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ENGLAND

Confidential Report

R638/L

LAST REPORT

OCT 1975 TO DEC 1977

METALS ADVISORY SERVICE IN PAKISTAN

UNIDO CONTRACT 75/36 PROJECT DP/PAK/73/033

ACTIVITY CODE 02 AND EXTENSION

by

E.A. Brandes

FEBRUARY 1978

R638/L

LAST REPORT

METALS ADVISORY SERVICE IN PAKISTAN

PHASE I

SUMMARY

The first phase of the UNIDO project to establish a Metals Advisory Service in Pakistan has been completed. The technical part of the project was entrusted to the Fulmer Research Institute. The work consisted of periods of service in the project area by seven experts and of a continuous back up from the resources of the Institute in the U.K.

The project has completed nearly two hundred pieces of work of direct help to industry and an assessment enquiry has shown that the work was universally well received and often resulted in material advantage to the recipient companies.

Work on the development of Pakistans metallurgical mineral resources and on the introduction of new technology has been commenced and placed on a foundation strong enough to carry future expansion. The contractor's personnel have worked closely with Pakistani counterparts and given instruction both formal and informal throughout the project. Two fellowships for Pakistanis working at Fulmer, each for six months, have been completed satisfactorily.

The Service has established a documentation service which comprises library and information dissemination.

Equipment has been steadily assembled and commissioned so that the project stands ready poised to pass into a second phase in which the work of the first phase, and particularly the special projects, will be extended. The underlying idea has been that the service should eventually be able to run efficiently without external assistance.

1. INTRODUCTION

1.1. Metals Advisory Service Concept

This report reviews the work done under Phase 1 of the Metals Advisory Service in Pakistan project which is jointly sponsored by the government of Pakistan and UNIDO. The Fulmer Research Institute has served as technical contractor to the project for the review period, that is from October 1975 to December 1977.

The project was set up to assist the metal industry of Pakistan by providing:

i) An advisory service to the metal industries for day-to-day problems.

ii) A library and information service to keep industry in touch with modern technology.

iii) Training and instruction of Pakistani staff in metals technology.

iv) Coordination of metallurgical requirements and suggestions for subjects of national importance to be developed by the project's laboratories.

v) Establishing a centre for metallurgical development and information exchange.

In the Phase under review most attention has been given to i), ii) and iii), but during later stages iv) and v) have been increasingly developed.

1.2. Organisation

The government of Pakistan requested the project from UNIDO who approved it and obtained funds for it from UNDP. UNIDO employed a project manager (Dr. Kamal Hussein) and a technical contracting firm (Fulmer Research Institute Limited). The Pakistan government appointed a project director (initially Mr. Mustafa Hassan, and subsequently Brig. Farooqui). The project director was also the general manager of PITAC (Pakistan Industrial Technical Assistance Centre) and during the whole of Phase 1 the project operation has been housed on the PITAC site. Funds came from the UNIDO budget to the project manager and the contractor and directly to the project in the form of major pieces of equipment.

The Pakistan government provided for the local staff, local expenses and for running costs.

1.3. Contractor

The provision of technical metallurgical know-how which would ultimately lead to the establishment of a centre for metallurgical technology was contracted out to Fulmer Research Institute Limited under UNIDO 75/36 No. DP/PAK/73/033 Act. Code 02 on 28th October 1975. The first contract required the provision of 18 man/months of service in the project area in 15 months. In May 1977 the contract was extended to the end of December 1977. Subsequent phases of the project will be provided for by a new contract.

Seven experts from Fulmer have served in the project area. They were chosen to meet specific project needs in specialist subjects; these together with individual service periods are shown in Table 1. Apart from the service area work, Fulmer has provided a comprehensive back-up service. All problems that could not be immediately settled by the serving expert were referred to Fulmer in the U.K. and results were returned as quickly as possible to Lahore. Throughout the period of the project, the contractor has submitted monthly reports to UNIDO covering all the activities of the project. The technical reports issued to firms and organisations as part of individual jobs and enquiries have been attached as appendices. A list of these is given in Table 2.

2. REVIEW OF PHASE 1

2.1. Advisory Work

Metal firms in all the main industrial areas of Pakistan have been visited by MAS representatives with a view to introducing the project and finding in what way the service could help. During this phase all such help was offered free of charge. The total number of jobs undertaken for industry and completed by MAS approached 200. Table 3 lists the advisory work in job number order, with the firms name given in short form. The full name in alphabetical order is given in Table 4. The location of the firms is given and it can be seen that the service has covered a large area of the country.

The subjects are given in short form but from the references to the montly reports given, the full subject matter can be assessed.

Where the report is given as an appendix to a monthly report the first number is the monthly report number, and the A number is the appendix of that report.

An attempt has been made to assess the usefulness of the advisory work carried out by the service. To this end a questionnaire was sent out to the firms that have been served asking for their comments and enquiring about results. The questions asked and a summary of replies received are given in Table 5. Nearly all those that replied found the service helpful, and in some cases the problems were completely solved and resulted in financial gain or lower rejects.

2.2. \ Special Project Work

Whereas at the start of the project nearly all the effort was on trouble shooting and advisory work, there has been a steady change of emphasis to major development projects. A national co-ordination committee has assisted in steering the project towards areas of national importance.

The projects are divided between those dealing with exploitation of indigenous materials - iron ore, sands, bentonite, chromite, graphite etc, and those designed to introduce new technology - nodular cast iron, special steel making, sponge iron, cokeless cupolas and pipe spinning.

It is unfortunate that the melting unit ordered for the project arrived damaged and had to be returned. For this reason work on nodular cast iron and special steel making did not advance to the hoped for degree. It will find place in Phase 2 of the project.

The reports on special projects issued as appendices to monthly reports are listed in Table 6.

Good progress has been made in identifying and introducing good quality indigenous sands and bentonites for foundry useage. Especial attention has been given to the exploitation of Chichali iron ore. In conjunction with PCSIR, work on beneficiation of this ore is now making good progress. As part of the back-up service, specialist work on mineral modal analysis of Chichali iron ore was carried out at the U.K. government mineral process laboratory of Warren Spring.

There is an increasing world shortage of good grade metallurgical coke, which is reflected in Pakistan in terms of high price and low

quality. To meet this problem especial attention has been given to the development of a cokeless cupola. This runs with gas, which is an indigenous Pakistani fuel. The way has been prepared for the installation of a trial unit in later phases of the project.

Very special attention has been given to the pipe spinning plant at Northern Foundries - now a nationally owned plant - which although installed at very high cost has never gone into production. A specialist expert was brought in on this job and the final report issued is attached as Appendix 1. There is every hope that if the recommendations given are followed the plant may be able to start production under MAS guidance during Phase 2 of the project.

2.3. Instruction and Training

Throughout, the idea that eventually the service should be entirely operated and controlled by Pakistani staff, has been kept to the fore. To this end, a whole series of seminars have been arranged and every expert who has served in the project area has remained in close contact with Pakistani counterparts.

The seminar subjects given by experts, together with the locations and organisations at which they were delivered, are listed in Table 7.

Training of two members of MAS staff in the U.K. at Fulmer has been completed. Four fellowships were envisaged in the contract but up to the end of Phase 1, due to administrative delay, the only two which have been completed were Foundry Technology and in Documentation. Both were of six months duration at Fulmer, but instructional courses and visits were arranged during this time in the U.K. as appropriate to the subjects. Monthly progress reports were issued by the participants. Both reported satisfaction with the courses and training received. They both prepared papers relevant to their work.

2.4. Documentation

Metals Advisory Service has established a library of metallurgical books and periodicals. These are available for consultation in Lahore but any special articles required can be photocopied and sent to any firm or organisation in Pakistan. In addition, the documentation officer prepares an abstract of all subjects and papers of special interest in Pakistan and these will be circulated. This keeps the metal industry

abreast of current developments. Information on subjects of special interest can be requested from MAS who will send photocopies of the relevant papers at a nominal charge. The documentation section is also publicising the project and the facilities available amongst the metal industries so that what is available will be known to all concerned. A leaflet describing the MAS project has already been printed and circulated. Regular newsletters have also been prepared.

2.5. Back-Stopping Service

Those jobs which involved a significant effort from Fulmer personnel in the U.K. are shown with an asterisk(*) in Table 3. Fulmer was actively involved in 30% of these formal enquiries.

The back-stopping service was also active in supplying suplementary information to its experts in the field, and in providing services direct to MAS such as:-

i) surveying and critically appraising equipment which is required for Phase 2.

ii) arranging subcontracting of modal analysis of Chichali Ore to Warren Spring.

iii) arranging subcontracting of DTA and DGA analysis of Chichali Ore to John Laing R & D Ltd.

iv) arranging and participating in several meetings with Hayes Shell Cast Ltd. to explore possible terms on which a cokeless cupola can be set up in Pakistan.

v) Visiting Warren Spring to obtain information on the equipment and costs necessary for the setting up of a mineral beneficiation pilot plant.

vi) Conducting a liaison with British Industrial Sands Ltd., to obtain information on the setting up of sand production facilities in Pakistan, foundry sand types, transport costs and the like.

vii) Liaising with equipment suppliers in the West to ensure that MAS equipment was correctly specified and delivered on time.

viii) Providing urgently required goods by airmail. These include silica dip tubes for thermocouples (2 batches), mould coatings, charts, inoculants and spheroidizing additions.

ix) Market information on pressure pipe production in Europe and the Middle East.

x) Information on costs of sponge iron from European producers.

xi) Outline draft programmes have been formulated for the Linseis DTA and Dilatometer to enable expertise to be gained with the equipment prior to embarking on major investigations.

xii) Providing essential background information to MAS on such matters as graphite ores, and their utilization in crucibles, and obtaining quotations for further investigatory work on local ores, including graphite, chromite, iron and magnesite ores.

3. EQUIPMENT AND BUILDINGS

Equipment has been steadily building up during the lifetime of the project. To begin with the work was carried out in offices belonging to PITAC, but in June 1976 a bay within PITAC, adjacent to the PITAC foundry was modified to house MAS offices and laboratories.. The main pieces of equipment that have been received by MAS during this phase are listed in Table 8.

The chemical analysis and metallographic equipment have enabled the project to deal more effectively with the advisory work. The special project work will require specialist pieces like the melting furnace, rolling mill, pyrometric measurement control equipment, heat treatment furnaces and mechanical test machines. Some of this equipment is expected to be added to the project during Phase 2. The major set back due to damage in transit of the solid state generator has already been mentioned. The replacement for this should also arrive during the next phase of the project.

4. THE FUTURE

The first phase of the Metal Advisory Service project has established a set of laboratories, a staff that is steadily gaining experience, and a good connection with the metal industry of Pakistan.

This is the base upon which the future can be built.

It is envisaged that as in Phase 1, future work will continue to be both advisory and developmental. However as equipment and experience is increased, the special project work is likely to be developed more rapidly in Phase 2 than was possible in Phase 1. The present premises within PITAC will then become inadequate and new buildings on a separate site would be required. Of course any move from PITAC to another site will entail the establishing within MAS of those ancillary services at present provided by PITAC.

Although great progress has been achieved in developing local staff, particularly by the policy of taking fresh graduates from the Universities, the continued reliance on a technical contractor will be necessary if the forward momentum of the project achieved in Phase 1 is to be maintained during Phase 2.

At the completion of Phase 2 it is envisaged that MAS will be adequately equipped in terms of equipment and trained personnel to be able to function without assistance from an outside contractor.

5. CONCLUSION

The concept, establishment and organisation of the Metals Advisory Service in Pakistan is described with special reference to the work both in the project area and in the U.K. by the contractors - The Fulmer Research Institute Limited. The advisory work has been reviewed and it is shown that close on 200 jobs have been carried out for the metal industry. An investigation showed that this work was well received and that many firms benefited both technically and financially from the service.

Steady development of projects for the use of indigenous materials and in the introduction of new technology is reported. A special effort has been made to bring into life a pressure pipe spinning plant which up to now has not operated commercially.

Instruction and training have worked out well but only two of the intended four fellowships in the U.K. have been completed. Foundations have been laid for a documentation centre that will serve the whole metal industry of Pakistan.

Equipment has been building up during the first phase of the project but much more will be required as special project work is extended. Future work requiring a separation of MAS from PITAC and its change to a Centre for Metal Technology will make new buildings and autonomy necessary.

EAB/EP
20th February, 1978

Table 1

SERVICE IN THE PROJECT AREA

Phase I of MAS

OCT. 1975 TO DEC. 1977

MONTH	TEAM LEADER	MANAGEMENT AND PLANNING	METALLOGRAPHY AND QUALITY CONTROL	FOUNDRY TECHNOLOGY AND STEELMAKING	SPECIAL STEEL MAKING	PIPE SPINNING	CHEMICAL ANALYSIS
Oct.75	EAB A-20	-	-	-	-	-	-
Nov.75	EAB	-	-	-	-	-	-
Dec.75	EAB D-20	-	-	-	-	-	-
Jan.76	EAB A-11	-	-	-	-	-	-
Feb.76	EAB	DGSD A-26	-	-	-	-	-
Mar.76	EAB D-11	DGSD	-	-	-	-	-
Apr.76	-	DGSD D-15	-	-	-	-	-
May 76	-	-	-	-	-	-	-
June 76	EAB A-4	-	-	-	-	-	-
July 76	EAB	-	-	-	-	-	-
Aug.76	EAB	-	-	-	-	-	-
Sept.76	EAB D-12	-	TFR A-2	-	-	-	-
Oct.76	-	-	TFR	JC(A-4 (D-28	-	-	-
Nov.76	EAB A-1	-	TFR	JC A-7	-	-	-
Dec.76	EAB	-	TFR D-12	JC D-1	-	-	-
Jan.77	EAB	-	-	-	-	-	-
Feb.77	EAB	-	-	-	-	-	-
Mar.77	EAB D-3	-	-	-	-	-	-
Apr.77	-	-	-	-	-	-	-
May 77	-	-	TFR A-10	-	-	-	-
June 77	-	-	TFR	-	-	-	-
July 77	-	-	TFR	-	-	-	-
Aug.77	-	-	TFR D-6	-	-	-	-
Sep.77	-	-	-	JC(A-1 (D-30	JL A-20	-	-
Oct.77	EAB A-29	-	-	-	JL D-20	-	-
Nov.77	EAB	-	-	-	-	SW A-24	-
Dec.77	EAB	-	-	-	-	SW D-22	DN A-1 D-29

EAB = E.A. Brandes, DGSD = D.G.S. Davies, TFR = T.F. Ryan, JC = J. Campbell,

JL = J. Littlewood, SW = S. Wilson, DN = D. Nicholas.

A = Arrival Date D = Departure Date

Table 2

LIST OF APPENDICES IN MAS MONTHLY REPORTS

REPORT NO.	APPENDIX NO.	SUBJECT
1.	1.	Cast Iron Moulds for Steel Ingots PSM.
1.	2.	Market Survey Form PSM
1.	3.	Mild Steel Rolling LEPO.
1.	4.	Nodular Cast Iron Committee
2.	1.	Proposed mft. of spring steel
2.	2.	General Scheme Nodular Cast Iron
3.	1.	Stainless Steel mfting. costs
3.	2.	Supply of Socket Caps. EMCo.
4.	1.	Sponge Iron in Pakistan
4.	2.	Seminar Project Planning;Participant List
5.	1.	Conclusions and Recommendations P.S.M.
5.	2.	Cracks in S.S. Forgings; Anwar Industries
5.	3.	Participants MAS Project Planning; Sem Karachi
6.	1.	Nod.Cast Iron Heat Treatment
6.	2.	Exploitation of Low Grade Pakistani Iron Ore.
6.	3.	Service Timetable
7.	1.	Foundry Sands in Pakistan
8.	1.	Exam. of Bicycle sprockets
8.	2.	Tech. Subcontracting Seminar
9.	1.	Sand Casting in Al - 11% Si alloy
9.	2.	Cr-Ni-Mn-N Stainless Steels
9.	3.	In-Mould Nodularization
10.	1.	Foundry Practice at Ittefaq
10.	2.	Market Survey of Demand for Special Steel
10.	3.	Attendances Sand and Foundry Mats. - Lahore
11.	1.	Life Engineers
11.	2.	Steel Castings Ltd., Foundry Practice
11.	3.	Pakistan Cycle Ind.
11.	4.	Pakistan Elektron Ltd.
11.	5.	Bicycle Frame Brazing at PECO
11.	6.	Seminar on Metallography + QC.
12.	1.	Austenitic Mn Steel Castings
12.	2.	Prod. of HS Steel
12.	3.	Life Eng.
12.	4.	Prod. of chilled Iron Rolls
12.	5.	Prod. of White Iron Cement Mill Plates
12.	6.	Recommendations for Centrifugal Castings
12.	7.	Prod. of Malleable Castings
12.	8.	Bentonite in NWFP
12.	9.	Grey Iron Melting - Cokeless Cupolas
12.	10.	Seminar on Metallographic Techniques
13.	1.	Ore Supplement to a Steelmaking Arc Furnace - LIFE J64
13.	2.	Refractory Consumption at LEFO J60
13.	3.	Explosions and Roof Falls in Steelmaking Arc Furnaces - LEFO J 65
13.	4.	Welding of Motor Stators at PECO J84
13.	5.	Galvanizing at PECO J85
13.	6.	Steel scrap for Electric Furnace Steel Making at PECO J92
13.	7.	Steel Making at Punjab Steel Ltd. J75
13.	8.	Chrome Plating at Pakistan Cycle Co. J71
13.	9.	PSM Spring Steel J.76

Table 2 Continued

REPORT NO.	APPENDIX NO.	SUBJECT
13.	10.	PSM Ingot Hot Tops J78
13.	11.	PSM Steel Castings J79
13.	12.	Sand from the Kushrab Area
13.	13.	Metals in the Food Industry
14.	1.	Ingot Mould Failures at PSM J77
14.	2.	Bicycle Frame Failure P.I.C. Sohrab J70
14.	3.	Wear of Bottling Plant Parts J83
14.	4.	Steel Wire Ropes Metrop. Steel J90
14.	5.	Brass Rod Connectors EMCO J91
14.	6.	Centrifugal Cast Iron Pipes Northern J101
15.	1.	Carbamate Pumps;Dawood Hercules J38
15.	2.	Suleman Spring J81
15.	3.	Cycle Cranks J86
15.	4.	Parts for Shezan J98 - J 100
15.	5.	Connectors RGA J104
15.	6.	Mukhtar Oilite Bearings J 105
15.	7.	Iron Ore and Sand Mines - Kalabagh
15.	8.	Equipment for Iron ore testing
15.	9.	Steel Ingot Mould Life.
15.	10.	Steel Scrap
15.	11.	Cupola Modification
16.	1.	Bull Wheel Failure - EHV/WAPDA J127
16.	2.	Diesel Engine Cylinder Liners;Defence Workshop J117
16.	3.	Wire Rope Failure;PMDC J130
16.	4.	Power Line Bolts and Clamps J128 - WAPDA
17.	1.	Shop Floor Practice - Ittefaq Eng. Works J137
17.	2.	Quenching Austenitic Mn Steel Castings Steel Castings Ltd. J132
17.	3.	Power Line Bolts;WAPDA J133
17.	4.	Annealing Furnace Radiant Tubes - PECO J87
17.	5.	Composition and Structure Control of Grey Iron J138
18.	1.	Recommendations to Nowshera Eng. Co.
18.	2.	Cracked Turbine Condenser Tubes Guddu Power Stn. J115
18.	3.	Definition of ferrous phases J138/2
18.	4.	Synthetic Moulding Sands for Iron and Steel J148
18.	5.	Assessment of Iron Castings - Rastgar J149
19.	1.	Cokeless Cupola - Commercial Framework
19.	2.	Schedule of Equipment - Cokeless Cupola
19.	3.	Draft Confidentiality Agreement - Cokeless Cupolas Ltd.,
20.	1.	United Iron & Steel J156
20.	2.	Special Steel Seminar
20.	3.	Training Programmes
20.	4.	Steel Balls Rastgar J153
20.	5.	Visit Record Sheet
20.	6.	Seminar Roll Production
20.	7.	Seminar Roll Production J160
20.	8.	Steel Melting PECO J157
20.	9.	a.b.c. Ittefaq J174, J173, J,172.
20.	10	Costs and Linings U.I.S. J162
20.	11.	Steel Melting U.I.S. J166
20.	12.	Roll Production Life Eng. J159
20.	13.	LIFE Costs J158
20.	14.	LIFE
20.	15.	LIFE Production of Steel
20.	16	S.S. Costs J164

Table 2 Continued

REPORT NO.	APPENDIX NO.	SUBJECT
20.	17.	Materials for M.S. J.168
20.	18.	Pipe Spinning; Northern Foundries J171
20.	19.	Visit LIFE J158
20.	20.	H.F.F. Taxila J152
21.	1.	Action Plan;Northern Foundries J161
21.	2.	Case for Cokeless Cupolas in Pakistan
21.	3.	Chichali Iron Ore - Position Paper
21.	4.	Chichali Iron Ore - Modal Analysis
21.	5.	Program for Dilatometer DTA etc.
21.	6.	Improvements in Steel Making - Littlewood Lecture
22.	1.	Copper Powder Manufacture
22.	2.	Minutes of the Iron Ore Committee
22.	3.	Iron Ore Pilot Plant Schedule

Table 3

ADVISORY WORK OF THE METALS ADVISORY SERVICE

The advisory work undertaken by Metals Advisory Service between October 1975 and December 1977 are listed in job number order. The name of the organisation is given in initial form but its full name and address can be found in Table 4 where the listing is alphabetical. The subject is given in very short form but where there is a reference to the monthly reports, this is given so that the full information can be readily assessed. Single numbers in the reference refer to the number of the monthly report, e.g. 7 would mean the seventh monthly report and 10A2 would mean the second Appendix of the tenth monthly report.

In the few cases in which no reference is given, the advice was given verbally, or was not included in the monthly reports. These listings refer to advisory work only, and do not include the work on special projects, instructions or other special reporting.

Location F - Faisalpur (previously Lyallpur)
G - Gujranwala, GP - Guddu
I - Islamabad, K - Karachi, Ka - Kalagagh,
L - Lahore, P - Peshawar, T - Taxila

* Asterisk against the job number denotes those jobs which received back-stopping assistance from Fulmer.

J. No.	Firm see Table 4	Location	Subject	References to monthly reports
2*	PSM	K	Ingot Moulds	1A1, 3, 6
3*	PSM	K	Market Survey	1A2, 3, 10A2
4*	PSM	K	Spring Steel	1, 2A1, 3
5*	PSM	K	Costing & Pricing	1, 3A1
6	PSM	K	Works study	1A3, 5A1
7*	LEPO	L	Rolling procedures	1
8*	EMCo	L	Malleable Foundry	3A2
9*	EMCo	L	Galvanizing Etc.	3A2, 11
10	SC	G	Quality Control	4
11*	SC	G	Specifications	4
12*	SC	G	Stainless Ingots	4, 5A2
14	KT	L	Chill Rolls	
15	PMTF	K	Die Cast Aluminium	6, 7

TABLE 3 - 2

J. No.	Firm see Table 4	Location	Subject	References to monthly reports
16	KS	K .	Manganese Steel Castings	12
17	PAF	K	Anchor Bolts	
20	SC	G	Manganese Utilization	
21	PECO	L	Blow holes in Iron Castings	8
22	SC	G	Pig for SG Iron	7
23	CSWR1	K	Aluminium extrusion	6
24*	PMTF	K	Heat Treatment	7
25	SC	G	Mag. Coke	
26*	PECO	L	Foundry Layout	8
27*	PECO	L	Malleable Iron Caps	8
28	PCICS	L	Bicycle Sprockets	8A1, 10, 11, 11A3
30	IE	F	Foundry Control	9, 10, 10A1
31	SI	G	Pickling Tanks	8
32*	FLEC	L	Literature Supply	
33	SIMA	L	Bearing Metal Mft.	
34	WAPDA	L	Season cracking of Al Bronze	
37	LEFO	L	Quality Control	
38*	DH	L	Steel for Carbamate pumps	10, 12, 15, 15A1
39*	PECO	L	Brazing of Cycle Frames	10, 11, 11A5
42	SC	G	Foundry practice	11, 11A2
43	LIFE	L	Production programmes etc.	11, 11A1
44	CLEC	L	Welding of stainless steel	
46	PE	L	Connector manufacture	10, 10A4
47*	CC	F	Clock Springs	9
48	MF	-	Aluminium Silicon Castings	9A1
49	AMS	L	Aluminium Alloy Specifications	
50	CTL	L	Hardness Testing	
53	SC	G	Manganese Steel Castings	9, 9A2, 12, 12A1
54*	SC	G	High Speed Steels	12, 12A2
55	LIFE	L	Steel making practice	12A3
56	ASCM	L	Malleable Castings	12, 12A7
57	LEFO	L	Centrifugal Castings	12, 12A6
58*	LEFO	L	Cement mill plates	12, 12A5
59	LEFO	L	Chilled iron rolls	12, 12A4
60*	LEFO	L	Refractory consumption	13, 13A2
61*	LEFO	L	Refractory testing	
63*	LEFO	L	Ferro alloy specifications	
64	LIFE	L	Ore supplement in steel making	13, 13A1
65*	LEFO	L	Explosions in arc furnaces	13, 13A3

TABLE 3 - 3

J. No.	Firm see Table 4	Location	Subject	References to monthly reports
67	CTL	L	Hardness of nuts and bolts	
68	CTL	L	Thickness of silver coatings	
69	CTL	L	Thickness of nickel plate	
70	PCICS	L	Breakage of cycle frames	14A2
71*	PCICS	L	Power failures during plating	13, 13A8, 14
72	LEFO	L	ASTM Specifications	
73	LEFO	L	Specification advice	
75	PS	L	Arc melting practice	13, 13A7
76*	PSM	K	Spring steel production	13, 13A9, 14
77*	PSM	K	Ingot mould cracking	13, 14, 14A1
78	PSM	K	Piping of steel ingots	13, 13A10
79	PSM	K	Steel castings	13, 13A11
81	Su	L	Spring rolling	15, 15A2
82	NDM	K	Malleable casting quality	
83	KRM	K	Casting steel rolls	
84	PECO	L	Welding Motor Laminations	13, 13A9
85	PECO	L	Galvanizing practice	11, 13, 13A5
86	PECO	L	Forged Cycle Cranks	13, 15, 15A3
87*	PECO	L	Gas burners	13, 17A4
88*	CCBC	L	Corrosion of Bottling Plant	14, 14A3
90*	MSC	K	Breakage of Wire Rods	14, 14A4
91	EmCo	L	Brass Connector mft.	14, 14A5
92	PECO	L	Steel Scrap for Steel Making	13, 13A6
93*	MI	L	Fixing leads to carbon brushes	14
96	PSM	K	Costs of flat steel products	
98	SL	L	Bottling plant repair	14, 15, 15A4
99	SL	L	Examination of Shaft	14, 15, 15A4
100	SL	L	Advice on disc repair	14, 15, 15A4
101	NF	L	Reduction of chill in spun pipes	14, 14A6
102	NF	L	Pig for spun pipes	14
104	RBA	L	Connector manufacture	15, 15A5
105	MEW	L	Oilite bearings	15, 15A6
107	EMCo	L	Forging Die Heat Treatment	15
113	LEFO	L	Quality Control Requirements	-
115	GP	GP	Turbine Tubes	16,18A2
117	-	L	Diesel Engine Cylinder Liners	16, 16A2
127*	EHV	L	Bull Wheel Failure	16, 16A1
128	EHV	L	Power Line Bolts	16, 16A4

TABLE 3 - 4

J. No.	Firm see Table 4	Location	Subject	References to monthly reports
130	PMDC	Ka	Wire Rope Failure	16, 16A3
131	NFC	L	Pressure Die Castings	16
132*	SC	G	Quenching Manganese Steel	17, 17A2
133	WAPDA	L	Power Line Bolts	17, 17A3
137	IE	F	Shop Floor Practice	17, 17A1
138	IE	F	Comp. and structure of C.I.	17, 17A4, A3
140	BB	L	SS Impeller Pumps	18
141	NEC	P	Steel Ingot Moulds	18, 18A1
142	NEC	P	Sand Recommendations	18, 18A4
143	NEC	P	Ingot Mould Production	18, 18A1
144	NEC	P	Refractories in Arc Furnace	18, 18A1
149	RI	I	White and Grey Iron Castings	18, 18A5
150	IE	F	Classification of Cast Irons	18, 18A6
151*	CLEC	L	Stainless Steel Identification	19
152	HFF	T	Casting Problems	20, 20A20
153	RI	I	Grinding Balls	20, 20A4
156	VIS	L	Report of Visits	20, 20A1
157	PECO	L	Steel Making	20, 20A8
158	LIFE	L	Steel Making Costs	20, 20A13
159	LIFE	L	Roll Production	20A12
161*	NF	L	Pipe Spinning	20, 21A1
162	VIS	L	Melting Facilities	20, 20A10
164*	PSM	K	Cost of Making SS.	20, 20A16
166	VIS	L	Steel Melting	20, 20A11
168	LEPO	L	Materials for MS	20, 20A17
171	NF	L	Pipe Spinning	20, 20A18
172	IE	F	Quality Control	20, 20A9C
173*	IE	F	Foundry Equipment	20, 20A9b
174	IE	F	Steel Rolls	20, 20A9a
183*	MI	L	Copper Powder Manufacture	22, 22A1
191	NB	L	Lathe Gears	21
198	AO	-	Aluminium Bearing	21

Table 4

LIST OF FIRMS ADVISED BY MAS
ALPHABETICAL ORDER

Abbreviation	Name and Location
AMS	Associate Menan Shaheed, Lahore
AO	Attock Oil Company
ASCM	Anwar Steel Casting and Moulding Works, Lahore
BB	Barter and Bevy. Lahore
CC	Champion Clock Co., Nishtarabad, Lyallpur
CLEC	Coca Cola Export Corp., Lahore
CTL	Central Testing Laboratory, Lahore
CSWRI	Chandry Steel Wire Rope Industry, Karachi
DH	Dawood Hercules Co. Ltd., Lahore
EHV	Extra High Voltage Consultants to WAPDA
EMCo	Electric Equipment Manufacturing Co., Lahore
FLEC	Federal Light Engineering Corp. Ltd., Lahore
GP	Thermal Power Station Guddu
HFF	Heavy Foundry and Forge Taxila
IE	Ittefaq Engineering Works, Lefallpur
KS	Karachi Shipyard & Engineering Works, Karachi
KT	Khyber Tobacco Co., Lahore
LEFO	Lahore Engineering Foundry Organisation, Lahore
LIFE	Life Engineering Co., Lahore
MEW	Mukhtar Engineering, Lahore
MF	Military Factory
MI	Majid Industries, Lahore
MSC	Metropolitan Steel Corp., Ltd. Karachi
NDM	Naya Daur Motors Ltd., Karachi
NEC	Nowshera Engineering Co. Peshawar - NWFP
NF	Northern Foundries Ltd., Lahore
PAF	Pak. Arab Fertilizer Co., Karachi
PCICS	Pakistan Cycle Industries Co-operative Soc. Ltd., Lahore
PE	Pakistan Elektron Ltd., Lahore
PECO	Pakistan Engineering Co. Lahore
PMTF	Pakistan Machine Tool Factory, Karachi
PS	Punjab Steel Co., Lahore
PSM	Peoples Steel Mills Ltd., Karachi
RGA	RGA Ltd., Lahore

Table 4 Continued

RI	Rastgar Industries Islamabad.
SC	Steel Castings Ltd., Gujranwala.
Sh	Shezan Ltd., Lahore.
SI	Searoze Industries Ltd., Gujranwala.
SIMA	SIMA Industries Ltd., Lahore.
Su	Suleman & Co., Lahore.
UIS	United Iron and Steel Ltd., Lahore.
WAPDA	Water and Power Development Authority, Lahore.

Table 5

Assessment of MAS Advisory Work

Questions asked:

1. Did the assistance help?
2. Have any of the recommendations been put into effect?
3. Improvements?
4. Do you require more help?
5. Comments

FIRM	ANSWERS TO QUESTIONS				
	1	2	3	4	5
Nat. Spring Mft.	Yes	Yes	-	No	Good Prompt Service
Ittefaq Eng.	Yes	Yes	Better Castings Lower rejects	Yes	Very satisfied
EMCo.(Nod.Iron)	-	-	-	-	Trials not complete
" (Brass Rod)	Yes	Yes	-	No	Better results
" (Galvanizing)	Yes	Yes	Financial gain	No	Considerable Improvement
PCICS (Cycle Tubes)	Yes	Taken up	-	No	Staff keen
" (Sprocket)	Yes	-	-	Yes	" "
" (Cr plate)	Informat	No	-	Yes	" "
LEFO	Yes	No	-	Yes	
" (Refractories)	Yes	Partial	-	Yes	Confirmed our thinking
" (Mill Plate	Yes	No	-	Yes	More information required
" (Specifications)	Yes	Yes	-	Yes	Helped in discussi. with clients
" (Cokeless Cupola)	Yes	No	-	-	Food for thought
" (Chilled rolls)	Yes	No	-	-	Report introductory
" (Cemt. Casting)	Yes	In Progress	-	-	Useful
Dawood Hercules (Pumps)	Yes	Yes	-	Yes	Excellent
Steel Castings Ltd. (SG. Iron)	Yes	Yes	-	Yes	Not yet implemented
" " (QC)	Yes	Yes	-	-	Lab. under construction
" " (HS Steel)	Yes	Yes	-	Yes	New Project
" " (Cracks)	Yes	Yes	Yes	No	Problem solved
" " (Mn C.I.)	Yes	Yes	-	Yes	Very Useful
" " (Specifications)	Yes	Yes	-	-	Useful
" " (Shop Floor Prac)	Yes	Yes	Yes		Installing QC Lab.
Coca Cola	Yes	Not Yet	-	-	Suggestions under trial

Table 6

SPECIAL PROJECT REPORTS

SUBJECT	MONTHLY REPORT/APPENDIX REF.
Iron Ore	
Exploitation of low grade Pakistani Iron Ores	6 A2
Iron ore at Kalabagh	15 A7
Equipment for Iron Ore Beneficiation Tests	15 A8
Position Paper - Chichali Ore	21 A3, 22 A1
Modal Analysis - Chichali Ore	21 A4
Pilot Plant Schedule and Committee	22 A2, 22 A3
Sponge Iron	
Sponge Iron from Pakistani Ores	4 A1
Cupolas	
Grey Iron Melting	12 A9
Cupola Modification	15 A11
Cokeless Cupola	[19A1, 19 A2, 19A3, 21 A2.]
Foundry Materials	
Foundry Sands in Pakistan	7 A1
Sand and Foundry Materials Committee	10 A3
Sand from the Khushab area	13 A12
Sand at Kalabagh	15 A7
Synthetic Moulding Sands for Iron and Steel	18 A4
Bentonite from NWFP	12 A8
Nodular Cast Iron	
Nodular Cast Iron Committee	1 A4
General Scheme for Nodular Cast Iron	2 A2
Nodular Cast Iron Heat Treatment	6 A1
In-mould Nodularization	9 A3
Centrifugal Pipe Spinning	21 A1 and Special Report
Steel Scrap	15 A10
Dilatometry Programme	21 A5

Table 7

SEMINARS AND INSTRUCTION GIVEN IN PHASE 1 OF MAS

SUBJECT	LOCATION	EXPERT
Project Planning and Control	Chamber of Commerce Lahore	D.G.B. Davies
Metallography and Quality Control	MAS - Lahore	T.F. Ryan
Foundry Technology	MAS - Lahore	J. Campbell
"	PSM - Karachi	"
S.I. Units	MAS - Lahore	E.A. Brandes
Sub Contracting and Joint Ventures	Dir. of Ind. & Min. Dev. Lahore	(M.K. Hussein (M. Hassan (E.A. Brandes
Industrial Engineers	Asian Prod. Council Lahore	E.A. Brandes
Metals in Food Industry	Coca Cola Corp. Lahore	E.A. Brandes
Material Selection for Chemical Engineers	Chem. Eng. Soc. Lahore	E.A. Brandes
Welding of Stainless Steel.	Dawood Hercules Lahore	E.A. Brandes
Special Steel Production	MAS - Lahore	(G. Littlewood (J. Campbell
High Quality Steel	PSM - Karachi	G. Littlewood
Rolls for Steel Rolling Mills	MAS - Lahore	G. Littlewood
Instrument Analysis and Atomic Absorption	MAS - Lahore	D. Nicholas

TABLE 8

MAIN ITEMS OF EQUIPMENT RECEIVED BY MAS DURING PHASE 1

1.	Office Equipment (including photocopying)
2.	Glassware and Wet Chemical analysis apparatus including a still and balances.
3.	Atomic Absorption Apparatus.
4.	Hardness Testers - Brinell and Rockwell.
5.	Metallographic Preparation Equipment.
6.	A bench microscope and a metallograph.
7.	Photographic equipment including an enlarger.
8.	Dilatometer.
9.	Solid State 100 kW generator and Melting furnace [The generator was received damaged and was returned to supplier. The replacement was not received during Phase 1.]

APPENDIX

PRESSURE PIPE MANUFACTURE AT NORTHERN FOUNDRIES, LAHORE

SUMMARY

The pressure pipe spinning plant at Northern Foundries, Lahore, has been studied both as it was originally and in its present state since it was heavily modified by Rheinstahl during commission attempts.

An action plan to restart plant trials was prepared and executed and following this a series of plant trials. During these, full length pipes were cast and the experience gained in these trials has enabled the position to be more accurately assessed.

The MAS assignment was to try to rescue the already existing spinning unit. The high cost of re-installing the original retractable metal feeding device making this economically unfeasible, especially with the smaller diameters. The remaining option, which is recommended involves trials using imported forged steel moulds initially of 8" diameter.

1. INTRODUCTION

Northern Foundries in Lahore is a FLEC (Government of Pakistan) - Rheinstahl (Essen - West Germany) Joint venture established to produce cast iron pressure pipes.

After many set backs and plant alterations, commissioning took place in 1974 but no saleable quantity of pressure pipes was produced. The German team withdrew and the pressure pipe spinning plant has stood idle until the trials which will be described in this report; a period of 3½ years.

At the request of FLEC, Metals Advisory Service have investigated the plant condition, both as it was originally, and how it was modified by the German team in vain attempts to start production. MAS was given the assignment to study the feasibility of rescuing the present plant so that it could produce sound pipes.

After preparatory work by MAS and deciding on a work schedule, the plant was put into a condition for shop floor trials. These have been carried out and will be described here in detail.

Attempts have been made to discover the reasons for the extensive and virtually irrevocable plant modifications which were carried out by the Rheinstahl team. Particular consideration has been given to the unfortunate decision to use cast iron instead of the forged steel moulds which are used universally for this type of pipe production.

In MAS trials, full length pipes of the difficult 4" (100 mm) diameter were produced but these were not pressure tight or saleable. However, the trials have been enormously useful in making a judgement on the plant and on possible future courses of action. This is clearly urgent since the idle time on such a capital intensive plant represents a continuing financial loss. Four possible future courses of action have been considered. These are:

i. attempting to operate the plant as it was left by the German team,

ii. to operate the plant as at present but with forged steel moulds,

iii. to reconstruct the plant with retractable moulds and full length pouring launder as originally designed or

iv. to scrap the spinning section of the plant and replace it by conventional water cooled pipe casting machines.

What is involved in carrying out each of these actions and the probable results from each are discussed. Recommendations are given to guide the decision makers in what will be important choices.

2. PLANT AND PLANT MODIFICATIONS

The plant set-up as originally planned and modifications introduced in the course of production trials is given in Appendix - I.

3. CASTING TRIALS BY M.A.S.

In order to reproduce the conditions that existed at the time

of the closure of the plant, a comprehensive plan of action was drawn up by MAS (J.101) as preparations were made in conjunction with Northern Foundries to prepare for the running of the pressure pipe plant. This is attached as Appendix - II. The work commenced on 14.10.1977 and continued until 14.12.1977.

A meeting took place at FIEC in Karachi on 5.10.1977 which was followed by another meeting on 18.10.1977 in Lahore to review progress and arrange a hot run in an endeavour to find the cause of the failure of the plant and propose a remedy.

MAS expert on Spun Pipes, Mr. Wilson, reported to Northern Foundries on 25.11.1977 accompanied by two MAS members and was assisted during all his mission by the plant Deputy Manager who had worked with the Rheinstahl personnel and had received his training in Germany.

From 25.11.1977 until the 14.12.1977 files and drawings were studied and all preparations were made for casting trials.

Moulds available were cast iron S.G. moulds 100 mm x 6 metres cast at Northern Foundries. No data regarding metal composition was available. Out of four moulds available, only one mould was found to be in fair condition, the other three were bent to various degrees. The moulds are very heavy castings weighing around 3 tons. All show longitudinal cracks.

Several days were spent in improving the mould coating system by changing mould wash mixtures, reducing feed pressures, increasing atomizing pressure etc. This was difficult since with the small diameter mould, the spray nozzle was too close to the mould wall. This caused runs and unsatisfactory coating. In these trials, the German prescribed mould coating, material and technique were applied.

Preparations were made for a hot run which took place on 6.11.1977 and 7.11.1977. These trials were not satisfactory since it was only possible to cast a short length pipe on both occasions due to low fluidity caused by incorrect metal analysis and electrical trouble causing low temperature metal. From these results it is obvious that better metallurgical control and a higher standard of electrical maintenance is absolutely necessary.

A further casting trials took place on 14.12.1977. Local bentonite of the non-activated type with a swelling Index of 270% provided by MAS was used. The mould coating was noted to be better than that of previous trials.

Metal was tapped out of the induction furnace and transferred to the casting station after pre-heating the casting ladle by filling it with molten metal and repouring it back into the furnace.

The temperature was checked using an immersion pyrometer, it was 1500°C. The first pipe was cast with a mould rotation speed of 1150 RPM. Metal quickly ran the full length of the mould and a full pipe was cast. The pipe was extracted by the mechanical extractor which moves far too slowly. A second pipe was cast with the same results.

Metallurgical examinations of the full length pipes cast during the present trials showed fine graphite structures and complete absence of chill even at the outer surface in contact with the mould wash. This proves that this has been effective in its chill preventing function. The iron contained a large volume proportion of iron-carbon-phosphorus ternary eutectic. This agrees with the phosphorus analysis of about 0.6%. The high proportion of low melting eutectic provided the fluidity that enabled a 6 m long pipe to be cast from one end only. The structure did not reveal any manganese sulphide phase so that since manganese was known to be present, the sulphur content must have been very low. Although the structure is that of a brittle iron it would be satisfactory for pressure pipes. Chemical analysis reveal the following:

C = 3.12%, Si = 2.11%, P = 0.66% and Mn = 0.45%.

Both pipes subjected to pressure tests showed unacceptable leaks but both pipes were cast in faulty moulds, therefore, the fact that they leaked under pressure cannot be taken as failure of the system as a whole.

The cause of leaks in pipes is mainly due to inclusions especially gas inclusions, and since the moulds were known to have many small cracks and depressions, this is probably the reason for the failures in pressure testing. It was noted that the mould coating was effective in eliminating chill but it could be further improved by future trials.

Results would be better with a large diameter mould but further investigations are required to produce a coating that will meet the following requirements:

1. A highly refractory coating which will insulate the metal from the mould and ensure even cooling to prevent the necessity of heat treatment.

2. A smooth even coating that will not wash off at high temperature.

4. DISCUSSION OF M.A.S. TRIALS

It can be now concluded that after full investigations and a careful study of events which eventually led to the closure of the plant, that the choice of cast iron moulds played a major part in the problems which were experienced. Excessive vibrations due to the unbalanced moulds must have played a major part in the decision to dispense with the full length pouring launder. Cast iron moulds will distort when subjected to serve stresses like those which exist in the centrifugal casting of pipes.

It must also be pointed out that with the existing system at Northern Foundries, using only 2 sets of mould rotation rollers, a very thick heavy mould is employed to prevent mould bounce during casting. The use of 6 metre long moulds is also a factor which tends to increase the distortion or bending of the mould during operation. So far as is known, no plant in the world operates a pressure pipe plant in 6 metre lengths using cast iron moulds.

A conventional water cooled casting machine would contain at least 5 sets of bottom rollers with a corresponding number of top rollers if a 6 metre long mould was used. The decision to use indigenously produced cast iron moulds was clearly too ambitious and had calamitous results.

Forged steel moulds should be adopted in any future system of centrifugal pressure pipe casting.

Considerable research has been carried out for many years to produce moulds that will withstand the stresses set up during the spinning operations. To this end, vacuum degassing of steel is usual when producing steel ingots for forging to moulds.

A specialised forging technique is employed and rigid inspection together with extensive machining facilities, and metallurgical control of the highest order are necessary. Very few mould manufacturers have succeeded in producing moulds to the high standards required.

British Steel Corporation under the name of Firth Brown of Sheffield and National Forge Company of Irvine (US) are two of the principle suppliers. Cast iron moulds are unlikely to be suitable for centrifugal casting of pipes, other than non-pressure pipes of short lengths.

5. POSSIBLE FUTURE PLANT STRATEGIES

In order to arrive at the best future action we have considered the following possible courses:

1. Plant as at present with existing cast iron moulds.
2. Present plant using forged steel moulds.
3. Change back to the original plant design with moveable spinning machine and full pouring launder.
4. Change over to conventional water cooled spinning machines.

These will now be discussed in turn.

5.1. PLAN 1:

Plant as at Present with Existing Cast Iron Moulds:

It is considered that the use of cast iron mould was a major factor in the failure to produce saleable pipes. Another reason was the changing of the pouring system from a full length launder and moveable mould carriage to the present system. Inspite of the joint efforts of the German and Pakistani Teams, it was not possible to produce sound pipes using this system.

It is a well known fact that any type of mould used for centrifugal casting of pipes is subjected to severe thermal stresses, especially thick cast iron moulds which distort causing uneven mould rotation and vibration. This causes damage to the mould and mould rollers rendering satisfactory production very unlikely. Moulds produced at Northern Foundries failed after producing only a few pipes. It is our considered opinion, that production of pressure pipes in

economic quantities will not be possible under the presently existing conditions.

5.2. PLAN 2:

Present Plant using Forged Steel Moulds:

This would be a definite improvement since steel moulds would not distort to the same extent as cast iron moulds. The use of steel moulds would ensure far better mould rotation and they would not crack after the first few casts as was the case when using cast iron moulds. Pipes would be extracted more easily and give a far better chance of continuous production.

Since full length pipes were cast with the present pouring system in the recent trials, it is reasonable to assume that the plant can continue to do so with better results as experience with the system is accumulated. Pipes can be produced by the present pouring method but it must be pointed out that moulds cost would be high, since the thick moulds used would produce far less pipes per mould than thin walled moulds used in conventional water cooled machines.

The fact that in the installed system, all the metal is poured on one spot (i.e., the spigot end) will also cause rapid mould wear at this spot unless full precautions are taken. Many moulds of each size would be required for regular production but to test whether or not the adoption of steel moulds is justified, a small number of moulds of one size could be ordered and trials carried out with the plant in the existing condition.

Delivery time of 4 - 5 months for suitable moulds has been quoted by National Forge Company, USA but tenders should be invited from several mould manufacturers. It is suggested trials should be with the 8" size and that two should be ordered. This should be sufficient to establish whether or not the system is viable.

An 8" mould size is far easier to cast than a small diameter pipe since mould coating is less difficult. Only after trials extending to the full life of the moulds have been completed should it be expected regularly to produce sould pressure pipes since teething troubles alway occur.

For conventional moulds of 8" x 5.5 metre, US $ 6800 per mould has been quoted.

With good metal control and an improved mould coating, it should be possible to produce saleable pipes. Initially production costs will be high since rejections must be expected that mould life will be lower than with conventional casting. It is suggested that an extra spraying be made at the spigot end of the mould to prevent excessive wear at this point. This could be easily done especially on the larger size of mould by using a portable sprayer.

5.3. PLAN 3:

Change Back to the Original Plant Layout with a Moveable Spinning Machine and a Full Length Pouring Launder:

Since the length of the pouring launder would be approx. 7 metres in length and it is only supported for approx. 1 metre at its extreme end by the hopper tilting frame, it would sag excessively especially on the 4" size. During casting of this size the pouring launder would rest on the bottom of the mould for the first 1 - 2 metres. This would damage the mould coating so that the production of this size will not be possible.

With improved mould coating and using larger diameter pipes, this system would be attractive. Due to the fact that the necessary mechanical parts of the system have been completely destroyed, it would be a very costly operation to re-install the original feeding device. The whole unit would have to be dismantled and rebuilt. Much of replacement necessary would probably be imports involving heavy foreign currency expenditure. By changing back to a moveable tilting mould carriage, it is assumed that with dynamically balanced mould all vibration would be eliminated. This cannot be ascertained until this major modification is made. Therefore, this proposal cannot be recommended.

5.4. PLAN 4:

Change over to Water Cooled Spinning Machines:

This is substitution of the existing spinning section of the plant by a conventional pipe spinning section, using water cooled spinning machines to cover the range of 100 mm to 400 mm. To give the designed output, 3 of these machines would be required to cater for emergencies and ensure the supply of the required product mix. A

normalizing furnace would also have to be installed. When deciding the type of furnace to be adopted, consideration should be given to further developments when ductile iron pipes may be demanded by the market.

As a guide the advantages of conventional pipe spinning are given at the end of this appendix.

6. RECOMMENDATIONS

Having now described each of the possibilities, a comparison may be possible. Each plan will involve expenditure. It has not been possible to quantify this in the time available since quotations would need to be obtained for a number of capital items. If required, work can proceed on this at a later date. As a direct recommendation plan 5.2. is the only one to be considered at this stage. This involves forged steel moulds of 8" diameter and conducting trials on (a) coating, (b) casting the full length at various speeds keeping control of the composition and temperature, (c) mould life time and coating modification to increase life time, and (d) feasibilities of use of the same mould to produce bigger sizes after service completion on the pre-designed size.

Further action would then be guided by the results of these trials.

CONVENTIONAL PIPE SPINNING METHOD

ADVANTAGES OF INSTALLING CONVENTIONAL PIPE SPINNING MACHINE:

1. This system has been universally adopted through the world.
2. Rejections are low.
3. Higher casting rates are possible.
4. Mould cost per tons of output is low.
5. Know-how of operation is easily accessable.

Since conventional pipe spinning machines are in use at Northern Foundries for soil pipes, considerable amount of experience already exists and the personnel are more capable of operating a conventional pipe spinning plant.

TYPE OF CONVENTIONAL CASTING SECTION RECOMMENDED:

This should consist of a unit employing 3 water cooled casting machines complete with water circulating system and should be as simple as possible provided it has the following:

1. Smooth traverse movement.
2. Variable speed mould rotation.
3. Variable speed pouring hopper.
4. Suitable extraction equipment.

NORMALIZING FURNACE FOR WATER COOLED SYSTEM:

This should consist of a suitably geared chain conveyor approx 90 ft. in length with a minimum speed of 55 minutes. It should be gas fired through burners arranged along the whole width of the furnace to ensure equal heat distribution.

Burners should provide uniform heating at 950-1000°C. If furnace drawings were obtained, such a furnace could be locally manufactured.

COST OF INSTALLATION OF CONVENTIONAL WATER COOLED SPINNING SECTION:

This could only be given after a careful study of the various types of casting machines that are available. Stanton & Staveley Nr. Nottingham, (England) have supplied spinning machines but only when they participate in joint ventures. These are expensive installations.

Several European types of machines are available and enquiries could be instituted to check on costs. Since the Rothfisher type of machine is already installed at Northern Foundries for soil pipes, this manufacturer should be given favourable consideration but it would be important to obtain as many quotes as possible.

This also applies to a suitable normalizing furnace.

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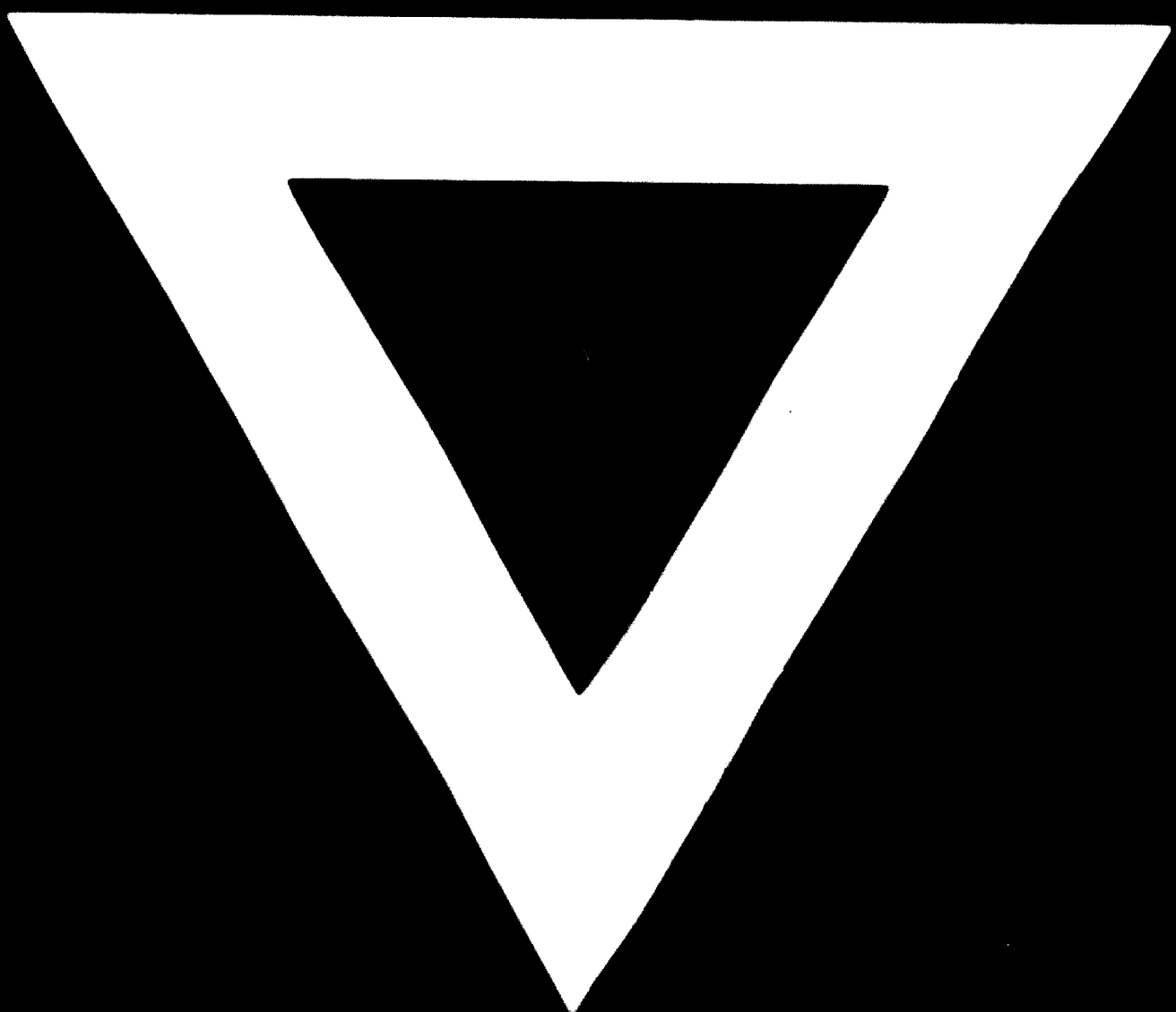

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