P. - 29.1% W. Bengal - 12.6%
2.	Automobile castings	Bihar - 9.2% Gujarat - 23.4% Maharashtra - 28.1% U.P. - 19.3%
3.	Bottom plates	W. Bengal - 57.6% Maharashtra - 39.6%

4. Cooking Pans & Pots	West Bengal - 74.0% Uttar Pradesh - 15.5%
5. Diesel Engines	Gujarat - 18.6% Maharashtra - 47.1% Uttar Pradesh - 23.7%
6. Electric Fans	West Bengal - 63.4% Maharashtra - 29.6%
7. Industrial Machinery	West Bengal - 46.6% Maharashtra - 12.3% Madhya Pradesh - 8.9% Uttar Pradesh - 19.2%
8. Ingot Moulds	West Bengal - 64.0% Maharashtra - 14.6% Uttar Pradesh - 21.3%
9. Loco Castings	Assam - 17.1% Delhi - 19.6% West Bengal - 48.0%
10. Machine Tool Castings	Madras - 14.6% Maharashtra - [illegible] Punjab - 38.4% West Bengal - 14.1%
11. Manhole Covers	Maharashtra - 12.3% Madhya Pradesh - 8.9% Uttar Pradesh - 19.2% West Bengal - 46.6%
12. Electric Motors	Uttar Pradesh - 85.4% Madras -
13. Municipal Wires	Delhi - 8.1% Madhya Pradesh - 7.0% Uttar Pradesh - 12.1% West Bengal - 64.8%
14. Pipes, pressure	Andhra Pradesh - 66.2% Orissa - 10.7% Uttar Pradesh - 5.2% West Bengal - 11.5%
15. Pipes, rainwater	Uttar Pradesh - 46.7% West Bengal - 48.3%
16. Pipes, soil	Uttar Pradesh - 30.2% West Bengal - 58.8%
17. Pumps	Gujarat - 19.1% Madras - 21.9% Maharashtra - 19.5% Madhya Pradesh - 16.0% Uttar Pradesh - 9.5%
18. Railway Sleepers, Brake blocks, bottom plates.	Orissa - 20.4% West Bengal -73.6%

19.	Sewing Machines	Punjab - 4 . .8% Uttar Pradesh - 21.6%
20.	Telegraph pole sockets	Uttar Pradesh - 97%
21.	Textile castings	Madras - 10.9% Maharashtra - 12.1% West Bengal - 15.1%

Due to equalisation of prices of pig iron the grey iron foundries came up in every part of the country from Kashmir to Cape Comorin offering employment to large numbers of people.

Looking at the potentiality of foundry industry particularly small scale grey iron foundry industry, the planning commission of the Government of India projected [illegible] period 1975-76 as against the past demands of 1970-71 as may be seen from Table 14, given below.

Table - 14 - Projected demand of castings All grades (Production in tons

Type of castings	1970-71	1975-76
Grey Iron	2,105,360	2,937,460
Ductile, white	16,930	24,080
Malleable Iron	[illegible]	[illegible]
sub-total for Iron castings	2,206,160	4,066,080
Plain carbon steel	244,610	343,780
Alloy steel	[illegible]	[illegible]
sub-total for steel castings	271,460	379,660
Aluminium	2,493	3,103
Brass and bronz	40,084	56,016
Other nonferrous	[illegible]	[illegible]
sub-total for nonferrous castings	44,234	61,540

With the projected demand indicated above and the infrastructure already prevailing in the country, it is expected that there will be further growth of foundry industry particularly grey iron foundry industry in the small scale sector in the near future. With the research and

development activities of the National Metallurgical Laboratory, standardisation by the Indian Standards Institution and training facilities provided by the Institute of Indian Foundrymen, National Institute of Foundry and Forge Technology and by the Central Training Institute of the Ministry of Labour of the Government of India the Indian grey iron foundry industry will grow to strength, maintaining the high quality that the present day national and international standards demand.

In the foregoing, attempts have been made to highlight the very basis on which the Indian foundry industry has thrived in the last two decades; and never before in the history of the country has there been so much growth of small grey iron foundries on systematic, scientific basis. Thanks to the Council of the Institute of Indian Foundrymen who have opened the door to the Indian foundrymen by being an affiliated member of the International Committee of Technical Associations, Switzerland. Thus any new development taking place anywhere in the world is available almost immediately to the Indian foundrymen through exchange of papers on different aspects of foundry technology presented at the International Foundry Congresses held every year in different countries.

14. FOUNDRY INDUSTRY OF HOWRAH INDUSTRIAL BELT

Calcutta is situated on the east bank of the river Ganges (Ganga) and Howrah is on the west bank. Although Calcutta was in existence since 1596 with the name of 'Kali Khetra', the process of urbanisation did not start until 1700s.

While the east bank of the river provided facilities for setting up Government administrative offices and residential area, the west

bank known as Howrah provided facilities for setting up factories for engineering industries with facilities for casting grey iron and non-ferrous metals. In those days grey iron castings were extensively used even for construction purposes, as may be seen even today from the number of bridges and buildings with iron pillars. A foundry was also set up in Cossipore to cast guns and cannons which is even today known as 'Cossipur Gun Foundry' and is presently one of the ordnance factories of the Government of India.

The foundries in each of the engineering factories used to operate on imported pig iron and coke from the United Kingdom of Great Britain and Northern Ireland until commercial interests started exploiting the local resources by setting up coal mines, coke oven batteries and even blast furnaces to manufacture pig iron for foundry use. Thus the basic foundation for the foundry industry in India was laid down in the Howrah area for the first time. In the beginning most of the foundries were owned by British companies, but gradually a few entrepreneurs set up their own grey iron foundries. These foundries took up manufacture of simple castings such as manhole covers and frame castings for road construction, sanitary fittings and soil pipes for domestic use, weights and measures, cooking pans and pots in ordinary grey iron while the more sophisticated items like components for ship or bridge construction or mill spares and spare parts for machine tools were still manufactured in the foundries owned by the British companies in the Howrah area.

In those days it was most inexpensive to set up a grey iron or a non-ferrous foundry. The melting equipment used to be a cold blast cupola for grey iron and coke-fired crucible for non-ferrous metal. For sand preparation a normal 'pugmill' popularly kown as 'soorky mill' for grinding mortar for building construction was utilised. The moulding sand was river bed sand collected by bullock carts or boats 30 miles upstream from Calcutta at a place known as Magra on the west bank of the river Ganges and a natural clay-bonded sand known as 'ovarya sand', where the present steel plant of Hindustan Steel Ltd., at Durgapur has been set up on the bank of the river Damodara. The same pugmill was also used to grind coal to powder for addition to the sand mix. For core making cowdung was extensively used. Molasses, which was then abundantly available, was also used as a core binder. The cores thus made either by cowdung or molasses used to be dried in a chamber-type oven. The same oven was also used for drying of moulds for heavy castings. Even today many of the old foundries use the same materials particularly those who are still manufacturing sanitary castings, soilpipes, pans and pots, railway sleepers etc.

Moulding operations were carried out normally on a specially prepared moulding bed for the purpose.

Cope and drag moulding was used only when the castings were large and needed drying in the oven. The same type of oven was used for drying of moulds as was used for core drying.

Where drying of moulds was not necessary the skin drying was applied by allowing the coal to burn on a perforated metal sheet placed on the moulds overnight. The degree of dryness was by the feel of the thumb of the moulder.

With regard to sand mix and properties each moulder used to ask for his own composition consisting of new sand, old sand (used) natural bonded clay sand, cowdung etc. and the testing was carried out by the moulder himself by picking up a handful of sand, pressing it in his palm and breaking it by the force of his thumb. This was the most important test; on it depended the successful production of the casting for which the moulder himself was exclusively responsible. The moulder was also responsible for core making, core setting, closing, weighing and pouring operations. Even the size of the ladle, the metallic charge composition and the temperature at which the metal should be tapped was dictated by the moulder, as it was his sole responsibility to ensure the end result, which was to produce a good casting. It was therefore essential for the moulder to develop his own feel for the operations, which he acquired the hard way through years and years of experience and self education by making mental notes of previous production of a good or bad casting. Depending on the degree of his personal skill he was evaluated by the management for fixing his daily wages.

Similarly the skill of a core maker was also judged on the same basis, but he had to work in a team with the moulder in the ultimate production of a sound casting.

Cupola was universally used for melting purposes and there was hardly any calculation regarding the volume of air to be provided for a required melting rate. The blowers capacity was always selected on the high side and the flow of air to the tuyeres used to be adjusted by a damper on the wind pipe of the cupola for getting a uniform melt in the melting zone of the cupola. The skill of the cupola operator was judged by the smooth operation of the cupola without any bridging effect and steady flow of metal from the spout.

The only test of the metal was that it should not be hard during machining operations. This was mainly avoided by using pig iron of high silicon content, which had normally low melting temperature, and metal quality (from the point of view of cementite formation) was judged by the formation of 'kish' on the surface of the liquid metal in a ladle. All cupolas, even of high melting rate of up to 10 tons per hour, used to be charged manually. The labour force was employed to carry the charge material such as pig iron, coke, limestone, etc. by head loads on a ladder to the cupola platform. Even heavy castings up to 1 to 3 tons weight were cast manually without the help of a crane. The pouring of such heavy casting was made possible by carrying the metal in a number of hand shanks to a bigger ladle which was placed adjacent to the heavy moulds.

The castings after cooling used to be handled manually as it involved very little fettling or cleaning operation due to use of best quality graphite imported from Sri Lanka as mouldwash either as dry or wet coat.

The fettling tools were a simple wire brush for cleaning the casting surface and normal manually operated hammer and chisel for dressing the fins and levelling the extra metal near the risers. The risers were normally broken by hammering.

After dressing operations the castings were inspected visually for surface finish and by measuring rules for dimensional accuracy.

With regard to metal quality the test was by visually examining the fracture which should have a grey fracture when broken.

There were only two classes of iron, 1) normal grey iron, 2)semi-steel.

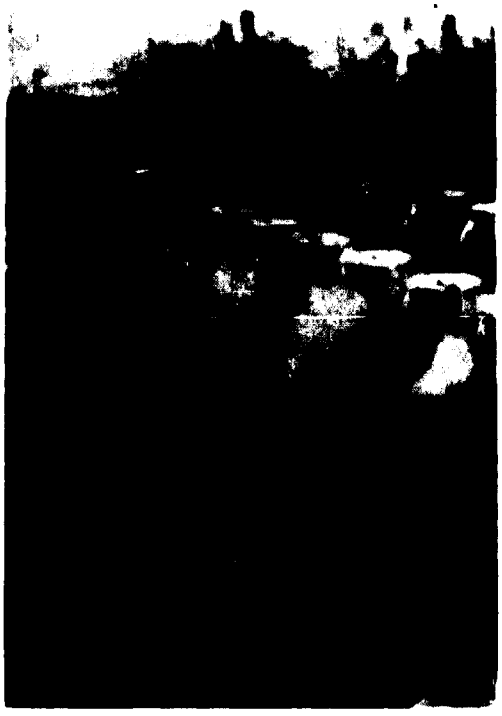
The normal grey iron was produced by melting only virgin pig iron of high silicon content to avoid any hard spots or cementite formation.

The word semi-steel was used to differentiate metal from normal grey iron and was produced by adding a certain percentage of steel scrap in the cupola charge which gave the surface hardness of the metal for making machine tools and such other highly stressed components. The metallurgical reactionsof present-day high-duty iron was rather unknown. Due to the complicated nature of operation such castings were not attempted in the indigenous foundries as it involved different type of 'feel'which only the foreign technicians in the larger British engineering factories used to provide.

Heat treatment of grey iron castings or so called 'semi-steel' was unknown but they used to leave the castings in the open air for natural seasoning which used to relieve the stresses to some extent.

These foundries were known as jobbing foundries. In addition there were number of mass production foundries for production of cast iron (C.I.) pipes or pans or railway sleepers, as shown in Fig. 3.

Fig. 3 Mass Production Foundry for C.I. PAN



In a mass production foundry the total number of boxes (cope and drag) required for a day's production used to be placed on the shop floor. Near each box sufficient sand was stored so that the moulder would not have to make too much movement for preparing the mould. The sand was normally tempered every day by addition of a little new sand, coal dust, water etc. after the screening of old shaken-out sand by a hand sieve (chalna as they are popularly known). The number of patterns on use depended on the number of teams of moulders as to how many moulds a team will be able to prepare, close and pour within a period of 8 hours. Normally these moulders were paid on piece rate basis on the number of good castings produced at the end of the day. Generally if the shift started at 8.00 a.m. moulding and closing operations were carried out up to 2.00 p.m. and metal pouring up to 4.00 to 4.30 p.m. or even up to 5.00 p.m. The shaking out operations were carried out the next morning between 6.00 a.m. and 8.00 a.m. before the moulders started their next day's work.

The moulders were paid on total number of good castings produced which acted as an incentive for the moulders to maintain their normal earnings, which was related to normal daily output. The daily rated workers were only employed for the operation of the cupola, sand preparation, shakeout operations and sometimes fettlers. The system is still prevalent in many Howrah foundries particularly those still carrying on with old mass production technique.

Due to very little capital investment needed to set up such a foundry even today many new foundries in Howrah area are coming up for the production of electric motor bodies, pipes and pipe

fittings, cooking pots and pans where high metal quality is not a criterion, because of the abundant cheap labour of skilled type in the area.

The capital investment for such a foundry in Howrah area can be estimated as follows:

1.	Land - one acre at Rs.10,000/- per acre	Rs. 10,000
2.	Building - covered area light structure - 6000 sq.ft. at Rs.10/- per sq.ft.	Rs. 60,000
3.	Plant and equipment	
	a) 1½ ton per hour cupola with blower and platform, etc.	Rs. 25,000
	b) Sandmill	Rs. 15,000
	c) Drying oven	Rs. 10,000
	d) Mould boxes to be made during the initial period, about 20 tons	Rs. 30,000
	e) Weighing machine	Rs. 5,000
	f) Other tools and tackles	Rs. 5,000
4.	Installation cost and common services etc. such as water, power, foundation etc. and misc. expenses such as telephone, furniture etc.	Rs. 10,000
		Rs. 170,000

The total production from such an investment can be expected to be, if the cupola operates only 10 days in a month on a batch operation for about 3 hours per day, a total of 45 tons of liquid metal

out of which a total of about 30 tons of finished castings can be produced per month, fetching a sale value of about Rs.75,000/- per month on an average price of Rs. 2.50 per kilogramme of unmachined castings or an annual output of Rs. 9 lakhs,[2/] which means about 5 times turnover of the initial fixed invested capital. This can be considered as an excellent investment from the point of view of investment turnover. This is cited just as an example why large number of grey iron foundries are still coming up on Howrah area. This has been possible because

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2/ 1 lkh = 100,000.

[illegible] BASIC FACTORS FOR THE LOCATION AND/OR DEVELOPMENT OF FOUNDRIES

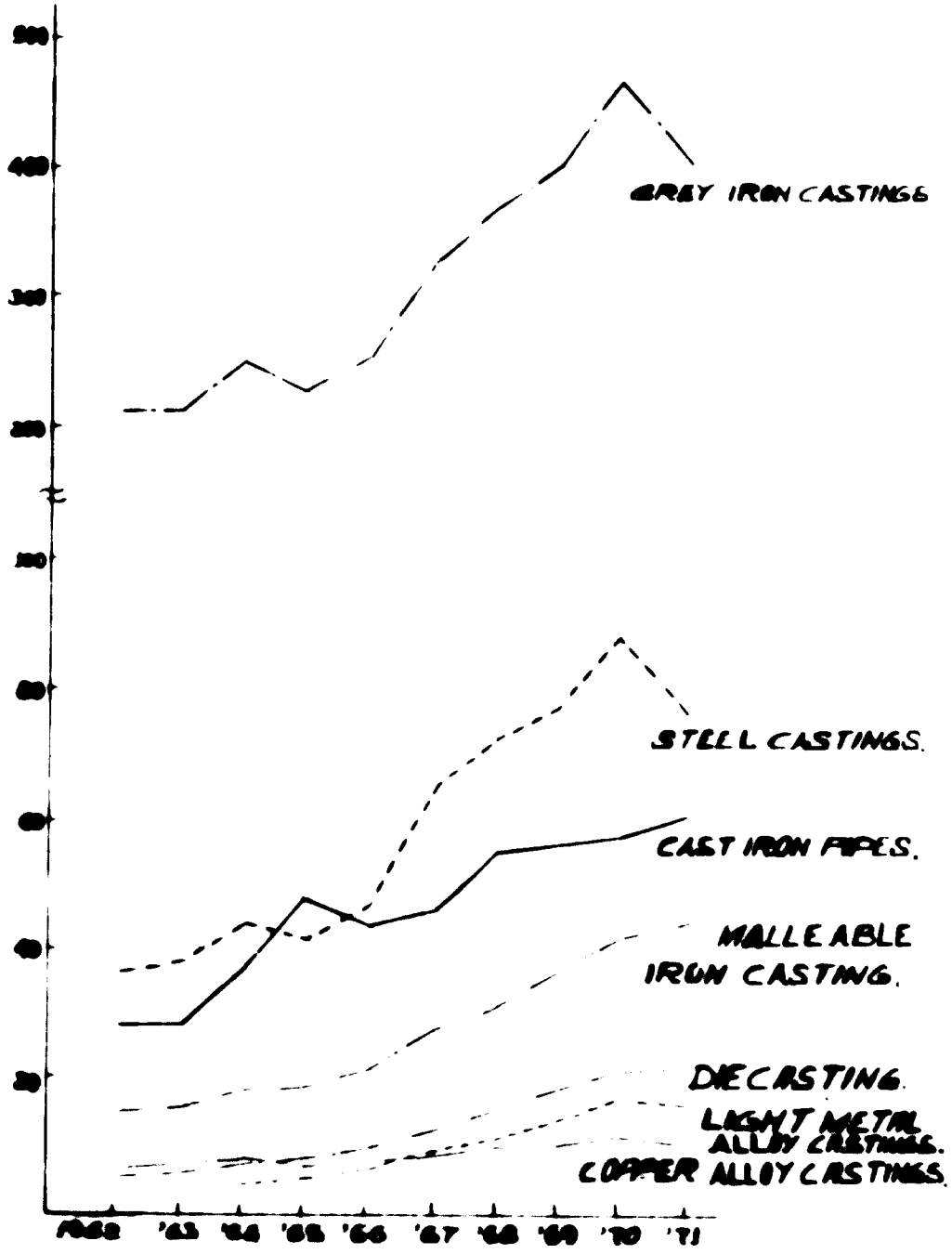
[illegible] countries of Asia and the Far East region have depended for [illegible] their national economy on land and agricultural product[illegible]. On account of population growth and impact of present lay[illegible] development in other countries the standard of li[illegible] in countries is rapidly changing. With the change of [illegible] people the demand of manufactured goods is also [illegible] and consequently the pattern of national economy is also changing. Together with the increase the volume of agricultural production, the share of the manufacturing production in the gross national product should be increased further in order to allow attainment of higher standards of living. The first country in Asia who [illegible] South was Japan. It was only in 1868 that the Emperor [illegible] Japan expected the idea of setting up factories following the industrial pattern of the western countries. For this purpose he allowed the Japanese people to go freely round the world and see how their countries developed the industrial base in diversified fields.

[illegible] more than a century Japan has proved beyond doubt [illegible] industries [illegible] even though it had hardly [illegible] sources of essential raw materials. This country [illegible] the world's third largest country for steel production [illegible] cost and quality equal to international standards. [illegible] the country industry had to be equally developed to [illegible] building industry. The extent of growth [illegible] be judged on the following [illegible] the countries

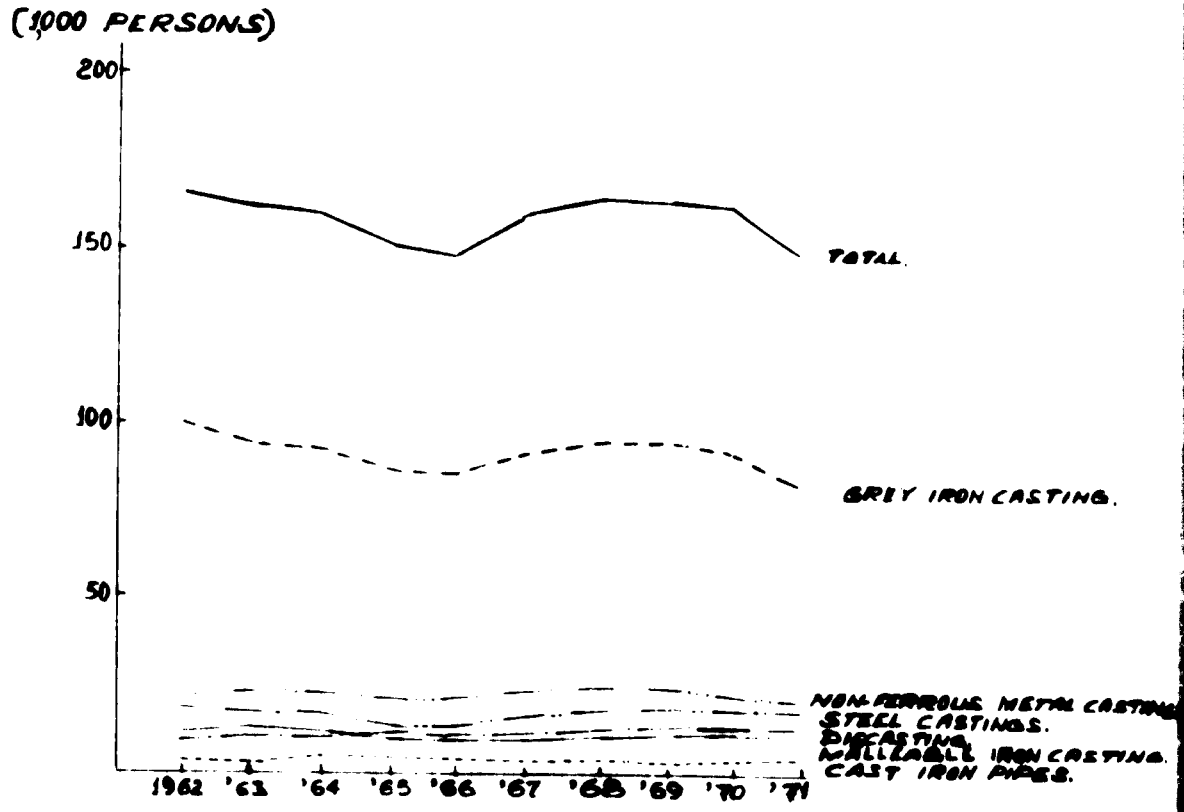
[illegible] country country

Enough [illegible] beyond [illegible].

10 THOUSAND TONS.



GRAPH I TREND OF PRODUCTION OF FOUNDRY INDUSTRY IN JAPAN



GRAPH II TREND OF FOUNDRY EMPLOYMENT BY MATERIALS IN JAPAN

In the year 1960, when the author led a 10-member Indian foundry productivity team to study the Japanese foundry industry, it was revealed that they were able to buy the best quality of pig iron and coke at the cheapest price. With the basic materials for foundry available at the lowest price and cheap but hard-working labour force they were able to produce and sell sophisticated machine tools in the world market at the chsapest price. The very base of the machine tool and foundry industry was in Kawaguchi area. The river Kawaguchi separates Tokyo from Kawaguchi industrial belt just as the city of Calcutta is separated by the river Ganges from the Howrah industrial belt. There are hundreds of foundry cum machinery works in the Kawaguchi area, which is the hub of Japanese industrial activity for basic industry. The small foundries share the majority of the common services such as purchase of raw materials on a global tender basis and sale of the finished products through large industrial houses. Even the purchase of local materials is made by a single purchase organisation and delivered to the small foundries. Thus the small foundries in Japan even today are doing a spectacular job in maintaining the overall economy of the country.

Following these examples the Government of India also invited the Japanese specialists to put up a prototype production cum training centre in Howrah for the benefit of the small foundries of Howrah area.

If it was possible for Japan having no raw material resources of her own except limestone to supply to foundry industry, there is no reason why the countries of Asia and Far East cannot develop a foundry industry of their own.

The fundamental requirement is a motivating force, as was shown by the Japanese, and lately by Indian, entrepreneurs.

The organisation of any industrial enterprise and foundry industry needs the combinations of various essential factors starting with the letter 'M', and these are:

(a) Mind — mental preparation of an entrepreneur;

(b) Market — to survey the local demands of the products to be taken up for manufacture;

(c) Material — to check up availability either from local sources or from imports of essential raw materials;

(d) Methods — to be adopted most economically for processing under the circumstances prevailing in a country;

(e) Machines — to be employed for output of the product both qualitatively and quantitatively;

(f) Men — to operate the machines strictly in conformity with the technical practices;

(g) Money — needed to set up the plant and subsequent production activities;

(h) Management — to coordinate and control the activities of the factors to ensure a sound end product and overall economy of the industrial unit.

Now let us examine each one of the above aspects and see to what extent it is possible to apply them in the development of small industries in the countries of Asia and the Far East.

a Mind

As has been stated earlier the essential requirement for starting of an industrial activity is the motivation of a man. The very fact that a team of men are coming to India from countries like Burma, Indonesia, Malaysia, Nepal, Philippines, Sri Lanka and Thailand to examine the operation of small grey iron foundries proves that the

people of these countries have been fairly motivated to undergo the pains and pleasures of economic development in their respective regions. The gentlemen who are in the team have already gained sufficient knowledge on foundry technology and foundry operations. With the basic background they can see for themselves how the foundry industry in Howrah area has grown and what other good points they can pick up after visiting the foundries of Howrah region so that further knowledge they gain can be usefully applied for developing their own small grey iron foundries in their respective regions.

(b) Market

The entreprensurs should now on their return, if they have not done so earlier, examine what type of cast products can be readily sold in their respective regions. Are these products required for a short term or long term? In this respect, pattern of demand as indicated in the earlier chapters of this study of Indian foundries can serve as a broad guideline. In any developing country the demand of castings can be from one or more of the following sources:

1) Sanitary fittings and municipal items: Such as rainwater pipes and pipe fittings for domestic plumbing, manhole covers and fixtures for underground drainage system, sanitary fittings like flushing cisterns, valves, ventilators etc.

2) Weights and measures: Due to expansion of trades and trading activities many foundries take up these items for production and one or more foundries can be specially engaged only to produce these items on a long-term basis.

3) Domestic kitchen appliances: Cast iron cooking pots and pans have been manufactured in India for centuries and are being exported to various countries of Asia and the Far East. Although aluminium has come up in a big way in the market, it is found that cooking pots and plans made of grey iron last much longer than their counterparts in aluminium. Several foundries can be kept busy producing these items.

4) Agricultural implements and irrigation pumps: Agricultural implements like plough shares are also good items for production in a small foundry. The shares can also be fitted to a wooden plough drawn by a bullock cart and several foundries in India are producing these items on a long-term basis. Even if a modern tractor is used the demand of plough shares will not only go up but many other components of the tractor which are essentially made of grey iron can be taken up for manufacture in a small foundry. With the development of mechanised agriculture, which is bound to take place in all the countries of Asia and the Far East, the production of agriculture implements in grey iron could be a very good long-term business.

Agriculture and irrigation must go hand in hand. Although in many areas of the Far East natural rain water does the job, in case of flood or drought pumps of various capacities are needed to maintain the balance and have a good harvest. Along with the pumps, pipes and pipe fittings are also required.

As most of the pumps are required in villages where electrical power may not be available, diesel or petrol engines are required to be coupled up with the pumps of various capacities.

The production of pumps and diesel engines can itself keep several grey iron foundries busy as it has done in India and Japan.

5) Domestic Appliances such as Sewing Machines and Electric Fans:

These items which are principally made of cast parts of grey iron, are required in every house and can be locally manufactured. These items can be taken up for production in small foundries on a long-term basis.

6) Castings for Electrical Machinery and Fittings:

Electricity is now the main life line for human society everywhere on earth and electrical machinery like electric motor bodies of various sizes, switch boxes, fuse boxes, junction boxes etc. are all cast parts and cast in grey iron. Production of these items alone can keep several grey iron foundries busy on a long-term basis in any country. The production of these castings does need strict metallurgical control, however.

7) Cement and Construction Machines Industry:

In every developing country of Asia and the Far East, construction activities such as construction of public buildings, residential houses, roads and bridges etc. are bound to take in an organized manner for many years to come. Construction machinery industry has been developed to a great extent where cast components are required in large quantities such as spares for brick-making machines and brick moulds, concrete mixer and vibrators, stone-crushing machines etc.

Similarly, the cement industry needs large quantities of

castings of both iron and steel to the extent of 0.5% of the cement produced. Although the majority of these castings are required in special steels for cement grinding, there are a large number of grey cast iron components which are consumable items and can be produced in a small foundry locally.

8) Sugar and Flour Milling Industry:

Sugar and flour are materials of daily necessity. In every country of the Far East region, mills for processing sugar and flour are in operation. There are many components of these mills which are made of grey cast iron. A systematic market survey may reveal that a fair amount of grey iron casting products are necessary to keep these mills in proper condition.

9) Railway Permanent Way and Rolling Stock Fittings:

The railway system in any country consumes many castings in the form of cast iron sleepers, bottom plates for the permanent way, brake block for wagons, coaches and locomotives, which are required in large quantities in addition to spare parts for locomotives, wagons and carriages. In India, the extensive railway system of about 50,000 track miles keeps the major part of foundry industry busy. Since there are railway systems in almost all countries of Asia and Far East, it is not difficult to assess the requirements of grey iron castings consumed by the railways in each country.

10) Machine Tools and Industrial Plant and Equipment:

Although machine tool industry needs specialized castings, a beginning should be made to start a machine tool industry in each country. In this connexion it should be particularly noted that various surveys undertaken under the auspices of the United Nations Economic Commission for Asia and Far East (ECAFE) have shown that there is considerable scope for the manufacture of petrochemical products in Asia. At the second Asian

Conference on Industrialisation (1970), a programme for developing the petrochemical industry was initiated. This programme included proposals to close the annual gap between prospective demand and capacity estimated in terms of ethylene at about 500,000 tons. It was also recommended that more countries should manufacture machinery and equipment for the fabrication of plastics. An increase in the production of synthetic fibres, specially polyester was also considered important. In the beginning only simple machines can be taken up for the production. Manufacture of machine tools for plastic products as has been recommended by ECAFE will also need many grey iron castings.

11) The Automobile Spare Parts Industry:

In any country the automobile industry is largely responsible for beginning a snowball action on industrial development activities. In the present day civilisation, an automobile is a bare necessity and not a luxury. To keep the automobile really mobile, spare parts of the wearing type are needed in large quantities. Many Indian small foundries are engaged in the manufacture of truck spare parts like brakedrum castings. Because of the overloading factor, the breakage of brakedrum castings is nearly 30%. The production of these items alone on a regional basis can be a sizeable load for small grey iron foundries. Although the production of automobile castings needs a fair amount of metallurgical control during manufacture, a beginning can be made to take up the manufacture in a modest manner and it may not be difficult to assess the requirements of such castings in any country of Asia and Far East.

(c) Material

The basic raw materials for a grey iron foundry are as follows:

Pig iron

B.P. hard coke

Limestone

Moulding sand

Binding materials such as bentonite, dextrine, coal dust, Core oil, such as linseed oil.

Natural graphite for mould and core wash.

The basic materials of grey iron foundries are of course pig iron and coke. The Encyclopedia Brittanica reports on the natural occurrence of mineral resources like coal and metallic ores in Asia are as follows:

Minerals such as Coal - Asia has enormous reserves of coal amounting to almost 60 per cent of the world total, but they are unevenly distributed. The largest reserves are found in China and the Asian part of the Soviet Union. The Democratic People's Republic of Korea, the Democratic Republic of Viet-Nam, India, Indonesia, and the Republic of Korea have smaller but economically important reserves. Burma, Malaysia, the Philippines, the Republic of Vietnam, and Thailand, have only insignificant amounts of poor coal. In South-East Asia, both Afghanistan and Turkey, have small economic reserves.

Metallic Ores, Iron - All portions of Asia have deposits of iron ore, although not every country has its own private supply. The Republic of Korea, the Republic of Viet-Nam, Sri Lanka and several smaller countries in South-East Asia appear to have only small iron ore supplies. Japan has not enough iron ore to meet its large iron and steel industry and largely depends on imported supplies. The Philippines has much more ore than needed by its small industrial needs and is an ore exporter. Malaysia also exports a considerable volume. Burma, Pakistan and Thailand, have fair amounts of relatively low grade ores. The Democratic Republic of Viet-Nam and Turkey

have good ores in substantial volume. India and Indonesia both have large deposits of good iron ore that are well distributed.

The production of pig iron in this region will greatly accelerate the growth of small grey iron foundries. Specifications for all the above materials have been given in the chapter dealing with standards and for the benefit of the foundry industry. Efforts should be made to locate indigenous resources on identical lines in each country. It is understandable that pig iron and coke must be obtained by importing from other countries until the integrated steel plants with coke oven batteries in the region come up during the interim period. If the indents are grouped in one lot perhaps the best quality of material at lowest cost can be available as is done in Japan. Moulding sand and other binding materials must be locally available in the region. However, careful tests must be carried out in national laboratories before final selection.

With regard to other common services facilities such as roads, electric power, factory sheds, the lessons can be taken from the Indian example. Instead of overburdening the entrepreneurs, the Government of each country of Asia and the Far East may set up industrial estates with common services facilities such as electric power, water supply and sanitation, communication by road and rail transport etc., so that pace of progress can be expedited. The subject has been dealt with in greater detail in an earlier chapter in this report.

(d) Methods

The basic technological steps required to be taken for the production of grey iron castings have been diagrammatically explained in Fig. 2 of this report. However, to adopt to the local conditions, certain concrete decisions must be taken depending on the products to be cast for manufacture in grey iron foundry. The basic steps are however generally as follows.

1) Metal melting and pouring

2) Moulding and core making

3) Fettling, cleaning and heat treatment

4) Test and quality control

There are a number of different ways of melting iron such as in (a) coke or oil-fired crucibles, (b) oil-fired rotary melting furnaces, (c) oil-fired reverbratory type sklenar furnaces, (d) electric furnaces both induction and arc, and (e) cupola furnaces. The simplest of all are the cupola furnaces, whioh are universally used. It is therefore recommended that in countries of Asia and the Far East, cupolas of different capacities should be utilised for melting of grey iron even if it requires importation of pig iron and coke. The main advantages of cupola installations are: (1) low capital investment; (2) operation can be done by semi-skilled workers; (3) they do not involve extensive metallurgical control.

Depending on the local conditions, other forms of melting technique oan also be introduced but cupola method of melting is the simplest of all.

With regard to moulding and core making techniques, the synthetic sand practice is by far the simplest for whioh sand

mixer mullers can be employed and with the synthetic sand practice, machine moulding for semi-mass-production can also be introduced depending on the product mix. With regard to core making, oil sand practice will be more versatile. The core oils, can either be linseed oil which is produced in this region or other forms of synthetic core oil from petro-chemical products. Shell cores either with thermo setting or cold setting resin or 'nobake' types of resins can be used on a restrictive basis due to high cost. Sodium silicate bonded sand can also be used in a limited manner depending on the availability of sodium silicate and CO_2 gas. Out of all different core binders, linseed oil and dextrine are by far the cheapest. Only precaution that needs to be taken for linseed oil based cores, is drying the core at a temperature which should not exceed 250°C, otherwise the cores may get overbaked and consequently break.

With regard to fettling and cleaning, grey iron castings-surfaces are normally clean due to use of graphite paint in the mould anc cores; hand brushing of the surfaces is good enough. However, in cases of high production, a shot blasting machine can be employed. The chipping of fins and dressing of risers can either be done by normal hammer and chisel or by a pneumatic chisel and grinding.

(e) **Machines**

As has been indicated earlier, the machines to be employed will depend on the methods to be followed. The machinery needed for a grey iron foundry are generally as follows:

1) **Melting:**

a) Cupola with blower having hourly melting rate depending on total monthly capacity of finished products. With or without the skiphoist depending on the available capital and manpower.

b) An oil-fired or coke-fired crucible when the monthly production quantum is extremely low, or

c) An oil-fired rotary melting furnace, or

d) An oil-fired reverbratory type sklenar furnace for specialised and limited operation, or

e) An electric mains-frequency induction-melting furnace for highly specialised products needing meticulous metallurgical control.

Other equipment in the melting shop can be one weighing machine and ladles and hand shanks of various capacities.

2) Sand Preparation:

Sand mixer muller with capacity as may be needed for the preparation of moulding sand and core sand. Also a sand riddle and a sand royer.

A combined unit of shakeout, screen, sandmill and round lump breaker unit when the production quantum is high.

3) Moulding and Core Making Machines:

In a small grey iron foundry, most of the operations are carried out manually but where capital investment permits, it is always an advantage to install one or two jolt squeeze pin lift types of moulding machines, a small coreblower and baking oven of a simple chamber type.

4) Fettling, cleaning and heat-treatment equipment:

Normally in a small grey iron foundry the fettling and cleaning operations are carried out by wire brush and hand chipping. However, if the production volume is large enough to keep a shot blasting machine quite busy for at least 8 hours, one shot blast machine may be added with the capital available. Pneumatic chipping hammers and different types of grinding machines such as a pedestal grinder, bench grinder or a pneumatic hand grinder may be used if compressed air is available.

Grey iron castings normally do not need any heat treatment except high-duty graded iron, in which case a low-temperature stress-relieving furnace can be locally fabricated.

5) Testing and quality control:

In a grey iron foundry, it is always an advantage to have a testing laboratory for chemical analysis and sand testing. A conventional type of chemical laboratory for determination of carbon, silicon, manganese, sulphur and phosphorous by wet process is always an advantage. A combined carbon and sulphur determinator, a simple microbalance and muffle furnace are all that are needed for the purpose under a qualified chemist.

Sand-testing apparatus may consist of (a) a moisture tester, (b) a green-strength determinator and a (c) permeability tester for doing the routine tests along with a baking oven for drying the core-sand test specimens.

An entrepreneur must investigate in his respective country whether or not the equipment listed above is available. If not, these should be imported either from other countries, depending on the price and delivery, for which the Government of the country should issue the necessary import licenses.

With regard to quality control in grey iron foundries, it will be comparatively simpler to introduce quality control in a new foundry than in an established old foundry. The quality control measures must be enforced from the stage of raw material procurement. This can be achieved rather easily if the tests specified in various international standards, are strictly enforced subject to such relaxation as the local conditions may demand. Similarly a quality control programme should be introduced at every basic stage of operation such as pattern making, melting, sand preparation, moulding and core making, heat treatment and at the final stage of inspection.

These measures could be defined as follows:

a) Chemical analysis of the metal.

b) Log Sheet recording the (a) time of melting (b) additions of various fluxes and alloys.

c) Standardisation of sand mixtures for various purposes by composition and tests.

d) Predetermining the gating and risering system.

e) Recording the cycle of heat treatment operation.

f) Correlating all the above results and final inspection before delivery.

6) Men:

The men to be employed in a grey iron foundry may be of three categories i.e. skilled, semi-skilled and unskilled. While unskilled and semi-skilled people are abundantly available in each country of the region, availability of skilled men such as moulders, core makers or furnace operators, may consitute a problem during the initial period. However, with the training facilities available in many trade training centres it may be possible to get a few skilled people to start the operation and eventually each foundry should have its own simple type of training programme within the industry. It has been found that a few young people having some initiative and drive as trade apprentices to work with the skilled men, will pick up the key points of the trade and exhibit skill within a very short time.

For men on supervisory work, local technical school and university may be a good source for supplying specialists as supervisors.

Above all, the managerial ability of the entrepreneur himself and his leadership, will go a long way to select a good local team of technicians for the successful operation of the grey iron foundry.

(g) Money

In the earlier chapter, it has been clearly described how India offer various types of credit facilities whereby an entrepreneur can start his small scale grey iron foundry with even 10% of the cost of the project. Similar facilities may be offered by the Governments and the commercial banks in the countries of Asia and the Far East. The success achieved by India in this respect, may serve as an example.

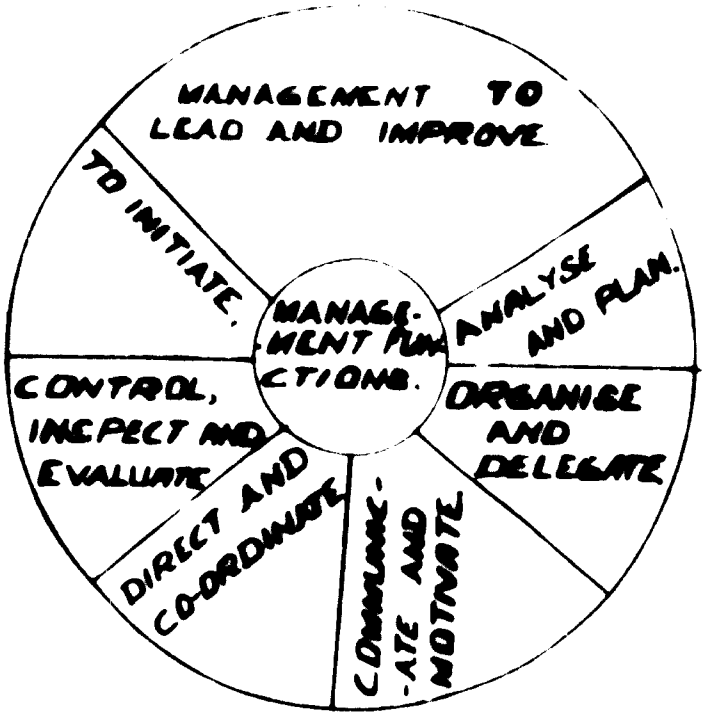
To get an idea of the cost of the project, some hypothetical cases have been worked out in this report which gives the overall cost of the project under Indian conditions which can be further modified depending on the local conditions prevailing in other countries of the Asian and the Far East region.

(h) Management

The management of an industrial undertaking is a science as well as an art. It is an intellectual process which every entrepreneur must develop partly by visiting identical establishments, undergoing specialised courses either in his own country or abroad or by self education under pressure of circumstances.

The management function is basically co-ordination, correlation and maintaining intellectual balance for the purpose of effectively and precisely carrying out the technical processes and other allied operations (illustrated in Fig. 4). For convenience, typical layouts with sketches for a few small scale grey iron foundries are given in Annexes A, B, C, D, and E.

FIG. 4



MANAGEMENT FUNCTIONS.

6. RECOMMENDATIONS FOR THE PROMOTION OF FOUNDRY INDUSTRY

If India's experience is considered suitable for other countries of the region then the appropriate government organisations may be encouraged in helping the growth of small scale foundries industries and may take the lead in providing the required infrastructures in the same pattern as was done in India, the details of which have been elaborately discussed in the earlier chapter of this report. In India being a sub-continent various agencies were entrusted with the job. But in a small country it will be possible to operate through one or two agencies or organizations. In this respect the specific recommendations that were made by the prospective planning team of the Ford Foundation to the Government of India in 1953-54 and detailed in chapter 5 of this report may serve as a broad guideline.

A beginning can be made if appropriate ministries in countries of the region provide in part or in full the following common service facilities:

a) Industrial estates with common service facilities such as communication by road and if possible by rail also, supply of electric power in each of the factory premises, supply of water, both industrial and for drinking purposes, sanitation and drainage system for the disposal of waste products, technological library and auditorium for holding meetings, recreation facilities and welfare arrangement for employees;

b) A multipurpose institute and trade training centre for the training of artisans in technological processes for small scale industries including foundries with testing, research and development facilities;

c) Marketing organization which may be involved in the procurement of essential raw materials and sale of finished products both for home and export market;

d) A financial institution through which hire-purchase credit

facilities and banking facilities can be made easily available to an entrepreneur at a rate of interest much lower than normal bank interest and not more than 5%.

17. DEGREE OF MECHANISATION IN SMALL GREY IRON FOUNDRIES

In foundry operations handling of materials is a factor which should receive the best attention of foundrymen as on it depends the very operation of the foundry both economically and qualitatively. The object of mechanisation is two fold:
(a) To eliminate manual handling; employing humans to do lift-and-carry work, not only creates health hazards, but is expensive.
(b) To be able, by material handling by mechanical means, to deliver the predetermined quantity at a regular rate and yet maintain uniform quality. The mechanical handling problems in a large production foundry, are quite different from those in a small jobbing foundry. It has been stated earlier in this report that mechanical handling and automation has been developed to such an extent for foundry operations that a mass-production foundry can be operated by a few men by pressing a few buttons. But the problem of handling in a small jobbing foundry is quite different. In such small foundries, the operators can be given some mechanical aids rather than mechanised equipment for the purpose of removing hasards and ensuring both qualitative and quantitative operation. Furthermore the cost of mechanical equipment should be fully justified and cannot just be kept idle, only adding depreciation value to the

overall cost of the products. For example, the cost of a belt conveying system is fully justified when the hourly rate of sand movement is high, say from 5 tons per hour to 100 tons per hour. In a small foundry, only 5 tons of sand may be needed for a whole day's operation. To install a mechanical handling system in this case, would be uneconomical and wasteful. The resources for a small scale industrial unit are limited and therefore financial resources must be utilised only after careful consideration. The mechanical aid in a small jobbing foundry can therefore be limited to the following.

(a) for cupola operation - a skip hoist

(b) for sand reclamation and preparation system -
(i) a mechanical riddle (ii) sand aerator

(c) A bucket loader for the sand mill

For moulding and core making:

(a) Pneumatic rammers for moulders and core makers

(b) Moulding machines either hand operated or pneumatically operated when items of repetitive nature are to be produced

For fettling:

(a) Pneumatic chisels

(b) Shot blasting machines

In the typical foundry layout suggested in annexes A, B and C, typical mechanical aids needed for the purpose have been clearly indicated.

18. CONCRETE CONCLUSIONS AND RECOMMENDATIONS FOR EVENTUAL FUTURE CO-OPERATION BETWEEN DEVELOPED COUNTRIES OF THE REGION.

The phenomenal growth of India's multifarious industrial complexes is largely due to international co-operation. The pattern of arrangements with foreign firms for creating and developing foundry units were as follows:

a) A lump-sum down payment for the preparation of initial project report outlining objectives and the total cost of the project and the Foreign Exchange required to import specialised plant and equipment;

b) Technical fees for the preparation of detailed project reports paid in easy instalments;

c) Technical fees for erection, supervision and commissioning including provision of foreign technicians for a limited period. The local subsistance expenses for the foreign technicians were, however, paid in local currency and the technical fees were paid in easy monthly instalments.

d) Royalty on patented processes on finished products up to a maximum of [illegible] was taxable in India;

e) The foreign collaborators were allowed to participate in the equity capital upto 49% (now reduced to 40% only) and allowed to repatriate the profit after paying local taxes.

In the last two decades, the above policy has worked very satisfactorily and such joint venture complexes are still allowed to expand their activities on similar pattern.

But so far as the small scale industries are concerned foreign collaboration did not really work due to the fact that the financial base of small scale enterprises did not either have the resources or could not justify the expenses involved in paying for the services to be rendered by the foreign collaborators compared to the value of the products turned out within the price range prevailing in the country. The entrepreneur therefore had to depend on indigenously available technical knowledge backed by the services of initial project report by the Small Industries Service Institute.

In the case of developing countries of Asia and the Far East it may be possible to obtain expertise from India or from UNIDO (at government request) to help them to prepare project reports of small foundries.

It may also be feasible for an individual enterpreneur to pay for such technical services. If an entrepreneur is given a factual and realistic project report giving details of plant and equipment, production technique and utilisation of indigenous raw materials it may be possible for him to buy plant and machinery from India and arrange erection and commissioning by the erectors of plant supplier at an

extra cost. Due to various credit facilities granted to Indian exporters it is now possible for Indian equipment manufactures also to offer credit facilities upto a period of five years to the foreign buyer provided they arrange a bank guarantee for hire-purchase payment.

The multipurpose institute suggested in the previous chapter could provide useful services to small foundries, and establishing such institutes in other developing countries is recommended. The creation or the operation of such institute may be assisted through the services of experts from UNIDO as well as from other foreign countries including India where technical aid programmes for other foreign countries are in operation.

It is also possible on the part of an entrepreneur from the developing countries of Asia to enter into collaboration both technically and financially with Indian manufacturers of equipment like sewing machines, diesel engines, pumps and electric motors, electrical fans, agricultural equipment etc. which will create a sizeable demand for grey iron castings and which in turn can be taken up for production in small grey iron foundries in each country of Asia and Far East.

Since all kinds of manufactured goods and also machine tools are imported in this region the time is most appropriate now to establish industries in this region for which foundry industry must be given top priority so that snowball action is generated for the growth of other branches of industries.

During the last years organizations such as UNIDO and ECAFE devote more attention for the industrialization of this area. It is hoped that government organizations and individual entrepreneurs of this region having in mind the importance of foundry industry for the overall industrialization of their countries will promote further this branch of the metallurgical industry and will co-operate closer with each other for the benefit of their peoples.

ANNEX A

PROJECT DETAILS FOR A FOUNDRY FOR SANITARY FITTINGS AND MUNICIPAL CASTINGS

This project report deals with the details of costs etc. for a small grey iron foundry for the production of C.I. manhole covers and frames and sanitary castings etc. Some typical items are illustrated in Fig. 5

The production capacity of this foundry is estimated at 30 tons per month with a total fixed capital investment of Rs.6.02 lakhs which will bring a revenue of Rs.8.4 lakhs per annum employing about 27 workmen and 11 staff as elaborated in the subsequent pages. The layout drawing shown in Fig. 6 indicates the floor space and plant position etc.

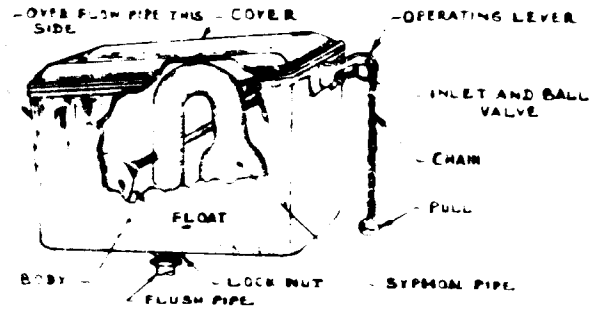
Total Cost of Project- A

No.	Description		Total Price
1.	Land	Rs.	10,000.00
2.	Boundary wall, office building other building and factory shed.	Rs.	1,61,650.00
3.	Plant and Equipments	Rs.	2,94,936.00
4.	Installation Cost 10%	Rs.	26,663.00
5.	Furniture and Fittings	Rs.	5,000.00
6.	Telephone	Rs.	4,000.00
7.	Moter Vehicle	Rs.	40,000.00
8.	Contingency	Rs.	10,000.00
9.	Marginal Working Capital 30% of 3 months production	Rs.	50,000.00
		Rs.	6,02,249.00

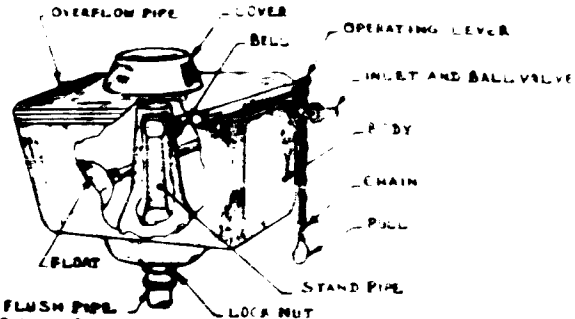
Detailed Breakup of Costs

Item No.	Description	Price	Total Price
A.	Land 220' x 113' (24,860 sq.ft)	@ 0.40 P.sq.ft.	Rs. 10,000.00
B.	Boundary Wall 670' x 10' heigh	@ 1.50 per sq.ft.	10,000.00
C.	Factory Shed 105' x 70'	@15.00 per sq.ft.	1,00,250.00
D.	Office Building 55' x 30'	@20.00 per sq.ft.	33,000.00
E.	Other Building 1300 sq.ft.	@15.00 per sq.ft.	18,400.00
		Total	Rs. 1,71,600.00

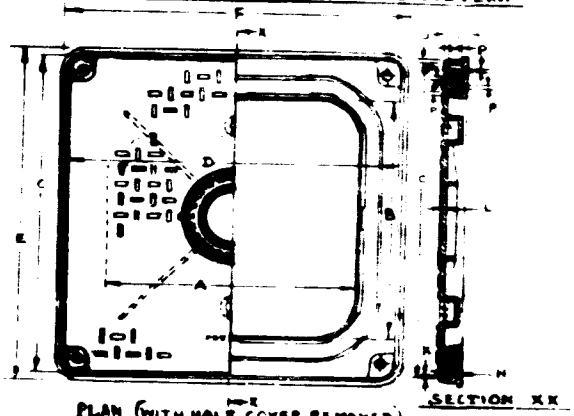
PROJECT - 9 (MANHOLE COVER & CISTERN) Fig 5



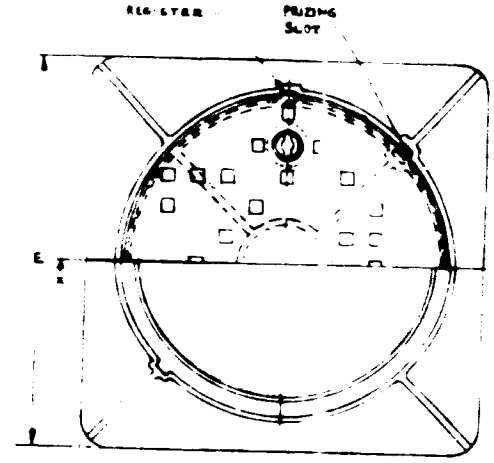
TYPICAL SKETCH OF CURVED SIPHON TYPE CISTERN



TYPICAL SKETCH OF BELL TYPE CISTERN



LIGHT DUTY DOUBLE SEAL RECTANGULAR COVER AND FRAME



HEAVY DUTY AND MIDIUM DUTY CIRCULAR COVER AND FRAME

TABLE 1 DIMENSIONS OF COVERS AND FRAMES

(All dimensions in millimetres)

Grade	Type	A	B	C	D	E	F	G	H	J	K	L	M	N	P
HE	Double triangular	560	504	—	760	—	100	15	38	3	29	100	600		20
		504	350	—	910	—	100	15	32	3	29	100	600		20
HD	Circular	500	600	—	760	—	100	15	32	3	29	85	—		20
		560	660	—	860	—	100	15	32	3	32	85	—		20
MD	Circular	500	580	—	710	—	100	15	12	3	20	85	—		11
		560	630	—	760	—	100	15	12	3	26	85	—		11
MD	Rectangular	610	485	610	585	760	585	100	15	12	3	26	85	—	11
LD	Rectangular single seal														
	Pattern 1	485	610	685	385	390	560	60	7	5	2	7	22	—	5
	Pattern 2	485	660	675	585	690	845	30	8	5	5	3	26	—	8
	Double seal	485	610	760	590	775	685	60	7	5	8	7	22		5

Plant and Machinery for common services

Item No.	Description	H.P.	Price	Total Price
1.	Water pump with tubewell and angle structure with overhead tank 6000 litters capacity and pipe line	3-H.P	Rs.15,000	Rs. 15,000.00
2.	Main oil storage tank 8000 littres capacity and overhead oil tank size 4'-0" x 4'-0" x 4'-0" 2000 littres capacity with angle structure and oil pump pipe lines.	3-H.P	Rs.20,000	Rs. 20,000.00
3.	Electric Switch board power and lighting distribution system about		Rs.15,000	Rs. 15,000.00
4.	Sanitation, septic tank and sanitary fittings		Rs.10,000	Rs. 10,000.00
5.	Watch and ward, time keeping clocks and watcher etc.		Rs. 2,500	Rs. 2,500.00
6.	Welfare and first aid facilities and safety and fire fighting equipments		Rs. 2,000	Rs. 2,000.00
7.	Furniture and fittings		Rs. 5,000	Rs. 5,000.00
8.	Telephone		Rs. 4,000	Rs. 4,000.00
9.	Motor Vehicle and other transport		Rs.40,000	Rs. 40,000.00
			Total	Rs.1,13,500.00

Plant and Equipments (Melting Shop)

1.	2-M/Tons capacity cupola with blower, and charging platform	20-H.P	Rs.40,000	Rs. 40,000.00
2.	Oil fired laddle preheater with oil burner and blower	2-H.P	Rs. 8,000	Rs. 8,000.00
3.	Fixed hearth metal receiver 1-M/Tons capacity		Rs. 3,000	Rs. 3,000.00
4.	Hand shank ladle 100 kg.(6-nos)		Rs. 400	Rs. 2,400.00
5.	Hand shank ladle 50 kg (12-nos)		Rs. 300	Rs. 3,600.00
6.	Hand shank laddle25 kg (4-nos)		Rs. 250	Rs. 1,000.00
7.	Weighing scale, 500 kg capacity		Rs. 3,000	Rs. 3,000.00
			Total	Rs. 61,000.00

Plant and Equipments (Moulding Shop)

Item No.	Description	H.P	Price	Total Price
1.	2-M/Tonne capacity bucket conveyer with rotary hexagonal screen	3-H.P.	Rs.15,000	Rs. 15,000.00
2.	150 kg. capacity sand mixing machine with bucket charger	5-H.P.	Rs.18,000	Rs. 18,000.00
3.	Hand operated turn-over moulding machine (2 nos)		Rs. 9,000	Rs. 18,000.00
			Total	Rs. 51,000.00

Plant and Equipment (Core shop)

1.	50 kg. capacity core sand mixing machine	3-H.P	Rs. 5,000	Rs. 5,000.00
2.	Auto Ridler with Triped	3-H.P	Rs. 4,000	Rs. 4000.00
3.	Core drying oven size 8'-0" x 6'-0" x 7'-0" with trally, oil burner, hot air recirculating fan, combustion, chamber and blower for burner	7-H.P	Rs.30,000	Rs. 30,000.00
4.	Hot room coal firing arrangement with blower, size of room 16'-0" x 10'-0" x 7'-0"	2-H.P	Rs.10,000	Rs. 10,000.00
5.	Core making branch size 10'-0" x 3'-0" (4 nos)		Rs.10,000	Rs. 10,000.00
			Total	Rs. 99,000.00

Plant and Equipment for (fettling shop)

1.	15" wheel dia pedestal grinder	5-H.P	Rs.10,000	Rs. 10,000.00
2.	4" wheel heavy duty portable hand grinder.	1-H.P	Rs. 4,500	Rs. 4,500.00
			Total	Rs. 14,500.00

Plant and Equipments for (Maintenance & Pattern Shop)

Item No.	Description	H.P.	Price	Total Price
1.	Drill Machine	1.5	Rs. 3,500	Rs. 3,500.00

Plant & Equipment for (Laboratory)

1.	Precision balance with wt. 100 gm. to 10 gm.		Rs. 1,800	Rs. 1,800.00
2.	Rapid Moisture Tester		Rs. 2,000	Rs. 2,000.00
3.	Permeability, Testing Apparatus		Rs. 2,200	Rs. 2,200.00
4.	Green Sand Strength Testing Apparatus		Rs. 1,800	Rs. 1,800.00
5.	Complete sand sieve shaker		Rs. 2,500	Rs. 2,500.00
6.	Core hardness tester (portable)		Rs. 1,500	Rs. 1,500.00
7.	Mould Hardness tester (portable)		Rs. 1,500	Rs. 1,500.00
			Total	Rs. 13,300.00

Miscellaneous Items

Item No.	Description	Nos.	Price of each	Total Price
1.	Wheel Barrow	4	Rs. 550	Rs. 2,200.00
2.	Moulding Tools			Rs. 400.00
3.	Shovel	8	Rs. 50	Rs. 400.00
4.	Steel Brush	12	Rs. 3	Rs. 36.00
5.	Hand Lamp	6	Rs. 25	Rs. 150.00
6.	Woolf's electric blower for mould cleaning	3	Rs. 400	Rs. 1,200.00
7.	M.S. Moulding Box size 36" x 36" x 3"ht	25	Rs. 250	Rs. 6,250.00
8.	M.S. Moulding Box size 30" x 30" x 3" ht	20	Rs. 200	Rs. 4,000.00
9.	M.S. Moulding Box size 24" x 24" x 3" ht	20	Rs. 175	Rs. 3,500.00
10.	Other tools			Rs. 1,000.00
			Total	Rs. 20,136.00

Monthly Salary for Staff

Item No.	Description	No. of staff	Rate	Salary/month
1.	Enterpreneur cum manager	1	Rs. 1,500/-	Rs. 1,500.00
2.	Asst. Manager	1	Rs. 1,000/-	Rs. 1,000.00
3.	Foundry Engineer	1	Rs. 600/-	Rs. 600.00
4.	Accountant cum cashier	1	Rs. 500/-	Rs. 500.00
5.	Accounts clerk	1.	Rs. 300/-	Rs. 300.00
6.	Chief Office Clerk(steno typist)		Rs. 400/-	Rs. 400.00
7.	Store keeper	1	Rs. 300/-	Rs. 300.00
8.	Watchman	4	Rs. 200/-	Rs. 800.00
				Rs. 5,400.00
	Fringe Benefit 20%			Rs. 1,080.00
			Total	Rs. 6,480.00

Monthly wages for workers

Sl.No.	Description	Department	No.of workers	Wage/month
1.	Cupola operator	(melting shop)	1	Rs. 250.00
2.	Cupola helper	"	1	Rs. 200.00
3.	Cupola Khalasi	"	2	Rs. 300.00
			4	Rs. 750.00
4.	Hand Moulder	(Moulding shop)	3	Rs. 675.00
5.	Hand Moulder Helper	"	2	Rs. 400.00
6.	Machine Moulder	"	2	Rs. 450.00
7.	Sand mixing operator	"	1	Rs. 200.00
8.	Screening Machine Operator	"	1	Rs. 200.00
9.	Floor Khalasi	"	2	Rs. 300.00
			11	Rs. 2,975.00
10.	Core Maker	(core shop)	2	Rs. 450.00
11.	Core helper	(")	2	Rs. 350.00
			4	Rs. 800.00
12.	Swing grinding machine operator	(fettling shop)	1	Rs. 200.00
13.	Pedestal machine operator	"	2	Rs. 400.00
14.	Portable Grinding Machine operator	(")	1	Rs. 200.00
15.	Khalasi Fettler	(")	2	Rs. 300.00
			6	Rs. 1,100.00
16.	Pattern Maker	(pattern & Maintanance shop)	1	Rs. 250.00
17.	Mechanical & Elec.Fitter	"	1	Rs. 250.00
			2	Rs. 500.00

(a)	No of Heads	27 Nos.		
(b)	Total Wages	...	...	Rs. 6,125.00
(c)	Fringe Benefits 20% of Rs.6,125/-		...	Rs. 1,225.00
			Total	Rs. 7,350.00

RAW MATERIALS REQUIRED FOR 30 M/T GRADES OF GOOD CASTING PER MONTH AFTER 10% MELTING LOSS :

Item No.	Description	Price per unit	Total Requirements		
1.	Pig Iron 70%	Rs.900/P/M Tonne	23.1	M/Tonne	Rs. 20,790.00
2.	C.I. Scrap 30%	Rs.850/P/M Tonne	9.9	M/Tonne	Rs. 8,415.00
3.	Lime Stone 5%	Rs.150/P/M Tonne	1.65	M/Tonne	Rs. 2,475.00
4.	S.P.Hard Coke 20%	Rs.350/P/M Tonne	6.6	M/Tonne	Rs. 2,310.00
5.	Moulding Sand	Rs. 40/P/M Tonne	60	M/Tonne	Rs. 2,400.00
6.	Bentonite 5% of total sand	Rs.450/P/M Tonne	3	M/Tonne	Rs. 1,350.00
7.	Dextrine .1% of core sand	Rs.2000/P/M Tonne	.25	M/Tonne	Rs. 500.00
8.	Graphite .5% of total sand	Rs.2000/P/M Tonne	.3	M/Tonne	Rs. 600.00
9.	Soap stone.25% of total sand	Rs.1000/P/M Tonne	.15	M/Tonne	Rs. 150.00
10.	Coal Dust .5% of total sand	Rs. 300/P/M Tonne	.3	M/Tonne	Rs. 90.00
11.	Fire Wood (40 kg. in each charge)	Rs. 400/P/M Tonne	1	M/Tonne	Rs. 400.00
12.	Fire Brick (300 piece)	Rs. 2 each	200	nos.	Rs. 400.00
13.	Fire Clay	Rs. 500/P/M Tonne	.5	M/ Tonne	Rs. 250.00
14.	Ramming Mixture	Rs. 350/P/M Tonne	.5	M/Tonne	Rs. 175.00
15.	Furnace Oil	Rs. 800/P/M Tonne	1500	Litre	Rs. 1,200.00
17.	Grinding Wheel	Rs. 90/- each	10	Pieces	Rs. 900.00
18.	Pottling Tool				Rs. 50.00
19.	Lubricating Oil	Rs.20/- P/Litre	10	Litres	Rs. 200.00
20.	Cotton Waste	Rs.5/- P/Kg	20	Kg	Rs. 100.00
21.	Nuts & Bolts	Rs. 12 P/Kg	5	Kg	Rs. 60.00
22.	Power	Rs.0.25 P/Unit	2000	Kw	Rs. 500.00
				Total	Rs. 43,315.00

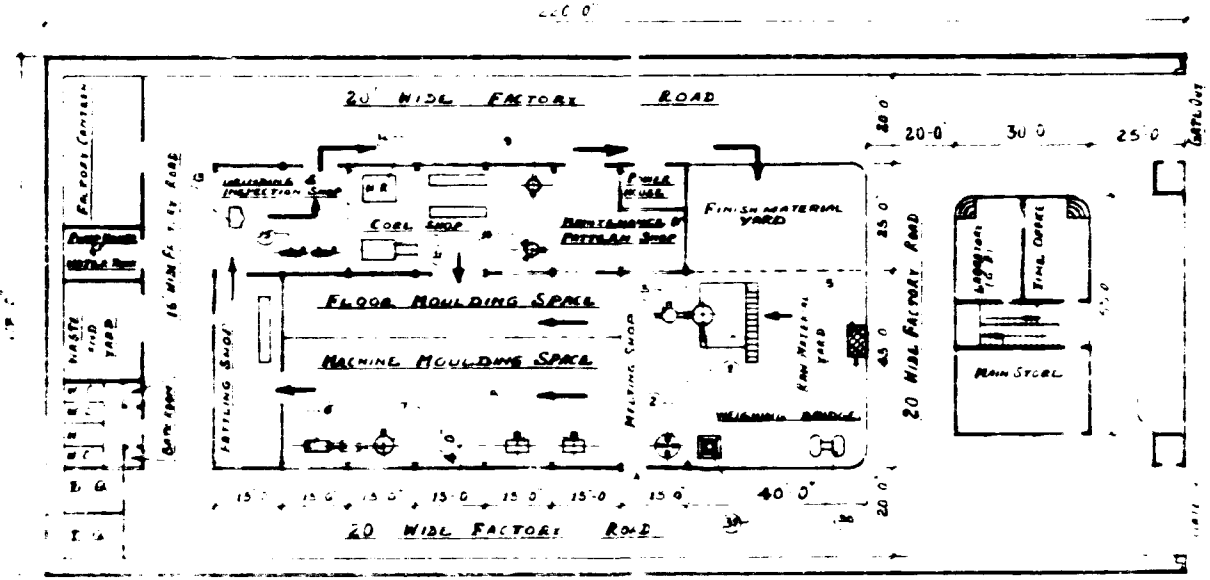
Cost of Production for 30 M/Tonnes of good casting per month

Sl.No.	Description	Total Price
1.	Raw Material - Pig Iron and C.I. Scrap	Rs. 29,268.00
2.	Raw Material - Moulding sand	Rs. 2,400.00
3.	Raw Material - Lime Stone	Rs. 2,475.00
4.	Raw Material - Bentonite, Dextrine, Graphite, Soap stone, coal dust	Rs. 2,695.00
5.	Refractories - Fire Bricks, Fire Clay, Ramming Mixtures	Rs. 825.00
6.	Fuel - Fire Wood, S.P.Hard Coke, Furnace Oil and other items	Rs. 3,910.00
7.	Consumable Store Items- Grinding Wheel, Fettling tools, Lubricant Oil, Cotton Waste, Bearings, Nuts and Bolts	Rs. 1,310.00
8.	Power	Rs. 500.00
9.	Rent and Taxes @ 1½% on sales	Rs. 1,350.00
10.	Printing & Stationary	Rs. 50.00
11.	Travelling Expenses	Rs. 300.00
12.	Delivery cost	Rs. 500.00
13.	Sales Commission ½%	Rs. 450.00
14.	Monthly salary of staff	Rs. 6,400.00
15.	Monthly wages of workers	Rs. 7,350.00
16.	Depreciation cost of plant and equipments @ 10% of plant cost	Rs. 3,055.05
17.	Depreciation cost building and boundary wall @ 5% on value	Rs. 673.56
18.	Indirect over head, rejection or cancellation of the order 1% of manufacturing cost	Rs. 626.27
19.	Bank interest @ 12% per annum on running capital	Rs. 536.86
	Total	Rs. 64,712.48
A.	Cost of production for one tonne of good casting	Rs. 2,157.00

Annual Profitability statement of full production

(A)	Sales Proceeds of 300 M/Tonnes of grey iron good casting @ Rs.2800/- per M/Tonne	Rs.8,40,000.00
(B)	Cost of production at floor level per M/tonne of good grey iron casting @ Rs.2157/- per M/tonne	Rs.6,47,100.00
		Rs.1,92,900.00
(c)	Gross profit 22.96%	Rs.1,92,900.00

Fig 6



S.NO	DESCRIPTION	QUANTITY
	MELTING SHOP	
1	2-M/TONE CAPACITY P/H CUPOLA WITH MOTOR DRIVEN BLOWER CHARGING PLATFORM	1 NO
2	OIL FIRED LADDLE PREHEATER WITH MOTORISED BLOWER AND BURNER	1 NO
3	FIXED HEARTH CUPOLA RECEIVER 1 TONE CAPACITY	1 NO
4	HAND SHANK LADDLE	
	A 100 KG CAPACITY	8 NOS
	B 50 KG CAPACITY	12 NOS
	C 25 KG CAPACITY	4 NOS
5	PLATFORM WEIGHING SCALE 500 KG CAPACITY	1 NO
	MOULDING SHOP	
6	2-M/TONE CAPACITY BUCKET CHARGER WITH ROTARY HEXAGONAL SCREEN	1 NO
7	150 KG CAPACITY SAND MIXING MACHINE WITH BUCKET CHARGER	1 NO
8	HAND OPERATED TURN OVER MOULDING MACHINE	6 NOS
	CORE SHOP	
9	100 KG CAPACITY CORE SAND MIXER	1 NO
10	AUTO RIDDLER WITH TRIPOD	1 NO
11	CORE BAKING OVEN SIZE 9'X6'X6' COMPLETE WITH HOT AIR RECIRCULATING FAN AND OIL BURNERS EQUIPMENTS	1 NO
12	HOT ROOM CORE SPRING ARRANGEMENT SIZE 16'-0"X10'-0"X7'-0" WITH RACKS	1 NO
	FETTLING SHOP	
13	6'-0" TABLE DRY SHOT BLAST UNIT	1 NO
14	SWING GRINDER	2 NOS
15	PEDESTAL GRINDER	2 NOS
	MAINTENANCE & REPAIR SHOP	
16	[illegible]	1 NO
17	LATHE MACHINE 5'	1 NO
18	SHAPPING MACHINE 24" STROKE	1 NO
19	RADIAL DRILLING MACHINE 3" SPINDLE	1 NO
20	TOOL GRINDER 10" DIA	1 NO
21	HACKSAW MACHINE 8" STROKE	1 NO
	LABORATORY EQUIPMENT	
22	PRECISION BALANCE	1 NO
23	MOISTURE TESTER	1 NO
24	PERMEABILITY TESTING APP.	1 NO
25	GREEN STRENGTH TEST APP.	1 NO
26	COMPLETE SIEVE SHAKER	1 NO
27	[illegible]	[illegible]
28	[illegible]	[illegible]
29	[illegible]	[illegible]
	COMMON SERVICES	
1	[illegible]	[illegible]
2	[illegible]	[illegible]
3	[illegible]	[illegible]

TITLE: PROJECT FOR GRAY IRON FOUNDRY OF MANHOLE COVER FRAME CASTINGS

ANNEX B

PROJECT DETAILS FOR A GREY IRON FOUNDRY FOR PIPE AND PIPE FITTINGS

This project deals with the setting up of a C.I. Foundry for the production of C.I. Pipes and Pipe Fittings as illustrated in Fig 7 at a total fixed capital investment of Rs.10 lakhs for the production of about 900 Tons of C.I. Pipes and Pipe Fittings valued at Rs.22.68 lakhs per annum employing about 51 workmen and 15 staff. The layout drawing shown in Fig. 8 indicates the floor space and plant position etc.

Total Cost of Project -B

Sl.No.	Description	Total Price
1.	Land	Rs. 18,328.00
2.	Boundary Wall, Factory Shed, Office Building and other building	Rs. 2,83,560.00
3.	Plant and Equipments	Rs. 3,78,436.00
4.	Installation Cost	Rs. 39,130.00
5.	Furniture and Fittings	Rs. 5,000.00
6.	Telephone	Rs. 4,000.00
7.	Motor and vehicles	Rs. 40, 000.00
8.	Contingency	Rs. 25,000.00
9.	Marginal Working Capital 30% of 3 months working	Rs. 1,07,000.00
		Rs.10,00,000.00

Detailed Breakup of cost

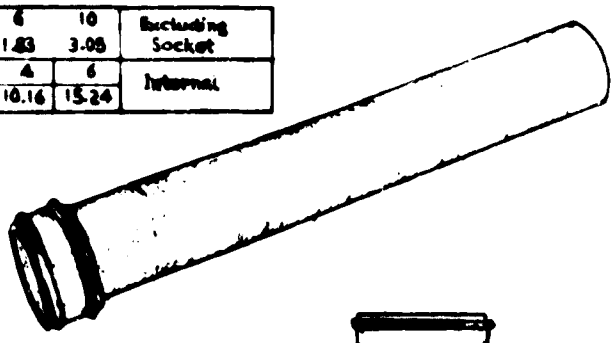
Item No.	Description	H.P.	Price	Total Price
A.	Land 316'-0" x 145'-0" (45,820 sq.ft.)		@ 0.40 per sq.ft	Rs. 18,328.00
B.	Boundary Wall 900'-0" x 10'-0" (9,000 sq.ft.)		@ 1.50 per sq.ft	Rs. 13,500.00
C.	Factory Shed 140'-0" x 95'-0" (13,300 sq.ft)	15 KW	@15.00 per sq.ft	Rs. 1,99,500.00
D.	Office Building 72'-0" x 30'-0" (2,160 sq.ft.)	5 KW	@20.00 per sq.ft	Rs. 43,200.00
E.	Other Building 1,824 sq.ft.	4 KW	@15.00 per sq.ft	Rs. 27,360.00
			Total	Rs. 3,01,888.00

PROJECT 'B' (SOIL PIPES & PIPE FITTINGS OF C.I.)

FIG 7

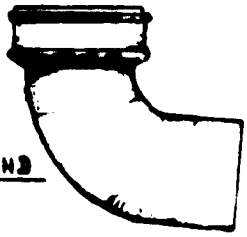
LENGTHS	FEET	2	3	4	6	10	Excluding Socket
	METERS	0.61	0.91	1.22	1.83	3.05	
DIAMETERS	INCHES	2	2½	3	3½	4	6	Internal
	CENTIMETRES	5.08	6.35	7.62	8.89	10.16	15.24	

SINGLE SOCKETTED PIPE



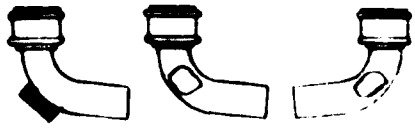
DEGREES		92½°	105°	112½°	120°	135°
DIAMETERS	INCHES	2	2½	3	3½	4	6
	CENTIMETRES	5.08	6.35	7.62	8.89	10.16	15.24

BEND



PLAIN BEND

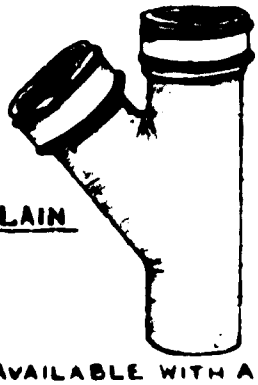
ALSO AVAILABLE WITH ACCESS DOOR



TYPE 'X' TYPE 'Z' TYPE 'Y'

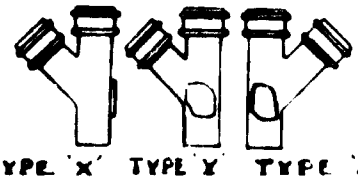
SINGLE EQUAL JUNCTION

DEGREES		92½°	105°	112½°	120°	135°
DIAMETERS	INCHES	2	2½	3	3½	4	6
	CENTIMETRES	5.08	6.35	7.62	8.89	10.16	15.24



PLAIN

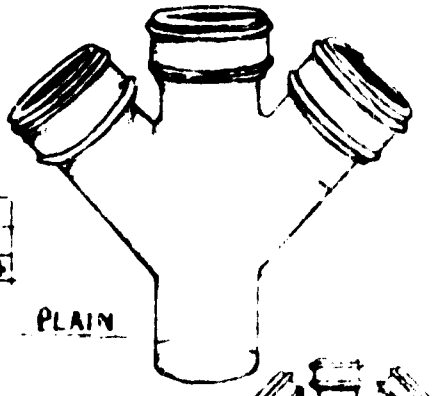
ALSO AVAILABLE WITH ACCESS DOOR



TYPE 'X' TYPE 'Y' TYPE 'Z'

DOUBLE EQUAL JUNCTION

DEGREES		92½°	105°	112½°	120°	135°
DIAMETERS	INCHES	2	2½	3	3½	4	6
	CENTIMETRES	5.08	6.35	7.62	8.89	10.16	15.24



PLAIN

ALSO AVAILABLE WITH ACCESS DOOR

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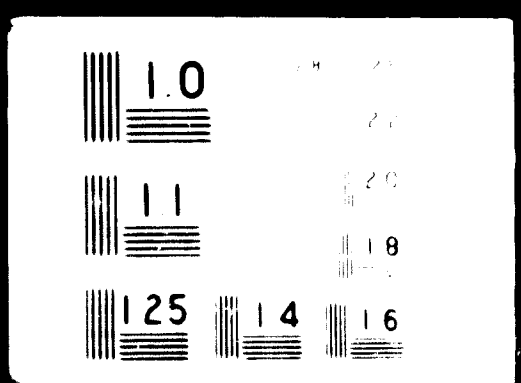


Plant and Equipment for Common Services

Item No.	Description	H.P.	Price	Total Price
1.	Water pump with tubewell and angle structure with over head water tank 6,000 littres capacity and pipe line.	3-H.P	Rs.15,000	Rs. 15,000.00
2.	Main oil storage tank 8000 littres capacity and overhead tank size 4'-0" x 4'-0" x 4'-0" 2000 littres capacity with angle structure and oil pump pipe line	3-H.P	Rs.20,000	Rs. 20,000.00
3.	Electric switch board power and lighting distribution system for 50 K.W. continued load		Rs.15,000	Rs. 15,000.00
4.	Sanitation, aeptic tank and sanitary fittings		Rs.10,000	Rs. 10,000.00
5.	Watch and ward, time keeping clocks and watchers etc.		Rs. 2,500	Rs. 2,500.00
6.	Welfare and first aid facilities and safety and fire fighting equipments.		Rs. 2,000	Rs. 2,000.00
			Total	Rs.1,13,500.00

Plant and Equipments (Melting Shop)

1.	3-M/Tonne capacity P/H cupola with motorised blower, and charging platform (2-nos)	25-H.P	Rs.40,000	Rs. 80,000.00
2.	Oil fired laddle preheater with oil burner and blower	2-H.P	Rs. 8,000	Rs. 8,000.00
3.	Fixed hearth metal receiver 1-M/Tonne capacity		Rs. 3,000	Rs. 3,000.00
4.	Hand shank Laddle 100 kg (6 nos)		Rs. 400	Rs. 2,400.00
5.	Hand shank Laddle 50 kg (12 nos)		Rs. 300	Rs. 3,600.00
6.	Hand shank Laddle 25 kg(4 nos)		Rs. 200	Rs. 1,000.00
7.	Weighing scale, 500 kg. capacity		Rs. 3,000	Rs. 3,000.00
			Total	Rs.1,01,000.00

Plant and Equipments (Moulding Shop)

Item No.	Description	H.P.	Price of each	Total Price
1.	Shake out machine	5-H.P	Rs.15,000	Rs. 15,000.00
2.	2-M/Tonne capacity bucket charger with rotary hexagonal screen.	3-H.P	Rs.15,000	Rs. 15,000.00
3.	150kg. capacity sand mixing machine with bucket charger	8-H.P	Rs.18,000	Rs. 18,000.00
4.	Hand operated turn-over moulding machine (2 nos)		Rs. 9,000	Rs. 18,000.00
			Total	Rs. 66,000.00

Plant and Equipments (Core Shop)

Item No.	Description	H.P.	Price of each	Total Price
1.	50 kg. capacity core sand mixture	3-H.P	Rs. 5,000	Rs. 5,000.00
2.	Auto ridler with tripod	3-H.P	Rs. 4,000	Rs. 4,000.00
3.	Core drying over size 8'-0" x 6'-0" x 7'-0" height with trally, oil burner, hot air recirculating fan, combustion chamber and blower for burner.	7-H.P	Rs.30,000	Rs. 30,000.00
4.	Hot Room coal firing arrangement with blower size 16'-0" x 10'-0" x 7'-0"	2-H.P	Rs.10,000	Rs. 10,000.00
5.	Core making bench size 10'-0" x 3'0" (2 nos)		Rs. 1,000	Rs. 2,000.00
6.	Pipe core making table (4nos)		Rs. 1,500	Rs. 6,000.00
			Total	Rs. 57,000.00

Plant and Equipments (Maintenance & Pattern Shop)

Item No.	Description	H.P	Price of each	Total Price
1.	Drill machine	1.5 kw	Rs. 3,500	Rs. 3,500.00

Plant and Equipments (Laboratory)

Item No.	Description	H.P.	Price of each	Total Price
1.	Precision balance with wt. 100 gm to 10 gm.		Rs.1,800.00	Rs. 1,800.00
2.	Rapid moisture tester for sand		Rs.2,000.00	Rs. 000.00
3.	Permeability testing apparatus		Rs.2,200.00	Rs. 2,200.00
4.	Green sand strength testing apparatus		Rs.1,800.00	Rs. 1,800.00
5.	Complete sand sieve shaker		Rs.2,500.00	Rs. 2,500.00
6.	Core hardness tester		Rs.1,500.00	Rs. 1,500.00
7.	Mould hardness tester (portable)		Rs.1,500.00	Rs. 1,500.00
			Total	Rs.13,300.00

Miscellaneous Items

Item No.	Description	Nos.	Price of each	Total Price
1.	Wheel barrow	4	Rs.550.00	Rs. 2,200.00
2.	Moulding tools			Rs. 400.00
3.	Shovel	8	Rs. 50.00	Rs. 400.00
4.	Steel Brush	12	Rs. 3.00	Rs. 36.00
5.	Hand Lamp	6	Rs. 25.00	Rs. 150.00
6.	Woolf's electric blower for mould cleaning	3	Rs.400.00	Rs. 1,200.00
7.	M.S. Moulding box size 36" x 36" x 3" ht.	25	Rs.250.00	Rs. 6,250.00
8.	M.S. Moulding box size 30" x 30" x 3" ht.	20	Rs.200.00	Rs. 4,000.00
9.	M.S. Moulding box size 24" x 24" x 3" ht.	20	Rs.175.00	Rs. 3,500.00
10.	Other tools			Rs.10,000.00
			Total	Rs.28,136.00

Monthly salary for staff

Sl.No.	Description	No.of Staff	Salary/month
1.	Enterpreneur cum manager	1	Rs. 1,500.00
2.	Assistant Manager	1	Rs. 1,000.00
3.	Foundry Engineer	1	Rs. 600.00
4.	Foundry Foreman	1	Rs. 600.00
5.	Accountant cum casheer	1	Rs. 500.00
6.	Chief Office clerck (steno typist)	1	Rs. 400.00
7.	Watchmen (@ Rs.200/-)	4	Rs. 800.00
8.	Supervisor for Moulding shop	1	Rs. 350.00
9.	Supervisor for Core shop	1	Rs. 350.00
10.	Supervisor for Melting shop	1	Rs. 350.00
11.	Accounts clerck	1	Rs. 300.00
12.	Store keeper	1	Rs. 300.00
			Rs. 7,050.00
	Fringe benefit 20%		Rs. 1,410.00
		Total	Rs. 8,460.00

Monthly Wages for Workers

Sl.No.	Description	Department	No. of workers	Wages/month
1.	Cupola operator	(Melting shop)	1	Rs. 250.00
2.	Cupola helper	"	1	Rs. 200.00
3.	Cupola Khalasi	"	4	Rs. 600.00
				Rs.1,050.00
4.	Hand Moulder (for pipe division)	(Moulding Shop)	4	Rs. 900.00
5.	Moulder helper	"	4	Rs. 800.00
6.	Sand mixing operator	"	1	Rs. 200.00
7.	Screening machine operator	"	1	Rs. 200.00
8.	Floor Khalasi	"	4	Rs. 600.00
				Rs.2,700.00
9.	Core maker for pipe division	(core shop)	4	Rs. 900.00
10.	Core helper "	"	4	Rs. 700.00
11.	Core maker for general	"	2	Rs. 450.00
12.	Core helper "	"	2	Rs. 350.00
13.	Core Khalasi	"	2	Rs. 300.00
				Rs.2,700.00

Sl.No.	Description	Department	No. of Workers	Wage/Month
14.	Pressure Testing Operator	(Fettling Shop)	1	Rs. 250.00
15.	Pressure Testing helper	"	2	Rs. 300.00
16.	Turing plant operator	"	1	Rs. 250.00
17.	Turing plant helper	"	3	Rs. 450.00
18.	Inside grinder operator	"	1	Rs. 200.00
19.	Khalasi Fettler	"	2	Rs. 300.00
			10	Rs.1,750.00
20.	Pattern maker	(Pattern shop)	1	Rs. 250.00
21.	Pattern helper	"	2	Rs. 300.00
			3	Rs. 550.00
22.	Mechanical Fitter	(Maintenance shop)	1	Rs. 250.00
23.	Mechanical helper	"	1	Rs. 150.00
24.	Electrical Fitter	"	1	Rs. 250.00
25.	Electrical helper	"	1	Rs. 150.00
			4	Rs. 800.00

A.	No of heads	...	51		
B.	Total Wages	...	...	...	Rs. 9,550.00
C.	Fringe Benefits	20%	...	...	Rs. 1,910.00
				Grand Total	Rs.11,460.00

Monthly Raw Material required for 75 M/Tonnes of good casting after 10% melting loss :

Sl.No.	Description	Price Per Unit	Total Requirement	Total Price
1.	Pig Iron 70%	Rs.900/P/M/Tonne	58.75 M/Tonne	53,875.00
2.	C.I. Scrap 30%	Rs.850/ "	23.75 "	20,187.50
3.	Lime Stone 5% of Total Iron	Rs.150 "	4.2 "	630.00
4.	B.P. Hard Coke 20% of Total Iron	Rs.350 "	16.5 "	5,775.00
5.	Fire Wood 20% of total coke	Rs.400 "	2.5 "	1,000.00
6.	Furnace Oil	Rs.800 "	2500 Litre	2,000.00
7.	Moulding Sand 2-M/Tonne per tonne of iron	Rs.40 "	150 M/Tonne	6,000.00
8.	Bentonite 5% of total sand	Rs.450 "	7.5 "	3,375.00
9.	Dextrine.1% of total sand	Rs.2000 "	.625 "	1,250.00
10.	Graphite .5% of total sand	Rs.2000 "	.75 "	1,500.00
11.	Soap Stone .25% of total sand	Rs.1000 "	.375 "	375.00
12.	Coal Dust .3% of total sand	Rs.300 "	.75 "	225.00
13.	Fire Bricks	Rs.2 each	700 nos.	1,400.00
14.	Fire Clay	Rs.350/P/M/Tonne	1.25 M/Tonne	437.50
15.	Ramming Mixture	Rs.500 "	1.25 "	625.00
16.	Grinding Wheel	Rs.90 each	25 nos.	2,250.00
17.	Fettling Tools			125.00
18.	Lubricating Oil	Rs.20 per litre	25 litres	500.00
19.	Cotton Waste	Rs.5 per kg.	50 kg.	250.00
20.	Nuts and Bolts	Rs.12 per kg.	10 kg.	120.00
21.	Bearings			150.00
				Rs.1,02,049.00

(A) Total cost of raw material for one month production Rs.1,02,049.00

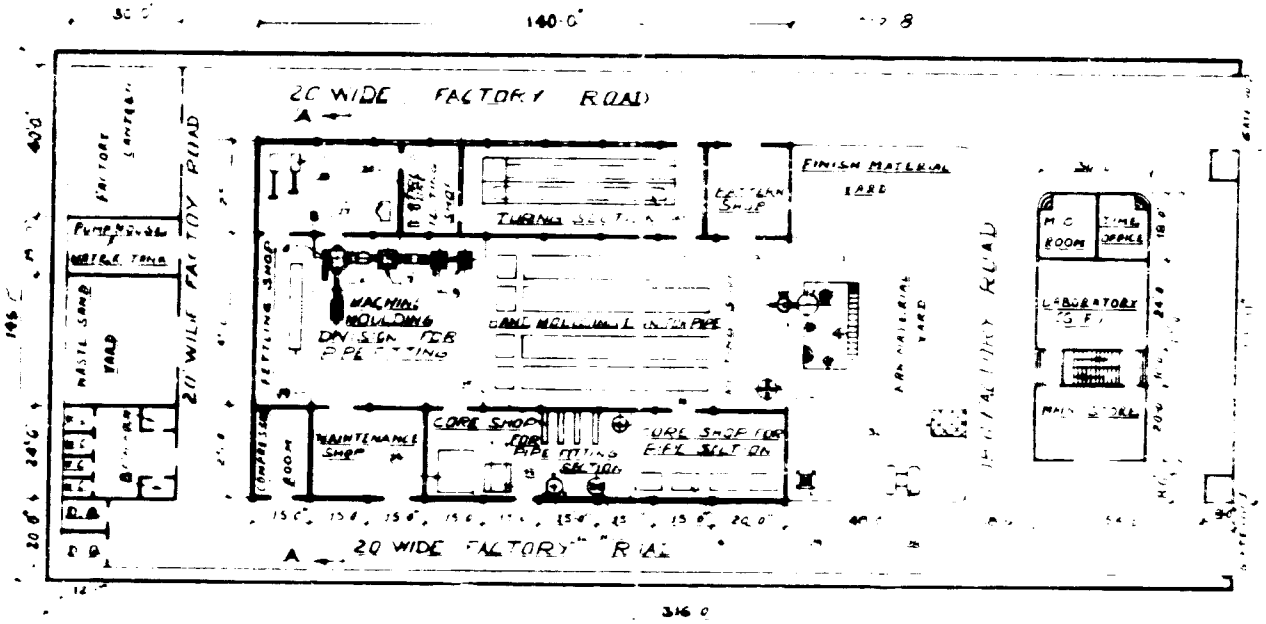
Cost of Production for 75-M/Tonnes of Good Castings per month

Sl.No.	Description		Total Price
1.	Raw Material - Pig Iron and C.I. Scrap	Rs.	74,062.50
2.	Raw Material - Moulding Sand		6,000.00
3.	Raw Material - Lime stone		630.00
4.	Raw Material - Bentonite, Dextrine, Graphite, Soap Stone and Coal Dust.		6,725.00
5.	Refractories - Fire bricks, Fire Clay, Ramming Mixture		2,462.00
6.	Fuel - B.P. Hard Coke, Fire Wood, Furnace Oil		8,775.00
7.	Consumable & Store Items - Grinding Wheel, Fettling Tools, Lubricant Oil, Cotton Waste, Bearings, Nuts and Bolts.		3,395.00
8.	Power		1,000.00
9.	Rent and Taxes @ 2% on sales		3,750.00
10.	Printing & Stationary		80.00
11.	Travelling Expenses		1,500.00
12.	Delivery and Transport		800.00
13.	Sales Commission 1% on Sales		1,875.00
14.	Monthly salary of staff		11,460.00
15.	Monthly wages of workers		8,460.00
16.	Depreciation cost of plant and equipment @ 10% of the plant cost		4,404.00
17.	Depreciation cost of Boundary wall and building @ 5% on value		1,181.50
18.	Indirect over head such as rejection, cancellation of order 2% of manufacturing cost.		3,750.00
19.	Bank interest @ 12% per annum on running capital		833.00
	Total	Rs.	1,41,143.00

(A)	Cost of Production per M/Tonne of good castings	Rs.	1,881.90

Annual Profitability statement on full production

(A)	Sales Proceeds of 900 M/Tonnes of Gray Iron good castings @ Rs.2520 per M/Tonne	Rs.	22,68,000.00
(B)	Cost of Production at floor level per M/Tonne of good gray iron casting @ Rs.1853.40 per M/Tonne.		16,68,060.00
		Rs.	5,99,940.00
(C)	Gross Profit = 35.96%	Rs.	5,99,940.00



SECTION AT AA

S.NO	DESCRIPTION	QUANTITY
	MELTING SECTION	
1	5m TONE CAPACITY RH	
	BLOWER CHARGING	
2	INDUCED DRAUGHT EXHAUST WITH MOTOR	
3	BASKET AND BUCKET	
4	CRANE LADLE	
A	100 KG CAPACITY	
B	50	
C	25	
	MOULDING SECTION	
5	SHAKE OUT MACHINE	
6	SAND MIXER	
7	SAND CONVEYOR	
8	SAND CRANE WITH BUCKET ELEVATOR	
9	SAND STORAGE HOPPER	
	SAND MOULDING MACHINE	
	CORE SECTION	
10	CORE SAND MIXER	
	SAND CONVEYOR WITH	
	CORE DRYING OVEN	
14	CORE ROOM CRANE ARRANGEMENT	
	CORE TABLE	
	FITTING SECTION	
	MAINTENANCE AND PATTERN SECTION	
24	LATHE MACHINE	
	DRILLING MACHINE	
	POWER HACK SAW MACHINE	
	COMMON SERVICES	
	MAIN OIL STORAGE TANK	
	DISTRIBUTION TANK	
	POWER HOUSE	

SECTION AT AA

CC RAINWATER PIPE

ANNEX V

PROJECT PROFILE FOR MULTIPURPOSE GREY IRON, STEEL AND NON-FERROUS FOUNDRIES

Thia project deals with the setting up of a composite C.I., Steel and non-ferroua foundry at a total fixed capital at Rs.16.80 lakhs producing 720 M-Tons, 300 M-Tons and 60 M-Tons per annum of C.I., Steel and non ferrous castings reapectively valued at Rs.66.16 lakhs. The layout as shown fig indicates the floor space and plant positions etc.

Total Cost of Project -C

Sl.No.	Description	Total Price
1.	Land	Rs. 20,160.00
2.	Boundary Wall, Factory Shed, Office Building	Rs. 4,00,800.00
3.	Plant and Equipments	Rs. 8,23,920.00
4.	Installation Cost	Rs. 82,392.00
5.	Furniture and Fittings	Rs. 5,000.00
6.	Telephone	Rs. 4,000.00
7.	Motor Vehicles	Rs. 40,000.00
8.	Contingency	Rs. 25,000.00
9.	Marginal Working Capital 30% at 3 months working capital	Rs. 2,38,000.00
		Rs.16,39,272.00

Detailed Breakup of Cost

Item No.	Description	Price	Total Price
A.	Land 280'-0" x 180'-0" (50,400 aq.ft)	@40P,per sq.ft.	Rs. 20,160.00
B.	Boundary Wall 880'-0" x 10'-0" height (8800 sq.ft)	1.50 "	Rs. 13,200.00
C.	Factory Shed 150'-0" x 130'-0" (19,500 aq.ft)	@ Rs.15/- "	Rs. 2,92,500.00
D.	Office Building 30'-0" x 100'-0" (3000 aq.ft)	@ 20/- "	Rs. 60,000.00
E.	Other Building (2340) sq.ft.	@ 15/- "	Rs. 35,100.00
F.	Furniture & Fittings		Rs. 5,000.00
G.	Telephone		Rs. 4,000.00
H.	Motor Vehicle and other transport		Rs. 40,000.00
		Total	Rs. 4,69,960.00

Plant and Equipments for Common Services

Item No.	Description	H.P.	Price	Total Price
1.	Water pump with tube well and angle structure with overhead water tank, 1,000 litters capacity and pipe line.		Rs.15,000	Rs. 15,000.00
2.	Main Oil Storage tank, 8000 Litters Capacity and overhead tank size 4'-0" x 4'-0" x 4'-0" 2000 litters capacity with angle structure and oil pump line.		Rs.20,000	Rs. 20,000.00
3.	Electric Switch board power and lighting distribution system about		Rs.20,000	Rs. 20,000.00
4.	Sanitation, septic tank and sanitary fittings		Rs.10,000	Rs. 10,000.00
5.	Watch and Ward, time keeping clocks and watcher etc.		Rs. 2,500	Rs. 2,500.00
6.	Welfare and first aid facilities and fire fighting equipments.		Rs. 2,000	Rs. 2,000.00
7.	Weighing bridge, 1000 kg. capacity		Rs. 3,000	Rs. 3,000.00
				Rs. 72,500.00

Non-ferrous Foundry Plant and Equipments (Melting Shop)

Item No.	Description	H.P.	Price of each	Total Price
1.	Oil fired Tilting Furnace 100 kg. capacity with blower and oil burning equipments	3 H.P	Rs.12,000	Rs. 12,000.00
2.	Weighing scale 250 kg.capacity		Rs. 2,500	Rs. 2,500.00
3.	Coal Fired laddle pre heater	½ H.P	Rs. 2,000	Rs. 2,000.00
4.	Hand shank laddle 50 kg (4 Nos)		Rs. 200	Rs. 800.00
				Rs. 17,300.00

Plant and Equipments (Moulding Shop)

Item No.	Description	H.P.	Price of each	Total Price
1.	Auto Ridler with Triped	3-H.P	Rs.3,500	Rs. 3,500.00
2.	50-kg Sand Mixing Machine	3-H.P	Rs.7,000	Rs. 7,000.00
3.	Moulding Box (15 pair) Size 18" x 15" x 4"		Rs.150 per pair	Rs. 2,250.00
4.	Blow lamp 2 liter capacity(one)		Rs.150	Rs. 150.00
5.	Hand Lamp (100-W) Two nos.		Rs.30	Rs. 60.00
6.	Shovel (Three nos)		Rs.40	Rs. 120.00
7.	Moulding Tools			Rs. 200.00
8.	Electric Hand Blower (woolf's)			Rs. 700.00
9.	Other Tools			Rs. 800.00
			Total	Rs. 14,780.00

Plant and Equipments (Fettling Shop)

Item No.	Description	H.P.	Price of each	Total Price
1.	Pedestal Grinding Machine wheel dia (12")	3-H.P	Rs.6,000	Rs. 6,000.00
2.	Fettling Shop Tools			Rs. 1,500.00
			Total	Rs. 7,500.00

C.I. FOUNDRY

Plant and Equipments (Melting Shop)

Item No.	Description	H.P	Price of each	Total Price
1.	2-M/Tonne capacity cupola blower and fixed receiver	20-H.P	Rs.35,000	Rs. 35,000.00
2.	Oil fired Laddle pre-heater with blower and burner	3-H.P	Rs. 6,000	Rs. 6,000.00
3.	Weighing scale 500 kg. capacity		Rs. 2,500	Rs. 2,500.00
4.	Hand shank laddle 50kg.(12-nos)		Rs. 250	Rs. 3,000.00
5.	Hand shank laddle 100 kg (6 nos)		Rs.300	Rs. 1,800.00
6.	Hand shank laddle 25 kg (4 nos)		Rs.150	Rs. 600.00
			Total	Rs. 49,900.00

Planting and Equipments (Moulding Shop)

Item No.	Description	H.P.	Price of each	Total Price
1.	Auto Ridler with Triped	3-H.P.	Rs.3,500	Rs. 3,500.00
2.	150 kg. Sand Mixing Machine	8-H.P.	Rs.12,000	Rs. 12,000.00
3.	Hand operated turn over moulding machine (2 nos)		Rs.6,000	Rs. 12,000.00
4.	Blow lamp 2 litre capacity (3 nos)		Rs.150	Rs. 450.00
5.	Hand lamp (100-W) (4 nos)		Rs.30	Rs. 120.00
6.	Shovel (6 nos)		Rs.40	Rs. 240.00
7.	Electric Blower (Woolf's) (2 nos)		Rs.700	Rs. 1,400.00
8.	Moulding Tools			Rs. 300.00
9.	Other Tools			Rs. 2,000.00
			Total	Rs.32,010.00

Plant and Equipments (Fettling Shop)

Item No.	Description	H.P.	Price of each	Total Price
1.	Pedestal Grinder 15" dia. wheel	5-H.P	Rs.10,000	Rs. 10,000.00
2.	4" Wheel Heavy Duty Portable Hand Grinder	1-H.P	Rs. 3,500	Rs. 3,500.00
3.	Fettling Shop		Rs. 3,000	Rs. 3,000.00
			Total	Rs. 16,500.00

STEEL FOUNDRY

Plant and Equipments (Melting Shop)

Item No.	Description	H.P.	Price of each	Total Price
1.	600 kg. capacity induction melting furnace, with transformer and controling panel.	125-KW	Rs.2,50,000	Rs. 2,50,000.00
2.	Slag cleaning tools			Rs. 500.00
3.	Shovel and other tools			Rs. 1,500.00
4.	Weighing scale 250 kg. capacity		Rs.2000	Rs. 2,000.00
5.	Tea-pot laddle 250 kg. capacity		Rs.3000	Rs. 3,000.00
6.	Hand shank laddle 100 kg. (3 nos)		Rs.300	Rs. 900.00
7.	Hand shank laddle 50 kg. (4 nos)		Rs.250	Rs. 1,000.00
				Rs. 2,59,900.00

Plant and Equipments (Moulding Shop)

Item No.	Description	H.P.	Price of each	Total Price
1.	Auto Ridler with triped (one)	3-H.P	Rs.3,500	Rs. 3,500.00
2.	150 kg. capacity sand mixing machine (one)	5-H.P	Rs.12,000	Rs. 12,000.00
3.	Blow Lamp 2 litres capacity (3 nos)		Rs.200	Rs. 600.00
4.	Hand Lamp 100-W (3 nos)	.3 KW	Rs.30	Rs. 90.00
5.	Shovel (6 nos)		Rs.40	Rs. 240.00
6.	Electric Blower (2-nos)	1-H.P	Rs.700	Rs. 1,400.00
7.	Moulding Tools			Rs. 300.00
8.	Moulding Box (20 pair) size 24" x 20" x 4"		Rs.150 per pair	Rs. 3,000.00
9.	Other tools			Rs. 1,000.00
			Total	Rs. 22,130.00

Plant and Equipments (Fettling Shop)

Item No.	Description	H.P.	Price of each	Total Price
1.	Transformer welding set 400 amp.	15-H.P	Rs.7000	Rs. 7,000.00
2.	Gas cutting complete set		Rs.2500	Rs. 2,500.00
3.	Fettling Tools set			Rs. 1,000.00
4.	Pedestal grinder 15" dia wheel	5-H.P	Rs.8000	Rs. 8,000.00
5.	Portable Hand Grinder	1-H.P	Rs.3000	Rs. 3,000.00
6.	Annealing Furnace 3-M/Tonne capacity with blower and oil burning equipments.	7.5-H.P	Rs.65,000	Rs. 60,000.00
7.	Shot blast machine 6'-0" table dia. with dust collecting unit	10-H.P	Rs.60,000	Rs. 60,000.00
			Total	Rs.1,46,500.00

Plant and Equipments (Core Shop) for Non-ferrous C.I. & Steel Foundry

Item No.	Description	H.P.	Price of each	Total Price
1.	100 kg. Capacity Core Sand Mixture	5-H.P	Rs.8,000.00	Rs. 8,000.00
2.	Auto Ridler with Triped	3-H.P	Rs.3,500.00	Rs. 3,500.00
3.	Core drying oven size 8'-0" x 6'-0" x 7'-0" height with trally, oil burner, hot-air recirculating fan, combustion chamber and blower for burner.	7-H.P	Rs.30,000	Rs. 30,000.00
4.	Core machine tools			Rs. 500.00
			Total	Rs. 42,000.00

Plant and Equipments (Pattern Shop) for Non-ferrous, C.I. and Steel Foundry

Item No.	Description	H.P.	Price of each	Total Price
1.	Flexible Grinder	1-H.P	Rs.4,000	Rs. 4,000.00
2.	Measuring Instruments		Rs.5,000	Rs. 5,000.00
			Total	Rs. 9,000.00

Plant and Equipments (Maintenance Shop) for Non-ferrous, C.I. and Steel Foundry

Item No.	Description	H.P.	Price of each	Total Price
1.	Lathe Machine 6'-0"	5-H.P	Rs.10,000	Rs. 10,000.00
2.	Drill Machine (1" capacity)	1.5 KW	Rs. 5,000	Rs. 5,000.00
3.	Tool Grinder 10" dia.	1.5 KW	Rs. 3,000	Rs. 3,000.00
4.	Flexible Grinder	1-H.P	Rs. 4,000	Rs. 4,000.00
5.	Measuring and Maintenance Tools			Rs. 1,000.00
			Total	Rs. 27,000.00

Plant and Equipments (Laboratory) for Non-ferrous, C.I. and Steel Foundry

Item No.	Description	H.P.	Price of each	Total Price
1.	**Sand Testing Section**			
	(a) Moisture Tester		Rs.1,500	Rs. 1,500.00
	(b) Permeability Tester		Rs.3,000	Rs. 3,000.00
	(c) Green Strength determinator		Rs.2,000	Rs. 2,000.00
	(d) Mould Hardness tester		Rs.200	Rs. 200.00
	(e) Core Hardness tester		Rs.200	Rs. 200.00
2.	**Chemical Analysis Section**			
	(a) Strehlen Apparatus for Carbon & Sulphur	5-H.P	Rs.6000	Rs. 6,000.00
	(b) Precision Balance with wt.		Rs.2,000	Rs. 2,000.00
	(c) Muffle Furnace	5-H.P	Rs.2,000	Rs. 2,000.00
	(d) Glass ware and other Reagent Bottles etc.		Rs.1,000	Rs. 1,000.00
	(e) Fume Cup Board and other tools		Rs.2,000	Rs. 2,000.00
3.	**Mechanical Testing Section**			
	(a) Universal Testing Machine	5-H.P	Rs.75,000	Rs. 75,000.00
4.	**Metallography Section**			
	(a) Microscope with polishing machine and accessories		Rs.10,000	Rs. 10,000.00
			Total	Rs. 1,04,980.00

Miscellaneous Items

Item No.	Description	H.P.	Price of each	Total Price
1.	Wheel Barrow (1 No)	7-H.P.	Rs.550	Rs. 550.00
2.	Inspection Tools			Rs. 2,000.00
			Total	Rs. 2,550.00

Monthly Salary and Wages for Non-ferrous, C.I. and Steel Foundry

A.	Monthly salary for staff with fringe benefits 20%		Rs. 30,420.00
		20% Fringe Benefits	Rs. 5,070.00
		Total	Rs. 35,490.00
B.	**Monthly Wages for Non-ferrous Foundry**		
	b-1) Melting Shop	Rs. 600.00	
	b-2) Moulding Shop	Rs.1,200.00	
	b-3) Fettling Shop	Rs. 750.00	Rs. 2,550.00
		20% Fringe Benefits	Rs. 510.00
		Total	Rs. 3,060.00
C.	**Monthly Wages for C.I. Foundry**		
	c-1) Melting Shop	Rs. 1,875.00	
	c-2) Moulding Shop	Rs.2,625.00	
	c-3) Fettling Shop	Rs.1,775.00	Rs. 5,475.00
		20% Fringe Benefits	Rs. 1,095.00
		Total	Rs. 6,570.00
D.	**Monthly Wages for Steel Foundry**		
	d-1) Melting Shop	Rs.1,475.00	
	d-2) Moulding Shop	Rs.2,375.00	
	d-3) Fettling Shop	Rs.2,750.00	Rs. 6,600.00
		20% Fringe Benefits	Rs. 1,320.00
		Total	Rs. 7,920.00
E.	Core Shop (for non-ferrous, C.I. & Steel Foundry)		Rs. 1,975.00
		20% Fringe Benefits	Rs. 395.00
		Total	Rs. 2,370.00
F.	Pattern Shop (for non-ferrous, C.I. and Steel Foundry)		Rs. 1,250.00
		20% Fringe Benefits	Rs. 250.00
		Total	Rs. 1,500.00
G.	Maintenance Shop(for non-ferrous, C.I. & Steel Foundry)		Rs. 3,850.00
		20% Fringe Benefits	Rs. 770.00
		Total	Rs. 4,620.00

H.	Laboratory (for non-ferrous, C.I. and Steel Foundry)	Rs.	700.00
	20% Fringe Benefits	Rs.	140.00
	Total	Rs.	840.00

Monthly Salary for Staff

Sl.No.	Description	No.of staff		Total Salary/Month	
1.	Works Manager	1		Rs.	2,000.00
2.	Metallurgist	1		Rs.	1,500.00
3.	Foreman	6		Rs.	4,500.00
4.	Shift Supervisor	4		Rs.	2,000.00
5.	Laboratory Chemists	6		Rs.	1,800.00
6.	Inspectors	2		Rs.	1,000.00
7.	Methods Engineers	2		Rs.	2,000.00
8.	Estimator	2		Rs.	1,000.00
9.	Draftsman	2		Rs.	800.00
10.	Drafts Tracer	1		Rs.	300.00
11.	Chief Office Clerck (Steno-typist)	1		Rs.	400.00
12.	Stores Clercks	4		Rs.	1,200.00
13.	Accounts Clercks	6		Rs.	2,400.00
14.	Time Clercks	2		Rs.	600.00
15.	Cashier	1		Rs.	400.00
16.	Apprentices	6		Rs.	600.00
17.	Watch and Ward	7		Rs.	2,100.00
18.	Peon and Attendants	3		Rs.	750.00
		57			
		—	Total	Rs.	25,350.00

(A)	Total Salary for the month	Rs.	25,350.00
(B)	Fringe Benefits 20% of Rs.25,350/-	Rs.	5,070.00
	Grand Total	Rs.	30,420.00

(C) No. of staff = 57 nos.

Monthly Wages for Workers (non-ferrous foundry)

Sl.No.	Description	No.of Worker required	Wages for each worker	Total Wages/month	
	Melting Shop				
1.	Furnace Operator	1	@ Rs.250	Rs.	250.00
2.	Operator Khalasi	1	@ Rs.175	Rs.	175.00
3.	Laddle Repairing Khalasi	1	@ Rs.175	Rs.	175.00
		3	Total	Rs.	600.00

Sl.No.	Description	No. of Workers Required	Wages for each Worker	Total Wages/Month
	Moulding Shop			
1.	Sand processing	1	@ Rs.175	Rs. 175.00
2.	Moulder	2	@ Rs.250	Rs. 500.00
3.	Moulder Helpfer	1	@ Rs.175	Rs. 175.00
4.	Floor Khalasi	2	@ Rs.175	Rs. 350.00
		6	Total	Rs. 1,200.00
	Fettling Shop			
1.	Fettler	1	@ Rs.175	Rs. 175.00
2.	Padestal Grinder operator	2	@ Rs.200	Rs. 400.00
3.	Store Khalasi	1	@ Rs.175	Rs. 175.00
		4	Total	Rs. 750.00
(A)	Total Wages for the month			Rs. 2,550.00
(B)	Fringe Benefits 20% of Rs.2550/-			Rs. 510.00
			Grand Total	Rs. 3,060.00
(C)	No. of workers = 13			

Monthly Wages for Workers (C.I. Foundry)

	Melting Shop			
1.	Cupola Operator	1	@ Rs.250/-	Rs. 250.00
2.	Cupola Helper	1	@ Rs.200/-	Rs. 200.00
3.	Cupola Khalasi	3	@ Rs.150/-	Rs. 450.00
4.	Laddle Repairing Man	1	@ Rs.175/-	Rs. 175.00
		6	Total	Rs. 1,075.00
	Moulding Shop			
1.	Sand Processing	2	@ Rs.175/-	Rs. 350.00
2.	Sand Mixing Operator	1	@ Rs.175/-	Rs. 175.00
3.	Moulding Machine Operator	2	@ Rs.200/-	Rs. 400.00
4.	Moulding Machine Operator Helper	2	@ Rs.150/-	Rs. 300.00
5.	Hand Moulder	3.	@ Rs.250/-	Rs. 750.00
6.	Hand Moulder Helper	2	@ Rs.175/-	Rs. 350.00
7.	Floor Khalasi	2	@ Rs.150/-	Rs. 300.00
		14	Total	Rs. 2,625.00
	Fettling Shop			
1.	Fettler	3	@ Rs.175/-	Rs. 525.00
2.	Khalasi	3	@ Rs.150/-	Rs. 450.00
3.	Padestal Grinder Operator	2	@ Rs.200/-	Rs. 400.00
4.	Tumbling Barrel Operator	1	@ Rs.200/-	Rs. 200.00
5.	Portable Grinding Machine	1	@ Rs.200/-	Rs. 200.00
		10	Total	Rs. 1,775.00

(A)	Total Wages for the month	Rs. 5,475.00
(B)	Fringe Benefits 20% of Rs.5475/-	Rs. 1,095.00
	Grand Total	Rs. 6,570.00

(C) No. of Workers = 30

Monthly Wages for Workers of (Steel Foundry)

Sl.No.	Description	No. of Workers Required	Wages of each Worker	Total Wages/Month
	Melting Shop			
1.	Induction Furnace Operator	1	@ Rs.450/-	Rs. 450.00
2.	Induction Furnace Operator Helper	1	@ Rs.300/-	Rs. 300.00
3.	Furnace Repairing Man	1	@ Rs.250/-	Rs. 250.00
4.	Laddle Repairing Man	1	@ Rs.175/-	Rs. 175.00
5.	Melting Shop Khalasi	2	@ Rs.150/-	Rs. 300.00
		6	Total	Rs. 1,475.00
	Moulding Shop			
1.	Sand Processing	2	@ Rs.175/-	Rs. 350.00
2.	Moulder	3	@ Rs.300/-	Rs. 900.00
3.	Moulder Helper	3	@ Rs.175/-	Rs. 525.00
4.	Floor Khalasi	4	@ Rs.150/-	Rs. 600.00
		12	Total	Rs. 2,375.00
	Fettling Shop			
1.	Gas Cutting and Welding Man	1	@ Rs.275/-	Rs. 275.00
2.	Fettler	3	@ Rs.175/-	Rs. 525.00
3.	Pedestal Grinding Operator	2	@ Rs.175/-	Rs. 350.00
4.	Flexible and Swing Grinding Machine Operator	1	@ Rs.200/-	Rs. 200.00
5.	Grinder Helper	1	@ Rs.150/-	Rs. 150.00
6.	Fettling Shop Khalasi	3	@ Rs.150/-	Rs. 450.00
7.	Annealing Furnace Operator	1	@ Rs.400/-	Rs. 400.00
8.	Shot Blast Machine Operator	1	@ Rs.250/-	Rs. 250.00
9.	Shot Blast Machine Operator Helper	1	@ Rs.150/-	Rs. 150.00
		14	Total	Rs. 2,750.00

(A)	Total Wages for the month	Rs. 6,600.00
(B)	Fringe Benefits 20% of Rs.6,600/-	Rs. 1,320.00
	Grand Total	Rs. 7,920.00

(C) No of Workers required = 32

Monthly Wages for Workers of (non-ferrous, C.I. & Steel Foundry)

Sl.No.	Description	No of Workers Required	Wages of each Worker	Total Wages/Month
	Core Shop			
1.	Sand Processing	1	@ Rs.175/-	Rs. 175.00
2.	Sand Screening	1	@ Rs.150/-	Rs. 150.00
3.	Core Maker	5	@ Rs.200/-	Rs. 1,000.00
4.	Core Oven Operator	1	@ Rs.200/-	Rs. 200.00
5.	Core Shop Khalasi	3	@ Rs.150/-	Rs. 450.00
		11	Total	Rs. 1,975.00
(A)	Total Wages for the month			Rs. 1,975.00
(B)	Fringe Benefits 20% of Rs.1,975/-			Rs. 395.00
			Grand Total	Rs. 2,370.00
(C)	No. of Workers required = 11			

Monthly Wages for Workers of (non-ferrous, C.I.Foundry & Steel Foundry)

	Pattern Shop			
1.	Pattern Maker	2	@ Rs.300/-	Rs. 600.00
2.	Pattern Maker Helper	2	@ Rs.200/-	Rs. 400.00
3.	File Man	1	@ Rs.250/-	Rs. 250.00
		5		Rs. 1,250.00
(A)	Total Wages for the month			Rs. 1,250.00
(B)	Fringe Benefits 20% of Rs.1,250/-			Rs. 250.00
			Grand Total	Rs. 1,500.00
(C)	No. of Workers Required = 5			

Monthly Wages for Worker of (Non-ferrous, C.I. Foundry & Steel Foundry)

Maintenance Shop

Sl.No.	Description	No of Workers Required	Wages of each Worker	Total Wages/Month
1.	Lathe Machine Operator	1	@ Rs.250/-	Rs. 250.00
2.	Mechanical Fitter	6	@ Rs.250/-	Rs. 1500.00
3.	Electrical Fitter	3	@ Rs.250/-	Rs. 250.00
4.	Fitter Helper(Mechanical)	6	@ Rs.150/-	Rs. 900.00
5.	Fitter Helper(Electrical)	1	@ Rs.150/-	Rs. 450.00
		20	Total	Rs. 3,850.00
(A)	Total Wages for the month			Rs. 3,850.00
(B)	Fringe Benefits 20% of Rs.3850/-			Rs. 770.00
(C)	No. of Workers required = 20		Grand Total	Rs. 4,620.00

Monthly Wages for Workers (Non-ferrous, C.I. Foundry & Steel Foundry)

Laboratory (Sand Testing, Chemical, Mechanical & Metallography Section)

Sl.No.	Description	No of Workers Required	Wages of each Worker	Total Wages/month
1.	Drill Operator	1	@ Rs.175/-	Rs. 175.00
2.	Laboratory Boy Sand Testing Section	1	@ Rs.175/-	Rs. 175.00
3.	Laboratory Boy Chemical Analysis Section	1	@ Rs.175/-	Rs. 175.00
4.	Laboratory Boy Mechanical Testing Section	1	@ Rs.175/-	Rs. 175.00
		4	Total	Rs. 700.00
(A)	Total Wages for the month			Rs. 700.00
(B)	Fringe Benefits 20% of Rs.700/-			Rs. 140.00
			Grand Total	Rs. 840.00
(C)	No. of Workers required = 4			

NON-FERROUS FOUNDRY

Monthly Raw Materials Required for 5-M/Tonnes of Good Castings after 5% melting loss

Item No.	Description	Total Requirement	Unit Price per Tonne	Total Price
1.	Copper 87%	4.568-T	Rs.25,000	Rs.1,14,200.00
2.	Zinc 7%	.420-T	Rs.18,000	Rs. 7,560.00
3.	Lead 4%	.210-T	Rs.10,000	Rs. 2,100.00
4.	Tin 2%	.105-T	Rs.30,000	Rs. 3,150.00
5.	Other Fluxes 3%	.160-T	Rs. 3,000	Rs. 480.00
6.	Steam Coal 15% of Metal	.7-T	Rs. 150	Rs. 105.00
7.	Fire Wood 10% of Coal	.70-T	Rs. 400	Rs. 28.00
8.	Furnace Oil	1500 Litters	Rs. 800	Rs. 1,200.00
9.	Moulding Sand	10-T	Rs. 40	Rs. 400.00
10.	Sodium Silicate 4% of Sand	400 Kg.	Rs. 3,000	Rs. 1,200.00
11.	Ce_2 Gas	1 Cylinder	Rs.150.00 (per cylinder)	Rs. 150.00
12.	Fire Bricks	200-Nos.	Rs.2 each	Rs. 400.00
13.	Fire Clay	.250-T	Rs.350.00	Rs. 90.00
14.	Ramming Mixture	.250-T	Rs.500.00	Rs. 125.00
15.	Grinding Wheel	2-Nos.	Rs.90 each	Rs. 180.00
16.	Fettling Tools			Rs. 10.00
17.	Lubricating Oil	2-Littere	Rs.20 (per littre)	Rs. 40.00
18.	Cotton Waste	4-Kg.	Rs.5/- (per Kg)	Rs. 20.00
19.	Nuts and Bolts	1-Kg.	Rs.12/- (per Kg)	Rs. 12.00
20.	Bearing			Rs. 30.00
			Total	Rs.1,31,480.00

(A) Total Cost of Material for one month production = Rs.1,31,480.00

C.I. FOUNDRY SECTION

Monthly Raw Material Requirement for 60-M/Tonnes of Good Castings after 10% melting Loss

Item No.	Description	Total Requirement	Unit Price per Tonne	Total Price
1.	Pig Iron 70%	46.2-T	Rs. 900	Rs. 41,580.00
2.	C.I. Scrap 30%	19.8-T	Rs. 850	Rs. 16,830.00
3.	Lime Stone 5% of Iron	3.3-T	Rs. 150	Rs. 495.00
4.	B.P. Hard Coke 20% of Iron	13.2-T	Rs. 350	Rs. 4,620.00
5.	Fire Wood 20% of coke	2.6-T	Rs. 400	Rs. 1,040.00
6.	Moulding Sand 2-M/Ton	120-T	Rs. 400	Rs. 4,800.00
7.	Furnace Oil	2000 Litters	Rs.800	Rs. 1,600.00
8.	Bentonite 5% of Total sand	.6-T	Rs.450	Rs. 2,700.00
9.	Dextrine .1% of Total sand	.12-T	Rs.2000	Rs. 2,400.00
10.	Graphite .5% of sand	.6-T	Rs.2000	Rs. 1,200.00
11.	Sea Stone .25% of Sand	.3-T	Rs.1000	Rs. 300.00
12.	Coal Dust 3% of sand	3.6-T	Rs.300	Rs. 1,080.00
13.	Fire Bricks	560-Nos	Rs.2 each	Rs. 1,120.00
14.	Fire Clay	1-T	Rs.350/- (per Ton)	Rs. 350.00
15.	Grinding Wheel	20-Nos.	Rs.90/- each	Rs. 1,800.00
16.	Ramming Mixture	1-T	Rs.500/- (per ton)	Rs. 500.00
17.	Fettling Tools			Rs. 100.00
18.	Lubricating Oil	16 Litters	Rs.20/- (per litre)	Rs. 320.00
19.	Cotton Waste	40-Kg	Rs.5/- (per kg)	Rs. 200.00
20.	Bearing			Rs. 120.00
21.	Nuts and Bolts	8-Kg	Rs.12 (per kg)	Rs. 96.00
				Rs. 83,251.00

(A) Total Cost of Material for one month Production = Rs.83,251.00

STEEL CASTING SECTION

Monthly Raw Material Requirement for 25-M/Tonnes of Good Castings after 10% melting Loss

Sl.No.	Description	Total Requirement	Unit Price per Tonne	Total Price
1.	Steel Scrap	27.5-M/Tonne	Rs.800	Rs. 22,000.00
2.	Lime Stone (5% of Total Steel)	1.4-M/Tonne	Rs.150	Rs. 210.00
3.	Ferro Silican(1.5%)	.42-M/Tonne	Rs.3500	Rs. 1,470.00
4.	Ferro Manganese(1.5% of Total Steel)	.42- "	Rs.2000	Rs. 840.00
5.	Carbon Powder (1% of total steel)	.28 "	Rs.1000	Rs. 280.00
6.	Aluminium Shot (1% of total steel)	.028 "	Rs.12,000	Rs. 336.00
7.	Flovokspar (.5% of total steel)	.14 "	Rs.1,000	Rs. 140.00
8.	Oxygen (300 Cft per tonne of steel)	8250 cft	Rs.18/- per 100 cft.	Rs. 1,485.00
9.	Lance Tube(10 Rft per tonne of steel) 1/8"-I/Dia	275 Rft	Rs.1 per Rft	Rs. 275.00
10.	Moulding Sand (2-M/Tonne per Tonne of steel)	50-M/Tonnes	Rs.40 per tonne	Rs. 2,000.00
11.	Bentonite (7% of total sand)	1.6-M/Tonnes	Rs,450	Rs. 720.00
12.	Dextrine (1% of total sand)	.3-M/Tonnes	Rs.2000	Rs. 600.00
13.	Silica Flor(6% of core sand)	.3-M/Tonnes	Rs.1000	Rs. 300.00
14.	Core Oil (2% of core sand)	.1-M/Tonnes	Rs.1500	Rs. 150.00
15.	Cereal Binder (1% of core sand)	.05-M/Tonnes	Rs.1000	Rs. 50.00
16.	Furnace Oil	Rs.10,000 Liter	Rs.800	Rs. 8,000.00
17.	Chilled Iron Shot (.3% of total casting)	.75-M/Tonnes	Rs.5000	Rs. 3,750.00
18.	Grinding Wheel (Rs.80/- per Ton of Casting)			Rs. 2,000.00
19.	Fettling Tools (Rs.10/- per Ton of Casting)			Rs. 250.00
20.	Welding Rod (Rs.40/- per tonne of casting)			Rs. 1,000.00
21.	Oxygen (100 Cft. required for cutting per tonne of casting)	Rs.18/- per Cft.		Rs. 450.00
22.	Acetylene (250 Cft.required for cutting per tonne of casting)	Rs.50/- per 100 Cft.		Rs. 300.00
23.	Cal-Gas (6-Cylinders)	Rs.30/- per cylinder		Rs. 180.00
			C/e	Rs. 46,886.00

Sl.No.	Description	Total Requirement	Unit Price per Tonne	Total Price
			B/F.	Rs.46,986.00
24.	Refractory Mass (Rs.100/- required per tonne of castings) Sodium Silicate, Magnesite and Bricks etc.			Rs. 2,500.00
25.	Lubricating Oil	7-Litre	Rs.20/- per litre	Rs. 140.00
26.	Cotton Waste	17-Kg	Rs.5/- per kg.	Rs. 85.00
27.	Nuts and Bolts	4-Kg	Rs.12/- per kg.	Rs. 48.00
28.	Bearings			Rs. 50.00
			Total	Rs.49,809.00

(A) Total Cost of Material for one month Production = Rs.49,809.00

Cost of Production for 5-M/Tonne (non-ferrous castings) per month

Sl.No.	Non-ferrous Foundry Description	Total Price Rs.
A.	Cost of Raw Material for 5-M/Tonne Finish Castings	Rs.1,31,480.00
B.	Power	Rs. 150.00
C.	Laboratory Testing Chemical	Rs. 30.00
D.	Printing & Stationary	Rs. 25.00
E.	Delivery and Travelling Expenses	Rs. 500.00
F.	Supervision Charges	Rs. 1,150.00
G.	Direct Wages	Rs. 3,060.00
H.	Indirect Wages	Rs. 560.00
I.	Rent and Taxes @ 2% on Sales Value	Rs. 4,000.00
J.	Depreciation Cost of Plant & Equipments @ 10% of Plant Cost	Rs. 210.00
K.	Depreciation Cost of Building, Shed and Boundary Wall @ 5%	Rs. 100.00
L.	Sales Commission 1% on sales value	Rs. 1,000.00
M.	Indirect Overhead, Such as rejection, cancellation of order @ 2% on Manufacturing	Rs. 2,745.00
N.	Bank Interest @ 12% per annum on running capital	Rs. 970.00
	Grand Total	Rs.1,46,970.00
	Cost of Production one M/Tonne of Good Casting =	Rs. 29,200.00

Cost of Production for 60-M/Tonnes of C.I. Good Castings per month

C.I. FOUNDRY

Sl.No.	Description	Total Price
A.	Cost of Material for 50-M/Tonnes Finish Castings	Rs. 83,251.00
B.	Power	Rs. 790.00
C.	Laboratory Testing Chemical	Rs. 120.00
D.	Printing & Stationary	Rs. 60.00
E.	Delivery & Travelling Expenses	Rs. 1,800.00
F.	Supervision Charges	Rs. 13,780.00
G.	Direct Wages	Rs. 6,570.00
H.	Indirect Wages	Rs. 4,200.00
I.	Rent and Taxes @ 2 % on sales value	Rs. 3,360.00
J.	Sales Commission 1 % on sales value	Rs. 1,680.00
K.	Depreciation cost of Plant and Equipments @ 10 % of Plant Cost.	Rs. 2,561.00
L.	Depreciation cost of Building, Shed and Boundary wall @ 5 %	Rs. 1,110.00
M.	Bank Interest @ 12 % per annum on running capital	Rs. 960.00
N.	Indirect over head , such as rejection , cancellation of order @ 2 % on Manufacturing	Rs. 3,360.00
	Grand Total	Rs.1,23,592.00
	Cost of Production One M/Ton of Good Casting =	2,060.00

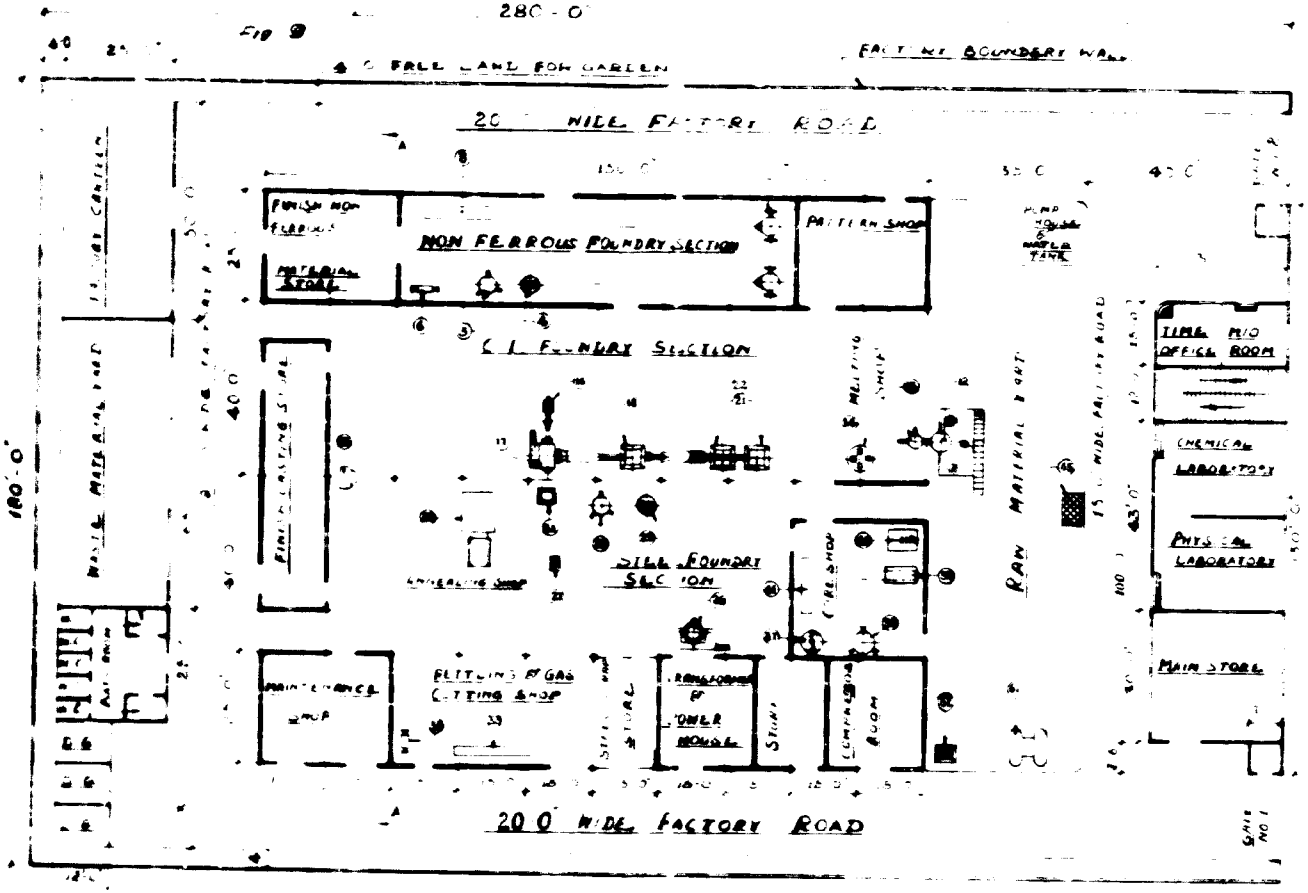
Cost of Production for 25 - M/Tonnes of Good Castings per month

STEEL FOUNDRY

Sl. No.	Description	Total Price
A.	Cost of Raw Material for 25 - M/Tonnes Finished Castings	Rs. 49,724.00
B.	Power	Rs. 9,500.00
C.	Laboratory Testing Chemicals	Rs. 220.00
D.	Printing & Stationery	Rs. 75.00
E.	Direct Supervision charges	Rs. 17,900.00
F.	Direct Wages	Rs. 7,920.00
G.	Indirect Wages	Rs. 5,600.00
H.	Delivery and Travelling Expenses	Rs. 1,200.00
I.	Rent and Taxes @ 2 % on Sales value	Rs. 4,000.00
J.	Sales Commission 2 % on Sales value	Rs. 4,000.00
K.	Depreciation cost of Plant and Equipments @ 10 % of Plant Cost.	Rs. 4,296.00
L.	Depreciation cost of Boundary Wall , Buildings, Factory shed @5%	Rs. 462.00
M.	Indirect overhead , such as rejection , cancellation of order @ 5 % on manufacturing cost.	Rs. 10,000.00
N.	Bank Interest @ 12 % per annum on running capital	[illegible]
	Grand Total	Rs.1,[illegible]
	Cost of Production one M/Tonne Good Casting	Rs.4,[illegible]

Annual Profitability Statement on Full Production of

(A)	**NON-FERROUS FOUNDRY**		
	(a) Sales Proceeds of 60-M/Tonne per year @ Rs.40,000/- per M/Tonne		Rs. 24,00,000.00
	(b) Cost of Production at Floor level per M/Tonne of Castings Rs.29,200/- cost of 60-M/Tonne Castings		Rs. 17,52,000.00
		Profit	Rs. 6,48,000.00
(B)	**C.I. FOUNDRY**		
	(A) Sales Proceeds of 720-M/Tonnes per year @ Rs.2,800/- per M/Tonne		Rs. 20,16,000.00
	(b) Cost of Production at Floor level per M/Ton of Castings Rs.2,060/- , cost of 720 M/Tonnes Castings		Rs. 14,83,200.00
		Profit	Rs. 5,32,800.00
(C)	**STEEL FOUNDRY**		
	(A) Sales Proceeds of 300-M/Tonnes per year @ Rs.7,000/- per M/Tonne		Rs. 21,00,000.00
	(b) Cost of production at floor level per M/Tonne of casting Rs.4,400/- cost of 300-M/Ton Castings		Rs. 13,20,000.00
		Profit	Rs. 7,80,000.00
(A)	Total Sales of Non-ferrous, C.I. & Steel Foundry		Rs. 65,16,000.00
(B)	Total Manufacturing cost of Non-ferrous, C.I. & Steel Foundry		Rs. 45,55,200.00
(C)	Gross Profit 43.02%		Rs. 19,60,800.00



SECTION AT AA

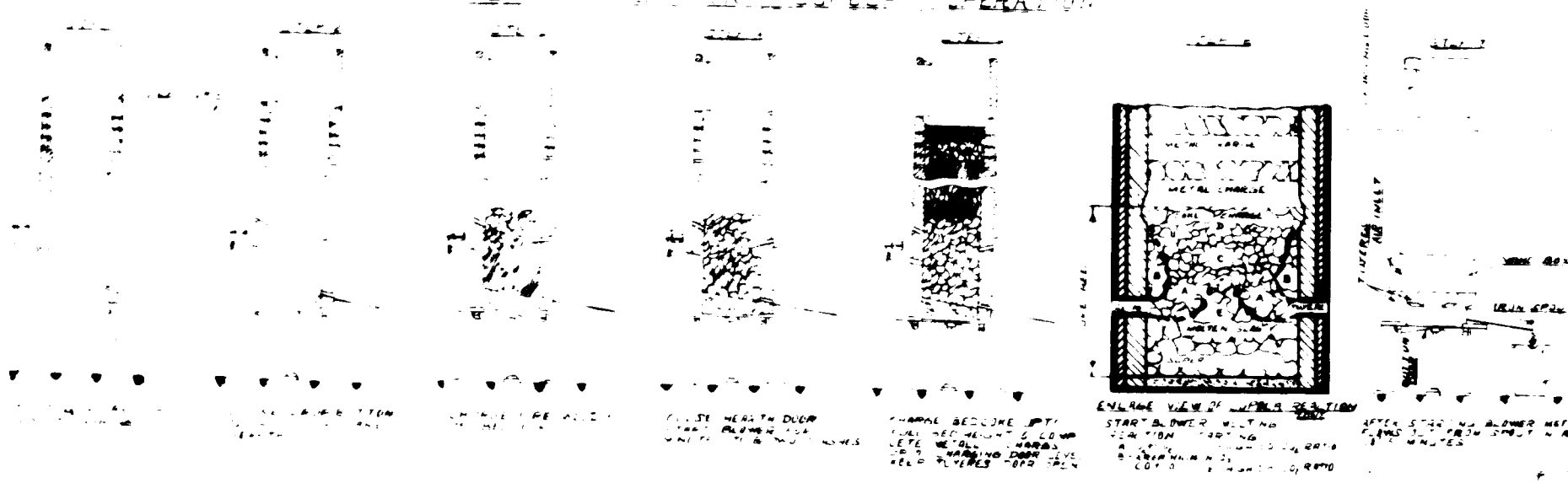
S.No	DESCRIPTION	No.	S.No	DESCRIPTION	No.
	NON FERROUS FOUNDRY		35	INSPECTION TABLE	1
			36	WIRE GRINDER	1
			37	PEDESTAL GRINDER	1
			38	TON CAPACITY ANNEALING FURNACE	1
				CORE SHOP (COMMON)	
			39	SAND MIXER	1
			40	AUTO RILER WITH TRIPOD	1
			41	DRYING OVEN	1
			42	COMPLETE WITH HOT AIR BLOWER FAN AND OIL BURNING EQUIPMENTS	1
			43	COKE FIRED CORE BAKING ARRANGEMENT	1
			44	CORE MAKING BENCH	1
	C.I FOUNDRY			**MAINTENANCE SHOP (COMMON)**	
15	TON CAPACITY	1	45	LATHE MACHINE	1
16	CUPOLA WITH MOTORISED BLOWER CHARGING PLATFORM	1	46	SHAPING MACHINE	1
17	CUPOLA RECEIVER	1	47	RADIAL DRILLING MACHINE	1
18	COKE FIRED LADDLE PRE HEATER WITH MOTORISED BLOWER AND BURNER	1	48	HACKSAW MACHINE	1
19	HAND SHANK LADDLE	6	49	PEDESTAL GRINDER	1
	A 100 KG CAPACITY	2		**PATTERN SHOP (COMMON)**	
	B CAPACITY	2	50	WOOD PLANER	1
	CAPACITY	2	51	CIRCULAR SAW	1
	SHAKE MACHINE	1	52	SPINDLE SHAPER	1
20	TON CAPACITY SAND MIXING MACHINE WITH BUCKET	1	53	LATHE MACHINE	1
	CRANES			**LABORATORY EQUIPMENTS**	
21	CONCRETE FIXATION	1	54	PRECISION BALANCE	1
22	OVER HEAD ELECTRIC CRANE	1	55	MOISTURE TESTER	1
23	SAND BY WASH HOPPER	2	56	TENSILE STRENGTH TESTING MACHINE	1
24	HAND OPERATED JIB CRANE	1	57	SIEVE SHAKER WITH SET	1
25	MOULDING MACHINE	1	58	JUMPING SAND RAMMER	1
26	SHOT BLAST MACHINE	1	59	PORTABLE MOULD HARDNESS TESTER	1
27	GRINDER	1	60	PERMEABILITY & ALL ACCESSORIES	1
28	PEDESTAL GRINDER	1	61	COMBINED SAND STRENGTH & HARDNESS TESTING MACHINE	1
	STEEL FOUNDRY			**COMMON SERVICES**	
29	TONS CAPACITY INDUCTION FURNACE WITH TRANSFORMER AND CONTROLLER	1	62	MAIN STORAGE TANK	1
30	TAPE CUT MACHINE	1	63	OVER HEAD STORAGE TANK	1
31	AUTO RIDDLER	1	64	WATER PUMP HOUSE OVER HEAD TANK	1
32	SAND MIXING MACHINE	1	65	POWER HOUSE	1
33	MOULDING BOX	1	66	PLATFORM WEIGHING SCALE	1
34	BURNER	1	67	FIRE SAFETY EQUIPMENTS	1
35	WELDING AND CUTTING SET	1	68	DRAINAGE SANITARY SYSTEM	1

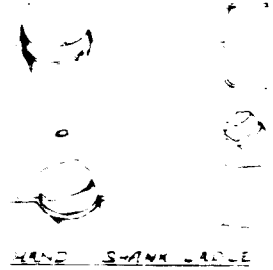
PROJECT DETAILS FOR A COMBINED NON-FERROUS GRAY IRON & STEEL FOUNDRY

ANNEX D

GENERAL ASPECTS OF CUPOLA OPERATIONS

The general aspects of cupola operations are pictorially shown in Fig. 10.





ANNEX E

HINTS ON RISERING AND GATING OF GREY IRON CASTINGS

A. Riser dimensioning for grey iron castings

1) Results derived from the application of 'Cooling Factor' method of riser calculation have been found quite satisfactory in a foundry. The following paragraphs contain an outline of this method.

The 'Cooling Factor' of a casting is the ratio of volume to surface area. The cooling factor of the riser must be greater than that of the casting. Our Foundry has been using the following relationship between the cooling factor of riser and the cooling factor of casting :

$$\frac{Vr}{Ar} = \frac{100}{100.9 - 0.039\ BHN} \times \frac{Vc}{Ac} \quad \ldots\ (1)$$

Where Vr, Vc, Ar, Ac = Volume and surface area of riser and Casting respectively.

and BHN = Brinell Hardness number of the heaviest section of the casting with the composition of the iron concerned.

(Not to be confused with the BHN of the Standard Test Bar)

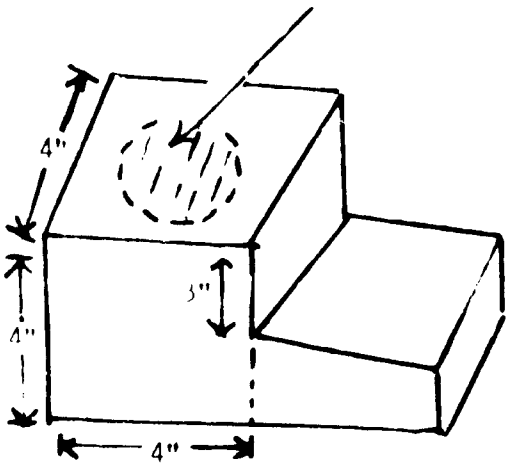
The above formula may be used until the individual foundry arrives at a closer value by trial and error.

2) Calculation of Vc and Ac

The volume and area of the casting should be taken geometrically in case of simple shapes. In complex shapes Vc and Ac should be taken as the value of the simplest shape in the heavy section and the area of the same portion minus the sectional area of the adjoining parts.

For instance, a cube with adjoining thin sections.

3" Ø (Riser connection)



$V_c = 4 \times 4 \times 4 = 64$ cu.in.

$A_c = 6\,(4 \times 4) - (1 \times 4) - \frac{\pi}{4}(3)^2$

$= 84.8$ sq. in.

$\frac{V_c}{A_c} = \frac{64}{84.8} = 0.755$

Fig.11

Note the subtraction of area for the riser connection, this must be an approximation to begin with, but will become fairly accurate with a little practice.

3) Calculation of V_r : A_r

The cooling factors for blind cylindrical risers of the top and side types has been calculated and are being given below.

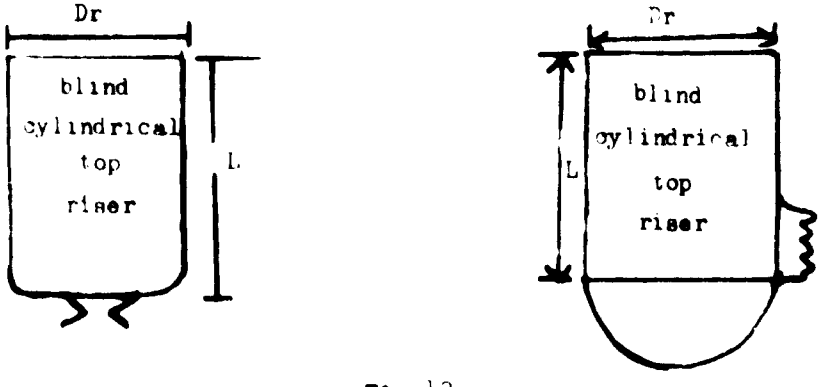


Fig 12

$\frac{V_r}{A_r} = 0.222\ D_r$. when $L = D_r$ ..... (ii)

$\frac{V_r}{A_r} = 0.233\ D_r$. when $L = 2\ D_r$ ..... (iii)

Cooling factor for other types of risers and other ratios of L/s D_r can be calculated easily.

4) Formula for Riser Diameter

Substitution of above Vr/Ar values in equation (1) gives :

(1) When L = D_r,

$$D_r = \frac{450}{100.9 - 0.039\ BHN} \times \frac{V_c}{A_c} \quad \ldots\ldots\ (iv)$$

(2) When L = 2 D_r,

$$D_r = \frac{428}{100.9 - 0.039\ BHN} \times \frac{V_c}{A_c} \quad \ldots\ldots\ (v)$$

5) Specific Example:

Let us assume that we want to find the riser dimension for a four inch, cube with a one inch, adjoining section as illustrated in para (2) above. Also, the moulding shop considerations are such that a top riser of L = 2 D_r has to be used,

$$\frac{V_c}{A_c} = \frac{64}{84.8} = 0.755$$ as in para (2) above

Substituting this value in equation (v) we get

$$D_r = \frac{428}{100.9 - 0.039 \times 170} \times 0.755$$

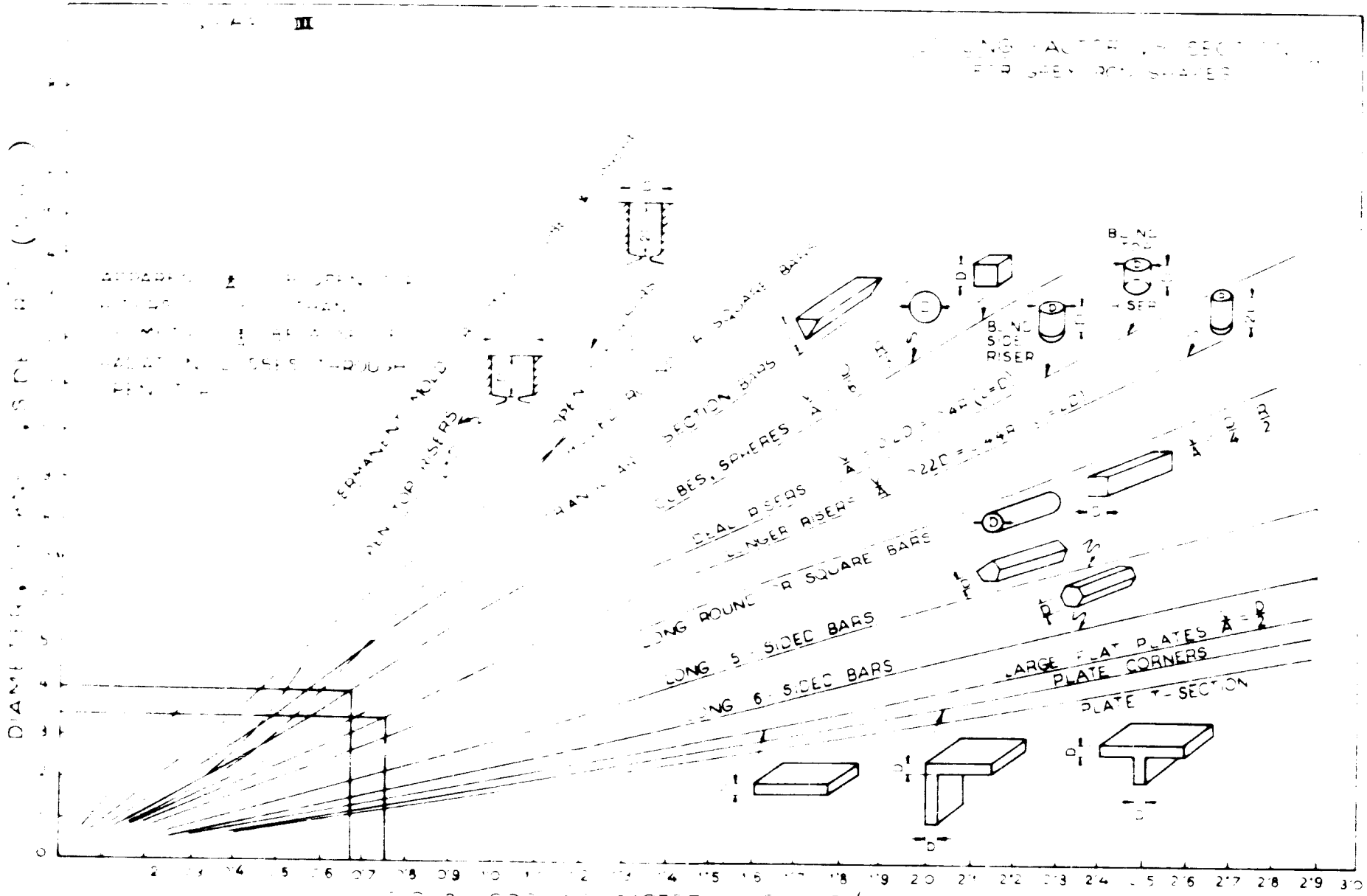
$$= 3.5"$$

Here, 170 is the BHN of a 4" section

Riser dimensions for more complicated castings can be determined similarly by following the basic steps outlined above.

6) Aids to the Routine Work :

In place of the above calculation for Vc/Ac it can be derived at a glance from graph III.


SPHERES
LONG ROUND OR SQUARE BARS
LONG 5-SIDED BARS
LONG 6-SIDED BARS
LARGE FLAT PLATES
PLATE CORNERS
PLATE T-SECTION
BLIND SIDE RISER
0
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
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30

Using graph III go up the vertical axis (casting side length) and then across to interception with the curve for cube. At the point of interception come down to the horizontal axis and read the Vc/Ac as 0.68. Allowing for the sectional area of the appendage to the cube would have given the same value of Vc/Ac as found by calculation.

Having determined the value of Vc/Ac either from graph III or by calculation, another curve on graph III can be used to obtain the riser size. Go up vertically at the decided value of Vc/Ac (0.755) to the rider line for L = 2 Dr and read the riser diameter as 3.5". This compares very well with the riser diameter found by calculation.

Thus the use of graph III enables the determination of riser dimensions in a matter of seconds and without necessitating tedious calculations.

7) Further Scope of this Method :

Graph III can also be used for other simple shapes, for cored hubs, bosses etc. Separate graphs have been drawn out for determining the equivalent of the cored cavity to a solid cylinder.

The equivalent solid cylinder can then be used as the shape for determination of the riser dimensions by applying graph III.

Graphs have also been drawn out similar to those in graph III, which incorporate 5%, 10% and 15% safety factors, so that we get correspondingly higher values of riser dimensions.

This method, therefore, enables the determination of riser dimensions for a vast multitude of cast shapes giving reliable and safe values very expeditiously.

4. Gating calculations for grey iron castings

1. The Basic Formula :

1.1. Grey Iron with some degree of superheat follows the basic laws of hydrodynamics. If, therefore, it flows through a channel of area.

A aq.inches with a mean velocity

V inches per section, then the weight of metal

W lbs. which flows in t secs. is given by the relationship

$$W = 0.22 \cdot t \cdot V \cdot A \cdot \alpha \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

Here 0.22 lbs. per cu.inch is its density and α is the loss coefficient, determined as 0.2 for a sprue choke and 0.3 for runner choke.

1.2. Weight of the casting, W, can be estimated from the drawing. Size of the moulding box usually dictates the value of velocity V and, therefore, the sought quantity 'A' can be found out from the above equation.

2. The Pouring Time 't'

2.1. Pouring time must not be so long that the metal starts solidifying before the mould has been filled up entirely. Also long exposure to radiation from slow rising metal causes thermal strains and leads to various casting defects from the damaged mold walls.

2.2. Nor must the pouring time be so short that the walls of the mold are damaged by mechanical strains and the air, steam and gases are unable to escape out completely.

2.3. Following relationships have given excellent results in scores of green sand practice foundries.

for metal sections	1/4" and below	$t = 1.4 \sqrt{w}$
"	3/8" to 3/4"	$t = 1.8 \sqrt{w}$
"	1" to 1½",	$t = 2.2 \sqrt{w}$
"	2" to 3"	$t = 3.0 \sqrt{w}$

2.4. For instance, if a casting of predominant wall thickness 1½" weighs 100 lbs. It should be filled up in

$$t = 2.2 \times \sqrt{100}$$
$$= 22 \text{ secs.}$$

2.5 If, however, the yield on this casting is found below 75% weight or risers should be added to w before computing the square root.

3. Area of down sprue :

3.1. The velocity of metal in the sprue, assuming a free fall and no initial velocity, is given by

$$V = \sqrt{2gH}$$

where g = acceleration due to gravity
= 32.2 ft./sec./sec.
= 386.4 in./sec/sec.

and H = Effective sprue Height explained with the help of sketches on Fig XVI

3.2. Now the sought quantity 'A' can be found out by substituting above values in the basic formula.

$$W = 0.22 \cdot t \cdot V \cdot A\alpha$$

$$A_B = \frac{W}{0.22 \cdot t \cdot V\alpha}$$

Where A_B = Area at the bottom of sprue

With reference to case I shown on Fig. XVI. If the casting is entirely in the drag, B. S. H. = H

So the above equation becomes :

$$A_B = \frac{W}{0.22 \cdot t \cdot \sqrt{2 g H} \cdot \alpha} \quad \ldots\ldots\ldots \text{(iii)}$$

3.2 Area at top of Sprue, A_T

This is given by the relationship

$$A_T = A_B \times \sqrt{\frac{\text{Total Head over choke}}{\text{Total Head over sprue}}} \quad \ldots\ldots \text{(iv)}$$

To this area 25% should be added to compensate for actual pouring conditions under which it is hard to keep the sprue full.

If the values of A_T and A_B are related by the above equation, it would ensure minimum of turbulence and aspiration as the metal travels down.

4. Area of Runner :-

4.1 For sprue type chokes, the most desirable ratio would be 1: 3: 2. That is the total runner area should be 3 times the area at the bottom of sprue and the total ingate area should be 2 times the area of the sprue bottom.

4.2. However, the value of runner area thus obtained must satisfy the condition that the velocity in the runner should be 12 inches per sec. or less. If this is achieved, the metal would free itself of sand or slag in a distance of 6". So the first ingate should be located beyond this point.

So the runner Area, $AR = 3 . A_B$ ..... (v)

4.3. This is the total runner area, if it is a double sided runner, its area should be half of that given by (v)

4.4. Also, the runner area is reduced as each ingate is passed in the interest of yield and to help equalize the flow from each ingate. It is to be reduced in proportion to the area of gates down the runner.

5. Pouring Basin :

If the pouring basin is too small, a vertex forms in the metal pool and the trapped sand or slag go down the sprue and possibly into the casting. The volume of iron needed in the pouring basin is determined by the flow gate. Higher the flow rate, bigger the basin. But if it is too big, yield on the casting gets reduced. The design and dimensions of a few typical pouring basins are shown in Fig. 11.

6. Sprue Base :

It is an enlargement at the bottom of sprue. It should extend both above and below the runner at least $\frac{1}{2}$" where the choke is used. The diameter should be two times the sprue choke.

7. Specific Example :

Suppose we have to calculate the running system for a 30" x 10" plate casting, $1\frac{1}{2}$" thick

Step 1. Calculate the Weight, W

$W = 30 \times 10 \times 1\frac{1}{2} \times .26 = 100$ lbs.

Step 2. Select pouring time, t

for a casting of $1\frac{1}{2}$" wall thickness weighing 100 lbs.

$t = 2.2 \sqrt{100} = 22$ secs.

Step 3. Find E. S. M :

For a 12" high (sprue + basin) system with the entire Casting is drag.

E.S.M. = M = 12"

Step 4. Find Area of Sprue Bottom, A_3 Substituting values in the basic formula. $W = 0.22 \cdot t \cdot V \cdot A \cdot \alpha$

We get $A_3 = \frac{100}{0.22 \cdot 22.96 \cdot 0.2} = 1.07$ sq.in.

$= 1\text{-}1/8"\ \phi$

Step 5 Find the size of sprue top A_T

If the combined ht. of sprue + basin = 12"

ht. of basin alone = 3"

Therefore from equation (iv)

$A_T = A_B \sqrt{12/3} + 25\%$

= 1.07 .2 + 0.535

= 2.68 sq. in.

= 1 7/8" ∅

Step 6. Find size of runner bar

Substituting 1.07 sq. in. for A_B in equ. (v)

we get, $A_R = 3.\ 1.07 = 3.21$ sq. in

with a singe runner of trapezoidal section, we require 2" at base ht. 1-3/4" and 10° draft on vertical sides.

Step 7. Find size of ingates

Substituting 1.07 sq. in. for A_B in the relationship given in para 4.1 above we get, total ingate area

= 2. 1.07 = 2.14 sq.in.

Assuming three ingates,

Area of each = 0.71 sq. in.

the width : thickness ratio of ingates lies between 4 to 6

So, 2" x 5/16" section of ingate would be ideal.

Step 8. Sprue base sizes

From considerations in (5) above

dia of sprue base = 2 x 1-1/8 = 2-1/4"

ht. of sprue base = 1-3/4" + 1/2" = 2-1/4" above parting line

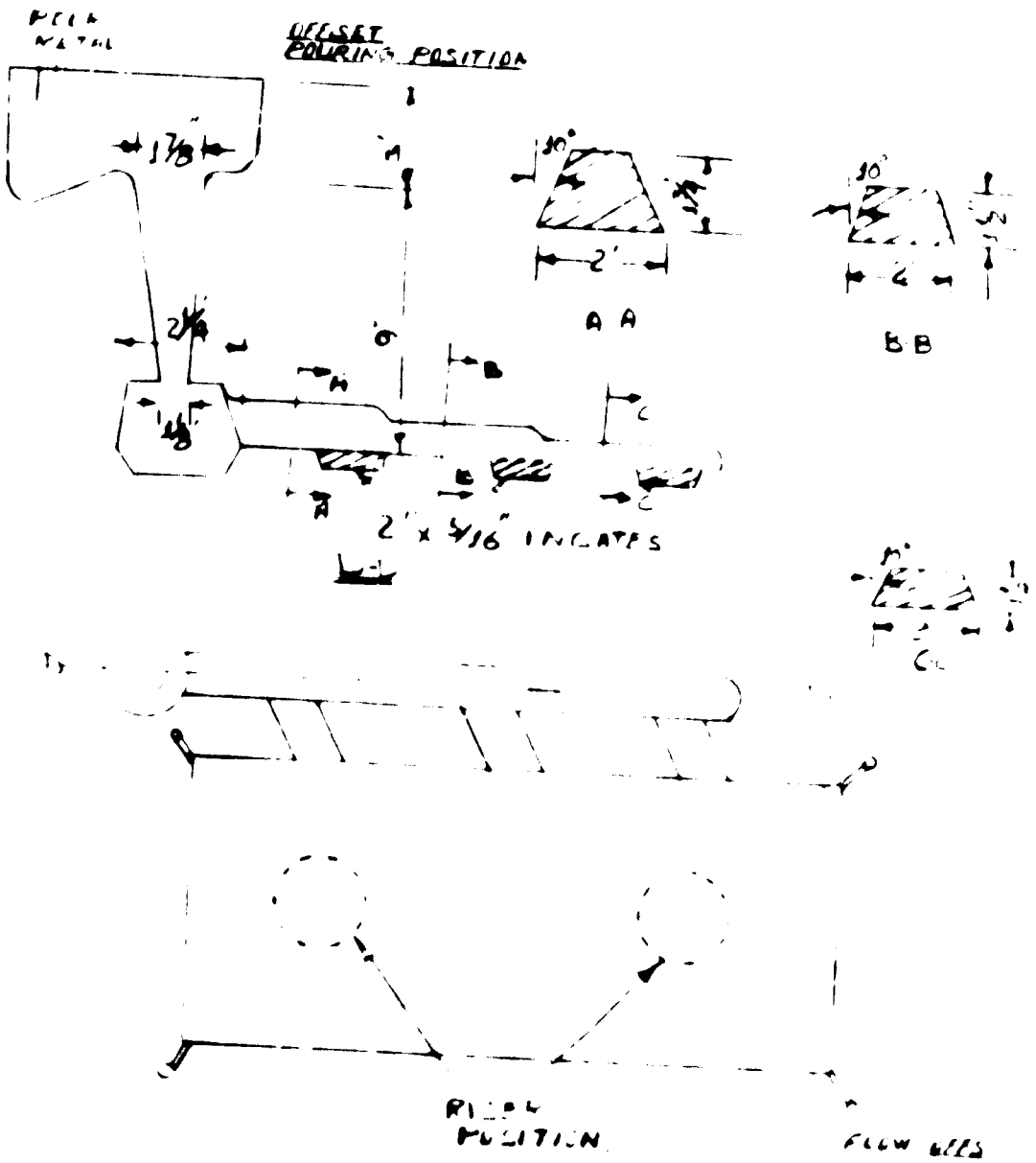
= 1/2" below parting line

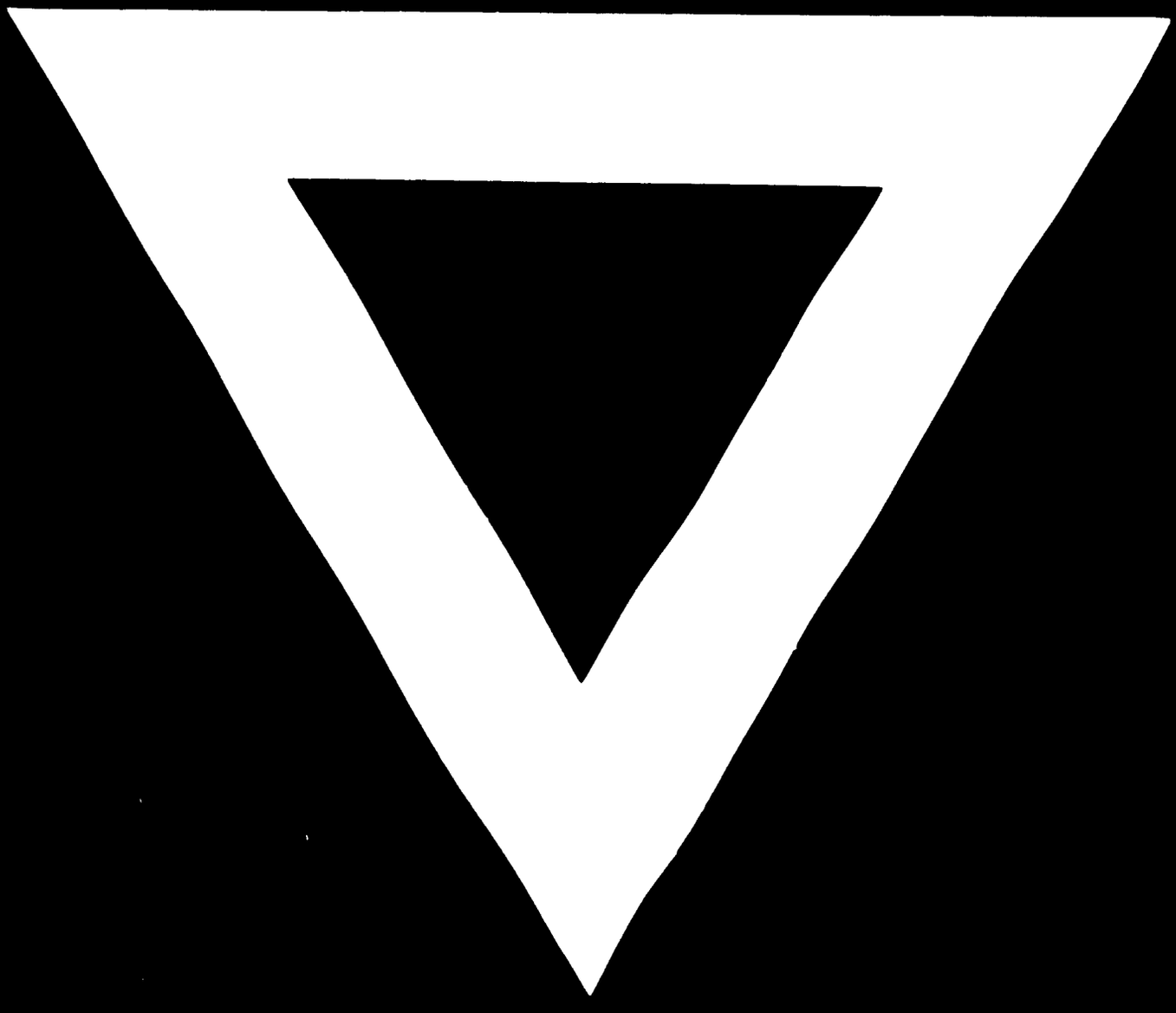
= 2-3/4" total.

These dimensions are illustrated in figure 13.

FIG. 13

DIMENSIONS





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