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FINAL REPORT

of

FOUNDRY INDUSTRY PLANNING, MODERNIZATION 1/ AND RATIONALIZATION

prepared by

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Expert in Foundry Shops

1/ The views and opinions expressed in this paper are those of the author and do not necessarily reflect the views of the secretariat of UNIDO.

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We regret that some of the pages in the microfiche copy of this report may not be up to the proper legibility standards even though the best possible copy was used for preparing the master fiche

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LIST OF EXHIBITS

Note: Reference to exhibits included in interim reports is made in the report. However, another copy of the reference is not attached to this final report.

A. Summary of report made by American Colloid Co. laboratory on TMMC Sand Samples.

B. Letter report to Mr. Wei-Liang Lee,TMMC dated 17 May 1972

C. Modernization of Steel Foundry Proposition I dated 30 April 1972

D. Relocation of Steel Foundry Proposition II dated 29 May 1972

E. List of Foundries Visited with summary recommendations.

F. Evaluation of Steel Foundry Industry - Taiwan dated 24 May 1972

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I. Testing Programme - Taiwan Sands and Binders.

1.0 Summary

Taiwan Machinery Manufacturing Company

1.1 Modernisation of the present steel foundry is feasible and will permit a break-even including investment cost at about twice the present production level. Relocation to a new site is not considered advisable in view of the substantial increase in volume needed for break-even performance and the uncertainty as to when the market demand will support this needed increase.

1.2 The introduction of molding machines and sand preparation facilities in the steel foundry is essential for improvement in quality and productivity.

1.3 A programme has been initiated designed to improve the effectiveness of the foundry staff in daily planning, in directing the work force and in developing improved quality.

Metal Industries Development Centre

1.4 The needs of the entire steel foundry industry has been summarized in a comprehensive report. Substantial improvement in molding methods and materials is essential for better quality castings, lower costs and higher productivity.

1.5 Continuing activity on the part of MIDC in materials testing and evaluation is needed for the entire foundry industry.

1.6 It has been proposed that MIDC be equipped to provide engineering and technical assistance to all industry in the field of air pollution control.

1.7 The entire foundry industry will continue to require assistance in equipment and facility planning; in methods and quality improvement, and in developing suitable and useful materials for use in attaining the latter.

1.8 It is considered essential that a strong, stable consulting staff be maintained at MIDC to provide this assistance. The industry will have to be sold on using this consultancy service for it to be developed and maintained at the Centre.

2.0 OBJECTIVE

2.1 The Job Description CNA-021-C (SIS) specified an equal division of the one year assignment between Taiwan Machinery Manufacturing Company who operate both an iron and steel foundry, and the Metal Industries Development Centre to provide consulting service to the foundry industry throughout the country. The activity was to involve advising on quality improvement, foundry methods, practices and materials. In addition, consulting service was to be furnished on modernization and relocation of foundry facilities, specification and selection of new foundry equipment at both Taiwan Machinery Manufacturing Company and for selected foundries throughout Taiwan. Training of workers, technical and supervisory personnel at TMMC and the preparation of a series of lectures and seminars for use at MIDC were also to be required.

2.2 After a few weeks observation of the operations at TMMC and short inspection trips to a few other foundries it seemed advisable to adjust the objectives to reflect more clearly the needs of a poorly equipped industry. There was little point in discussing modern core making practice when core blowers and over drying equipment were not available. Sophisticated molding and control methods mean little when hand molds are produced with sweeps in CO_2 - sodium silicate sand and gassed to harden. It is ridiculous to discuss the importance of accurate and uniform temperature control in heat treating where a single coal fired stoker fed burner supplies the heat input and an optical pyrometer provides the control. The degree of quality attained in view of the methods used and absence of equipment is to be marvelled at.

2.3 A high priority was then established on developing long range plans at TMMC for modernization and or relocation. Further, in view of the limited market for steel castings it was essential that the economic justification for such modernization must be developed.

2.4 In view of the forthcoming termination of all UN programmes by 1 June 1972 it became necessary to concentrate during the short time left at MIDC on the evaluation of the steel foundry industry in Taiwan, so effective programmes could be developed by the Ministry of Economic Affairs to improve this essential industry.

2.5 Training was to be provided throughout the assistance at Taiwan Machinery Manufacturing Company and later during brief visits to other foundries in connection with their problem solving.

3.0 OBSERVATIONS AND RECOMMENDATIONS:

Taiwan Machinery Manufacturing Company

3.1 Every aspect of the operation of the iron, steel and non-ferrous foundries was reviewed during the nearly seven months association with TMMC. While a great number of problems were uncovered either by inspection of the operation or the castings produced, many were brought up through questions raised by the members of the foundry shop supervisory staffs. It should be emphasized that the experienced foundry men from outside will "see" many items which go unnoticed by the regular staff. Advice on and solutions to these problems were daily activities during the frequent contacts with the staffs of the iron, and steel foundries.

3.2 A good deal of time was devoted also in preparing written confirmation of all recommendations primarily because of the always present difficulty in communicating and to be certain instructions were fully understood.

3.3 It is evident that many of the methods and materials employed in both iron and steel foundries have been necessitated because of the absence of even simple foundry production equipment. This has imposed severe restrictions on the attainment of minimum quality levels and has kept productivity low.

3.4 Some modern equipment had been procured during the past few years such as core blowers, jolt squeeze molding machines and a motive sand slinger but are not now being used because of a commitment to the restriction of "jobbing quantities" on pattern construction. In many cases the cost of good solid patterns suitable for conventional molding methods would not be substantially greater than the sweeps, skeletons or poorly constructed and reinforced solid patterns. Strong recommendations have been presented on this most important change in foundry planning.

3.5 The most serious restriction to improved quality has been the almost complete dependence upon sodium silicate CO_2 bond systems for molding and core making. This system is used exclusively in the steel foundry, and partly in the iron foundry. The CO_2 sand system must be replaced before progress in quality and productivity can be made. Conversion to a conventional sand practice is to require first a modern sand preparation and recycling plant. In the iron foundry the present sand preparation plant must be modified to assure the maintenance of a consistent and acceptable level of sand properties.

3.6 Prior to the planned installation of new molding and sand preparation equipment, it has been recommended that modification of the base sands and the sand mixes would produce some improvement in casting surfaces.

3.6.1 Discontinue the introduction of Perng Fwu coarse sand in iron facing.

3.6.2 In conjuction with sand suppliers and with the assistance of MIDC who are working on the project a base sand is to be developed having a distribution of 80% on three adjacent screens and a maximum of 35% on one, at a grain finesses number of about 50 - 55.

3.6.3 All clay bonded molding sands are to be modified by decreasing clay and increasing bentonite additions to attain over 9 psi (.64 kg/sq. cm) green strength). The use of dextrine or similar cereal flour as a buffer to the expansion characteristics of silica sand is essential for improved workability.

3.6.4 By elimination of the coarse Perng Fwu sand from heavy iron facing and consequently from the backing or return sand, it should be possible to reduce the thickness of the graphite mold coating trowelled on molds for heavy castings (to produce a smooth finish). The too frequent occurrence of blow holes resulting from moisture trapped behind the impervious coating can be thus minimized.

3.6.5. Until a sand preparation system can be installed in the steel foundry it may be necessary to modify the sand practice by employing new sand facing with imported western bentonite to provide hot strength. Backing sand can be bonded with the less expensive local bentonite. A change from the sodium silicate system for small and medium castings is essential if castings quality is to improve and cleaning costs are to be decreased.

A laboratory study was completed by the American Colloid Company in the USA covering simple sands submitted by TMMC. A summary report is included as **Exhibit A.**

3.6.6 Where sodium silicate bonded sands must still be used, improvement in peel and collapsibility is essential. The experimental work involving additives of pitch, cereal, oil or other materials to promote improved surfaces is to be continued until satisfactory results are obtained.

3.6.7 It is believed the continued conversion of core making practices to oxygen cured tung oil binders will permit improvement in surface quality and ease of cleaning. The core making area set up in the iron foundry has capacity to produce and dry some cores for both steel and iron foundries. Its expanded use has been and is encouraged.

3.7 Serious deficiencies in the adequacy of feeding was evident in both iron and steel foundries. Shrinkage under risers and at various locations throughout castings was frequently observed. Informal sessions were started and the general principles applying to feeding both iron and steel castings were reviewed. It was evident that the problem did not result from a lack of knowledge or understanding of the basic fundamentals of solidification of metals. Compromises were made too often to accommodate the design of a customers pattern, the availability of proper flask equipment or to permit easy riser removal by machining or gas cutting. Risering of specific castings cannot be discussed here because of their number, but some of the basic principles discussed and emphasized will be reviewed for reference.

3.7.1 Risers must be located so as to feed the heavy sections which will be the last to solidify.

3.7.2 Heat dissipation from a riser will be more rapid than the adjacent casting and must be compensated for through insulation, heat input (through exothermic materials) or increased size. In most operations metal capacity was adequate and it was recommended that risers could be oversized without excessively increasing costs.

3.7.3 Riser must be greater in diameter than the contact in order to maintain a passage open for the flow of liquid metal to the section to be fed.

3.7.4 The application of a riser to any section, in effect will change the dimensions of the section to be fed which must be compensated for in sizing the riser.

3.7.5 Riser and the area being fed constitute an isolated system affected by the temperature of the metal. Cold metal may reduce the volume of shrinkage in the section but also will reduce the effectiveness of the riser function.

3.7.6 While differences exist in the solidification of grey iron and non-ferrous metals the basic principles were applicable to all. Naturally, graphitization in soft cast iron will reduce the late feed demand but not the need for metal reservoirs to compensate for liquid contraction.

3.7.7 While the staffs of the foundries are familiar with the above basic principles and how to use them, the practical application is often left to the molder. The problem is also discussed under organization - but the failure of supervisors and staff engineers to assure proper performance in the shops can often be critical.

3.8 Housekeeping -

3.8.1 Emphasis was placed on the importance of a clean, orderly work place in developing a quality oriented work force, in improving the efficiency of employees, and in releasing needed floor space for productive activity.

3.8.2 Some progress in this direction was evident in the iron foundry where a concerted effort was made to dispose of obsolete materials and equipment, to re-arrange flasks and patterns in an orderly manner and to arrange for the regular transfer of refuse from the foundry. Most important, the effort became a regular and continuing activity in the operation of the foundry.

3.9 Melting Practices and Procedures -

Except for problems created by the character of the scrap purchased and local pig iron which did not meet needed limits on phosphorus and sulphur, melting practice is good . Finished iron and steel adhere generally to required specifications. Emphasis must be placed on the need of a vigorous boil for gas free steel. When the scrap charge does not contain sufficient carbon for a good oxygen boil, it must be added in the form of pig iron or graphite. A carbon drop of at least .25 is to be required during the lancing.

3.10. Ladle heating and ladle practice

Considerable stress has been placed upon the importance of thoroughly dried and heated ladles for quality casting in the jobbing steel foundry. Designs of a ladle heating station preferably burning propane or natural gas were submitted. Because of the frequent occurrence of leaking stoppers, a procedure for assembly was prepared and a design of a stopper drying oven developed. It is expected that action is to be taken to implement the proposals.

3.11 Austenitic Manganese Steel -

3.11.1 Because of the importance of controlling pouring temperatures in relation to section thickness it was proposed that all austenitic manganese steel be tapped in and poured with open ladles. Small castings were to be poured from a shank ladle filled from the large ladle. The open ladle also provided the opportunity of adjusting pouring rates, needed to assure clean sharply defined castings.

3.11.2 Recommendations were made on the correct method of loading and heating austenitic manganese castings to assure proper treatment and a carbide free austenitic structure.

3.11.3 The proper welding procedure for welding austenitic manganese steel was demonstrated. This must involve the use of an electrode having a composition of:

C	-	.60/.80
Manganese	-	13.0/14.0
Nickel	-	2.75/3.25 or
Molybdenum	-	.90/1.25

Rods having either nickel or molybdenum were not available in Taiwan but action was initiated to obtain a supply. The use of rods with carbon over 1.0 was discouraged except for small surface defects. The importance of vigorous peening was demonstrated.

3.12 Information was obtained from qualified suppliers on a DC Power Source for use with carbon arc-air electrodes recommended for metal removal in the steel foundry and riser cutting and scrap preparation of ductile and cast iron rolls. Authority to purchase a 750 amp unit was obtained.

4.0 Foundry Organization - Taiwan Machinery Manufacturing Co.
(Reference: A.Organization and Procedures - March 28, 1972
Included as Schedule E of 2nd Interim Report
B.Letter Report to Mr. W.L. Lee, President TMMC
dated May 17, 1972 Included as Exhibit B.

4.1 As outlined in a report entitled Organization and Procedures dated 28 March 1972 and included as Exhibit E of the second Interim Report dated 31 March 1972, urgent and positive action must be taken to provide an effective and vital operating organization.

4.2 This was again emphasized in a final letter report dated 17 May 1972 and attached as Exhibit B directed to the President of the Company, Mr. Wei Liang Lee. It is a problem of considerable proportions since it involves overcoming the traditional pattern of elationshi-s between the manager and the managed. Since the management of the foundry operation is aware of this condition, a carefully defined programme becomes a logical next step in the mechanics of change. It is believed the recommendations contained in the two reference reports are practical and should be implemented.

5.0 Modernization of Foundry Facilities

References:

A. Feasibility Study and Cost Analysis
Mechanized Iron Foundry - 5 January 1972
Exhibit H of Second Interim Report, 31 March 1972

B. Modernization of Steel Foundry Proposition 1
dated 30 April 1972 Included as Exhibit C.

C. Relocation of steel foundry Proposition II
dated 29 May 1972 Included as Exhibit D.

5.1 The most important element in the decisions to be made on the modernization or relocation of the foundries is the extent of the market for castings available and attainable in each of the first few years after completion of the facilities. A new steel foundry designed for the range of castings now produced (1 kg to 7 tons) will have a normal capacity on one shift of from 600 to 900 tons per month, depending upon the t pe of molding equipment installed. It seems likely that with present outputs averaging only a little over 100 tons per month, it will take some years to develop markets and customers to permit a break-even operation in a new foundry at 450 tons per month. Thus substantial losses can be predicted until the combination of improved quality, productivity and competitive selling prices will produce sufficient volume of orders to assure profitable operations.

5.2 An increased casting demand is to develop in Taiwan from the erection of the new steel mill, from new highway construction, modernization of the railroad, new ship building operations and the general growth of the economy. But, the major source of added volume must result from a greater share of the 1,600,000 tons of steel castings produced annually by the South East Asian market area countries.

5.3 The ultimate market penetration attainable cannot be predicted until it can be tested with a quality product at competitive prices. Substantial investment in new facilities becomes a very hazardous undertaking in the light of fixed charges for interest and loan amortization that become due and payable at once.

5.4 It seems logical and prudent then to analyze first the feasibility of modernizing the existing plant in steps. First priority would be the development of quality capability. This will require effective molding equipment, sand preparation and control facilities, core making and drying and heat treating furnaces. In addition continuation of operations at the present site make air pollution control equipment mandatory. Consideration must be given to productivity to the extent that quantity orders can be produced in reasonable time. Because of the low labour unit costs, labour saving equipment by itself will have low priority.

5.5. It is expected that a plant having a capacity of from 350 to 450 tons per month will result from the limited mechanization planned. Since over 50% of the labour force in a steel foundry is indirect and will not increase proportionate to output it is essential to provide a balanced productivity capacity in all departments. Naturally, if facilities are operated effectively at 60-70% of capacity substantial cost reduction over present operations can be expected.

5.6 As detailed in Reference A a study was made to develop the facilities needed to produce a maximum of 4,000 engine sets of iron castings per year divided equally between 4 cyclinder and 6 cylinder engines. Adding the small volume of castings currently being produced, the foundry could foresee orders for only 175 tons per month. Since initially the requirements for cylinder block, heads were to be only 1200 per year, the assured work load would amount to less than 100 tons per month. The molding equipment required for the size and type of castings to be produced would yield a capacity of 450 tons per month. This programme was not recommended since the assured work load amounted to less than 25% of the capacity. Another very important consideration particularly in view of the shortage of capital funds was the dire need for investment in modern facilities for the existing iron and steel foundries. It seemed illogical to consider building a new foundry which would provide so little advantage for the existing work load. Decisions were made by the management to withdraw from the programme.

5.7 Studies were undertaken of the feasibility of modernizing the steel foundry in its present location and the alternative of erecting and equipping a foundry at a new location. Although, in view of the limited assured market for steel castings, it appeared logical to consider only Proposition 1, Modernization of the Existing Plant, political considerations made it necessary also to evaluate the economic feasibility of a completely new foundry.

5.8 Relocation of the steel foundry is to require over double the investment as the modernization of the existing steel foundry. Operating costs will not be substantially lower than obtainable in Proposition 1 since the same facilities are proposed. Only when the volume increases to over 750 tons per month will the operating cost attainable be lower, because of the distribution of fixed and other overhead costs over greater volume.

5.9 Without the assurance of increased tonnage to provide sufficient earnings to cover the cost of the invested capital, it would be very unwise to undertake the greater risk of a new foundry. A break-even level of 240 tons per months is a more realistic and easily attainable goal than over 450 tons per month required for Proposition II.

5.10 Based upon the above, it has been recommended that the following programme be developed:

5.10.1 Prepare detailed plans for the modernization in steps of the existing steel foundry with high priority being given to the equipment and processes essential for the production of castings meeting an international standard of quality. It is essential that such plans have growth capability as the demand for castings increases.

5.10.2 Develop plans for the modernization of the iron foundry. It is essential that this step be taken before the steel foundry modernization is started. It is possible that some facilities can be integrated with resulting economies in installation and later operating cost. This phase of the programme must include all needed environmental control facilities.

5.10.3 When the economic climate is suitable and particularly when the demand for good quality, competitively priced castings begins to exceed present capacity, plans can be undertaken for a combined steel-iron-non ferrous foundry complex at a new location.

5.10.4 Once detailed planning for the above has been completed it will also be feasible to accomplish the construction and relocation in steps. Consideration should be given to the erection of the new steel foundry and installation of equipment needed for effective operation. After production has been started, facilities used in the modernization of the steel foundry, Proposition I, can be relocated for expansion of the steel capacity or in the new iron foundry where compatible. It is essential that total long range planning be completed in detail before even the first step be taken.

5.11 It should be emphasized that failure to undertake the modernization of both iron and steel foundries will commit the operations to second rate performance. Non competitive quality and pricing will assure the early decline of the foundry department.

6.0 Taiwan Machinery Manufacturing Company

6.1 As the industrial economy in Taiwan grows, the need for a capability and capacity to produce heavy and complex capital equipment locally will increase. TMMC presently is equipped for much of this type of work. A competent engineering department can provide needed designs alone or in joint ventures with foreign companies.

6.2 Iron and steel foundry and forging facilities permit production of the basic elements of most types of machinery. Heavy and light machine shops can perform most of the finishing operations required. Facilities are available for fabrication of light and heavy plate and structural shapes into high quality assemblies in which rolled, forged or cast parts can be integrated.

6.3 It is essential that the present capability be improved and modernized and made an effective and vital key in the growth of the industrial economy. The alternate of permitting the continuing deterioration and obsolescence of equipment facilities and people just cannot be tolerated.

6.4 It should be emphasized that the improvement in plant and equipment has a corrallary advantage in its influence in changing the outlook of the manufacturing staff. Changes in the organization are essential as discussed in Section 4. Enthusiasm and personal involvement can be expanded by removing the daily frustrations of working in a congested, disorderly environment with worn out equipment and obsolete methods. Employee and supervisory staff's attitude will receive tremendous phsychological encouragement through the investment in new plant and facilities.

6.5 The tendency to expand into too many unrelated fields of industry must be controlled. Basically, TMFC is a heavy industrial equipment manufacturer. It should concentrate generally on that class of work. Admittedly, high production consumer type products have an appeal, but neither are the facilities nor the staff equipped to operate in this area of industry.

6.6. Improving production facilities, developing an imaginative and experienced engineering and manufacturing staff and above all adhering to uncompromising high standards of quality performance will assure its continued and expanded participation in local and area markets.

7.0 <u>Metal Industries Development Centre</u>

Foundry Evaluation Study

References: A. List of Foundries visited Exhibit E
B. Summary report of evaluation Exhibit F

7.1 Because of the curtailment of UNDP programmes in Taiwan only a little over two months were left to devote to the foundry industry throughout the country. It was decided that an evaluation was to be made of the steel foundry industry to measure its capability and effectiveness to serve the expanding industrial economy. This study was undertaken with the able assistance of Mr. M.L. Tsai of the Metal Industries Research Institute.

7.2 The foundries selected and evaluated are listed in Exhibit E. A brief summary outlining subjects covered with each foundry is also included in this Exhibit.

7.3 The Foundry Evaluation Report dated 24 May 1972 with recommendations for a programme of improvement is attached as Exhibit F.

7.4 During the visits of from one to two days duration to each foundry technical problems were presented and discussed. A brief report to each foundry was prepared confirming and elaborating on the questions raised. It is felt this phase of the programme in itself could justify the time devoted to the visits.

7.5 It is evident that a substantial infusion of capital must be made to equip the steel foundry industry with modern tools. While the degree of need varied, the same problems required solutions in each foundry. These are listed as follows in order of importance:

7.5.1 Modern mechanized molding equipment is required for all sizes of castings. This is primarily essential to improve mold quality and uniformity and consequently casting quality.

7.5.2 Sand reclaiming, preparation and delivery is an essential part of the effectiveness of a molding system. Molding sands may vary widely in properties thus affecting the surface quality and integrity of the castings. Control must be maintained automatically and not allowed to depend upon operator manual control.

7.5.3 While pattern equipment is not truly an item of modernization, foundries must be prepared to construct solid, mounted patterns with core boxes suitable for mechanized production. This will represent a sizeable added cost since very little of the existing pattern equipment will meet the quality levels required.

7.5.4 Core making must be transferred from moulding departments and proper production and drying equipment installed.

7.5.5 The almost exclusive dependence upon sodium silicate - CO_2 bonded molding and core sands must be eliminated and replaced by clay bonded green or skin dried systems. Acceptable surfaces are not obtainable with present materials. The fusion of sand at the metal interface under heat to a hard ceramic combination of silica sand, sodium silicate, CO_2 and iron oxide makes the cleaning of steel casting surfaces a long and costly operation and the cleaning of cored holes nearly impossible.

7.5.6 A concerted and co-operative effort must be made by the foundries through the Chinese Foundrymen's Association and the Metal Industries Development Centre to catalogue, classify and ultimately develop specifications for the base molding sands in use through the island. Performance, not initial cost, must be established as the only criterion for purchase. The alternate is now true.

7.5.7 Properly designed heat treating furnaces with effective automatic temperature controls are essential. Operation of cars and doors must be mechanized to permit rapid handling of castings into the quench medium. Uniformity of temperature within the furnace chamber must be assured.

7.5.8 While not as critical in the effect on casting quality as the items above, it is considered that shot blast facilities, heavy duty gas cutting torches, DC powered "Arc-Air" equipment for trimming and shaping of risers and riser pads, and heavy duty grinding equipment with wheels of proper specification will make the attainments of good surface appearance easier. Psychologically, this will encourage the employee to better workmanship. Such equipment is also essential to assure a "flow" of castings through the cleaning of operation.

7.5.9 Since most metal quality is acceptable, the major recommendations are in ladle heating and ladle refractories. When furnace capacity becomes insufficient, low powered transformers which average only 300 KVA or less per ton of charge can be replaced with high powered transformation. At least 600 KVA per ton of charge will reduce melting time substantially. A corrallary benefit will be in lower refractory losses and in steel making effectiveness.

7.6 Since most of the existing steel foundries have evolved in one corner of the ingot shop, the layouts are not efficient. Congestion is normal, material flow is random, safe working conditions do not exist. Foundries have grown without benefit of any semblance of overall planning and the result is chaotic.

7.7 The first and most important element in developing effective and efficient growth is for each foundry to develop a master plan for its modernization and growth. The elements of such a study are contained in the Exhibits attached to Reference F of this section. It will be through such systematic and factual studies that sound decisions can be made. Over-investment in new facilities can be just as critical to the future health of the company as under-investment. The economic justification for modernization and expansion can be developed through feasibility studies as proposed. Conversely, the facts can also point to a lack of justification which is of equal importance.

8.0 Metals Industries Development Centre

While the steel foundry evaluation survey including the technical reports to each foundry required most of the time available during the short assignment, there were other requests for opinions and assistance:

8.1 Pilot Steel Plant - Metal Industries Research Institute

Plans for the new pilot steel plant to include one ton arc furnace, forging hammer and heat treating equipment were received. Recommendations for revision of the original plan and specifications for equipment were presented and incorporated in the architect's plan. Rough notes including these recommendations are included as Exhibit C.

8.2 Seminar - Quality Control on Steel Making and Rolling - Metal Industries Development Centre

A paper on "The Importance of Production Equipment and Materials in Quality Control" attached as Exhibit H was prepared by the expert and presented by his counterpart at the five day seminar organized by MIDC. The seminar was attended by twenty-two representatives from twelve steel Companies and the Metal Industries Research Institute.

8.3 Molding Sand Investigation

8.3.1 The absence of standards which can be used by foundries in purchasing new sand for molding and core making has been a serious handicap to casting quality improvement.

8.3.2 The wide variation among the sands being used in grain distribution and character of grain, in the purity of sand and in the amount of natural clay and silt present made it essential that a comprehensive study be undertaken to evaluate existing materials and prepare standards for use in procurement. The proposed investigation to follow the rough outline included in Exhibit I is to catalogue all sands in Taiwan identified as foundry sands. Physical characteristics are to be measured and the sands are to be tested using a standard mix and evaluated. This programme has only just been started. Sieve analyses have been run and magnified photos to show grain characteristics have been prepared. As yet samples of all sands have not been collected. The programme is important and should be given priority attention.

8.4 Air and Water Pollution Control

8.4.1 City and National Governments are well aware of the urgent need to install control equipment on all polluting sources. Industry, except in a few instance, has not yet accepted its responsibility to the community in this respect.

8.4.2 This attitude was evident among the members of industry in the Kaohsiung city area attending a conference sponsored by the Public Health Department of the city on 2 May 1972. There is a lack of knowledge of the degree of pollution and the means to correct the condition.

8.4.3 It has been proposed that MIDC develop the technical capacity to serve all industry in identifying sources of pollution in sampling and measuring the type and amount of emmissions and to prepare recommendations on the means to control the pollutants at source. It is recognised that technical knowledge will be required and it is proposed that arrangement can be made with experienced consulting firms in Europe or the USA for such technical assistance.

8.4.4 Suggestions were submitted via MIDC to the Chief, 4th Section, Institute of Environmental Sanitation on a programme which might be more realistic than the punitive approach recommended by some of the "Clean Air Adherants" attending the meeting. It was suggested that industry be required first to:

(i) Submit an emmission inventory with details on the amount and character of the pollutant by a certain date;

(ii) In a reasonable length of time (4-6 months) each company would be required to furnish an engineering report showing how each violating condition was to be corrected with a time table for accomplishment;

(iii) Each company programme must receive the Government agency's approval of design and time schedule for implementation.

8.5 South East Asia Iron and Steel Institute - Proposed Seminar on Foundry Practice, September 1972

8.5.1 At the request of the Secretary of the National Committee (ROC) a suggested outline of a programme was prepared. It was proposed that a format used by the Steel Founders Society of America in running the annual Technical and Operating Conference might enable the seminar to attract more interest in preparing and presenting papers. By assigning only one aspect of a subject to an individual the time needed to prepared a paper would be reduced. All of the separate papers would then combine to present the subject in full.

8.5.2 The subjects for the programme which is designed to relate closely to the needs of industry in these countries are listed briefly below:

Pattern Making and Materials

Ladle Practice - Steel

Austenitic Manganese Steel - Melting - Pouring, Heat Treating - Welding

Evaluation of Molding and Core Making Materials

Gating and Risering Practice

Steel
Iron
Non-Ferrous

Planning for Modernization and its Economics
Melting Methods and Practice - Iron
Good Housekeeping - Principles and Means
Air and Water Pollution Control for the foundry
Foundry Costing - for control - for profit
Foundry Organization

8.5.3 It will be expected that concurrent sessions can be organized since interests of those attending will vary.

8.5.4 It is also considered essential to arrange round table discussions at the end of each day to encourage exchange of ideas.

9.0 Marketing: Practice - Promotion - Pricing

9.1 As stated earlier in this report the modernization and expansion of one or more foundries can be justified on a sound financial basis, only if the market for castings can be expanded at the same time. When the foundry is equipped to produce castings at acceptable quality levels it must then seek out markets and promote the sale of its products. A substantial volume of castings is produced and used in the South East Asia market. Penetration of this market will occur only through an aggressive promotional effort.

9.2 The foundry, except for speciality items such as centrifugally cast pipe, pipe fittings, valves or hardware does not actually have a product to sell. For this reason "the Trading Company" may not be the most effective medium through which to develop an expanded market. This effort must be planned thoroughly. Engineers with knowledge of the foundry capability, and a thorough education on the types of markets to be explored should be assigned to this project.

9.3 An important element in developing new markets will be an accurate pricing system which will reflect the work content needed to produce each type and size of casting Pricing by weight only can be disastrous. The cost system must permit the assignment of direct man hours for moulding, core making and cleaning. Then a proper costing rate must be developed for each significant department.

9.4 In addition to quality andprice the foundry must be able to supply the customer with accurate estimates of shipping schedule and expedite the orders to meet the dates promised.

10.0 Conclusions and Recommendations

Taiwan Machinery Manufacturing Company

10.1 Modernization

The effective modernization of the steel foundry is feasible and economically sound provided an expansion in volume of orders from 100 tons per month to 300 tons is attainable with good quality competitively priced castings. At an estimated average sales price of 16.45 per kg, the net profit after tax would be 11.75% at 319 tons and 18.3% of net sales at 450 tons per month. The above figures include amortization and interest on the capital invested. Break even to permit payment of interest and amortization of the loan would result at 240 tons per month.

10.2 Erection of a new steel foundry and relocation of all facilities is not a sound venture at this time. The additional volumes needed for a break even is over four times present level. In an untested market this is too hazardous.

10.3 Substantial improvement in quality together with a reduction in costs is essential for increased market opportunity.

10.4 To attain the optimum results from a modernized foundry it is essential that the effectiveness of the operating staff be improved. The talent and knowledge of the foundry staff engineers must be applied actively and aggressively to the task of constantly improving quality and performance.

10.5 It is recommended that steps be taken at once to develop a detailed effective plan for the modernization of the two foundries in their present location. Approval must be obtained from the City of Kaohsiung to erect the added buildings needed. The programme then should be submitted to the authorities for the funds needed for Step I.

10.6 It is also recommended that the steps outlined in two reports be taken at once to improve the foundry staff effectiveness.

Metal Industries Development Centre

Foundry Industry - Taiwan

10.7 The efficient and logical modernization and expansion of the foundry industry in Taiwan must be carefully and thoroughly planned. Over expansion or the installation of equipment too sophisticated for the market to be serviced will be as crucial as too little or none at all. The substantial force of hard working skilled employees cannot be displaced. Equipment must first provide a consistant level of quality and secondarily improved productivity and later utilization. It is expected that an expansion of the sale of castings must keep pace with the availability of labour freed by more productive equipment.

10.8 Both private and government enterprise foundries must have the benefit of comprehensive studies leading to sound plans for modernization. Modernization will prove an immediate competitive edge for the first one to complete new facilities and the Government authority involved in such a programme should take cognizance of this and act to provide uniform assistance in developing the initial costly planning.

10.9 It is recommended that the Government support a continuation of consulting service to this important industry.

10.10 To assist all industry in developing acceptable solutions to problems of air and water pollution, it is recommended that technical assistance in measurement, evaluation and design to be provided by a government agency through an organization such as Metal Industries Development Centre or Research Institute.

10.11 Consideration to permit the import of needed pollution control facilities at a lower duty rate might be a feasible way to initiate earlier action to correct this serious menace to the health of the people.

10.12 The post assignment to the Republic of China has provided a seldom available chance to use some thirty eight years of technical and operating experience in assisting the foundry industry in this country to improve their performance. It is indeed unfortunate that the activity was terminated before finite evidence of the nine months of concentrated effort. Because of the serious deficiences in equipment, improvement in methods and quality were necessarily restricted. An awareness of the need for continued technical assistance is universal and action is underway by the Government (ROC) to assure a continuation of the good work started and sponsored by the United Nations Industrial Development Organization.

10.13 Everyone cannot be cited for the immeasurable assistance provided to the expert during the assignment in Taiwan because it would be unfortunate if someone were overlooked. Thanks must go to all with whom

the expert had contact. This applies to his friends at TMMC, at the Metal Industries Development Centre and to all of the foundries visited. A special word of appreciation should go to Mr. Wei Liang Lee, President of TMMC for his vision in seeing the need for assistance and making the assignment so enjoyable and to Mr. S.C. Chi, Director General of MIRI for his guidance and sound judgement in the work there.

EXHIBIT A

METAL INDUSTRIES DEVELOPMENT CENTRE

P.O.BOX: 00232 KAOHSIUNG
3350 TAIPEI

CABLE: MIDC KAOHSIUNG
MIDC TAIPEI

TEL:KAOHSIUNG:221128 ...
TAIPEI:713181 ...

001 KAO-NAN HIGHWAY, KAOHSIUNG, TAIWAN, THE REPUBLIC OF CHINA

YOUR REF:

OUR REF:

May 26, 1972

Mr. C. C. Chang, Foundry Manager
Taiwan Machinery Mfg. Co.
P. O. Box 0030
Kaohsiung

Dear Mr. Chang,

Subject: American Colloid Co. Sand Testing

COPY

I apologize for taking so long to analyze the research reports and letters evaluating the samples of sand we forwarded to their Lab. in December. I have analysed the information they furnished and have attempted to give you a logical report in some detail. Copies of their letters and reports are attached. Also I have had a copy of Mr. Clyde Sanders booklet on Steel and High Alloy Foundry Practice reproduced for use by you and your staff.

1. A base sand for steel should have an AFS Grain fineness of about 55 and should have no more than 35% on one screen and 75 to 80% on three adjacent screens.

2. Green strength is too low for good moldability in both iron and steel foundry. Mold hardness attained with 3 rams was well below desired levels.

3. The use of coarse Perng Fwu sand in heavy iron facing does nothing but coarsen the surface and detract from the quality of the backing sand. I think it should be eliminated.

4. The use of imported US Bentonite as a bond for steel facing sand should be thoroughly explored. Taiwan bentonite should be satisfactory for use in all backing

TAL INDUSTRIES DEVELOPMENT CENTRE

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TEL:KAOHSIUNG:221128.221129.2211..
TAIPEI:713181.713182.71318.

REF:

OUR REF:

sands. Economies may be possible without loss of surface quality in blending US and Taiwan bentonite.

5. A contiuning and agressive program leading to better molding and core sands should pay real dividends in improved surfaces, reduced cleaning time and fewer defects to be welded.

Sincerely yours,

Herbert E. Cragin, Jr.
Expert - Foundry
U. N. I. D. O.

cc: Mr. W. L. Lee
Mr. P. C. Chen
Mr. T. S. Lan
Mr. M. L. Tsai

Encl.

HEC/sc

Summary Report
From
American Colloid Co. - Skokie
For
Analysis of Samples from
Taiwan Machinery Mfg. Co., Kaohsiung, Taiwan

References: (Copies enclosed)

A. TMMC letter (H. E. Cragin, Jr.)	30 Dec. 1971
B. American Colloid letter with	15 Feb. 1972
C. Research Reports	18 Feb. 1972
D. Research Reports	2 March, 1972
E. Research Reports	23 March, 1972
F. Method for Determining Active Clay	7 May, 1972

1. Two of the samples (S-2 and S-3) of washed sand were apparently mixed up in shipment or possibly by American Colloid when making their investigation.

1.1 The screen analysis reported by American Colloid for sample S-2 (Fwu Long fine) corresponds to a seive analysis run by TMMC for Pergn Fwu fine sand on December 14, 1971.

1.2 The seive analysis by American Colloid for sample S-3 (Perng Fwu, fine) is very similar to the analysis for Fwu Long fine sand run by TMMC.

1.3 We suspect these two have been exchanged. We are changing the designations to correspond with the correct identification

1.4 In the opinion of American Colloid Nan Shyh Joau sand is somewhat coarse for most of the iron castings. The very high concentration on the 50 screen of 44.3% will give this sand a strong tendency to promote expansion defects. The ideal sand will have a maximum of 35% on any one screen and up to 80% on three adjacent screens.

1.5 Sample S-2 (the Pergn Fwu fine) sand according to A. C. analysis has over 50% retained on the 40 mesh. Two samples of this have been tested and reported by TMC which differ substantially as noted below:

Screen	Sample #1	Sample #2	American Colloid
20	.2	.1	4.8
30	2.0	3.7	15.0
40	37.4	76.7	31.8
50	38.8	16.7	26.2
70	13.0	1.3	14.1
100	5.6	.5	5.9
140	1.4	.3	1.1

The TMC sample as shown in the first column would be borderline while sample 2 would be much too coarse.

.6 Washed sand having a nominal AFS grain fineness number of 50 to 55 and a distribution with no more than 35% on the middle screen, 22 to 25% on the two adjacent screens is considered ideal for most of the work now produced in both iron and steel foundries.

.7 Fwu Long Fine identified as S-3 in the A. C. report is perhaps too fine for steel molding. It would be quite acceptable for small cores where good finish is required. But again with 85% on two screens expansion problems will exist.

.8 The use of Pergn Fwu Coarse accomplished little but to coarsen the surface and make the sands hard to work with.

2. Bentonite and Clay

2.1 The test report indicates that C-2 which was Taiwan blue bentonite will provide satisfactory green strength at 5% bentonite and 2.5 to 30% moisture. Hot strength properties are lower than desired and will be conducive to cutting, wash and other erosion defects.

2.2 Mr. Sanders comments in his letter of 15 Feb. 1972 that testing by American Colloid of both Taiwan and Japanese bentonite has shown them to be more similar to the calcium southern bentonite than the sodium bentonite obtained in western USA only. Durability of both are low compared to the western material and it would be expected cleaning costs would be high.

2.3 American Colloid in their report, project No. 4196, evaluates the "bentonites" in relation to their market potential, Our interest of course, was whether good steel castings could be produced in a green sand molding system. Of the four clay samples only C-2 Taiwan Bentonite, was recommended for use in molding sands. C-3 and C-4, fire clay and Taiwan clay, have low water holding capacity and a very low ion exchange sum which according to the literature has a profound effect on the performance of clays; how we cannot say. Sample C-2, bentonite has total of 75 while C-3 & 4 only 10 and 12.

2.4 It is recommended that changes be made in the mixes in use in both iron and steel foundries for green and dry sand molding. An increase in green strength is necessary to provide a more workable material. A mold can be rammed harder, and will suffer less damage when pattern is removed, with proper green strength. Hot strength is adequate on both iron facing P-1 and dry sand steel facing P-4, but very low on P-2 the iron green sand.

2.5 This program will involve experimental send mixes and testing. It is not advisable to make any major changes in a sand system without a test program because of the long term effect of change.

The following is suggested:

2.5.1 Obtain from sand suppliers or blend from available sands a silica sand which will have as close to desired properties as possible. As indicated in paragraph 1.6 it is proposed that the following specifications be used as a basis.

AFS Grain fineness	50 to 55
Clay content	1.00% max.

Screen analysis which approximates the following:

20, 30	2%	
40	16%	(14 - 17%)
50	32%	(30 - 35 max.)
70	27%	(26 - 29%)
100	15%	(14 - 17%)
140	6%	(4 - 7%)
200, 270, Pan	2.0%	

2.5.2 If a sand similar to the above is obtainable, it is suggested that the basic mixes P-1, P-2 and P-4 iron facing, iron green sand and steel dry sand be used as a basis. Adjustments by increasing bentonite and decreasing clay should be tried and tested for the desired properties. Green compression should be near 10 psi and hot dry strength over 500 psi. Since equipment is not available to obtain high temperature strength, a practical test mold may be used and the surfaces evaluated compared to existing mixes.

.6 The cost of importing US bentonite makes consideration of its use remote. On the other hand the cost of cleaning castings, and repair of surface defects is substantial with present molding methods. A reasonable solution might the use of western imported bentonite in preparing facing sand which is to be used in a thin layer against the pattern. Backing sand for the balance of the mold is to be return sand rebonded with Taiwan Bentonite. The durability of US bentonite would contune also to contribute to the properties of the backing sand. One other advantage in the use of Taiwan bentonite in backing sand is the better collapsibility it promotes over US bentonite.

2.7 After experimental work to make sure of performance, it may be possible to substitute some Taiwan Bentonite for imported in the facing. But careful and continuing evaluation and control will be essential to protect against future deterioration of casting surfaces.

3. Methylene Blue Test for Active Clay

3.1 It is advisable in any sand system which depends ypon the retention of clay, to make the needed additions of bentonite according to the above test for active clay. The values can be calibrated against the green strength desired in the backing sand.

3.2 If some return sand is to be used with new sand for facing it is essential to use the above test to measure the total bentonite needed to bond the mixture.

3.3 A copy of the test procedure used by one U.S. foundry is attached. Also a brief outline from American Colloid on the Clay test is enclosed.

4. Molding Sands

4.1 American Colloid also commented on the four molding sands forwarded as P-1, 2, 3, & 4. Although some of the comments are discussed above it will be advisable to summarize these comments as follows:

4.1.1 P-1 Iron Facing

This is obviously the sand identified as No.1 for heavy iron castings. With 50% retained on the 40 screen or above, this sand will not permit a good finish. Permeability is higher than is required and the sand is hard to work, ram and finish. Only very heavy coatings of graphite will provide good finish. Green compression is low for best molding conditions. Dry strength is quite adequate. Elimination of the Pergn Fwu coarse sand addition should be explored.

4.1.2 P-2 Green Sand, Iron

The Fwu Long sand appears in the seive analysis run by American Colloid Co. to be finer than the raw sand - GFN 73 to 65. However, this difference may result from variation in the product supplied by the sand distributor. Green strength is barely adequate. The combination of Taiwa Taiwan bentonite, Taiwan clay, and pitch do not yield acceptable hot strength levels. Adjustment to the sand mix must be studied.

4.1.3 P-3 Backing Sand

So many different base sands are used in the iron foundry producing a return sand of very broad distribution. This will have a large surface area soaking up temper water too easily. Bond usage will be high and mold wall movement prevalent. 15% of clay and pan will tend to tighten up the mix and reduce permeability. 100 is low for the mix. also moisture content at 6.9 is too high.

4.1.4 P-4 Steel Dry Sand Facing

Green compression strength as mentioned above is too low.

Increase bentonite and reduce clay while checking performance at elevated temperatures using a test mold. Clay content is very high and sand distribution quite broad. The seive analysis does not look like the tests previously run on Nan Shyh Jeau sand. Perhaps, this mix included some CO_2 reclaim which would tend to broaden the distribution.

5. Core Binders

5.1 The corn starch is much lower in density and solubility than the normally used gelatinized corn flour. There is no direct evaluation of its properties as a foundry sand additive.

5.2 Both Lin-oil and Tang -oil are considered to be applicable as core binders. American Colloid oil at 1% had about 1½ times the dry tensile strength of either of the materials used here. It should be noted that only 1% by weight of any of the oil binders gave good properties. In excess of this only increases drying problems and gassing in the mold.

6. It is suggested on the basis of these reports that a sand evaluation program be developed and initiated. It must include the following:

6.1 A base sand having proper distribution and freedom from clay if used as a core sand.

6.2 Improvement in green compression strength for all green and dry sands.

6.3 Increase hot strength for iron green sand.

6.4 Improved and more selective screening in sand system to reduce broad distribution. More effective dust exhaust to remove excess fines must be considered.

6.5 In connection with the steel casting training program in green sand molding, mixes must be adjusted to obtain normal steel molding sand properties. No progress toward improved quality can be made unless this is done.

EXHIBIT B

May 17, 1972

Mr. Wei Liang Lee, President
Taiwan Machinery Manufacturing Corp.
P.O. Box No. 30
Kaohsiung, Taiwan, R.O.C.

Dear Mr. Lee,

It is my belief that the successful growth and profitable per-
formance of the foundries at T.M.M.C. will depend as much upon
changes in organization and good management as upon the install-
ation of modern facilities and methods. Certainly, without sub-
stantial investment in new equipment, there can be no growth
or essential improvement in quality. However, it is my opinion
that considerable improvement in quality and cost is feasible,
provided only that the foundry staff does properly the job it
knows how to do and agressively seeks better methods and quality.

Decisions as to the optimum plan for foundry modernization can
only be made after a detailed study of the complex situation.
Based upon the limited analysis made in preparing feasibility
studies of a Mechanized Iron Foundry and Proposition I for
Steel Foundry Modernization, it would not appear to be a fin-
ancially sound investment to relocate either steel or iron
foundry until sufficient volume is assured to maintain the
foundries at 60 per cent of capacity. The engineering study
which should be made now, before any action is taken, should
include the following elements in probable order of priority:

1. Modernization of the steel foundry in the present location.
This seems to be the most logical and basically essential need.

2. Limited modernization of the iron foundry and non-ferrous
foundry.

3. Installation of air pollution control equipment to meet the
standards of the City of Kaohsiung for the present location.

4. When the economic climate is suitable and the steel cast-
ing volume is sufficient to justify the move, construct a new
steel casting plant in the proposed new location and transfer
operations.

5. After the new steel foundry is operating at expected capa-
city and quality level, erect the proposed new iron foundry.
This should be planned to utilize much of the new equipment
installed for the steel foundry modernization in Step 1. It

Mr. W. L. Lee

May 17, 1972

must also provide for the integration of steel and iron casting operations wherever quality and compatibility permit.

The above is to be a comprehensive study and will provide the needed facts and cost data to permit T.M.M.C. management and directors to establish a program which can be adequately justified financially. I would be pleased to review the attached suggestions with you and supply any additional data required.

It has been my privilege to work with you and your staff under the sponsorship of the United Nations Technical Assistance Programme. Everyone at T.M.M.C. has been most cooperative and helpful to me. They have all been most tolerant and patient in bridging the language barrier. I hope I have justified your decision to call upon the U.N. for assistance.

It appears likely that my work will continue in Taiwan on another basis. I trust I will be able to continue the work we have started.

I wish you the best of luck in your growth for the future.

Very truly yours,

Herbert E. Cragin, Jr.

1. <u>Organization.</u>

1.1 The deficiencies in equipment and facilities are substantial handicaps to the consistent production of high-quality castings at competitive costs. This condition thus places a premium on the ingenuity, imagination and perserverance of the foundry operating staff.

1.2 This group has the capability and knowledge of foundry operations and methods. They have shown in many instances the imagination and capacity to develop good solutions to many of the problems which develop every day, when permitted freedom of action.

1.3 However, in order for both foundries to attain essential levels of quality and productivity, these staff engineers must become more effective in directing the operations of their departments. Their failure to apply their experience fully results, in part, from the traditional relationship here between the senior and junior supervisors in an industrial organization. It is believed a coscious effort must be made by top management to change this attitude.

1.4 As a start in developing the full capability of this important group, it is suggested that the duties, responsibilities and, most essential, the authority vested in the job be defined in detail. It would be a good idea to require the engineers as a group to participate in this exercise. Certainly, the Foundry Manager and assistants must coordinate this activity and agree on the definitions.

1.5 The delineation of the duties and responsibilities is to have the primary goal of establishing the engineering staff as line supervisors directly in charge of personnel and performance in their shops. They must be encouraged and stimulated to use their imagination and initiative in attacking the many day-to-day problems in quality, materials and methods.

1.6 Because of the many different problems requiring corrective action to find better methods, improved quality and materials, it is suggested the "team" or "task force" approach might be useful. This would provide the means to involve many of the staff in developing improvements. It would be advisable to prepare a list of projects to be set in order of priority. One project is to be assigned to a project team. The latter would be required to define the problems, set the goals and suggest the means to arriving there. Naturally, a time schedule must be established.

1.7 A staff meeting is to be scheduled regularly for the purpose of reviewing progress of each project. Changes or suggestions as to the method of approach should be encouraged from all staff members on each project.

1.8 It would be hoped that the redefinitions of the duties and responsibilities of the staff engineers will serve to keep them in the shops instead of at their desks. It would be advisable to review all paper work activity required of the foundry staff and reduce it to the minimum. This could be a project for each to prepare a list of every record he is required to maintain and all other desk work, with recommendations as to elimination or transfer to the clerical staff.

1.9 In summary, positive action is needed by top management to develop the staff engineers into an effective supervisory force, using initiative and their imagination in the everyday operations, as well as in developing solutions to the many operational problems. Top management must be prepared to provide full support in this effort because without their active support, a major improvement is not possible.

1.10 The development of a strong, agressive management team is essential for the growth and improvement in the operation. Certainly, in view of the proposal for the modernization of the foundry facilities in the near future, the foundry staff will have a tremendous job to do and it must be capable of doing it.

2. Casting Quality.

2.1 The most critical handicap to growth and improvement in performance is the lack of consistent casting quality. This is true to some degree in all three foundry operations; iron, non-ferrous and steel. Because of the more severe demands on materials and methods imposed in the manufacture of steel castings, quality deficiencies are greatest here.

2.2 The absence of even simple mechanical equipment places severe limitations on quality performance, particularly in the steel shop. This has forced a too-ready reliance on sodium-silicate as a binder and limited objective thinking about better methods and the obvious advantages to accrue from change.

2.3 The most frequently observed defect in steel, iron and non-ferrous castings has been shrinkage and other defects relating to gating and heading. This deficiency is not related to equipment, but results often from an attitude of compromise. "The proper riser could not be applied because:

"The pattern belonged to the customer; therefore, it couldn't be changed;

"The properly located riser on the aluminum fan blade couldn't be cut off;

"Four risers instead of six were used because the cope wouldn't fit on six."

2.4 Poor risering results because the moulder is not closely supervised. Too many risers in the steel foundry have contact diameters larger than the riser diameter. Risers are not properly placed over heavy sections and frequently where padding is needed below riser, the padding and riser do not match properly, resulting in an unfed section and consequent shrinkage.

2.5 Gating is too often applied for convenience rather than as an integral part of the feeding system. In part, gating practice will deviate from the ideal because of the extensive dependence on floor, sweep moulding. Unfortunately, internal and surface quality of the casting suffers.

2.6 The staff has the technical knowledge and experience necessary to plan and produce sound castings; but they must be encouraged to use it and to insist upon the needed equipment and tools to permit proper pattern design and rigging.

2.7 One recommendation made in the letter report of March 28th would certainly minimize the occurrence of a serious defect in all castings on an order. Reference is made to paragraph 7.1, with particular emphasis on "Pilot or Check Castings". The establishment of a formal procedure to accomplish this is strongly urged.

2.8 All of the above points have been detailed in reports to the foundry staff and have been covered in a number of sessions on "Gating and Risering". Further, whenever specific examples of poor rigging have been discovered, they have been brought to the attention of the staff with suggestions for correction.

2.9 Obviously, present moulding methods have much to do with poor surfaces and the presence of non-metallic inclusions on cope surfaces. Although the sodium silicate bonded mould is hard and has high dry strength, the mould metal interface is porous and contains unbonded sand grains. Zirconite wash does little to improve the condition. As a result, burned on and fused sand is a regular condition requiring many hours of cleaning time.

2.10 While it may not be possible to eliminate completely the use of sodium silicate as a binder, an effort must be made by the staff to try other materials and mould making techniques. Certainly, the operating staff should be dissatisfied with the present situation. Excessive cleaning time and generally unsatisfactory surfaces are sufficient reasons to initiate a search for a "better way". At least two foundries in Taiwan are producing moulds without sodium-silicate. With even limited mechanical equipment, the conversion to clay bonding is feasible.

2.11 Another important element in producing good quality castings is the use of good pattern equipment. Patterns must be well made, with adequate draft, and solid and well enough reinforced to permit the mould to be rammed hard without damaging the pattern. Sweeps, skeleton patterns and core boxes do not permit the production of a high quality mould.

2.12 In the iron foundry, the sand lacks green strength and compactibility. As a result, cutting and scabbing is prevalent. To counteract the open grain of a poorly rammed mould, graphite wash is applied much too heavily. It is doubtful if the mould is completely dried, and so moisture migrates back toward the surface. Since the thick graphite wash is substantially impervious, moisture will concentrate behind the coating, producing serious blow holes when poured.

2.13 The practice of wetting down the old sand in a mould after removing the casting and then ramming up a new mould on the old base is poor practice. Work is saved and perhaps the worker benefits in his incentive pay, but the high moisture content in parts of the mould could contribute to defective or bad castings.

3. Essential Facilities Needed.

3.1 Steel Foundry.

Ladle heating;

Stopper drying;

Increased power on 4-ton furnace transformer;

Stationary sandslinger, roll-over and mould transfer moulding system. Transfer of motive slinger.

Sand preparation and delivery with adequate dust collection.

Shot blasting.

Arc-air power sources for casting cleaning.

Heat treating furnace for quenching high manganese.

Separation of core making from moulding and installation of core making machinery, as well as core baking ovens.

Collector and hood for electric arc furnace fume control.

3.2 Iron Foundry.

Scrap handling and charging at the cupola. Dust and fume control.

Sand delivery for small casting moulding.

Squeezer and jolt squeeze strip moulding machines with mould handling conveyors.

Shakeout and sand return.

Complete dust control on sand system.

Separation of core making from moulding and the installation of core making equipment and core drying ovens.

No bake core making system for large cores, with continuous mixing and delivery.

Larger return sand storage.

Rearrangement of sand processing to permit use of pneumatic reclamation of moulding sand, instead of CO_2 sand. (Note: Conversion of steel foundry to clay bonded sands will eliminate the need for reclamation of CO_2 sands.)

Efficient high capacity grinding equipment for small to medium castings. Casting handling conveyors - separate cleaning area for small to medium weight castings.

Metal handling and pouring conveyors for small to medium castings.

3.3 Non-Ferrous Foundry.

Conversion of coke-fired crucible furnaces to gas firing or replacement with high frequency induction melting.

Installation of small moulding machines and sand system as required by volume.

Expansion of work area to include cleaning and finishing facilities.

3.4 Consideration at the present time of relocating the entire foundry operation does not appear to be reasonable. Also, overhead costs would increase if only the steel foundry were to be moved since many service facilities would have to be duplicated. Further, a substantial increase in volume, both in steel and iron would be required to justify the cost of relocation and to yield a profitable operation.

3.5 The most practical approach to the modernization of the iron and steel foundries is to develop realistic plans using existing facilities and buildings to the fullest. The steel foundry will require additional work area to permit an efficient layout for moulding, core making and sand preparation. Since mechanization is to provide increased capacity, additional work space is absolutely essential.

3.6 The cost and quality advantage resulting from the modernization is certain to provide an opportunity to expand the foundry output and permit the development of a larger export business, as well as the manufacture of castings now being imported as elements of machinery, railroad cars, trucks, etc.

3.7 A program of gradual modernization and expansion is a great deal safer and will lead to better long-range profit improvement than the sudden expansion that would have to result from the construction of a new foundry.

4. **Patterns and Pattern Storage.**

4.1 Mechanization of the moulding and core making functions is going to mean a substantial investment in new pattern equipment. It is one of the major keys to improved casting quality. Solid pattern equipment with well-rammed moulds is an essential step in quality improvement.

4.2 Patterns now are costly and will be even more so. Proper storage, protected from the weather, is needed to maintain this investment in usable condition.

5. Housekeeping.

5.1 Progress has been made during the past six months in moving obsolete material and refuse from work areas. Unfortunately, the job has never been completed. It is recognized that disposal is an expense. On the other hand, working around and over piles of sand, flasks, slag and other rubbish also adds to operating cost.

5.2 A further bonus from good housekeeping is the worker's attitude toward his own performance. If he must work in a poorly kept, disorderly shop, his work is more apt to be equally as poor. While a clean, orderly work place is no guarantee that better workmanship will result, experience has shown that work habits and quality improve.

5.3 Since a report to the Foundry Manager, dated January 31, 1972, has been prepared outlining the general program, with specific details included in memoranda to Mr. K. H. Hsu dated February 2 and 3, no further elaboration is needed.

6. Marketing and Customer Service.

6.1 It is my firm belief that a jobbing steel foundry must have an effective and knowledgeable sales organization.

6.2 This organization must be constantly searching for new opportunities, as well as maintaining proper contact with regular customers.

6.3 There must be immediate reaction to customer complaints about quality and delivery.

6.4 It is essential for continued growth that delivery promises and schedules be realistic and maintained. This means an aggressive and effective Production Control and Expediting Department which can obtain action from foundries and machine shops regularly.

7. Costing and Sales Pricing.

7.1 The sales price charged for each casting must reflect the standard work content involved in producing the casting order. Averages are not accurate and cannot assure profitable pricing. Costs according to weight will under-price complicated, light castings and over-price simple, heavy castings.

7.2 A review of the entire pricing procedure would be advisable. Significant cost centers must be selected and the work content involved in processing castings through that center measured by some reasonably accurate means. The Control Department has reviewed accounting data sheets prepared by the Steel Founders Society of America a few years ago which supply useful procedures to be followed in developing true product costs.

8. As indicated in the first paragraph, the first step in obtaining an effective operation is to develop an organization of "managers". Each man, from foreman to manager, should have his authority and responsibility defined.

8.1 Regular staff meetings are to be scheduled, at which each member should be encouraged toparticipate fully and to express opinions and make recommendations. There must be a positive and active effort made to have men at all levels contribute their own opinions and judgments.

8.2 A regular program of quality improvement must be formally established in which all the talent available is brought to bear on unsatisfactory conditions. A list of quality deficiencies should be prepared and priorities established.

EXHIBIT C

TAIWAN MACHINERY MANUFACTURING CO.

Kaohsiung, Taiwan

Modernization of Steel Foundry

Proposition I

Feasibility Report

Prepared and Submitted by

Herbert E. Cragin, Jr.

United Nations Industrial

Development Organization

April 30, 1972

I N D E X

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B. Production Capacity Molding Department

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R. Break Even Chart

1/ These drawings are annexed as part of final report; please refer to page 236

1. Summary

1.1 The modernization of the existing steel foundry by erection of a 16 x 54 meter building west of the main foundry and closing in the storage bay west of the cleaning room is feasible.

1.2 Equipment is to consist of sand preparation and delivery, stationary sand-slinger molding system, core making and drying equipment, shot blast, heat treating for cleaning in addition to improvements in material handling and metal removal capability.

1.3 The proposed program is to cost NT$80,000,000 which can be broken in to steps as :

I	13,096,000	
II	23,681,000	
III-IV	18,138,000	
V	22,594,000	
VI	2,499,000	(If required)

1.4 Output on one shift of 450 tons per month is planned to include:

Existing work	111 Tons
Railroad work	208 Tons
New miscellaneous	131 Tons

1.5 At an average sales value for the above work of NT$16.43 per kilogram an average net profit of NT$1,535,000 per month or 21.5% on sales is attainable, considering interest at 10%, a fifteen year amortization of the loan and 25% tax on corporate income.

1.6 This is considered highly attractive and the project should receive serious consideration by the management of Taiwan Machinery Mfg. Co. and the Ministry of Economic Affairs.

1.7 From the time the program receives approval by the government, it is expected the project could be completed within two years provided a competent organization can be assigned to the engineering planning and installation supervision.

1.8 The importance of this last must be strongly emphasized. Such a project cannot be directed by the operating staff. If it is attempted, both present operations and the new project will suffer.

1.9 With respect to the phased program as detailed in paragraph 1.2,1.3, it must be recognized that engineering planning of the total project must be completed before any single step be undertaken.

1.10 A plan has been prepared for a completely new foundry at a different site. Details of cost estimates and profit potential are being prepared and are to be submitted as a supplement to this report.

1.11 Since this proposal is predicated upon the inclusion of 100 car sets of railroad castings in the forecast, equipment and layout have been designed to accommodate this class of work.

If a change in product mix or character occurs it may be necessary to alter the equipment planning when the project is undertaken.

1.12 It is estimated that completion of step II to include cleaning, sand system and motive slinger will permit a reduction in gross costs at no increase in volume above 111 tons per month of NT$1,270,000, while this figure does not offset interest cost and increased taxes it will contribute and ease the cost burden until full volume can be attained.

Details are shown in Exhibit O.[1]

1/ Annexed as part of final report; please refer to page 236.

. OBJECTIVE

2.1 The preliminary phase of this study is to develop the equipment, facilities and building modifications needed to permit the production in the present foundry of one hundred sets per month of side frames, bolsters, couplers and other railroad bogie castings in addition to the present average output of 111 tons per month of castings normally produced.

2.2 For comparsion a complete new foundry layout is to be prepared for the above work load but with expansion potential as the demand increases.

2.3 Estimated operating costs are to be calculated for both propositions.

2.4 Estimated equipment and building costs are also to be prepared so a complete economic analysis of the feasibility of such a program can be made.

3. FORECAST WORK LOAD

3.1 As detailed in Exhibit A the proposed work load to include 100 sets of railroad bogie castings and 111 tons of existing work, based upon the average for June, July and August 1971, will provide a casting demand of 319 tons per month.

3.2 It must be recognized that by modernizing the steel foundry, the installation of even limited mechanical handling and production molding facilities will increase molding productivity substantially. To secure a proper flow of work thru cleaning and heat treating, it becomes necessary to provide better productive facilities here also.

3.3 The proposed work load of 319 tons per month will not utilize the new facilities to capacity. With normal productivity the foundry is capable of 450 tons per month on one shift. This is derived from calculations using mold production rate per hour and an average weight per mold as shown in Exhibit B.

3.4 Originally it was anticipated that a cope and drag mold unit for 800 x 800 flasks would be included in the planned facilities. With two jolt squeeze strip high pressure molding machines equipped with flask and mold handling conveyor, a mold output of 150 molds per day is attainable. At an average weight of 82.8kg per mold the productive output of this unit would be nearly 200 tons. This would exceed the estimated demand for this size range of castings substantially and would provide a total capacity on one shift with the other molding facilities of over 700 tons.

3.5 For this reason initially it was deemed advisable to combine the work available for unit 2 with the larger size flasks on unit 3A slinger loop. Space has been provided for a future unit 2 installation.

3.6 The new steel foundry developed as proposition II will ultimately have a capacity of nearly 1000 tons per month. This far exceeds any possible demand in the foreseeable future. However, the inclusion of suitable equipment for small castings, medium weight castings in production quantities, medium to large casting in jobbing lots and a floor molding output somewhat greater than at present establishes a molding production capacity of 1000 tons per month. For long range planning it is essential to plan for this growth in a new foundry.

3.7 It must be anticipated, however, that with modern facilities, superior quality castings at competitive prices should provide a competitive "edge" and that new work can be attracted to utilise the proposed capacity. The capability to produce must precede the development of new orders.

4. DESIGN DATA

4.1 Data included in Exhibit C has been developed from averages on the present class of work, and the molding data on the railroad castings.

4.2 It is summarized as follows:

	Casting Demand	1 shift capacity
Tons of Good Castings per month	319 T/mo	450 T/mo
Liquid metal demand	472 T/mo	727 T/mo
Sand Requirement Molding	129 T/day	160 T/day
Sand Requirement Molding	17 T/hr	21.5 T/hr
Sand Requirement Core	12 T/day	13.5 T/day

Description of Equipment and Facilities Needed for Modernizing the Existing Foundry Proposition I

5.1 The modernization of the existing steel foundry is to require mechanical molding equipment and the essential supporting sand preparation and delivery system as well as mold and flask handling facilities. Since, such equipment will increase mold making productivity, it is essential that other departments be equipped to process the same volume. This applies to core making which can be most effectively performed in a separate department and to cleaning which must be systematized and equipped. The principal equipment needed in the cleaning department is to include shot blast, arc air cutting, a straightening press and heat treating furnaces.

5.2 Melting

Arc Furnace capacity is adequate up to about 450 tons per month provided sufficient mold storage area is available to permit pouring on three shifts. It may be advisable to consider an increase in the transformer capacity to provide more frequent heats and more efficient use of floor space. Cost is not included.

5.2.1 Adequate ladle heating and stopper drying and heating, facilities are to be required.

5.2.2 Inside scrap storage is to be provided in the south end of the melting bay so charges can be made up using the overhead crane and magnet. This will reduce labor cost and assure moisture free scrap.

5.2.3 An accurate charge make up scale is essential for control of chemical analysis and efficient utilization of scrap.

5.3 MOLDING

5.3.1 Unit 1-A and B - Small Castings

One jolt squeeze molding machine for up to 400 x 400 flasks is to be used for both match board and hand rammed loose patterns. Roller conveyors for mold handling and a single monorail for pouring are required. One overhead sand supply hopper is to be located over the machine.

5.3.2 Unit 2 Small to medium size castings (15kg - 90kg). Space is to be provided and facilities planned for the future installation two jolt squeeze strip molding machines for an 800 x 800mm flask size. As indicated in paragraph 3.4, the work which would normally be produced on a pair of jolt-squeeze-strip molding machines is to be included in the slinger loop until the demand justifies the installation of molding equipment for 800 x 800 flask.

5.3.3 Unit 3-A. Stationary sand slinger - mold loop.

For maximum flexibility consistent with good efficency, a molding loop is to be planned for 800x800 to 1600 x 1600 flask sizes. The equipment required is as follows:

Stationary speed slinger or hydra slinger with two speed ramming head having a maximum capacity of up to .7 metric tons of rammed sand per minute. Control stand is to be separate from slinger and floor mounted. Mold roll over and draw machine is to be arranged for roll-in and roll-out of pattern and mold. Machine to be sized to receive a 1600 nominal width flask.

Flask and mold handing system is to consist of roller conveyors or mold cars running on a track. System is to be arranged so power can be applied as and when required by production demand.

An overhead crane is to be installed to service the core-up and close area.

5.3.4 Unit 3-B. Special molding unit for railroad side frame and bolster castings.

The 2.5 meter flasks required for these castings are too long for the mold loop (3A). Two strip-draw machines are to be installed and located so the stationary sand slinger in unit 3A can ram each mold on a draw machine. Although a single machine could be used it would require pattern changes for the cope and drag and would complicate the production of completed molds.

5.3.5 Other equipment required for unit 3B includes an overhead crane for flask and mold handling, mold core-up and closing, one-hot air jet type drying oven for skin drying washed molds.

5.3.6 Unit 4 Floor Molding

Although the number of large castings is not great, facilities for efficient production must be provided. Since, only one or two castings are required from each pattern it is probable that considerable sweep molding will still be necessary.

Future planning must consider the need to reduce labor costs. It is therefore planned to relocate to the steel foundry, the existing motive sand slinger from the iron foundry where it is of only limited potential use. It is to be located along the east wall of the main bay between columns 9 to 12.

5.4 SAND PREPARATION & DISTRIBUTION

The conversion of substantially all mold production to green or skin dried molding sand from the present sodium silicate-CO_2 hardened sand is considered essential for a modernized foundry.

While the proposed molding practice will require substantial cost in converting the pattern equipment to solid patterns from sweep or skeleton equipment, the improvement in casting surfaces, ease of shakeout, reduction in cleaning time and sand cost all appear to be strong reasons for conversion. The increase in productivity and reduction in molding cost is to partially offset the increase in pattern cost.

5.4.1 A peak demand of 38 tons of sand per hour will require the mulling capacity of a Beardsley and Piper 85-B muller at 40 MT/hr or two Simpson mullers having a capacity of 1.6 tons per charge on a 5 minute cycle. The efficiency and performance of the Speed muller dictates its consideration. The balance of the sand system has been sized for 40 tons per hour although the average usage will not exceed 25 Tons/hr.

5.4.2 The system is to included a shakeout, and spill sand grates and hoppers, conveyors and elevator to deliver return sand to storage bins. A rotary breaker screen, a fine screen and magnetic separator provide for the cleaning of return sand for reuse.

5.4.3 Cooling water and moisture controls are to be provided in addition to a muller cycle control, so that uniform sand can be produced.

5.4.4 A prepared sand elevator and belts are to deliver sand as required to the stationary slinger storage bins and to chutes for facing and floor molding. Automatic level control on all sand bins is to be included.

5.5 CORE ROOM

5.5.1 Core making facilities are to be separated from molding. Specialized equipment such as core blowers, sand preparation and core baking ovens are to provide greater efficiency in producing the high quality cores needed. Such facilities will permit the use of oil or resin bonded sands instead of sodium silicate-CO_2 core sand. Moreover, improved shakeout and reduced cleaning time will become essential as volume increases.

5.5.2 Facilities shall include batch type core ovens for rack loading of cores. Core blowers and core roll over machines are to be installed as specific needs for production develop.

5.5.3 It is also considered that conversion of large cores to a NO-BAKE type of binder will provide advantages. However; until materials become available at a reasonable cost it will not be considered in the first phase of the program.

5.6 ROUGH CLEANING

5.6.1 The conversion in the foundry to modern sand practices in molding and core making and the installation of efficient molding equipment will contribute substantially to a reduction in chipping and burning. The installation of high capacity blast cleaning facilities and the use of carbon-arc-air blast for removal of fins, riser pads and burned-on sand will provide further efficiencies in the processing of castings thru cleaning.

5.6.2 It is proposed to perform rough cleaning before heat treatment in the east bay of the foundry between columns 9 and 12. Equipment is to include a hanger type conveyor blast cabinet, gas cutting, arc air and welding equipment. This facility will have the capacity for up to 500kg castings which amounts to 80% of the total volume at 450 tons per month.

5.6.3 Large castings above 500kg are to be chipped, blasted, have gates and risers gas cut and trimmed by arc air in the main cleaning bay between columns 5 and 8. New equipment required is to include a large room blast with rotating table having capacity up to a 3 x 4 meter casting, and arc air and welding power units.

5.7 HEAT TREATMENT

5.7.1 New car type heat treating furnaces with power operated cars and door lifts are to be installed between columns 6 and 8. Cars are to be loaded in the bay now used for casting storage. With water and oil quench facilities and an air blast grate, proper heat treatment of all types of castings in weights up to 500kg and size to 2.5 x 3.5 meters can be accomplished.

5.7.2 It is considered the existing large car type and the two electric resistance furnaces in the main bay are more than adequate for all castings over 500kg.

5.8 CASTING FINISHING

5.8.1 After heat treatment all castings are to be descaled in the large room type blast cabinet. Doors have been provided at both ends so the car can be loaded and unloaded in either the main bay or heat treating bay of cleaning room.

5.8.2 All small to medium castings except railroad side frames, bolsters, coupler body and brake beams are to be finish ground in the side bay. Stand grinders and swing frame grinding equipment are to be installed in this bay between columns 4 - 6. A welding station and a straightening press are to be installed as and when required.

5.8.3 Railroad castings are to be discharged in the main bay and loaded on two roller conveyor lines served by grinding and chipping stations along the east wall of the main bay on either side of the column line. Two swing frame grinders, a straightening press and a welding station are to be supplied. At the inspection area a probe type magnaflux is to be provided for the inspection of the critical railroad castings.

5.8.4 Large castings are to be blasted after heat treatment and ground and chipped for shipment in the main bay.

5.8.5 Castings for shipment to customers or to other plants are to be delivered when finished to a shipping department located at the south end of the heat treating bay. Castings for rough machining are to be transferred by truck or car at column 4.

5.9 BUILDING MODIFICATIONS

5.9.1 The foregoing expansion and modernization is to require additional buildings. Space for expansion exists only along the west side of the foundry and cleaning department. Although this land presently has been earmarked by the city of Kaohsiung as a street right of way, it was agreed that the plan for expansion should be developed considering this space to be usable since it is the only feasible area in which the foundry can expand.

5.9.2 The new buildings are to include a new bay 16 meters wide x 81 meters long with a height to 12 meters at the chord of the truss except in the area of the sand system where the building is to be 20 meters high.

5.9.3 The area between cleaning room and machine shop is to be roofed over and suitable crane runways installed and extended about 7 meters south of column 8.

5.9.4 New laboratory and steel foundry office building is to be required and located east of the steel foundry storage area. An alternate location to be considered is in the area between the east end of the main iron foundry building and the cleaning room.

5.10 The increased demand for power and services will require an increase in the substation transformer capacity. Additional air and water service piping is to be provided.

5.11 Since good quality castings demands well lighted work area, it is proposed to install high bay mercury vapor type lighting.

Costs have included three units for each 100 M^2 of building area.

5.12 Increased use of oxygen and gas for cutting will make a central supply manifold a more efficient means of gas supply than individual bottles located throughout the shop.

5.13 Since two air raid shelters now occupy the expansion area west of the foundry the cost includes their replacement.

6. Cost of Phases in Progressive Modernization

Details are listed in Exhibit H

Phase I –	Cleaning room expansion, Heat treating, shot blast room Ladle and stopper heating.	NT$13,096,000 US$327,000
II –	New building for foundry, sand Shakeout and preparation, motive Sandslinger, core room, newsand delivery, power substation and services.	NT$23,681,000 US$593,000
III –	Stationary sandslinger, temporary mold handling, overhead sand delivery, molding unit 1, additional core making and cleaning equipment.	NT$8,156,000 US$204,000
IV –	Side frame and bolster molding with one strip draw machine, core making, spill sand system, heat treating, cleaning conveyors system.	NT$9,982,000 US$250,000
V –	Second strip draw machine, rollover and draw, mold conveyors in molding loop, hanger shot blast cabinet and rough cleaning for medium castings, core room, heat treating, arc furnace fume exhaust.	NT$22,594,000 US$565,000
VI –	No bake core system	NT$2,499,000 US$62,500
	TOTAL	NT$80,007,000 US$2,000,125

7. Manning & Labor Cost

(See Exhibit D)

7.1 The requirement for molders and core makers as well as foundry indirect labor for the proposed facilities can be predicted with reasonable confidence. It is in the cleaning room that the estimates become more hazardous. The installation of a sand preparation system replacing sodium silicate sand molding, together with the installation of efficient shot blast cleaning equipment will improve the effectiveness of workers in cleaning castings materially. It is believed that the manning is conservative in all cases.

7.2 As detailed in Exhibit D, the manning of the production departments in the foundry is summarized below. The man hour per ton figures as shown is to be attainable with the proposed equipment.

	319	450
Direct	53	65.5
Indirect	53	71.5
Supervision	10	12
Clerical	4	4
Total manning	120	153
Man hours/Ton	71.5	64.8

7.3 NOTES : All data is based on 190 hours per month. Labor costs are those in effect in 1971 plus 20%.

. Material Costs

Refer Exhibit F

8.1 Both direct and indirect costs have been developed at the proposed volume of 319 tons and 450 tons per month.

8.2 Current average material usage per ton of castings at present unit costs have been used as the basis for future projections.

8.3 Modifications to present costs have been made in instances where changes in method are proposed. (As sodium silicate sand to green sand.)

8.4 Details of material cost calculations are shown in Exhibit E and are summarized below.

	Cost at 319T	Cost at 450T
Direct Materials	NT$1,004,850	NT$1,542,530
Indirect Materials		
Melting	379,130	509,820
Molding	401,485	462,826
Core Room	253,334	290,840
Cleaning	177,100	201,600
Total Indirect Material	NT$1,211,049	NT$1,465,094

9. Overhead and Corporate Costs

9.1 Average monthly figures, for 1971 apportioned to the steel foundry have been used as the basis for projecting overhead for Proposition I.

9.2 Average operating costs for 1971 were based on the three months June, July and August as a representative period. Since fixed overhead costs do not vary with shop performance and since some figures appear in one or two months only, the use of an average based upon the entire year was chosen as more accurate.

9.3 The following adjustments to the actual figures shown in column 1, Exhibit I have been made:

9.3.1 Since the steel foundry supervisory cost has been included in operating costs, it has been deducted from overhead.

9.3.2 All salary costs have been increased by 20% to reflect future wage increases.

9.3.3 Depreciation cost based upon the new building and equipment as calculated in Exhibit J has been included.

9.3.4 Tax on equipment and buildings is 18.43% of the depreciation cost in 1971. This same rate is applied to the proposed new facility.

9.3.5 Service cost (2) including maintenance to increase 20%.

9.3.6 Materials and others (3) to increase 10%.

9.3.7 Office and Corporate Destribution has been increased by 10% to reflect greater work load because of new steel foundry, and salary increases.

10. Profit and Loss - Refer EXHIBIT L

10.1 Sales value has been developed from two sources: The average value for the months of July, August and September, 1971 including all alloy steel castings at an average of 22% of total and excluding ingots.

10.2 Railroad castings sales value has been calculated from data supplied by TMC Control Department. See Exhibit K.

10.3 Since the market is presently limited by the competitive activity of all foundries in Taiwan, it is probable that a foundry with modern facilities, producing quality castings at very competitive prices can command an added share of the market. To attain this, it has been assumed that a lower sales value may be required.

10.4 In Exhibit K and L the values are to be assumed as net sales value after commission and other sales cost which were not included in corporate cost distribution.

10.5 Operating costs have been taken from data calculated in Exhibit D, E, F and J as described in paragraphs 7, 8 and 9.

10.6 Based upon the above sales and cost data a gross profit has been calculated on the present operation at 111 tons per month and at 319 tons and 450 tons per month with proposition I, Modernization complete.

10.7 Annual gross profit for each set of conditions is:

		Gross Profit	% Sales
Present		NT$4,502	0.28
Prop. I	319 T -	2,025,634	35.9
	450 T -	2,919,783	39.8

11. Net Profit - Calculation - Cash Flow

11.1 It has been assumed for the proposes of evaluating the economic justification of this project that interest on the invested capital at 10% and amortization of the loan on a 15 years basis is to be deducted from gross profit.

11.2 Also is assumed that taxable profit is what remains after deducting interest and amortization.

11.3 Exhibit N has been prepared for the first full year with interest at the full investment cost and the first years amortization deducted.

11.4 Over the fifteen years of the life of the loan the average net profit after tax will be:

319 tons	NT$11,020,000	per year
450 tons	19,050,000	per year

This has been calculated as shown in Exhibit N on a corporate income tax of 25% on gross taxable income.

Actually during this time, labor and material costs are bound to increase but so also will unit sales value. Relative return on the investment should still be satisfactory.

11.5 If the net profit each year in addition to the annual loan amortization is applied against the principal of the loan, the entire investment would be paid off:

at 319 tons in	8	years
450 tons in	4.5	years

11.6 As shown on the Break-even chart Exhibit R, it is anticipated that profitable operations are to develop above 240 tons per month output. While this may appear to be substantial volume in comparison with past operations it is not unreasonable in view of the high fixed investment cost.

12. Conclusions and Recommendations

12.1 The modernization of the steel foundry at MMC utilising existing buildings, and a new building to be erected to the west of the main foundry building is to provide capacity for up to 450 tons per month.

12.2 The output of 208 tons of railroad bogie castings equal to 100 car sets plus 121 tons of existing work will permit profitable production at a minimum of 240 tons per month.

12.3 The present high cost of production with mainly hand labor cannot compete in the open market in either quality or price. It is essential that methods, equipment and procedures be modernized.

12.4 The foregoing report demonstrates the feasibility from an economic stand point of substantial investment in buildings and equipment.

12.5 It is recommended that detailed studies be undertaken promptly to develop the best layout meeting the production and quality requirements set forth in the forecast. It must be emphasized that the layout covered by Exhibit O[1] is a preliminary proposal to assess the feasibility of expanding the existing operation and cannot be accepted as a final engineering plan. Much work remains to be done before construction could proceed.

12.6 A plan covering a new foundry at a new site has been prepared. Building and equipment costs are being estimated and the economic feasibility of this proposition will be presented as a supplement to the foregoing report.

1/ Annexed as part of final report; please refer to page 236.

EXHIBIT A.

FORECAST - WORK LOAD

Work load proposed is to include the average production for June, July, August 1971 plus 100 car sets of railroad bogie and coupler castings per month. The distribution is based upon the following mold size ranges:

To 400 x 400 - Squeezer and Bench - Unit 1
To 800 x 800 - Cope and Drag: Jolt Squeeze Strip Molding Machines - Unit 2
To 1600 x 1600 - Stationary slinger, Rollover and draw and molding loop - Unit 3 A
900 x 2500 - Special flask for side frame with stationary slinger and special draw machine - Unit 3 B
Balance - Floor, with Motive sandslinger - Unit 4

Molding Unit	Type of Work	Av. Wt. per Mold	No. Molds per day	Total Wt. T/mo.
1A	Average of Period	5.1 kg	35	4.400 tons
1B	Average of Period	14.7	10	3.600
2	Average of Period	94.0	12	28.754 Note (1)
	R. R. Castings	63.8	14	21.20
3A	Average of Period	243	6	36.498
	R. R. Castings	140.5	12	40.0
3B	Side Frame and Bolster	248	25	147.0
4	MISC - Average	748	2	37
				318.452

Note (1) : The number of molds per day shown does not represent the production capacity but only the demand produced by the railroad program plus the average of past performance.

(2) : Productive capacities of each of the units with normal manning are : (See Exhibit B)

Unit 1 - Squeezer Machine 75 molds/day. each machine

2 - Cope and Drag - 3 molders, 150 molds/day

3 - Stationary slinger loop - 5 molders 70 - 80 molds/day

4 - Floor molding-depends upon number of molders assigned depending on size of load.

EXHIBIT D

Production Capacity Molding Department

Unit 1A = Squeezer	- Molds per day	65
	Average weight/mold	5.1 kg
	Scrap rate	5%
Bench	- Molds per day	10
	Average weight/mold	14.7 kg
	Scrap rate	
3A = Mold loop- Slinger		
	Molds/day	80
	Average weight	131.5 kg
	Scrap rate	3%
3B = Side frame and bolster		
	Molds/day	25
	Average weight/mold	248 kg
	Scrap rate	5%
4 = Floor		
	Molds/day	2
	Average weight/mold	748 kg
	Scrap rate	1%

Production Volume at 25 days per month

1A 65 x 5.1 x 25 x .95 = 7.9 T/mo

1B 10 x 14.7 x 25 x .95 = 3.5

11.4 T/mo

3A 80 x 131.5 x 25 x .97 = 254.6 T/mo

B 25 x 248 x 25 x .95 = 147

4 12 x 740 x 25 x .99 = 37

450 T/mo

PROPOSITION II

Unit 2	- Cope and drag	800 x 600 flask
	Production	20/hour
	Av. Wt. mold	82.8 kg
	Av. - scrap	2.8%

Unit 1A - 75 x 5.1 x 25 x .95 = 9.1 T

B - 30 x 14.7 x 25 x .95 = 11.6

2 - 150 x 82.8 x 25 x .972 = 303

3A - 80 x 227 x 25 x .98 = 446

3B - 25 x 248 x 25 x .95 = 147

4 - 4 x 806 x 25 x .99 = 80.3

997.0 T

EXHIBIT C - DESIGN CRITERIA

1. Melting

4 tons arc furnace with present transformer

Average time 4 hours/heat

Average weight 4 to 5 tons

Present Power usage - 670 kwh 1st heat

550 other heats

Proposed power usage based on continuous operation:

First heat 600 kwh/ton

Second heat 500 kwh/ton

Third and other 490 kwh/ton

Power Cost at 319 ? - NT$.53/kwh

450 ? - NT$.50/kwh

Pouring Percent - Gates and Risers

Unit 1A - 250%

1B - 225

3A - Miscellaneous 180 & 190%

Railroad 125 & 140

3B - Side Frame & Bolster 120

4 - Floor 170

2. Molding

Reference Exhibit A for mold production capacity

Sand - Rammed sand - 1,590 kg/M^3

- Loose sand - new dry - 1460

Return dry - 1315

Loose Mulled 950

Sand per mold

Volume x 1.590 x .8 x 1.20

Assume 80% of mold volume is molding sand

Assume 20% spill (sand slinger)

Scrap - Squeezer 5%

Medium castings 2 and 3%

Railroad (because of thin walls and critical inspection). 5%

Floor castings 1%

Sand system design from volume per mold and demand per hour

319 tons 3233/mo = 17 T/hr

450 tons 3924/mo = 21 T/hr

Sand system capacity - mulling

Beardsley and Piper speedmullor

75B 22 Mt/hr (Mt = Metric ton)

85B 49 Mt/hr

Simpson - 1.6T x 12 = 19.2 T/hr

Sand slinger capacity

Will depend upon size molds and range from 8 to 12 cubic feet per minute. This will be equalent to .36 to .54 ton/min. Production capacity is based upon 50% of slinging time for mold transfer.

Core Demand (from pattern design of railroad castings and an estimate of miscellaneous work)

	No.cores	Size	Total wt/day
Unit 1A -	5	2 kg	112 kg
B -	10	2	20
3A -	144	16	2300
	72	30	2160
	96	14.7 av	1413
3B -	388	16.8 av	6541
4 -	10	100	1000
At 450 T/mo	725		13.546 T/day
At 319 T/mo	700		12 T/day

6. Cleaning Demand

	319 T/mo			450 T/mo		
	No. pcs	Av. wt.	wt./day	No. pcs	Av. wt.	wt./day
0/5 kg	70	1.7	119.4 kg	130	2.6	388 kg
5/25	10	13.7	137	10	14.7	147
25/50	8	37	296	8	37	296
	26	46	1195	72	46	3312
	16	50	800	16	50	800
50/100	8	66	528	8	66	528
	8	100	800	8	100	800
100/200	10	150	1500	30	150	4500
200/500	16	230	3680	16	230	3680
	8	275	2200	8	275	2200
500/up	2	750	1500	2	750	1500
			12755 kg			18151 kg

7. General

Average Hours per employe - 190 hrs/mo

All labor costs at 1971 rates x 120%

EXHIBIT D - Average Costs - June, July, August 1971

1. Distribution of Existing Manning

	Workers	Supervisors
Melting	9	1
Molding (cat)	22	1
Core Making	10	
Cleaning-chip & grind	8	1
Welding	4	
Gas cut	2	
Sand Prep	2-4	1
Shakeout	4-2	
Crane	6	
Heat Treat	4	
	69	4

2. Tons production 107 T average/mo

	Total	Cost/ton
Direct labor (all)	NT$310,500	NT$2,890
Direct materials	440,415	4,105
Indirect materials		
Melting		
Power	73,168	682
Slag Mits	6,700	62.5
Refractory	38,866	362
Electrodes	25,650	239
Total	144,384	

	Total	Cost/ton
Molding & Core Making		
Sand & Binder	76,550	714.2
Fuel	30,185	281
Other	16,162	151
Total	122,917	

	Total	Cost/ton
Cleaning		
Gas and O_2	10,422	97
Welding Rod	13,446	125
Wheels	4,217	43
Total	28,085	
Total Indirect Mtts	295,386	
Supervision & Clerical	26,621	
Total	1,072,922	10,001
Overhead from Exhibit J	496,794	
	1,569,716	NT$14,650/Ton

Note: Present cost data includes all labor as "DIRECT LABOR". It is usual in foundry costing to class labor as :

DIRECT = Molders, coremakers, grinders, gascutters, etc.

INDIRECT = Shakeout, sand preparation pouring, service, crane operators, welders, heat treaters, clean up, etc.

EXHIBIT E - Manning & Labor Cost

		Labor cost 120% of 1971		Hours/mo - 190
		319 T/mo (2 shifts)		450 T/mo (3 shifts)
1. Melting				
Melter	2	NT$6,384	3	NT$9,576
Asst. Melter	2	4,560	3	6,840
Ladleman	2	5,472	3	8,208
Ladleman Helper	1	1,824	2	3,648
Crane	2	5,472	3	8,208
Scrap Service	3	5,472	4	7,296
Supervision	1	4,104	1	4,104
(1) Apportioned Overhead		3,050		3,095
Direct Labor	-	-	-	-
Indirect Labor	12	29,184	18	43,776
(2) Supervision	1	7,154	1	7,799
Total		36,338		51,575
2. Molding				
Unit 1 Squeezer and Bench				
Molder	1	3,192	1.5	4,780
Service	-	-	.5	1,140
Apportioned Indirect Labor		933		1,536
Foremen		378		1,057
Overhead & Supervision		351		495
Direct Labor		3,192		2,676
Supervision		729		1,646
Total		4,854		9,102

Unit 3A	Slinger Loop			
Molders	3	10,488	4	14,136
Helpers	2	4,560	2	4,560
Slinger	.5	1,596	.58	1,[illegible]
Service	1	2,280	1	2,280
Apportioned Indirect		13,775		26,200
Supervision Apportioned		3,190		7,534
Apportioned Overhead		2,245		3,490
Direct Labor	5.5	16,644	6.58	20,556
Indirect	1	16,055	1	28,540
Supervision		6,135		11,024
Total		38,834		60,120

Unit 3B	Slinger - Cope & Drag			
Molders	3	10,488	3	10,488
Helpers	2	4,560	2	4,560
Slinger	.5	1,596	.42	1,332
Service	1	2,280	1	2,280
Apportioned Indirect		12,760		12,617
Apportioned Supervision		2,820		4,725
Apportioned Overhead		2,614		2,1[illegible]
Direct Labor	5.5	16,644	5.42	16,380
Indirect Labor	1	15,040	1	14,897
Supervision		5,434		6,915
Total		37,118		38,192

Unit 4	Floor Molding			
Molders	3	10,488	3	10,488
Slinger-Helper	1	3,192	1	3,192
Service	1	2,280	1	2,280

Apportioned Indirect		6,390		6,337
Apportioned Supervision		1,820		3,090
Apportioned Overhead		1,689		1,425
Direct Labor	4	13,680	4	12,680
Indirect	1	8,670	1	8,637
Supervision		3,509		4,515
Total		25,895		26,032

undry Indirect Apportioned to Molding Units					
uring	2	5,472	3	8,208	
ckeout	4	7,296	7	12,768	
nd Mixer	1	2,736	2	5,472	
ucker	1	2,736	2	5,472	
er Tender	¼	570	½	1,140	
ane Operators	3	8,208	5	13,710	
Sub-total	11.25	27,018	19.5	46,770	HPS (2,[illegible])/mo
pervision	2	8,208	4	16,416	
pervision & Overhead		7,600		7,600	
		42,826		70,736	

RE MAKING				
re Blower Operators	4	10,944	5	13,680
nch Core Maker	1	3,192	3	9,576
rge Core Maker	5	15,960	5	15,960
nners Stock Core	1	2,736	1	2,736
nd & Service	1	2,280	1	2,280
nish & Paste	3	9,576	3	9,576
en Tender	.75	1,710	1.5	3,420
uck & Storage	1	2,736	1	2,736
pervision	1	4,104	1	4,104
portioned Overhead		4,410		4,335
Direct Labor	10	30,096	13	39,216
Indirect Labor	6.75	19,038	7.5	20,748
Supervision	1	8,514	1	8,215
Total		57,648		68,[illegible]

CLEANING DEPARTMENT

Gas Cutter	5	11,400	7	15,960
Arc Air	6	16,416	8	21,888
Chip and Grind	12	21,888	16	28,200
Rough Chip	2	3,648	2	3,648
Pressman	2	4,560	2	4,560
Welder	5	13,680	7	19,152
Blast Operator	2	4,560	2	4,560
Blast Labor	1	1,824	1	1,824
Heat Treat	4	9,120	4	9,120
Inspector	3	9,576	3	9,576
Service	1	1,824	1	1,824
Crane Operator	2	5,472	3	8,208
Shipper	1	2,280	1	2,280
Fork Truck	1	2,736	1	2,736
Supervision	2	7,752	2	7,752
Apportioned Overhead		11,560		11,253
Direct Labor	27	57,912	35	74,246
Indirect Labor	20	51,072	23	59,280
Supervision	2	19,321	2	19,037
Total	49	128,296	60	152,533

Overhead to be Apportioned to above Departments

Superintendent	1		1	
Engineer's	3	17,500	3	17,500
Clerical	4		4	
Total		17,500		17,500

Summary

319 Tons/Mon.

	Direct		Indirect		Super-vision		Cler-ical	Total
Melting	[illegible]		12	29,184	1	7,154		36,338
Molding	16	50,160	14.25	40,698	2	25,607		116,065
Core Making	10	30,096	6.75	19,038	1	8,514		57,648
Cleaning	27	57,912	20	51,072	2	19,312		128,296
Appor. O'head (3)					4		4	
Total	53	138,168	53	139,992	10	60,787	4	328,949
Cost/ton		433		439		159		1031/T

450 Tons/Mon.

	Direct		Indirect		Super-vision		Cler-ical	Total
Melting			18	43,766	1	7,799		51,575
Molding	17.5	55,396	23.0	54,750	4	24,100		134,246
Core Making	13	39,216	7.5	20,748	1	8,585		68,549
Cleaning	35	74,246	23	59,280	2	19,007		152,533
Appor. O'head(3)					4		4	
Total	65.5	168,858	71.5	178,554	12	59,491	4	406,903
Cost/ton		375		397		132		904

Note: (1) Where labor and overhead have been distributed only value has been shown.

(2) Distribution has been on following basis

- Pouring - Shakeout — % of liquid metal
- Sand system costs — % of sand volume
- Supervision and overhead — % of man hours

(3) Apportioned supervision and clerical-value included in total

EXHIBIT F - MATERIAL COSTS

Unit values are based in part upon the average for June, July and August 1971 adjusted or modified as noted.

1. DIRECT MATERIALS

1.1 Carbon steel is based on the average for the period.

1.2 Alloy steels represent 22% of the weight for the period.

1.3 Average cost for alloy steels is based on a "mix" as follows:

Low Manganese steel	62.96%
Chrome - Moly	14.8
H.H. - Heat Resistant	6.12
High Manganese	11.3
Nickel - Chrome	3.62
13% Chrome	1.2
	100.00

1.4 Direct material cost was obtained by deducting the labor and material costs from carbon steel increased by 10% from the total average cost.

1.5 Carbon steel US$2,640/Ton good castings
Alloy steel US$9,281/Ton good castings

2. ELECTRIC POWER

2.1 The estimated connected load in KW and a time and usage factor were estimated for each piece of equipment in a department.

2.2 No modification is planned in this phase of the project to increase the power of the transformers of the 4 ton arc furnace. Improved efficiency in the use of power is to be attained by continuous operation. Also the increased total power usage will produce a lower rate as :

319 T/mo NT$.55/kwh
450 T/mo NT$.50/kwh

2.3 Arc furnace power usage

319 T = 471.4 T liquid - First heat - 670 kwh/T
Other heats- 550 kwh/T

Assume automatic control on electrodes and the above could be reduced by 10%

To First heat - 600 kwh/T
2nd heat - 500 kwh/T
3rd heat - 490 kwh/T

2.4 319 T = 471.4 T liquid ÷ 25 = 18.85 T/day

18.85 = 4 heats/day @ 4.72T/heat

First	heat	4.72 x 600 kwh	= 2832
2nd	heat	4.72 x 500 kwh	= 2360
3rd	heat	4.72 x 2 x 490 kwh	= 4625.6

25 days x 9817.6 = 245,440 kwh

@ .55/kwh = NT$134,992/Mo

2.5 450 T/mo = 750 tons charge weight
= 722 tons liquid metal

At 6 heats/day - continuous melting

1st heat	5T x 600 x 4½	= 13000 kwh
2nd heat	5T x 500 x 4½	= 10850 kwh
3rd heat	5T x 490 x 34 x 4½	=361000 kwh
		384050

@ .50/kwh = NT$192,425

2.6 Plant Load - DEMAND

	319 T KW Demand	319 T KWH	450 T KW Demand	450 T KWH
Arc Furnace	2000	245440	2000	384850
Melting Dept.	120	21940	120	
Molding	145	18250	145	60806
Sand System	221	35670	221	
Core Room	41	5934	41	6059
Cleaning	1301	77110	1301	87200
	3820	386267 x 55	3828	538915
		NT$210,700		NT$269,500
		NT$660/T		NT$597/T

3. SAND

3.1 Unit Cost of Materials - NT$/kg

New Sand	.180
Core Sand	.270
US Bentonite	4.000
Taiwan Bentonite	2.300
Corn Flour	8.000
Water Glass	1.300
CO_2	2.790
Clay	.800
Tung Oil	20.000

3.2 Sand Mixes Used - Weight in kg

Mix.	New Sand	Return Sand	Bentonite U.S.	Bentonite Tai.	Clay	Corn Flour	Water Glass	CO_2	Tung Oil
A	150	850	20			5			
B		1000	10	5					
C	500	500	25			10			
D	1000						51	18	
E	1000		20	20	10	10			
F	(1)1000		5		10				25

3.3 Cost per Kilo of Sand Mixes

A.	Green Sand-Small	.144
B	Backing Sand-Slinger	.050
C	Facing (10% of volume)	.261
D	Water Glass	.296
E	Facing-Dry Sand	.372
F	Core Sand	.839
	(1) Sand is washed and dried	

3.4 Sand Usage by Molding Unit

	Mix.	319 T Volume T/Mo	319 T Cost/Mo	450 T Volume T/Mo	450 T Cost/Mo
Unit 1A - 1B	A	60	8,630	104	15,000
3A	A	19.05	2,730	52.6	7,520
	B	1,320.45	66,100	1,941.6	97,580
	C	117.7	30,650	151.8	39,600
3B	C	154	40,200	154	40,200
	B	1,386	69,647	1,386	69,647
4	B	132.3	6,648	132.3	6,648
	D	16.6	4,930	16.6	4,930
	E	16.6	6,200	16.6	6,200

3.5 Summary - Unit

Unit	319T	450T
1	NT$8,630	NT$15,000
3A	97,480	144,700
3B	109,647	109,647
4	17,778	17,778
	233,735	287,125

4. Other Materials have been estimated based on costs per ton at average for reference period:

	312T	450T
4.1 Melting		
Electrodes & Nipples	76,430	114,600
Consumable Aterials (Slag Making)	19,900	29,900
Refractory	104,000	125,000
Fuel (est) for Ladle Heating	31,900	47,900
Total Melting	232,230	317,400
4.2 Molding		
Unit 1		
Flasks & Repairs	1,000	1,200
Misc	100	100
Power	527	692
Unit 3A		
Power	12,177	15,923
Flasks	8,000	12,000
Small Tools	3,000	4,000
Misc	10,000	12,000
Unit 3B		
Power	11,829	10,650
Flasks	25,000	25,000
Small Tools	3,000	3,000
Misc	10,000	10,000
Fuel	18,000	18,000
Unit 4		
Power	5,133	3,138
Fuel	25,000	25,000
Tools	4,000	4,000
Misc	16,000	16,000
Flasks	15,000	15,000
Total Molding	167,766	175,703

4.3 Core Room

Sand – 300T

25% W. G. & 75% oil	214,700	242,000
Power	3,264	3,030
Fuel oil (40 l/T x 1.20	15,300	21,600
Misc Mtls 10% of sand cost	21,470	24,200
Total Core Room	254,734	290,830

4.4 Cleaning

Shot Blast	9,000	11,400
Weld Rod	31,900	35,000
Arc Air Rods	20,000	22,000
Grinding Wheels	15,000	15,000
Small Tools	6,000	6,000
O_2	12,750	15,200
Gas (C_2H_2)	11,150	13,300
Power	42,400	43,600
Fuel	40,000	40,000
Total Cleaning	180,200	201,500

EXHIBIT G - ESTIMATE OF EQUIPMENT & BUILDINGS

PROP. I - MODERNIZATION OF PRESENT FOUNDRY

Phase Installation Included at 20 - 40%

T = Taiwan manufacture

I + T = Imported with some Taiwan furnished

I = Imported

Buildings		Installation Phase	In 1,000 [illegible]
16M wide x 54 M.L x 12M chord	864 016,00	II	1,3[illegible] [illegible]
16M wide x 27 M.L x 20M high	432 02,200	II	950 [illegible]
13.8 " x 5.18 x 8 chord	716 01,200	I	8[illegible]0 [illegible]
			3,192

Melting Department		
2.1 One load cell type scale - 10T cap.	IV	600I
2.2 Scrap and alloy bins	I	5 T
2.3 Ladle car - power	I	120 T
2.4 Stopper drying oven	I	40 T
2.5 Ladle heater station - 3 positions	I	60 T
2.6 Exhaust hood, ducts, fan and dust collection 35,000 cfm (900) M^3/mn	V	500 [illegible]
Installation & foundations 20%		27[illegible]
Total		1,655

Molding		
3.1.1 Unit 1 - Jolt - squeeze molding machine		24 I
3.1.2 Roller conveyors 300 x 6.00		24 I
3.1.3 Monorail 200 kg - 7m		[illegible]
3.1.4 Install		[illegible]
	III	125
3.2 Unit 1A		
3.2.1 Stationary speed slinger	III	1,120 I
3.2.2 Two shuttle cars mold handling	V	100 T
3.2.3 7.5M track one M gauge - 2	V	2 T

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2 OF 3

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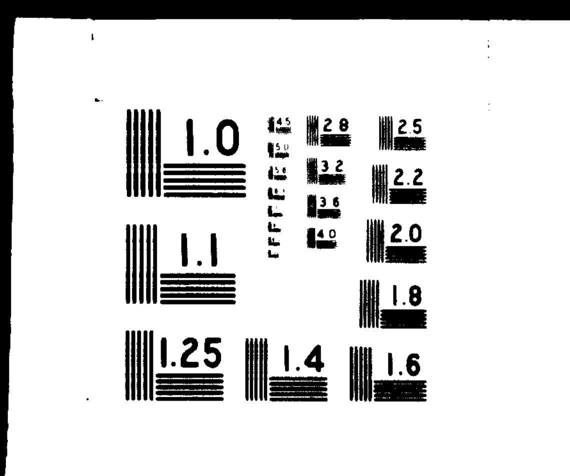

		Installation Phase	In 1,[illegible]
3.2.4	[illegible]-pattern [illegible] cars	V	[illegible]
3.2.5	2 - B & P Rollover & draw Universal ([illegible],030) or equal	V	57[illegible]
3.2.6	[illegible]orail [illegible] crane 14M - 500kg	V	36 [illegible]
3.2.7	[illegible] span x 7m [illegible] bridge crane [illegible] capacity 3 way power - Pendant Control	V	270 [illegible]
3.2.8	[illegible]ller conveyor double line 2 [illegible]400mm x [illegible]M - cap. 5 ton on 1.[illegible] M length	III	84 [illegible]
3.2.9	[illegible] storage conveyor [illegible],[illegible] mm x 10M - one x 90° bend	III	96 [illegible]
3.2.10	[illegible]ller conveyor air lift sections	V	12 [illegible]
3.2.11	[illegible]ller conveyor mold set out 600mm x 27m	V	2[illegible]6 T
3.2.12	[illegible] flasks [illegible] x [illegible] - 1000 x 1000 (50 sets)	III V	280 T
	Installation [illegible]30%		772
	Total	[illegible]	3,625

3.3 Unit [illegible]

3.3.1	[illegible] pin or rail lift draw machine equal to International [illegible] Co. - type LP 20	IV V	543 I
3.3.2	Flask return conveyor 1.200 wide x 17M	IV	170 T
3.3.3	Mold skin dry oven - jet type 4.00 wide x 2M long - 20 minutes per mold [illegible] drying time	V	800 I-T
3.3.4	Mold conveyor - closing - double line 400 mm x 18M - 2M spacing	IV	130 T
3.3.5	Mold and flask crane bridge type - 3 ton cap. - Rollover bail - 11M span - 10M runway	IV	360 T
3.3.6	Mold pusher cylinders 1.2M stroke 3 ton load on roller conveyor		8 T
3.3.7	Flasks-cast steel 900 x 2400 x 300/400 25 sets	IV V	750 T
3.3.8	Core delivery pallets	III	1 T
3.3.9	Core delivery truck	V	60 [illegible]

		Installation Phase	In 1,000 NT$
3.3.10	Pattern delivery car and track	V	20 T
	Installation and foundation 30%		619 T
	Total		3,461

3.4 Unit 4 Floor Molding

3.4.1	Sandslinger track 22M x 1Meter with foundation	II	5.5 T
3.4.2	Mold and core oven 2.5 x 3.5 M	V	800 P-I
	Installation		240 T
	Total		1,045.5

Total Mold

Imported	NT$2,263,000
Part Import	1,870,000
Taiwan	2,472,000
Inst.	1,651,000
Total	NT$8,256,000

Sand System

4.1 Shakeout sand system

4.1.1	Shakeout 2M x 3M (SH020) - 10T	350 I
4.1.2	Two 600 x 2.4M OSC Conveyors	200 T
4.1.3	800 x 5.2M OSC Conveyors	120 T
4.1.4	800 x 17.8M Inclined Belt	320 I-T
4.1.5	800 x 15.8M	300 I-T
4.1.6	Rotary breaker screen 1.500 dia x 4000 RCS 10 - 40	400 I
4.1.7	Magnetic belt separator 1 x 1.5	200 I
4.1.8	600 x 4.2 OSC conveyors	100 T
4.1.9	1200 x 600 bucket elevator x 18M high	320 I
4.1.10	Belt conveyor 800 x 8.5	100 T-I
4.1.11	1.000 x 6.000 double decked screen	340 I
4.1.12	600 x 6.5 belt conveyor	100 T

		Installation Phase	In 1,000 [illegible]
4.1.13	Storage bins 2 - 4.0 x 3.0 x 9.5 high $100M^3$		1,200 T
4.1.14	2 - 1.0 x 2.0 x 8.5M high $17M^3$		200 T
4.1.15	2 - 600 x 2.5 vibratory feeders		24 I
4.1.16	2 double acting gates-pneumatic		8 T
	Operation installation including foundations		2,171
	Total	II	6,513

4.2 Spill sand system

4.2.1	2 - 450 x 6.2 OSC conveyor		240 T-[illegible]
4.2.2	1 - 4.0 x 2.0 spill sand grate and hopper		100 T
4.2.3	2 - 450 x 7.5 oscillating conveyor 1 - Grate and hopper for cope and drag draw machines		280 T-[illegible]
4.2.4	600 x 10.0M oscillating feeder		180 T-[illegible]
	Installation 40%		330
	Total	IV	1,330

4.3 Prepared Sand System

4.3.1	Batch hopper - volumetric measurement	II	80 I
4.3.2	83B Beardsley and Piper Speedmullor or equal to supply 40T/hr minimum (note - B & P - 1.6T in 1½ min.)	II	2,200 I
4.3.3	Automatic cooling water, moisture and mullor cycling control Dietert or equal	II	1,000 I
4.3.4	Bin level controls - automatic	II	140 I
4.3.5	Mullor discharge hopper & belt 600x5.5M	II	120 T
4.3.6	Prepared sand elevator 1.000 x 450 x 14M high	II	270 T
4.3.7	Bifurcated distributing chute with remote controlled air operated flop gate	II	80 T
4.3.8	Prepared sand distributing belt 750 mm x 25.000 M	III	400 T

		Installation Phase	In 1,000 [illegible]
4.3.9	4 - remote controlled air operated plows with air cylinders	III	64 T
4.3.10	2 - 2.5M dia x 4M high Prepared sand (slinger) bins 23 tons each capacity 45T	III	360 T
4.3.11	2 - 1.800 dia plate feeders with one receiving hopper for slinger	III	250 T
4.3.12	1 - 1.0 x 1.0 x 2.0M sand hopper with double acting air operated gate	III	40 T
4.3.13	600 x 16.5 sand delivery belt	II	225 T
4.3.14	Swing delivery belt two position 25° arc on R of 7.0M monorail or rollers manual chain operated or air operated 600 x 7.5 long	II	175 T
4.3.15	Two receiving chutes for filling buckets	II	40 T
4.3.16	Muller operator platform	II	90 T
4.3.17	Sand aerator	II	160 I
	Exhaust duct on muller	II	40 T
	Water and air piping	II	10 T
	Electrical installation	II	22
	Installation and foundations 30%		1,720
	Total		7,534

4.4 Dust Collection

4.4.1	Exhaust hood on 2 x 3 shakeout		120 T
4.4.2	Wet type dust collector 40,000 cfm		800 I
4.4.3	Hoods and piping on sand system 19 points of exhaust 24M - 36" 20M Ø12" 25M Ø24" Hoods at 75% of piping cost		200 I
4.4.4	Controls		80 I
4.4.5	Waste disposal		75 T
	Installation (incl. piping)		250
	Total	III	1,525

Total sand system

Imported	6,094,000
Part Import Part local	2,440,000
Taiwan Produced	3,847,000
Erection & Installation	4,521,000
Total	16,902,000

4.5 Sand Binder Storage and Delivery

4.5.1	3.0 x 2.0 grate and hopper for truck delivery	80 T
4.5.2	Pneumatic transporter 65 mm pipe	120 T
4.5.3	70M - 65 mm pipe	4.6 T
	1 - 180° band	
	2 - 90° band	
	2 - 45° band	
4.5.4	4 - Receivers	6.4 T
4.5.5	4 - Dust collectors	10.0 T
4.5.6	4 - Two way switch	65 T
4.5.7	Two 4M ø x 10M high concrete stave silos-sand	740 T
4.5.8	One 4M ø x 10M high silo-bentonite	380 T
4.5.9	3 - 600 x 10.5M OSC feeder	180 T
	Convoy or 2" pipe	
	3.2#/ft 4.75 kg/m 68.0 NT/kg	
	say NT5/kg (.10 bl)	
	5 x 4.75 = 23.8 NT/meter	
4.5.10	Controls	160 T
4.5.11	Sand dryer and cooling system (sinto kogio)	600 T-[illegible]
	Installation	800
	Total	3,146

II
V

Imported	355,000
Taiwan + Imp.	600,000
Taiwan	1,931,000
Installation	800,000
Total	3,146,000

Core Making

	Installation Phase	In 1,[illegible] [illegible]
5.1 Core sand muller 1.5 [illegible]/hr. capacity (US10,000)	III	400 I
5.2 Sand delivery monorail 500 kg x 20M with special bucket	III	50 T
5.3 Core delivery belt 1,200 mm wide x 14.0 M long, speed control, automatic shut off, wooden slats, 2/4M per minute	IV	240 T-I
5.4 Core blowers		
5.4.1 25 kg cap. B & P CB15, SB05	IV	100 I
5.4.2 6 kg cap. sim. B & P CB10W, SB03 w/CO_2 gas attachment	III	40 I
5.4.3 2 kg cap. CB 5	II	12 I
5.5 Core ovens 1M x 1.5M rack 2M high car or rack type 4 units	II III V	600 T-I
5.6 Crane 3M span x 25M runway 2 tons, 2 units with 3 way power and pendant control	IV	
5.7 Core racks for oven	III	12 T
5.8 Wood pallets core storage	III	1 T
5.9 No bake core system, Large cores(when required)		
5.9.1 Continuous mixer similar to Fordath Mark 10 or Cecast Ribbon flow 200 kg/min	VI	340 NB I
5.9.2 Core box rollover and draw similar B & P N C R	VI	160 NB I
5.9.3 Roller conveyor 2 - 90° Elbows 2 - right angle transfer section 1 transfer car	VI	165 NB T
		2[illegible] NB T
5.9.4 Core handling overhead crane 2 ton 4M span x 20M runway 3 way pendant control	IV	250 R T-I

	Installation Phase	In 1.[illegible]
5.9.5 Core making benches with common hopper	II	15 R
5.9.6 Core finish area: benches and roller conveyors	III IV	40 R
5.10 Exhaust hood at core oven cooling area 1000 cfm	II	40 R
5.11 Stock core machine	III	20 R
5.12 Sand bin at No Bake - 10 ton capacity	VI	80 NB
5.13 Pneumatic delivery from storage system 30.[illegible] - 1 switch, receiver and dust collector, boosters		20 NB
5.14 Jet oven skin dry: 3 x 3.5 x 2M high	VI	400 NB
5.15 Roller conveyors - 2 lines 600 x 10	VI	85 NB
5.16 Transfer car	VI	5[illegible] NB

Regular core making	(R)
Imported	NT$580,000
Taiwan Imp.	1,440,000
Taiwan	159,000
Installation	600,000
	2,779,000

No bake core making	(NB)
Imported	NT$500,000
Taiwan Imp.	650,000
Taiwan	389,000
Installation	330,000
	1,869,000

	Installation Phase	In 1,000 NT$
Rough Cleaning		
6.1 Sorting and loading crane 4.0M span x 16.0 runway 1 ton - 3 way power pendant control		350 I
6.2 Monorail serving hanger Blast cabinet 33M long 6 - 90° bends		66 T
6.3 Hanger type shot blast SNB HA (Sinto)		1,580 I
6.4 Roller conveyors 1M x 22.0M		90 T
6.5 Work stations		
5 gas cutting		40 T
4 arc air 750 MM		357 I
5 welding 300 mm		200 I
1 seminantomatic		50 I
1 arc air 1000 amp		141 I
6.6 Fork truck 2-ton		150 I
Installation 30%		860
Total		3,884

Imported	NT$2,828,000
Taiwan	196,000
Installation	860,000
	NT$3,884

		Installation Phase	In [illegible]
7. Cleaning, Finish			
7.1	Heat Treating		
7.1.1	Two furnaces, car type 035,000 ea. for 1,100°C max.	I IV	2,000 [illegible]
	1 Furnace to 950°C, car type, both furnaces to be 2.5 x 3.5 x 2M, oil fired, auto control with power operation on car and door	V	1,200 [illegible]
7.1.2	Water quench tank 4M x3.75M x3M deep forced circulation 2-20 Hp propeller type agitators	I	120 [illegible]
7.1.3	Air blast cooling-4 fans	IV	48 T
7.1.4	Oil quench tank 2 x 2.5 x 3 deep oil circulating pump with finned coils in water tank	V	40 T
7.2	Cleaning, finish		
7.2.1	Room blast, double door, car type w/turntable 3M x 4M x 4M high, similar Sinto Kogio tt 10 30a with Dust Collector.	I	2,000 [illegible]
7.2.2	Transfer cars 2M x 2M Two Roller conveyor top, manual move, track 20M total	IV V	10 T
7.2.3	Roller conveyor: 2 lines each 19M x 1000 wide supported to 600 mm high	IV V	152
7.2.4	Monorails: 2 with 3-power hoists each 500 kg capacity 15.0M long	IV V	108 T
7.2.5	Straightening press C frame type 100 ton capacity 2M x1M table	IV	480 [illegible]
7.2.6	Straightening press, Post type 200 T, 2M x 2M table	V	600 [illegible]

	Installation Phase	In 1,000 NT$
7.2.7 Arc air & welders-large castings		
1 - 1000 amp	I	141 I
1 - 750 amp	III	100 I
3 - 400 amp welders	V	120 I
7.2.8 Magnaflux inspection, portable	IV	200 I
7.2.9 Overhead cranes		
1 - 13M span x 10T operator control	I	800 T-I
1 - 13M span x 5T 3 way power, pendant control	V	720 T-I
7.2.10 Shipping Dept. scale 10 ton cap.	V	80 I
7.2.11 Grinding equipment 3 swing frame type	III	
grinders similar Fox - 6 - 125 25 HP	V	168 I
20" x 3" wheel 1 stand grinder	V	100 I
similar Fox 2 - 30		
30" x 3" wheel 25 HP		
1 stand grinder, 25HP 30" x 2" Fox 12-30	V	100 I
2 bench grinders		20 T
5 hand grinders	III	40 T
7.2.12 5 - Work booths, Main cleaning		20 T
7.2.13 Service - air		40 T
- power, electric		55 T
- Gas and O_2		50 T
7.2.14 Jib crane, Press - 5 ton	V	80 T-I
Installation		2,734
Total		9,126

Imported	NT$3,049,000
Taiwan-import	7,000,000
Taiwan	551,000
Installation	4,240,000
	NT$14,840,000

		Installation Phase	In [illegible]
8. Relocate Laboratory and Foundry Office			
10M x 25 x 1M = 250 x NT$1,000/M^2		II	250
Relocate equipment, services			80
9. Service			
9.1 Substation Power 4,000 KW, connected load		II	2,000
9.2 Lighting in buildings			
Total area			
	16 x 81 = 2,310	II	
	20 x 89 = 1,600	III	
	21.5 x 81 = -		
	40 x 45 = 1,800	IV	
	8 x 23 = 184	V	
	12 x 7 = 84		
	= 5,978M^2		
62 Lights ca. 160M^2			
37 Lights - NT$6,000 ca.			221
9.3 Air mains		III	120
9.4 Gas & O_2 piping		IV	140
9.5 Gas for ladle heating		I	500
9.6 Rearrangement of access to melting dept & sand storage		I	40
9.7 Two air raid shelters		II	120
Total			3,141
10. Scrap Yard			
10. 1 22 meter span crane x 75M runway			800
Including structure			200
Installation			[illegible]
Total			1,270

Summary of Installation Costs Proposition 2 [illegible]

	IMPORTED	IMPORT + LOCAL	LOCAL	INSTALLATION	TOTAL
Building			3,192,000		3,192,000
Laboratory			250,000		250,000
Scrapyard			230,000		230,000
Engineering & Contingency 15%			3,672,000		550,000
Total Building					4,222,000
Melting Dept.	600,000	1,360,000	225,000	510,000	2,695,000
Molding	2,263,000	1,870,500	2,473,000	1,652,000	8,258,000
Sand System	6,449,000	4,188,000	3,930,000	5,321,000	19,888,000
Core Room	580,000	1,390,000	159,000	600,000	2,729,000
No Bake System	560,000	720,000	309,000	330,000	1,919,000
Cleaning Rough	2,918,000	-	106,000	860,000	3,884,000
Cleaning Finish	3,049,000	7,000,000	551,000	4,240,000	14,840,000
Services			3,201,000		3,201,000
SUB-TOTAL	15,359,000	16,520,000	11,014,000	13,513,000	57,414,000
Engineering 10%	1,636,000	1,653,000	1,101,000	1,351,000	5,741,000
Freight } 25%	4,086,000	1,655,000	-	-	5,741,000
Import Duty }					
Contingency 10%	2,208,000	1,984,000	1,211,000	1,[illegible],000	6,889,000
Total NT$	24,289,000	21,820,000	13,326,000	16,350,000	75,785,000
Total NT$ incl. Building					80,007,000
Total US$ (1)	607,225	545,500	333,125	408,725	2,000,125

(1) Includes Building with Engineering + Contingency @15%

EXHIBIT K – INSTALLATION PHASES

The modernization of the existing steel foundry is to proceed by phases, to minimize disruption to present operations, to avoid over capacity until the demand develops and to minimize the capital required at any one time. The following program is proposed as a possible approach. Other priorities are also feasible.

1. Phase I

1.1 Erect roof over area between cleaning and machine shop

1.2 Install one heat treating furnace

1.3 Install shot blast room

1.4 Procure arc air DC power sources

1.5 Erect new crane or raise the runway on present crane in this b

1.6 Install ladle drying facilities and provide for rearrangement of melting department

2. Phase II

2.1 Erect building on west side of the present foundry over the existing 4 meter roof and then raze the latter. This is to inc installation of all sand system pits and foundations required for future equipment

2.2 Install shakeout and return sand system including storage bins. Also install sand muller, discharge belt., elevator and belt between sand system and column 11. Install swing belt and filling chutes for backing and facing sand.

2.3 Relocate motive sand slinger

2.4 Install core ovens as needed

2.5 Install core room crane

2.6 Install core work benches and blowers as needed

Phase III

3.1 Install stationary sand slinger

3.2 Install temporary mold and flask conveyor to permit delivery of flask and pattern to stationary slinger, completed molds to be returned to main bay for rollover and pattern draw.

3.3 Install overhead sand delivery and sand slinger sand storage bins.

3.4 Install one jolt squeezer machine with roller conveyor and monorail for pouring. Install overhead sand bins for molding machine.

3.5 Install additional core making and drying equipment as required by demand.

3.6 Install added equipment in cleaning room as arc air, welders, small grinders as required to maintain output.

Phase IV - To meet railroad bogie demand at 25 - 50 car sets per month

4.1 Install one strip draw machine, flask conveyor, mold conveyor and mold and flask handing crane.

4.2 Install additional core making and drying equipment.

4.3 Install spill sand return system under the sand slinger.

4.4 Install one additional heat treating furnace.

4.5 Install conveyor line and grinding stations in cleaning room for railroad work.

4.6 Install one straightening press.

Phase V - Railroad requirement to 100 sets per month and other volume increasing.

5.1 Install second draw machine in unit 3B and skin dry oven.

5.2 Install roll over and draw at unit 3A and car type mold conveyor and transfer cars, flask return conveyor and monorail.

5.3 Install hanger type shot blast cabinet, service monorail and loading crane.

5.4 Provide gas cutting, arc air and welding stations as required for volume.

5.5 Install third heat treating furnace if capacity is required.

5.6 Set up core conveyor belt and additional core blowers and drying ovens.

5.7 Install grinders and additional cleaning conveyor line for railroad work.

5.8 As volume increases provide grinding and repair weld stations in new cast bay of cleaning department.

EXHIBIT H - 1

COST OF PHASED INSTALLATION

Department	I	II	III	IV	V	VI	TOTAL	
Building	860	2,382			230		3,672	
Melting	225			600	1,[illegible]		2,1[illegible]	Equip.
	40			120	350		520	Inst.
	265			720	1,710		2,695	TOTAL
Molding			1,546	1,315	3,739		6,607	
		7	410	282	959		1,651	
		7	1,956	1,597	4,698		8,258	
Core Making		682	701	610	150	1,589	3,718	
		157	175	153	38	397	920	
		[illegible]	[illegible]	763	188	1,98[illegible]	4,[illegible]	
Cleaning	4,461		325	2,379	6,459		13,624	
	1,735		[illegible]	953	2232		5,100	
	[illegible],246		[illegible]	3,332	8,691		[illegible],724	
Sand System		9,410	2,429	950	1,748		14,587	
		3,735	[illegible]	380	640		5,321	
		13,1[illegible]	3,0[illegible]	1,330	2,388		1[illegible],[illegible]	
Services & Other	540	2,250	170	190	51		3,201	
SUB-TOTAL	7,912	18,219	6,402	7,932	17,956	1,986	61,[illegible]	
Engineering	3,352	1,199	324	397	920	99	6,291	
Freight+Duty	705	1,[illegible]4	648	793	1,772	199	5,741	
Contingency	1,130	2,[illegible]	782	8[illegible]0	1,942	215	6,[illegible]	
TOTAL	13,[illegible]	23,[illegible]1	8,156	9,932	22,593	2,499	80,007,000	

EXHIBIT I – DEPRECIATION AND TAXES

1. Present Depreciation per month

Building	11,223	(13%)
Machinery Equipment	74,554	(87%)
	NT$85,777/mo.	

2. Proposed Depreciation on New Facilities

Buildings NT$4,222,000 ÷ 25 yrs. = 169,000/yrs.

= 14,050/mo.

Machinery & Equipment

NT$75,783,000 ÷ 15 yrs.= 5,060,000/yrs.

= 422,000/mo.

3. Total Depreciation

Building	25,273
Machinery Equipment	496,554
	NT$521,827/mo.

EXHIBIT J - OVERHEAD AND CORPORATE COSTS

	1971 Average	Proposition I 319T/mo	New Foundry 450T/mo
Salary	31,700 (1)	31,700	31,700
Service Cost	83,393	106,000	106,000
Materials & Others	4,787	5,270	5,270
Depreciation	85,777	521,027	521,027
Taxes @18.43% (2)	15,817	96,500	96,500
Loss Claims	28,032	28,000	28,000
Office Distribution	111,641	133,000	133,000
Corporate	130,647	156,000	156,000
Total Fixed Overhead	496,794	1,078,297	1,078,297

Note (1) : 43,870, average salary cost charged to foundry includes 17,500 cost for direct supervisory staff. Since this was included in direct charge in this study it has been deducted. Balance has been increased by 20% to compensate for future increases.

(2) Tax calculated at 18.43% of Depreciation.

EXHIBIT K -- SALES VALUE

1. Railroad Castings

	No.	Wt. ea.	Tot. wt.	Value ea.	Total
Bolster	200	275	55,000	NT$5,500	NT$1,100,000
Side Frame	400	230	92,000	4,600	1,840,000
Brake Beam	400	50	20,000	1,000	400,000
Center Plate	200	66	13,200	1,320	264,000
Coupler Body	200	100	20,000	1,500	300,000
Knuckle	200	37	7,400	555	111,000
Lock	200	3	600	45	9,000
			208,200		4,024,000

Based upon 100 car sets - average 19.33/kg

2. Average July, August & Sept. 1971
Present class of work
Weight and Value of Ingots Excluded

	Weight Good Cstgs	Total Value
July Steel Casting	84,696	1,016,352
Alloy Steel Casting	25,567	601,648
Aug. Steel Casting	91,069	1,092,816
Alloy Steel Casting	11,772	264,173
Sept. Steel Casting	69,105	829,260
Alloy Steel Casting	9,720	427,511
	291,929	4,231,760 = 14,470 kg

E X H I B I T L

PROFIT AND LOSS STATEMENT

Product Salos Value	Unit Sales Value/kg	Wt.	Present Foundry	Proposition I 319T/Mo Value	Proposition I 450T/Mo Value
Present Average	14.470	111 Tons	1,606,170	1,606,170	1,606,170
Raiaroad - Car Sets (av.)	19.330	208 Tons		4,024,000	4,024,000
Miscellaneous New Work	13.500	131 Tons			1,764,830
			1,606,170	5,630,170	7,395,000
Operating Costs					
Labor (incl. Staff (1)	3138		347,411	328,947	406,903
Indirect Material	2757		306,027	1,210,049	1,465,094
Direct Material	4106		456,766	1,004,850	1,542,530
Overhead			491,464	1,060,690	1,060,690
TOTAL COST			1,601,668	3,604,536	4,475,217
Difference in Sales and Cost					
(Gross Profit)			4,502	2,025,634	2,919,783

(1) Includes 17,500 staff supervisors - shown in salary cost account

EXHIBIT M : PROFIT ANALYSIS - CASH FLOW

Annual Basis - First Year

Refer EXHIBIT L for profit and loss statement

	Present Operation	Proposition I 319T	450T
Gross Profit	NT$54,024	24,307,608	35,037,396
Less Interest at 10%	-	8,000,000	8,000,000
Amortization in 15 years	-	5,350,000	5,350,000
Profit Before Tax	54,024	10,957,608	21,687,396
Income Tax (14%)	7,580	25% 2,695,000	5,430,000
Net Profit	46,444	8,082,608	16,257,396

Note: Above calculation is based upon data shown in EXHIBIT L.

EXHIBIT H

AMORTIZATION SCHEDULE AND AFTER TAX PROFIT

All figures in 1,000's

Year	Balance Loan Value	Interest 10%	Profit Before Tax	319T Tax	Net Profit	Profit Before Tax	450T Tax	Net Profit
1	80,005	8,000	10,958	2,695	8,063	21,637	5,430	16,257
2	74,655	7,466	11,492	2,873	8,619	22,221	5,555	16,666
3	69,305	6,931	12,027	3,007	9,020	22,796	5,699	17,097
4	63,955	6,396	12,562	3,141	9,421	23,291	5,823	17,468
5	58,605	5,861	13,097	3,274	9,823	23,826	5,957	17,870
6	53,255	5,326	13,632	3,408	10,224	24,261	6,065	18,196
7	47,905	4,791	14,167	3,542	10,625	24,896	6,224	18,672
8	42,555	4,256	14,702	3,676	11,026	25,431	6,358	19,078
9	37,205	3,721	15,237	3,809	11,428	25,966	6,492	19,475
10	31,855	3,186	15,772	3,943	11,829	26,491	6,623	19,868
11	26,505	2,651	16,307	4,077	12,330	27,036	6,759	20,277
12	21,155	2,116	16,842	4,211	12,632	27,571	6,893	20,693
13	15,805	1,531	17,377	4,344	13,033	28,106	7,027	21,080
14	10,455	1,046	17,912	4,478	13,434	28,641	7,160	21,481
15	5,105	511	18,447	4,612	13,835	29,716	7,294	21,882
	0	—						
Total		63,839		53,990	165,362		92,364	286,053
Total Average		4,260		3,600	11,020		6,150	19,050

EXHIBIT G

PROPOSITION I

Comparison of Operating Costs at 111 Tons in new and old foundry
(No railroad work or added volume)

	Present	Prop. I
Average Sales	1,606,170	1,606,170
Labor Cost (incl. Supervision)	347,411	189,000
Material Cost - Indirect	306,027	354,000
Material Cost - Direct	456,766	456,000
Overhead	491,464	496,794
Total Cost	1,601,668	1,495,794
Monthly Gross Profit	4,502	110,376
Annual Gross Profit	54,024	1,324,512

Estimated added depreciation & taxes

		Depreciation	Tax
Building	3,442,000	137,600	25,400
	33,335,000	2,220,000	408,000
		2,357,600	433,400

Interest on Loan @10% 3,678,000

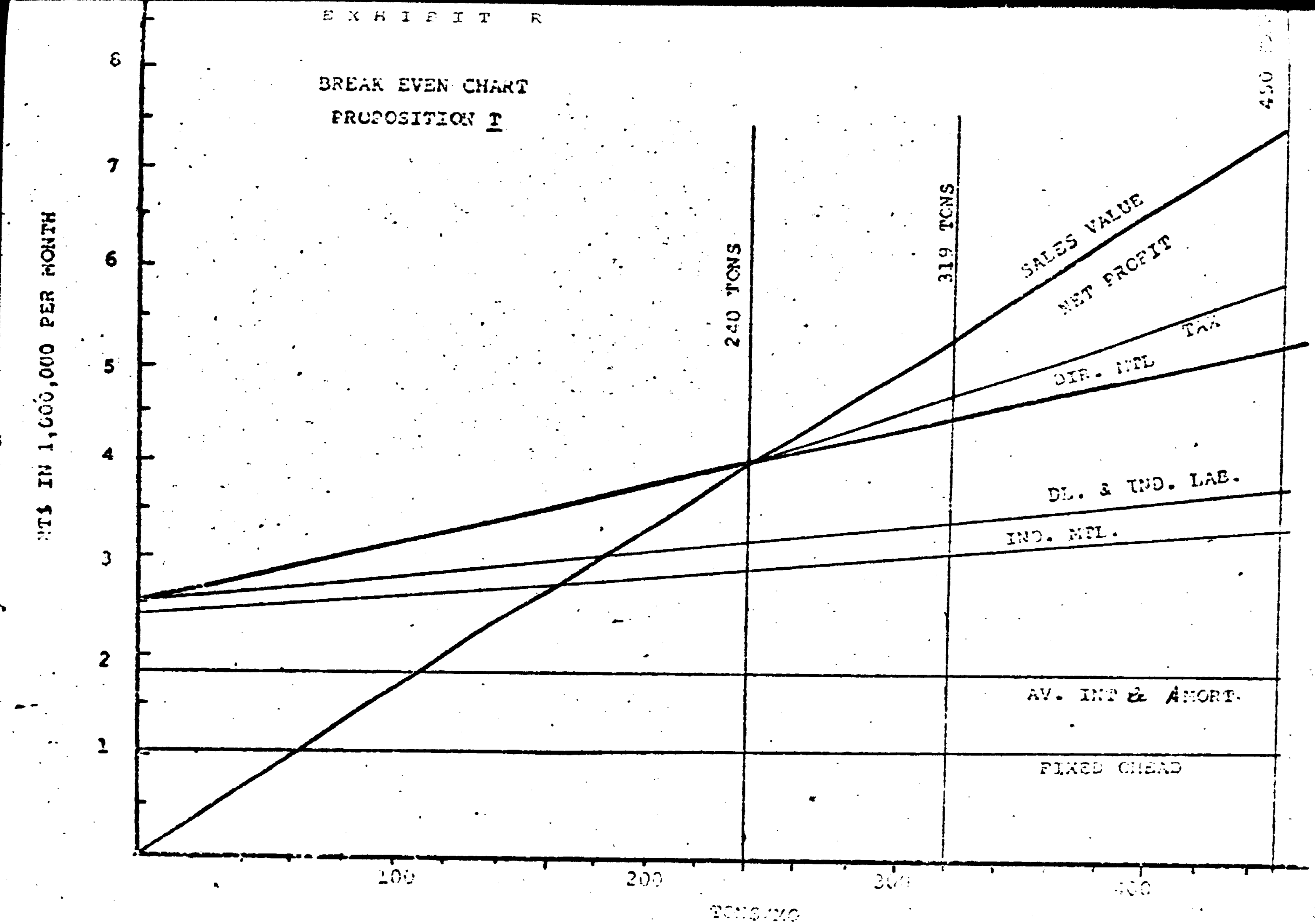
EXHIBIT R
BREAK EVEN CHART
PROPOSITION I
240 TONS
319 TONS
450
SALES VALUE
NET PROFIT
TAX
DIR. MTL
DL. & IND. LAB.
IND. MTL.
AV. INT & AMORT.
FIXED OHEAD
1
2
3
4
5
6
7
8
100
200
300
400
TONS/MO
NT$ IN 1,000,000 PER MONTH

EXHIBIT D

METAL INDUSTRIES DEVELOPMENT CENTRE

P.O.BOX: 60432 KAOHSIUNG
8350 TAIPEI

CABLE: MIDC KAOHSIUNG
MIDC TAIPEI

1001 KAO NAN HIGHWAY, KAOHSIUNG, TAIWAN, THE REPUBLIC OF CHINA

TEL:KAOHSIUNG [illegible]
TAIPEI [illegible]

YOUR REF:

OUR REF:

June 2, 1972

Mr. Wei Liang Lee
President
T. M. M. C.
Kaohsiung

Subject: <u>New Steel Foundry, Proposition II</u>
<u>Supplement to Report of April 30, 1972</u>

Dear Mr. Lee,

1. Attached are three copies of a report covering an analysis of the proposed new steel foundry to be erected on a new site. The planning does not include the relocation of the iron foundry and operating costs have been calculated on that basis.

2. While the figures developed for the attached analysis are based upon estimates only, it is felt the operating cost estimates are reasonable and conservative. Equipment costs were estimated on the same basis as Proposition I using existing data where available.

3. It is obvious from a study of the attached report that the planning and erection of a new steel foundry is far from being an attractive proposition financially. There is no guarantee of sufficient volume to assure repayment of the interest and amortization cost of the invested capital. Substantial losses are almost guaranteed until orders can be increased four fold.

4. Certainly the first prerequisite to widening the market must be substantial improvement in quality and this is to depend largely on changes in methods and the installation of molding equipment and sand preparation facilities. Quality improvement will lead also to reduced costs. Thus as modernization of facilities progresses so will quality improvement. This will permit an increased volume of orders and improved profit potential.

AL INDUSTRIES DEVELOPMENT CENTRE

P.O.BOX: 00232 KAOHSIUNG
3350 TAIPEI

CABLE: MIDC KAOHSIUNG
MIDC TAIPEI

AO HAI HIGHWAY, KAOHSIUNG, TAIWAN, THE REPUBLIC OF CHINA

TEL:KAOHSIUNG:221128.221129.221130
TAIPEI:713161.713162.713163

REF:

OUR REF:

5. Although the correction of conditions in the steel foundry is the most urgent project, the importance of improvement of the iron foundry facilities cannot be overlooked. Before undertaking any single phase of the program it is considered advisable to make a complete longrange study of the entire foundry operation. This must evaluate the economics of relocation versus modernization of existing plants, the cost advantage of combined iron and steel operations versus separate plants and a time schedule for accomplishment.

We trust the foregoing is of value to you and that we may be permitted to continue the program thru to completion.

Sincerely yours,

Herbert E. Cragin, Jr.
Expert - Foundry
U. N. I. D. O.

Encl.

HEC/sc

LIST OF EXHIBITS

1/ These drawings are annexed as part of final report; please refer to page 236.

Proposition II

New Steel Foundry

Reference Drawings SK FE 61-C-0118 1/
61-E-0119 1/

Summary

1.1 A new steel foundry is estimated to cost nearly US$4,500,000 excluding the cost of the land.

1.2 Designed for castings from 1 kg to 6 tons in both jobbing and production quantities the foundry will have a capacity on one shift for up to 900 tons per month.

1.3 Estimated operating costs including depreciation and taxes but not interest or amortization on the invested capital are shown together with the costs developed on modernization of the steel foundry, Proposition I:

	Ton/Mo.	Cost/ton
Present Operation	111	NT$14,400
Proposition I	319	11,300
	450	9,950
Proposition II	450	11,127
	600	9,766
	750	8,939
	900	8,549

1.4 At an average sales value of 16.45 per kg, sales volume of about 400 tons per month will be required to earn the interest and amortization on the invested capital based upon the average interest for 15 years.

1.5 It is not possible to develop this much new business until consumer acceptance of quality and price is assured. Substantial annual losses for a number of years must be expected until sales volume can be increased to the break even level.

1/ Annexed as part of final report; please refer to page 236.

1.6 Modernization of the existing steel foundry in step with a primary goal of quality improvement would appear a more prudent decision now. When the incoming business demand has the modernisation foundry operating at capacity, a new foundry at a separate location could be considered.

. Facilities

2.1 A building covering an area of 6,625 square meters is required to provide for the present demand and future expansion. While further study may dictate changes in the layout and disposition of equipment, the floor space planned cannot be reduced substantially if the production equipment as proposed is to be installed.

2.2 Melting Department

2.2.1 Equipment includes a new arc furnace, top-charge, rated at 3 tons per hour with a normal heat size of 6 tons.

2.2.2 The existing 4.5 ton furnace is to be relocated and equipped with high powered transformer when the demand requires.

2.2.3 Ladle heating, inside scrap storage, charge make up scale have been planned all serviced by overhead crane.

2.3 Molding equipment has been planned to provide efficient production of castings in both jobbing and production quantities to 6 tons maximum casting weight.

2.3.1 Initially, the molding is to be planned for maximum flexibility for jobbing work. As demand develops and increases, production molding facilities can be installed.

2.3.2 The molding units planned for the completed foundry are:

1. Squeezer and small bench
   400 x 400 maximum flask
   10 kg maximum weight per mold

2. Production work in cope and drag-jolt squeeze strip machines in 800 x 800 flasks

3A. Stationary sand slinger loop with rollover for miscellaneous jobbing work up to 1600x1600 flask

3B. Stationary sand slinger (same unit as in 3A) with two draw machines for side frame and bolsters.

4. Floor molding

2.4 It is anticipated that molding will be converted to green and skin dried sand. Sand preparation storage and delivery with a capacity of a about 60 tons per hour is essential to assure molding productivity.

2.5 All core making is to be separated from molding and concentrated in location where delivery of cores to molding will require minimum travel.

2.6 Cleaning and heat treating is to provide the space for the gradual addition of equipment and facilities as output in the foundry is increased. New heat treating furnaces, casting handling cranes and shot blast equipment are the major items of equipment to be required.

2.7 Costs of buildings and equipment by department are detailed in Exhibit A.

3. Installation Phases

3.1 It will be necessary that practically the entire building be erected at first, although certain areas may be unused. Equipment will be installed to provide for production levels as dictated by the demand. Certainly, melting, sand preparation, molding facilities for jobbing work and particularly to improve the quality of the mold; core making and some cleaning and heat treating equipment is essential.

3.2 Subsequently, new equipment mold and material handling facilities, additional heat treating, mold and core drying and cleaning facilities can be added with no disruption to current production since everything will be preplanned.

4. Operating Costs

4.1 Manning has been developed at each of the operating volumes as shown in Exhibit B. Since equipment must be operated with reasonable efficiency and at least a full shift, different combinations of molding facilities have been selected to yield the tons produced. In practice it is possible to split shifts between machines or operate on alternate days when volume is low.

4.2 The molding conditions used are as follows:

	Tons/Month			
[illegible]	450	600	750	900
Unit 1	7.2	7.2	7.2	19.6
2	162	304	304	304
3A	166.5	175.3	326	389
3B	73.6	73.6	73.6	147.5
4	39.9	39.9	39.9	39.9
	450	600	750	900

4.3 The above tonnage is to be produced by manning as shown in Exhibit B.

4.4 Productivity of the molding units at normal manning will be:

Unit 1	105 molds/day		14/hr.
2	150 "	"	20/hr.
3A	80 "	"	10.6/hr.
3B	25 "	"	3.3/hr.
4	4 "	"	

4.5 Melting

Liquid metal is to be required and supplied as shown below based upon an approximate 5 ton heat.

	450	600	750	900
No Heats	6	8	10	12
Average weight	5.15T	5.24	5.3	5.17
Furnaces Hours	18	24	30	36
Furnace #1	9 h	8	16	18
Furnace #2	9 h	16	14	18

Heat sizes can be adjusted up to 6 tons to improve efficiency of furnace utilization.

4.6 Unit labor costs have been calculated at 1971 rates plus 20% and are based upon an average 190 hour month.

4.7 All other costs are based upon the figures developed in Proposition I study adjusted where deemed advisable to suit the new foundry facility.

4.8 Average operating costs per ton for all size ranges are estimated to be: (Costs include fixed and overhead)

	Manhours per ton	Cost per ton
450	64	NT$11,127
600	57	9,766
750	56	8,939
900	55	8,549

5. Profit and Loss Calculations

5.1 Sales value has been assumed from the calculations made in Prop. I as follows:

111	T Existing work	14.470 (average July - Sept.
208	RR 100 car sets	19.33
131	new work	13.50
Average at 450 T/		16.45 /kg

5.2 The overhead and fixed including depreciation and taxes on the new facilities is assumed not to change with volume and will amount to NT$1,481,370/month.

5.3 Gross profit has been developed using operating costs from Exhibit C and overhead and fixed from Exhibit D. It is logical to assume that the cost of investment capital, inter and amortization, will be deducted from gross profit prior t payment of corporate income tax. Net profit values are show on the chart Exhibit E.

5.4 As shown in Exhibit E Proposition I, Modernization of the existing foundry will provide a break even considering investment cost at about half the volume needed for a new foundry:

	Tons/year	Annual Sales NT$1,000	Annual Net Profit after tax	Sa
Present Foundry	1,331	19,272	46,444	
Prop. I.	2,880	47,376	0	
	3,828	67,562	8,082,608	1
	5,400	88,741	16,257,396	1
Prop. II.	5,400	88,741	-1,814,520(loss)	-
	5,568	91,594	0	
	7,200	118,440	13,231,260	1
	9,000	148,050	27,848,160	1
	10,800	177,660	41,148,270	2

5.5 This is further illuminated in the breakeven chart shown in Exhibit F. in which average investment interest over 15 years is used. The impact of a drop in average sales value from 16.45 to 15.0 kg will have the effect of increasing breakeven point from 390 tons per month to 460. To estimate operating margins, plus or minus, during the first few years, interest costs close to first year charges must be used instead of the average. Thus to breakeven a greater volume from between 392 tons up to about 460 tons per month will be needed. This means an immediate large increase in orders to avoid substantial losses.

6. Conclusions and Recommendations

6.1 The new foundry Proposition II will have a normal capacity of 900 tons per month at an average cost of less than NT$9 per kg.

6.2 Unless firm guarantees of at least 400 tons per month at a sales value of 15 to 16 NT per kg can be obtained this project appears too hazardous a venture. Operating this new facility even if only partly equipped at less than 150 tons per month will produce substantial cash losses.

6.3 Until an acceptable quality level can be developed the size of the potential markets cannot be evaluated. A project costing 4.5 Million US is too great at this time to be absorbed.

6.4 It is recommended that steps be taken now to develop plans for the modernization of the existing iron and steel foundri[es]. Future relocation of both foundries must be postponed until the economic feasibility can be assured.

EXHIBIT A

BUILDING AND EQUIPMENT COSTS

		In NT$1000
1.	Buildings and Site Development	24,882
2.	Melting	13,585
3.	Molding	10,774
4.	Sand System	15,471
5.	Sand Storage	3,463
6.	Core Department	5,468
7.	Cleaning Room	25,144
8.	Service - Power, Lighting	7,250
9.	Scrap Yard	1,000
10.	Laboratory	1,900
11.	Pattern Shop	800
12.	Maintenance Shop	600
13.	Office	160
14.	Lunch Room & Lockers	200
15.	Air Raid Shelters	400
		111,097
	Installation	25,474
	Engineering	13,000
	Freight & Import Duty 25%	12,000
	Contingency 10%	16,157
	Total	177,728

Equivalent US$4,443,200

EXHIBIT B

MANNING - INCLUDING SUPERVISION

	450	600	750	900
Melting	16	23	28	41
Molding Direct	14	16	17	22
Indirect	17½	22	28	33
Core				
Direct	12	13	14	15
Indirect	8½	9	14	15
Cleaning				
Direct	33	42	54	62
Indirect	20	22	29	33
Maintenance	9	10	11	12
Pattern	9	9	11	12
Yard & Service	12	12	15	15
	151	178	221	260
Man hours/ton at 190 hrs/mo.	64	57	56	55
Direct	59	71	85	99
Indirect	92	107	136	161

EXHIBIT C

OPERATING COST SUMMARY

TONS PER MONTH	450	600	750	900
	NT$ per ton of good castings			
Direct Labor	346.50	306.50	290.10	282.00
Indirect Labor	483.00	422.25	413.00	405.00
Supervision	110.50	94.25	86.90	83.00
Total	940.00	823.00	790.00	770.00
Indirect Materials				
Power	823.00	820.00	767.00	751.00
Foundry - Sand	666.00	653.00	646.00	719.00
Other	350.00	350.00	350.00	350.00
Core Room	600.00	550.00	525.00	500.00
Cleaning	348.00	332.00	319.00	305.00
Maintenance	140.00	135.00	130.00	130.00
Total	2,927.00	2,840.00	2,737.00	2,755.00
Direct Material				
Tons Carbon	340 950,400	510 1,346,400	660 1,742,400	800 2,112,000
Tons Alloy	90 835,290	90 835,290	90 835,290	100 928,100
	1,785,690	2,181,690	2,577,690	3,040,100
Average Cost per Ton	3,968	3,636	3,437	3,378
Total Operating Cost/Ton	7,835	7,299	6,964	6,903

EXHIBIT D

Overhead and Fixed

(Note: It is probable that some of the elements in overhead cost will vary with increased volume but which and to what degree is not shown.)

Salary Cost	NT$31,700	/month
Service Cost	50,000	
Materials & Others	5,270	
Depreciation	920,400	
Taxes @18.43% of depreciation	170,000	
Loss Claims	150,000	
Office distribution	133,000	
Corporate distribution	156,000	
Total	1,481,370	

EXHIBIT E

FIRST YEAR PROFIT & LOSS CALCULATION (MONTHLY)

	Present Foundry	Proposition I Modernization		Proposition II New Steel Foundry			
Tons Shipped	111	319	450	450	600	750	900
Net Sales Value @av. 16.45/kg	1,606,170	5,630,170	7,395,000	7,395,000	9,870,000	12,337,500	14,850,000
Operating Costs							
Labor	347,411	328,947	406,903	423,000	493,800	592,500	693,000
Ind. Mtl.	306,027	1,210,049	1,465,094	1,317,150	1,704,000	2,052,700	2,479,500
Fixed & Overhead	491,464	1,060,690	1,060,690	1,481,370	1,481,370	1,481,370	1,481,370 (1)
Direct Mtl.	456,766	1,004,850	1,542,530	1,785,690	2,181,690	2,577,690	3,040,100
Total	1,601,688	3,604,536	4,475,217	5,007,210	5,860,860	6,704,260	7,693,970
Gross Profit	4,502	2,025,634	2,919,783	7,387,790	4,009,140	5,633,240	7,111,030
Less Amortization @15 years and Interest @ 10% (first year)		1,112,500	1,112,500	2,539,000	2,539,000	2,539,000	2,539,000
Profit before Tax (Monthly)	4,502	913,134	1,807,283	(-151,210)	1,470,140	3,094,240	4,572,030
Annual Profit	54,024	10,957,608	21,687,396	(-1,814,520)	17,641,680	37,130,880	54,864,360
Tax	7,580	2,695,000	5,430,000	-	4,410,420	9,282,720	13,716,090
Net Profit	46,444	8,082,608	16,257,396	(-1,814,520)	13,231,260	27,848,160	41,148,270
% Sales	.24	12.0	18.4	-(2.1)	11.2	18.8	23.2

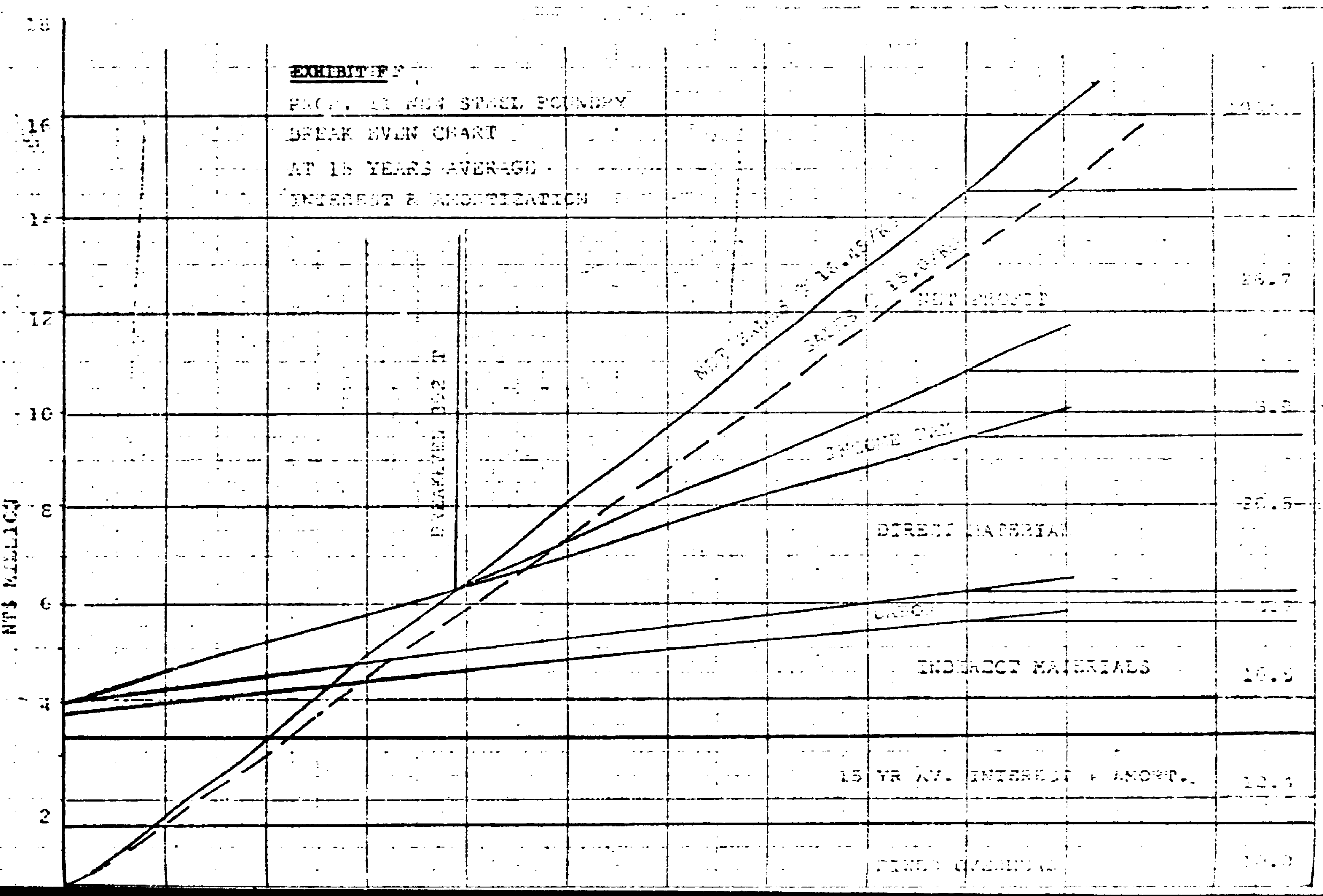
EXHIBIT F
BREAK EVEN CHART
AT 15 YEARS AVERAGE
INTEREST & AMORTIZATION
NT$ MILLION
16
14
12
10
8
6
4
2
DIRECT MATERIAL
INDIRECT MATERIALS
15 YR AV. INTEREST + AMORT.
INCOME TAX
NET PROFIT

EXHIBIT F

Foundries Evaluated for Summary Report on the Steel Foundry Industry

1. **Chou's Iron and Steel Company Limited, Keelung - 12, 13 April 1972**

Private enterprise. Steel foundry requires molding machinery, sand preparation, core making and drying. Serious defficiency in heat treating equipment, particularly for austenitic manganese steel where temperature control is non existent. Procedures for manganese steel must be modified to assure good quality. In depth study needed to develop workable solutions to modernization. Presently exporting to South East Asia market.

2. **Dah Yung Steel Manufacturing Company - Kaohsiung**

7 April 1972

Foundry operations occupy two small areas in the end of two buildings. Foundry only secondary to ingots and rolled products and could be abandoned as a viable foundry industry develops in the Kaohsiung area.

3. **Nan Lung Steel and Iron Corporation, Taipei**

11, 12 April 1972

A privately owned enterprise, this operation is the most productive foundry in Taiwan. Well over half of the output is exported to the USA and others demonstrating acceptable quality, but only after excessive chipping and grinding. Production volume over three times the output of other steel foundries. Producing castings in green sand and skin dried molds and some sodium silicate. Extensive rearrangement and improvement of facilities will be essential for continued growth and particularly to improve foundry quality and reduce costs. Growth is feasible in present location but must be planned carefully to minimize disruption and the most effective plan.

4. **Taiwan Machinery Manufacturing Company**

Covered in depth in first part of this report and previous interim reports.

5. **Taiwan Ship Building Company, Keelung. Dec. 18**

10 April 1972

A new foundry has been planned by the staff for relocation to the site of the main shipbuilding yard since the site of the old foundry is to be disposed of. Although relocation is essential it is also considered essential to provide improved performance and capacity and to provide some economic justification for the change. Molding machinery, sand reclamation and return, properly controlled heat treating equipment are considered as basic needs in a new shop.

6. <u>Tang Eng Iron Works, Kaohsiung</u>

31 March, 3, 25 April 1972

The foundry output is a small part of the total product. However, the volume of ingot moulds and steel and iron rolls is substantial and important to the company as well as to the steel industry. It is considered advisable for the foundry to concentrate on this class of work. Steel casting output is small and not of good quality. Molding machinery, sand preparation and core making equipment are needed for improvement. Plans made recently for a large foundry complex to produce engine blocks and heads, miscellaneous iron and steel castings, iron and steel rolls and ingot moulds do not appear to be very sound. Too much capacity with too small a market could make this a very unprofitable operation.

7. <u>Ya Chou Steel Manufacturing Company Limited, Kaohsiung</u>

27, 28 March 1972

Generalized plans for expansion to provide for conversion to green sand molding and additional space for cleaning and heat treating castings are not in sufficient detail. It is essential that all machinery, conveying facilities, furnaces etc., be shown to assure an adequate and efficient layout. Productivity among workers is good. Although hand tools are used exclusively, they are of a heavy duty design and perform effectively. Surface quality improvement will not occur until improvement is made. Casting soundness is good but surface appearance is not better than other foundries.

Copies of technical reports to each foundry are appended to this Exhibit under identifying numbers.

金屬工業發展中心（函）

受文者	副本抄送	事由	批示
周氏鋼鐵公司		函送 Mr. Crogin 訪問報告請查照	

擬辦

一、聯合國派駐我國鑄鋼專家 Mr. H.E. Crogin 於四月十二日至十三日訪問貴公司期間，承蒙接待，特致謝忱。

二、茲附上 Mr. H.E. Crogin 致貴公司周監事長函及訪問報告各乙份，供作參考。

三、請查照。

總經理 [signature]

發文	
日期	中華民國　年　月　日
字號	60金工字第0880號
附件	如文

ETAL INDUSTRIES DEVELOPMENT CENTRE

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1 KAO NAN HIGHWAY, KAOHSIUNG, TAIWAN, THE REPUBLIC OF CHINA

UR REF: OUR REF:

May 15, 1972

Mr. T. S. Chou, Chairman of the Board
Chou's Iron and Steel Co., Ltd.
187 Patou Road
Keelung, Taiwan

Dear Sir,

Thank you for permitting Mr. M. L. Tsai of the Metal Industries Research Institute and the writer to visit your works on April 12 and 13th. Messrs Chao, Hsu, Chang and Yu were most helpful and spent a lot of time with us. The attached exhibit covers detailed answers to many of the questions raised by your capable staff. We hope they will be helpful to both you and the organization.

We feel that improvement in the methods and equipment in the steel foundries on Taiwan is essential to support the continuing growth of heavy industry in the country. To assure the orderly and effective modernization of a foundry, detailed planning must be undertaken to develop a master program. In this way every step of improvement will fit into the total plan.

We believe a feasible growth plan can be developed for your foundry which can yield dividends in lower costs and higher profit. Unfortunately, the alternate of no improvement will commit the operation to a non competitive cost and quality operation eventually.

We are prepared to assist you in developing plans for modernization and in consulting with your staff on quality and methods improvement. We would be pleased to meet with you to discuss arrangements for undertaking any studies you deem advisable.

Thank you for your help and we hope the attached will be useful.

Sincerely yours,

Herbert. E. Cragin, Jr.
Expert- Foundry
U. N. I. D. O.

Encl.

Chou's Iron & Steel Co., Ltd.

Visit April 12, 13, 1972

1. Melting Practice - Austenitic Manganese Steel

1.1 Normally the charge will be made up of 30 to 40% high manganese steel remelt or scrap with the balance to be carbon steel purchased scrap. The percentage of manganese steel scrap in the charge will depend upon the amount generated as gates and risers or available in the scrap market. As a minimum the charge should be planned to consume the gates and risers generated in the foundry. The maximum should be not exceed 50% of the charge.

1.2 To avoid a substantial addition of ferro manganese after melt down which will cool the bath and even allow some alloy in the bottom to remain unmelted, a portion of the ferro-manganese is added to the charge at the start. Charge should be calculated so the melt down composition will be C – .90 to 1.0% and manganese 9.5 to 10.5%.

1.3 After heat is melted, a test is poured and run for carbon and manganese and the necessary additions made. Carbon control particularly for heavy sectioned casting where carbon will be under 1.20 while manganese may be over 13.5 will require medium carbon ferro-manganese in addition to the regular high carbon ferroalloy. Since most of the silicon will be lost to the slag it may also be advisable to have a supply of ferromanganese silicon (silico-manganese) to provide part of the silicon and manganese, while keeping carbon additions low.

1.4 Normally used ferro-alloys in producing manganese steel are:

	C	Mn	Si		P
High Carbon Ferro Manganese	6.0/8.0	75.0/80	1.50	Max.	.204
Mod. " " "	.50/2.0	75.0/80	1-1.5	max.	.25
Silico-Manganese	.5/2.0	65/75.0	15.0/25.0		.15
Ferro-Silicon 45%	.1/.15	-	45.0/47.0		.05

The above will provide the complete flexibility needed for proper control of composition.

1.5 Although specifications for the chemical composition of austenitic manganese steel are quite broad, experience has dictated more restrictive limits for use by the foundry itself. If it is necessary to submit a proposal to the customer it is best to use the ranges set by ASTM A-128 or a similar specification as:

C – 1.05 to 1.35%

Mn – 11. to 14.0

Si – 1.00 max.

P – .07 max.

However, it will be advisable to set more restrictive limits in the foundry operation to provide the best performance in service consistent with the most desirable properties as:

Class	C	Mn	Si	
A	1.10/1.18	12.5/13.5	1.00 max.	-For heavy sections large casting
B	1.18/1.22	13.0/14.0	1.00 max.	-For maximum toughness and impact resistance
C	1.20/1.26	12.0/13.0	1.00 max.	-Miscellaneous manganese steel castings

1.6 The addition of up to 1.75 chromium has been employed for many years as one way to reduce flow and improve the abrasion resistance of austenitic manganese steel. Unfortunately U. S. foundries have promoted this addition at no extra cost to the customer. It is felt that while chromium does increase Brinell hardness about 20 points and reduce the initial flow, it will not work harden any faster than unalloyed manganese steel. In heavy sections and particularly if carbon is on the higher end of the range, it may not be possible to fully absorb the carbides during heat treatment and ductility will be reduced. It has always been our opinion that with carbon over 1.20, a properly heat treated unalloyed composition will provide as good life as with chromium.

2. Pouring practice-austenitic manganese steel

2.1 Pouring temperatures must be controled so that castings are poured at as low a temperature as possible consistent with filling the mold properly.

2.2 It is not possible to refine the grain structure by heat treatment therefore, strict adherence to temperature control in pouring is essential to produce castings having optimum properties. Grain size control depends upon the pouring temperature as well as the rate of cooling. Large castings covering a big area must be poured at a higher temperature than thick sectioned castings. But because of more rapid cooling, a fine grained structure can result.

2.3 It is advisable for the foundry to develop its own set of standards. It is suggested that test bar molds for grain size evaluation be made up and poured at different temperatures as recorded by optical ~~in~~ or immersion pyrometer. Bars may then be fractured and the grain size reported. An approximate relationship is shown below.

	Pouring Temperature
Coarse columnar -	1,600° to 1,635°C
Medium coarse	1,525° to 1,600°
Medium fine	1,490° to 1,525°
Fine	1,460° to 1,490°

2.4 Naturally when pouring castings requiring widely different pouring temperatures from the same ladle, some effective method of measurement must be provided. In this case it is not feasible to use stopper ladles in the writers opinion because of the problems developing in stopper operation. When the metal becomes cold (below 1,450°) the metal is apt to freeze at or in the nozzle. Metal at elevated temperatures (over 1,600°) needed for thin castings may cause stopper or refractory failure and loss of the stopper head.

2.5 Although there are disadvantages to the use of open ladles, the temperature of manganese steel can be controlled.

3. Casting handling from shakeout to Heat Treating Furnace

3.1 Normally manganese castings can be allowed to cool to room temperature without damage.

3.2 Exceptions are castings with metal sections over 3" and castings with differences in thickness or complex shape where severe residual casting stresses may be present.

3.3 It is advisable then to remove those castings from the mold at no lower than 400°C. Castings are cleaned of sand particularly in cored holes and transferred to a furnace heated to the same temperature.

3.4 Risers should not be gas cut from castings until after heat treatment. Because of the brittle nature of the as cast structure, cracks or hair cracks can develop from the heat of the oxy-gas torch.

3.5 One exception to the above rule is in the case of very large risers which create a section too large to heat treat properly. In this case castings are to be removed from the mold after pouring at 450°C and cleaned. The riser will be gas cut from the casting leaving no less than 25 mm of riser contact above casting surface while castings are over 400°C. Castings will then be transferred to the heat treating furnace while still hot.

4. Heat treatment of manganese steel

4.1 Heat treatment consists in heating the casting above the austenitizing temperature followed by a rapid quench in water.

4.2 Because, of the brittle nature and low strength of as-cast manganese steel and the low heat transfer rate, castings can be easily cracked by heating too rapidly from room temperature. While the heating rate will vary for different thicknesses and shapes, it should be kept below 55°C per hour. Normally, castings are to be heated at 30°C per hour to 400°C when the rate can be increased to 50°C. If load is heavy or castings are heavy it is advisable to hold for one hour each at 550°C, 820° and 960°C to allow furnace and load to equalize.

4.3 If carbon is high (1.25 to 1.30) it will be necessary to heat more slowly than above and hold castings at quench temperature about 50% longer to be sure of carbide solution.

4.4 A simple test for proper treatment is the use of 20mm x20mm x300mm test bars. These can be cast on each heat of metal and heat treated with the as castings. Bar should bend 180° around a 25mm pin with without failure.

5. Design of Manganese steel castings

5.1 While it is important to adhere to good steel casting design principles some special restrictions do apply because of the characterstics of manganese steel.

5.2 Heavy sections must be located so that adequate risers can be applied and easily removed.

5.3 The greater susceptibility of the material to hot tearing makes elimination of all internal sharp corners essential. Also linear shrinkage at 1/40 will develop stresses and hot tears on cooling unless mold restraint is removed by soft cores and early loosening of sand in mold and around heavy risers and gate.

5.4 Pattern design where possible should permit wearing surface to be cast in drag. Because, risers promote slow cooling and coarse grain, risers should not be placed on wearing side of casting if possible.

6. Successful modernization and expansion programs for foundries must have detailed planning to assure orderly growth. This is as true in USA as in Taiwan. Foundries who have bought new machinery or rearranged the existing plant without developing a total plan have failed t- accomplish the goal of improvement.

6.1 We believe substantial improvement in quality and cost is obtainable by changes in method, rearrangement of equipment and by the introduction of limited mechanization in molding and core making.

6.2 Heat treatment furnaces must be provided with automatic temperature and burner control. Furnace design and burner arrangement must provide a uniform temperature throughtout the oad.

7. It is considered experimental work on sand materials and binders is essential to improve surface quality. For most castings the base sand is too coarse. Because of the lack of compactibility of sodium-silicate sand, the mold presents a coarse open surface to the metal. Burned on sand, erosion and inclusions naturally result.

8. Markets

8.1 There is a substantial market for austenitic manganese steel in the mining industry through out South East Asia. Cement, rock quarries tin and gold dredging and other mining all use substantial tonnages. Further penetration in this market must depend on modern methods and rigid control of process.

8.2 An output of 100/150 tons per month is not sufficient to permit the economic justification of a major investment in modernization. As mechanization is introduced capacity is increased. An assessment of the total market penetration even totally possible should be made to permit proper financial analysis of the project.

8.3 Certainly with casting quality meeting international standards and with an efficient productive unit, competitive sales pricing and out put will assure the availability of orders to fill the capacity.

8.4 Further a marketting concept must be developed where knowledgeable foundry engineers participate in the sale of the product to the user. Developing a proper understanding of the needs of the customer is essential. On the other hand the casting user must be educated in what steel castings can do for him and how best to apply the substantial technology available to improve his own operations.

9. Manganese Steel Plates for Jaw Crashers.

It is essential for effective performance of both the crusher and manganese plates that the jaws be properly seated on the pitman and crusher frame. The jaw crusher derives its energy from the heavy pitman casting and heavy frame. If the jaw must seat itself each cycle of the pitman because it is not flat, loss of efficiency of the crusher occurs. Therefore the backs of both fixed and movable jaws should be machine ground to close tolerances. These tolerances will vary from ±1mm to nor more than ±4mm or large jaws. Normally a planer type of grinder is used with a motor driven wheel mounted on the cross head.

10. Improved core drying could be obtained by a redesign of the present small oven to provide a hot air blower to recirculate the heated air. A thermostat to control heat input would improve uniformity of heating.

Nan Lung Steel and Iron Corp.

Observations and Recommendations

Visit April 11 and 12, 1972

- Mr. C. M. Lee, General Manager
- Mr. C. H. Loh, Plant Manager

1. Core Making and Core Sands

Improvement in surface finish, elimination of lumps and fused send in the cored pin holes of tread or crawler shoes is needed. Cleaning time and costs are high. The extra work needed to clean the holes free of sand must destroy the accuracy of the hold. A number of steps are possible and must be checked for their effectiveness and cost:

1.1 Conversion to shell cores. Most accurate and most costly would be the use of a high production shell core blowing machine. However, justification of this must depend upon the quantities to be made and the accuracy required.

The present hand methods of producing shell cores are slow and will not yield consistent thickness or quality.

1.2 A simple arrangement is proposed which can be assembled at minimum cost. This consists of a frame for holding a core box vertically. One side of the frame is fixed while the other slides on two or four rigid guides. An air cylinder opens and closes the movable half bos. Electric heater units are attached to the back of the core box halves. A timer actuates a solenoid valve which opens the bos after a predetermined dwell time. Box, after being heated to the correct, temperature is closed and filled manually. After the proper wall thickness has accumulated, a sliding bottom to the box is withdrawn and the excess sand falls into a container for reuse. The timer controls the amount of backing and opens the box for core withdrawal.

Since, most of the tread shoes being produced are standard items, boxes can be made up and heaters mounted permanently. It is believed the cost of the equipment and the needed core boxes will be more than offset by the savings in cleaning.

.3 Where quantities are small or future demand is unknown it may still be necessary to use either oil sand or CO_2 hardened, sodium silicate sand. In either case a finer sand should be used. An AFS 60 to 65 GFN would be desirable if possible.

Fwu Long fine is close to this but may not be of good enough quality.

.4 Since conventional oil or resin bonded sand must be baked and has low green strength it may be easier to use an air hardening, type of binder. The core can be hardered sufficiently with an oxidizing or acid type of hardener to be removed from the box and then oven baked.

.5 The simplicity of the sodium silicate-CO_2 system in view of existing factities and material may dictate its continued use for some core making. It is recommended that finer sand be used and different additives be tested to develop better collapsibility and reduced burn on. Materials to be tried for improvement would include.

1.5.1 Silica Flour - 200 mesh up to 10% addition.

1.5.2 Cellulose materials such as ground wood flour or equivalent.

1.5.3 Pitch - Although this provides high temperature bonding strength it also is an organic material which will burn out. Care must be used since it is a gas producer and quantity must be minimized.

1.5.4 Dextrine or corn flour up to .5%.

2. Molding Methods and Materials

2.1 Methods being used in producing skin dried castings on jolt squeeze draw machines represent a substantial improvement over sodium-silicate-CO_2 system in general use in Taiwan. Cleaner castings with less burned on sand and reduced non metal inclusions have been obtained. Also higher productivity and more effective use of floor space has resulted.

2.2 Minor charges in the sand mix would further improve moldability particularly in the deep pockets in the pattern where insufficient flowability prevents hard ramming. It is believed a small reduction in bentonite will help. Also part of the dextrine could be replaced with a cellulose such as wood flour or corn flour. The absence of any dust collection or exhaust system on the shakeout and sand screening allows all fines to be retained in the sand. Much of this fine material has no bonding capability and serves only to tighten and stiffen the sand. Its removal would have the opposite effect. The use of a moldability test pattern as shown on page 22, 23 of Dietert's Sand Control (copies attached) would be useful in experimental work to obtain improvement in the molding sand.

2.3 Future plans for modernization will have to include shakeout, screening, magnetic separation and storage of sand preparation with controls on moisture and additives and delivery to the molder are essential for the productivity considered necessary for growth.

2.4 Future planning should also consider the application of pneumatic reclamation to reduce the volume of sand purchased and discarded. Even though the cost of new sand is low the purchase of nearly 500 tons per month means costly handling. The amount can be substantially reduced by reclamation.

3. Melting Equipment

3.1 It is suggested that future planning should consider the use of a furnace smaller than the 6 ton size currently planned. The large heat size means more space for mold set out; will require more molds to receive a full heat of special composition.

3.2 A smaller furnace at 4 - 4.5 tons normal charge will improve flexibility and with a high capacity transformer can produce a heat in 2 hours and 30 minutes. At sixteen hours of melting, 360 tons of castings per month can be produced. As demand increased the furnace could produce over 600 tons of castings per month on a 24 hour operating schedule.

3.3 With the new baling press and selected bulky scrap charging time can be minimized using a top charge furnace and most important the second charges eliminated. With automatic electrode control and a high powered transformer, a 4½ ton charge can be melted down in about 1½ hours from tap of previous heat.

3.4 Since longrange plans includea 15 ton furnace for continuous casting of billets, castings requiring more metal than the 4½ tons available could be poured from the large furnace.

4. Furnace Fume Control

4.1 The proposed air pollution control regulations are to require a highly efficient system both in capturing the fumes at the furnace and in cleaning the air to be exhausted to the atmosphere. It will impose the need for a well planned system now to avoid costly replacement under government restrictions later.

4.2 The requirements of an effective system involve three main elements:

4.2.1 Hood design. The evolution of hood design has progressed from the orginal full roof type where supposedly all fumes were directed to an exhaust duct by a hood covering the entire roof and ring. Most small furnaces up to 10 tons now are equipped with a "side draft exhaust hood" which depends upon air velocity across the openings for the electrodes to collect fumes. In addition hoods over the operating door and sometimes the tap hole provide complete capture.

4.2.2 The primary advantage of the side draft design is that it does not restrict electrode movement and it permits dissipation of heat from the roof, prolonging life.

4.2.3 The effective performance of a side draft hood depends upon a properly designed volume of air flow in the system. Less than required air flow naturally will not permit capture of all fumes. This creates dirty air in the shop which will eventually escape thru windows or other openings in the roof.

4.2.4 Because of the high heat evolved during oxygen blow and the occurrence of sparks in the hot fumes it is essential that about 30 meters of duct work connect the bag house with the side draft hood.

4.2.5 The bag house must present a sufficient area of cloth (dacron type) to the dirty air to provide efficient filtering. Less than the correct amount of cloth area means rapid accumulation of dust and early loss of efficiency. Normally the ratio of cubic feet of air per minute divided by cloth area in square feet should be under 2.75:1. This is equivalent in the metric system to an air in cubic meter/min. ratio to cloth in square meters of .84 : 1.

4.2.6 The system now being installed does not appear to us to be adequate. The size furnace would require at least 450 M^3/min. air flow. Most systems for similar size furnaces with which I am familiar have been designed for over 500 M^3. The cloth filter system with 312 bags at 5" x 2 meter long will provide 4930 square feet or 458 M^2. This at a ratio of 2.75 : 1 (US system) is adequate for an air volume of 384 M^3 - 13500 cuft./min. It is recommended the entire system be reviewed by engineers competant in designing similar systems before investing further.

5.0 Plans for modernization and Expansion

5.1 It is believed an effective plan can be developed for the expansion and the essential modernization of the steel foundry. Such a plan must include more working space, the consolidation of all molding in one area served by sand delivery and shakeout system and with overhead crane equipment for pouring. Core making is to be separated from molding but located for easy delivery of cores to molding areas.

5.2 Because of the substantial investment in induction furnace equipment at the north and of the building, it is considered advisable to establish molding facilities especially for high alloy castings.

5.3 Melting

As detailedin paragraph 3, one 4 ton furnace will provide sufficient metal for up to 600 tons of castings per month. It appears desirable however to plan on the location of a second furnace for future growth. All melting activity should be consolidated located adjacent to the source of scrap and serving the main pouring bay of the foundry.

6. Ni Hard Grinding Plates for Paper Mill Machinery

It was suggested that the hair cracks developing during grinding the teeth resulted from the heat of grinding. A change in the type of wheel or the pressure and speed would correct the problem. M. I. D. C. is equipped to analyze the problem and make the needed recommendations on the best grade of wheel for the work and further test the recommendation on machine grinding equipment.

金屬工業發展中心(函)

受文者	台灣造船公司
抄送副本機關	
事由	函奉聯合國駐我國鑄造專家 Mr. Cragin 訪問報告由。
批示	
擬辦	

一、聯合國駐我國鑄造專家 Mr. H.E. Cragin 前於四月十日至 貴公司鑄造廠訪問承蒙接待，謹致謝忱。

二、茲隨函附奉 Mr. Cragin 致貴公司總經理函及其訪問報告乙份供作參考。

三、函請查照。

總經理 齊世基

發文 中華民國 （61）金工 字第 號

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OUR REF: ℓ 02...

May 10, 1972

婁海波先生

General Manager
Taiwan Shipbuilding Corp.
Keelung

Dear Sir,

We wish to thank you and your foundry staff for the courtesy and hospitality shown to Mr. M. L. Tsai and the writer during our visit on April 10, 1972. We had a full day and Mr. Liu and others of his staff were very helpful in answering our questions and supplying needed information.

Many subjects were covered during the day. We have prepared the attached notes to confirm and further elaborate on our answers to many of the questions raised by the staff.

We reviewed the proposed relocation of the foundry. We suggest that although it is essential that a new foundry be erected, there must be a return on the substantial investment in reduced costs, better productivity and improved quality. As we visualize the plan there is to be little change in method or improvement in the use of labor; in other words no reduction in operating costs. Based upon a present demand by Taiwan Shipbuilding for steel castings of only 100 tons per month it seems too small a justification for a major investment.

We do believe that within the approximate space planned for the building a comprehensive long range plan can be developed which would provide for the improvements desired. Installation could be done in steps as demand and need increased.

We are prepared to under-take such a study in conjunction with your foundry staff. A feasible plan would first be developed. Then proposed operating costs and potential savings possible could be compared with the cost to erect the new foundry.

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YOUR REF: OUR REF:

Recommendations on the economic feasibility of the project would be presented.

We would be pleased to discuss the means to accomplish such a program with you at your convenience.

Your help and assistance has been appreciated.

Sincerely yours,

Herbert E. Cragin, Jr.
Expert - Foundry
United Nations Industrial
Development Organization

Encl.

HEC/sc

cc: Mr. Liu, TSB
Mr. S. C. Chi
Mr. M. L. Tsai

Taiwan Shipbuilding Company

1. Further study of the layout for the new foundry planned as a replacement for the existing foundry would be advisable. Although it is essential that a new foundry be planned, since the present site is to be transferred to another activity, the facilities and layout should also be modernized. Reduced operating costs are essential to retain a competitive position and to provide needed quality improvement.

2. Mechanized molding should be considered for both quality and cost improvement. Hand methods do not assure consistency and will have over three times the labor cost as even the simplest of mechanical molding. Although, extensive mechanization probably cannot be justified or considered at present, the plan must provide space for mecnanical molding, sand preparation and delivery at a future date. Normally, it is advisable to locate all medium to small mechanized molding in a side floor bay with mold delivery to the main bay for pouring.

3. Since the core department may be required to service both iron and steel molding it would be desirable to locate the department between the two operations.

4. Consideration of an improvement in the transformer power should be given. Labor cost for melting is excessive. Twenty seven men for scrap preparation and furnace operation is well above normal for a four ton furnace. With automatic electrode controls, scrap handling and a top charge furnace this could be reduced to a furnace and ladle crew of no more than five per shift. Overhead crane for scrap loading should permit a crew of no more than four for charge preparation. With a transformer of 2,500 KVA or over 3,000 KVA, a heat in 2¼ hours tap to tap would be possible. Labor cost per ton could be cut from NT$208 per ton melted to

NT$65 per ton based upon an average rate of NT$13 per hour and 16 hours melting. The high powered transformer would yield 24 tons of metal per day, while the present unit would yield 13.5 tons in the same time.

5. Refractory and electrode costs also would be reduced. The savings in labor and material could offset the increased power fixed charge.

6. Heat Treating : Manganese Steel

The quality of austenitic manganese steel castings depends upon proper heat treating. Temperature for quenching must be at least 1050°C. Castings should remain at that temperature one hour for every 25 mm of thickness. Castings should not be heated from cold to 350°C faster than 30 - 35°C per hour. From 350°C to 600°C rate can increased to 45°C per hour. If castings are taken from mold over 400°C they will not be as sensitive to cracking thru rapid heating and can be charged into a furnace at 600 - 650°C. For heavy manganese steel castings over 100 mm thick, it is essential to avoid cooling to room temperature before heat treatment. The above practice of removing from the mold at about 400° - 500°C, cleaning sand from cored openings and charging in a furnace at the same temperature will avoid heat treating cracks.

7. Furnace Design

7.1 For the volume of manganese and carbon or low alloy steel being produced one properly designed car type heat treating furnace should be adequate.

7.2 Multiple burners spaced on either side of the furnace with inside baffles to avoid flame impingement on the castings will assure uniform heat distribution. Car must be designed with piers to permit circulation around the furnace load. At least two or three thermocouples are required to permit burner adjustment to equalize temperature in furnace.

7.3 Both car and door must be powered so furnace will have flexibility for quenching of manganese steel, normalize and temper or anneal of low alloy and carbon.

7.4 It will be possible to load both carbon and manganese on the same car. At 900°C the car can be run about half way out, the carbon steel castings removed by overhead crane and placed in air blast for normalize. Balance of manganese steel load is to be brought up to 1050°C held for soaking and quenched in the water tank near by. Furnace will be allowed to cool to draw temperature when carbon steel will be reloaded for tempering.

7.5 Burner equipment must be designed for the three ranges 1050°C, 900°C and 500 to 680°C for draw. Adequate control at the lower temperatures is obtainable by the use of "excess air burners" as produced by North American Manufacturing Co. Cleveland, Ohio, U. S. A.

7.6 The heat treating of manganese steel using car type furnaces and overhead crane handling can be recommended with confidence in view of the long years of experience with this method in USA. The best method is the use of a special gantry type crane with fork handling of trays. But these are costly and would require substantial volume to justify.

7.7 The calculations on the heat transfer capacity of a quench tank for manganese develops a requirement for 19300 kg of water to quench 3 tons of high manganese steel. A further requirement for a proper quench is vigorous agitation and circulation to remove the layer of water vapor (steam) which adheres to the surface of a hot casting during quench. A flow of cool water in at the bottom of the tank and overflow at the top plus propellor agitation will increase the heat extraction capacity substantially. A tank 3 meter x 3 meter by 2.500 should be adequate. If longer castings are to be produced the dimensions could be altered to suit.

Pouring Manganese Steel

8.1 Pouring temperatures of high manganese steel castings must be controlled to assure optimum grain size and grain structure. A course columar structure in manganese steel cannot be refined by heat treatment and will have 20% lower fatigue strength in repetitive stressing. Pouring temperature should be as low as will permit proper filling of the mold. Small thin sectioned castings must be poured hotter than small chunky castings. Big castings having a large area will have finer grain because of more rapid cooling than heavy sections poured at the same temperature.

8.2 Until experience can be developed it would be advisable to pour a grain size test bar attached to the down gate on all large castings. Bar should be 35mm x 35mm x 200mm in length. A V shaped marker at the center point will make it easy to fracture when it has cooled. See sketch attached.

8.3 Control of temperature in pouring manganese steel is generally done by eye. Using an optical pyrometer on a slag free surface is essential for accurate control, until experience can be gained in judging from color of hot metal.

8.4 Where all castings to be poured have similar metal sections and are about the same size the temperature can be controlled at the furnace and a stopper ladle is feasible. But where widely varying sections and sizes are to be poured from a single ladle, the only effective way to pour at the proper temperature is to use an open ladle and an optical pyrometer.

8.5 Another draw back to a stopper ladle is that pouring rates cannot be controlled and frequently large heavy castings will be poured too slowly.

). Manganese Steel Hammers

9.1 It is suggested that the hole for the shaft be cored and then drifted. The drift is a hardened steel plug so dimensioned that when pressed thru the cored hole it will produce a hole of the correct size to close tolerances. The operation will also work harden the surface of the hole.

9.2 The problem with using steel inserts is the manganese steel will have a tendency to develop "wrinkles or folds" at the surface of the insert. This can be the starting point of a crack. Failure of one hammer can cause considerable damage to the mill.

9.3 If shaft wear is too rapid, the use of hardened shafting would be indicated.

. It is suggested that a drawing for the 2870 kg jaw plate which was produced in December 1971 and which has now been reported as cracked by the customer, be sent to us for review and recommended design change. We may be able to assist you in convincing the Cement Company of the need for change.

Samuel, Samuel

金屬工業發展中心（函）

受文者	副本抄送	事由	批示
唐榮鐵工廠股份有限公司		函奉聯合國駐我國鑄造專家 Mr. Cregin 訪問報告由。	擬辦

一、聯合國駐我國鑄造專家 Mr. H.E. Cregin 於前三月底及四月初至 貴局公司鑄造廠訪問，承蒙接待，謹致謝忱。

二、茲隨函附奉 Mr. Cregin 致貴公司吳董事長函及訪問報告乙份供作參考。

三、函請查照。

總經理 齊世基

副本

如文

中華民國 年 月 日

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OUR REF:

May 17, 1972

Mr. Samuel S. C. Wu
Chairman, Board of Directors
Tong Eng Iron Works, Taipei Office
65 Kuan Chan Road
Taipei

Dear Mr. Wu,

I am honored to receive an invitation to the official opening ceremony on May 21, 1972 of the new alloy steel plant. You are to be congratulated upon the foresight and courage which it must have taken to start this program. I am looking forward to seeing the plant.

As you know, together with Mr. M. L. Tsai of MIDC, I have inspected your two foundry operations as part of a survey being made of the steel foundry industry in Taiwan. Summary report covering our observations and suggestions has been prepared. Unfortunately, it was misdirected and we understand you may not have received a copy. I am taking the liberty of sending another copy of the detailed report and our covering letter.

Investment in modern foundry facilities is essential if the industry is to compete successfully in the Asian and world markets. Modernization will produce increased capacity. The new capacity needs volume for profitable operation. It is for this reason we are concerned about the extensive facilities which were planned two years ago and which we learned are now being reviewed. If present plans are comparable to the former layout developed by Kubota, you will have a very large capacity for which orders must be obtained.

It has been my opinion that it would be better to modernize existigg facilities primarily for quality improvement, and cost reduction. With competitive quality and price the market can be penetrated and evaluated. On the basis of this experience and with increased volume at hand, plans for completely new plants can be more realistically developed.

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It seems to me that it would be as dangerous to the rapidly growing economy of Taiwan to create an over capacity in foundry plants as to do nothing about the serious deficiency in this area.

Although the United Nations Technical Programs are to be terminated June 1, I am planning on returning to Taiwan after a debriefing session in Vienna and expect to continue this work as a consultant to the foundry industry with M. I. R. I.

We trust we can assist you in developing a realistic and effective program for the growth of this very essential foundry industry. We would be pleased to discuss this with you and the means by which this can be accomplished.

Sincerely yours,

Herbert E. Cragin, Jr.
Expert - Foundry
U. N. I. D. O.

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OUR REF:

May 9, 1972

General Samuel S. C. Wu
Chairman, Bord of Directors
Tang Eng Iron Works, Taipei Office.
65 Kuan Chan Road
Taipei

Dear Sir,

During the visits Mr. M. L. Tsai and the writer made in March and April to observe your foundry operations Mr. C.L.Lee was very helpful. He supplied answers to our many questions and at the same time asked questions of us. The attached is a summary of the information we transmitted to him on our visits, as well as opinions we have developed following a study of the data and information. We greatly appreciate the time Mr. Lee spent with us and thank you for the opportunity to see your operation. We hope the information and suggestions contained in the attached may be helpful to you and your staff.

Since you are now considering the expansion and modernization of your foundry facilities, the comments in paragraph 8 will be pertinent.

It is our opinion that a foundry must concentrate its talent and knowledge in limited areas. Expansion in many directions will not produce an economical or profitable operation. Markets are limited as yet in Taiwan. Companies able to produce the best quality at competitive prices will assure themselves of a large share of any special market they enter. But we doubt if this can be done in several market areas at the same time.

Another important point must be considered in planning a mechanized molding system for an item like a truck engine cylinder block. Mechanization creates productive capacity as in molds per hour. Such equipment must be operated on a full shift and full month basis. Thus a substantial volume of business is needed to maintain efficient operation. A cylinder block line on one shift can produce up to 4,000 molds per month.

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Efficient operation would yield at least 3,000 molds per month or from 350 to 500 tons per month on one molding unit. At the present time, this added volume is just not available in Taiwan.

We suggest that before investing heavily in a new foundry facility, a thorough analysis or estimate must be made of the markets in terms of the productive equipment needed for molding. Thus rolls and ingot molds require high bay cranes, heavy flask equipment, large mold drying ovens and a large melting capacity per heat. On the other hand engine parts must have high pressure molding machines producing many molds per hour. This requires a steady flow of cores, of molding sand and of metal at the right temperature and composition, and most important a mold, sand, flask and casting handling system paced to the molding rate. A substantial investment is essential for such facilities, and it can be justified economically only if operated near capacity.

We are confident that the M.I.D.C. organization can supply valuable assistance to your staff in this project as much in avoiding over investment as in tailoring the planning to the best interests of Tang-Eng and of Taiwan.

We hope we may have the privilege of discussing the above with you. Thank you and Mr. Lee for the assistance you have given us in the current study.

Sincerely yours,

Herbert E. Cragin, Jr.

Expert - Foundry
U. N. I. D. O.

HEC/sc.

Teng Ing Iron Works Ltd.

Visit March 31., April 3, April 25

1. Ductile Iron Rolls

1.1 Failure of a number of ductile iron rolls by cracking thru the heavy center section would suggest deviations in melting practice and composition. The literature is comprehensive in defining the effects of carbon and silicon as well as the limits necessary on manganese, phosphorus, sulfur as well as many trace elements.

1.2 Having no details of the chemical composition or micro structure of the failed castings it is not possible for us to suggest the cause or recommend corrective action. We can suggest a number of fundamental principles which must be adhered to for assurance of successful performance.

1.3 The production of ductile iron is sensitive to many influences the most important of which is composition. Special pig iron having very low levels of silicon, sulfur, phosphorus and manganese is considered essential as a base material. The pig iron must also have very low levels of the "so-called" subversive elements which inhibit the formation of spheroids or which are carbide forming. The purer the pig iron the greater the tolerance for undesirable elements in the steel and other scrap to be used.

1.4 It is suggested that failure of the roll castings has occurred because of embrittlement, loss of ductility, segregation of graphite or failure to obtain a proper structure. Most of these conditions trace elements. Further, the effect of an undesirable structure is far greater in very heavy sectioned castings such as a roll. Internal casting stresses are present because of the variations in cooling rates caused by shape.-

1.4.1. Manganese

Although increasing manganese will raise the tensile and yield in both as cast and annealed ductile iron, the elongation is reduced rapidly when manganese exceeds 2%.

In very heavy sections manganese causes the formation of carbides and because of the slow cooling rate, segregation occurs producing areas of high manganese content near grain boundaries where carbides will then form. A maximum manganese in the iron of .40% is considered essential because of the above problem.

1.4.2 Phosphorus

Phosphorus should be held below .04 and preferably in heavy section around .025 to ensure optimum properties of ductility, and toughness in heavy sections. Retention of a ferritic structure instead of pearlitic would provide greater assurance against crack failure.

1.4.3 Sulfur

Under .02 retained is desirable for economy and quality. Higher amounts will necessitate more magnesium and can contribute to the formation of manganese sulfide which will appear in the form of inclusions.

1.4.4 Carbon and silicon

The carbon equivalent (C.E.) should be held below 4.3 for optimum properties.

1.5 While a single deviation from any of the above limitations may not be critical in normal castings, the cumulative effect of even small departures from standard practice in heavy section rolls can cause catastrophic failure as has happened.

1.6 We recommend a thorough analysis of every step in the manufacture if it has not already been done. This should include complete chemical analysis of every failed roll. Standard elements as well as the harmful trace elements must be checked. Microstructures of the surface and center of the section should be examined. Sufficient data will be obtained to establish the exact cause or causes for failure. Corrective action can be taken to set tighter limits on types of scrap, pig iron, alloy additions and inoculation procedures. Check points can be set on the procedure to ensure performance.

Note: A copy of an article in Modern Casting 1967 heavy ductile rolls is included for your information.

2. <u>Chilled Iron Rolls</u>

To avoid the inconsistencies which are certain to occur in heating chills with wood fires, it would seem reasonable to design and build an oven with thermostatically controlled temperature. Electric heaters with a circulating fan will provide uniformity and absolute control. Structure could be sheet metal with fiberglass or other insulation.

3. Modernization Planning

While it is essential that improvements be made in the facilities and equipment in the foundry, it is suggested that in many areas improvements in procedures and methods will result in better quality and lower costs. The last two factors can contribute to a widening market which in turn can permit expansion projects. Planning should involve first solutions to equipment limitations which affect quality and second productivity and cost.

4. Based upon our short survey of the two foundry operations it appears logical to concentrate in product areas in which competition is restricted. Presently, every shop operating on the island attempts to make miscellaneous steel castings. Quality is not [illegible] and productivity is low.

5. The size and height of the buildings make consideration of large size castings more attractive than an attempt to produce all sizes. Further, dependence by Tang Eng on rolls and ingot molds for use in its operations makes it urgent to analyze the market and the type of facilities needed to produce an acceptable quality roll at competitive prices. The new China Steel Co. will also represent a sizeable demand for rolls.

6. It would be our suggestion to develop preliminary plans using existing buildings for the production of steel, ductile and chilled iron rolls.

7. So long as the demand exists the foundry also could produce ingot molds.

8. A brief review has been made of the plans prepared by [illegible] covering a combined foundry operation to include a mechanized iron green sand molding system for gasoline engine parts, rolls and ingot molds and steel castings.

   8.1 We question the advisability of a combined operation such as this. It becomes very difficult to maintain effective quality control on products differing from a thin walled complicated six cylinder engine block and head to large ingot molds.

   8.2 The limited degree of technical experience in foundry operation in Taiwan makes it even more important to keep an operation simple. Concentrating all available talent on producing one type of product to high quality standards will be more rewarding than scattering the talent in many directions.

   8.3 Production Capacity

   (For details see Exhibit A.)

   8.3.1 The molding lines for iron castings with modern molding machine equipment will have a productive output if operated efficiently as:

   Small casting - 10,000 molds per month
   250 tons " "

   Cylinder Blocks and heads - 4000 molds/month
   630 tons/month

The military engine casting demand, based on 4,000 engines per year (two sizes) is only 110 tons per month. This means that the equipment required to produce high quality castings for the engines, will have almost 8 times the productive capacity needed.

8.3.2 Making similar estimates on the steel system and the proposed demand for ingot molds and steel and iron rolls the total output capability of this foundry on one shift would be:

Iron	- Engine Castings	110 T/mo.
	Miscellaneous to 200Kg	[illegible] T/mo
	Ingot Molds	400 T/mo
	Chilled & Ductile Rolls	300 T/mo
	Total	1,[illegible] Tons/Mo.
Steel	- Rolls	100 T/Mo
	High Alloy (Induction)	25 "
	Miscellaneous Steel to 200Kg	720 T/mo
	Large Steel -floor	25 T/mo
	Total	[illegible] T/Mo.

8.3.3 The above is an excessively large capacity in consideration of the existing market in Taiwan. It doesn't seem advisable to anticipate an export market which does not exist and cannot be developed until the facilities are in operation and producing castings of international quality.

8.3.4 To break even after paying the interest and loan amortization costs and depreciation on the new facilities will require approximately 60% of the capacity or [illegible] tons of iron castings, ingot molds and rolls and 540 tons of steel castings.

8.3.5 It should also be recognized that interest, taxes and profit are expressed in NT$ not tons. A large tonnage of an item like an ingot mold at NT$5 per kg doesn't supply many dollars to pay for the costs of money.

9. Although equipment in the foundry in some cases is old and not modern design, improvements in quality and cost could result if efforts were made in this direction.

9.1 Experimental work on materials used in molding should be undertaken to improve surfaces and reduce the excessive chipping time on steel castings.

9.2 A qualified engineer or practical foundry man should be assigned the single responsibility for all foundry planning to include molding method, pattern design and rigging for gating and risering. Improperly fed castings are ample evidence of a need for correction.

9.3 House keeping can be substantially improved. A clean orderly work shop promotes a better attitude by the worker towards his job and quality will tend to improve.

9.4 The limited output at present of both rolls, ingot molds and castings should make consolidation of all activity in one building advantageous. Staff could concentrate on developing the quality control functions needed to reduce to the minimum any losses on chilled or ductile rolls

10. Roll Manufacture

10.1 It is considered advisable to obtain advice from experienced roll manufacturers on the best practical procedures for iron and steel.

10.2 It should be possible to obtain a short term consultant thru the International Executive Service Corp. Roll foundries who may be contacted are listed in Exhibit D.

Tang Ing

EXHIBIT A

Proposed new foundry - <u>One shift operation</u>

1. MELTING <u>MONTHLY CAPACITY</u>

   1.1 6 ton arc furnace steel

   2½ heats in 8hrs. x 2 x 6T= 30T x 25 = 750T x 80% = <u>600 T/mo</u>

   1.2 2 - 1 ton high frequency furnace 2 hrs/heat

   1 x 4 x 25 = 100 x 60% = <u>60 T/mo</u>

   1.3 2 - 6 ton low frequency 3 tons/hr. each furnace

   3 x 8 x 2 x 25 x 80% = <u>960 T/mo.</u>

   1.4 2 - 3 ton low frequency 1 ton & tapped every 40 min.

   1 x 12 x 2 x 25 x 80% = <u>480 T/mo</u>

2. MOLDING

   2.1 Jolt squeeze strip 2 machines for cope and drag

   50 molds/hr. 25Kg/mold

   1250 Kg x 8h. x 25 = <u>250 T/mo</u>

   2.2 Mold line cyl. block

   Jolt squeeze high pressure

   20 molds/hr. x 8 x 150Kg x 25 = 600. Ton/mo

   2.3 <u>Steel Molding Line</u>

   2 - Cope and drag line

   1 line 10/hr. x 200Kg x 8 x 25 = 400 T/mo.

   1 line 20/hr. x 80Kg x 8 x 25 = 320 T/mo.

   2.4 Ingot mold 20/day 800Kg ea.

   16 x 25 = 400 T/mo

   2.5 Rolls 10/day x 1.6 t av. ea. = 400 T/mo

EXHIBIT B

Roll Foundries - U. S. A.

Blaw Knox Company

600 Sixth Avenue

Pittsburgh Pa. 15222

Mackintosh Hemphill Division

E.W. Bliss Co.

901 Bingham St.

Pittsburgh Penn. 15203

Ohio Steel Foundry Co.

P. O. Box F

West 4th Street

Lima, Ohio

United Engineering Foundry Co.

948 Fort Duquesne Boulevard

Pittsburgh, Penn. 15222

金屬工業發展中心（函）

受文者	亞洲鋼鐵公司
抄送 副本 收受機關	
事由	函送 Mr. Cregin 訪問報告請查照
批示	
擬辦	

一、聯合國駐我國鑄鋼專家 Mr. H.E. Cregin 於三月廿七日至廿八日前來 貴公司訪問期間，承蒙接待，特致謝忱。

二、茲檢附 Mr. H.E. Cregin 致 貴公司林協理函及訪問報告各乙份請參考。

三、函請查照。

總經理 [signature]

發文	
日期	中華民國 [illegible]
字號	(61)金工 字第 [illegible] 號
附件	如文

297×210cm

L INDUSTRIES DEVELOPMENT CENTRE

... HIGHWAY, KAOHSIUNG, TAIWAN, THE REPUBLIC OF CHINA

P.O.BOX: 00232 KAOHSIUNG
3950 TAIPEI

CABLE: MIDC KAOHSIUNG
MIDC TAIPEI

TEL:KAOHSIUNG:221128.221120.221130
TAIPEI:713181.713182.713183

OUR REF:

May 12, 1972

Mr. C. T. Lin, Deputy Managing Director
Ya Chou Steel Mfg. Co. Ltd.
11, Kao-Shan 3rd Road
Kaohsiung

Dear Mr. Lin,

We apologize for our delay in forwarding the attached observations and suggestions developed during our visit on March 27 and 28 1972. We are very appreciative of the time you gave Mr. Y. L. Tsai and the writer both days. It is hoped the attached comments will be of value to you. Any major investment in new or expanded facilities must have careful and thorough planning and analysis. An adequate return on the investment is essential. Further the new facilities must provide an increased flow of cash to permit repaying the source of funds.

It is also essential that detailed layouts and studies be made of the proposed expansion. It is mandatory if the program is to be accomplished in a series of steps that an early installation does not block an important phase of the program to be scheduled later. Thus, a total plan should be prepared in detail in order that future problems can be anticipated and dealt with in the original plan.

M. I. D. C. is available assist you in developing this study and in preparing the layouts and detailed operating and installation cost studies. We would be pleased to discuss arrangements with you when you are ready.

Again thank you for your help and courtesy during our visit.

Sincerely yours,

Herbert E. Cragin, Jr.
Expert - Foundry
U. N. I. D. O.

cc. Mr. Hsu, Chairman

HEC/ko

Ya Chou Steel Mfg. Co. Ltd.

Visit March 27 and 28, 1972

1. Marketing - Local and Export

1.1 Participation in any market whether foreign or local must depend upon quality, price and the capacity to meet the customers specific requirements. The steel foundry particularly has no "product" it can develop or "line" it can promote. Dependence upon Trading Companies for inquiries is an unstable proposition since the primary reason for the Trading Company's interest is low price.

1.2 On the other hand labor represents a large part of the sales value in U.S.A. and other western foundries because of high unit labor rates. With modern equipment and facilities the efficient utilization of labor will provide a foundry here with a very competitive position both in local and & foreign markets.

1.3 We should emphasize that this modernization must be accomplished first. Foreign users of castings have no incentive to invest in local foundry activity. The planning and execution of a modernization and expansion program must be initiated by the foundry management. Because such a project will involve substantial sums it must be well planned. Most operations cannot afford a large investment in new facilities so it is logical to undertake a program in steps. If it is possible to show cost reductions at each step of the program, some assistance in paying for the program will result. But it is essential that the total program be planned completely. Projected operating costs will permit estimates of of future profits and the ability to penetrate other markets.

1.4 We believe it to be essential that the expansion involving a new cleaning building and rearrangement of equipment be planned in detail. Onlythru such an analysis can management be confident of the soundness of the plan.

2. In view of the plan to convert molding from sodium silicate to green or skin-dried sand, an investigation and experimental work should be undertaken promptly to develop the materials to be used and the resulting quality to be obtained. The use of a molding machine to produce molds even if serviced by hand would provide a measure of the quality improvement to be anticipated.

3. Conversion to molding machines and molding sand system is to involve substantial cost for patterns and flasks. Justification must be developed thru reduced labor costs in molding and cleaning.

4. Furnace fume control

Information has been requested from foreign firms on the various methods in use for collecting and exhausting furnaces from electric arc furnaces. Assistance can be provided by NIDC in this area when required.

5. X-ray

5.1 While an X-Ray machine would be a very useful piece of equipment, it is considered too costly for the amount of work to be inspected now.

5.2 Generally, unless foundries are engaged in producing a large quantity of castings with very rigid requirements on quality such as air craft, high pressure steam and oil refinery castings, the X-ray system is not needed. Only where large numbers of castings require routine X-ray inspection is ~~ma~~ the equipment essential.

5.3 Cobalt 60 isotopes and radium can be used successfully for pilot casting examination and for a limited amount of routine inspection.

6. Ladle Practice - Austenitic Manganese Steel

6.1 Grain size in manganese steel can be controlled only by proper pouring temperature. Since a fine grain structure will have the highest strength and yield in repetitive stressing (fatigue limit), it is desirable to pour every casting at that temperature which will produce fine grained structure. This means that when many different size castings are to be poured from the same ladle, observation by eye or optical pyrometer is the only means to assure temperature levels to suit the size casting poured. While an immersion pyrometer is more accurate it is not practical where many measurements at different locations are necessary. For the above reasons, high manganese steel is most frequently poured from an open ladle and small castings are poured from small ladles to be filled from the large ladle while metal is hottest.

6.2 Naturally, under these conditions, the initial temperature of the ladle must be as high as heating facilities will permit. Ladle heating systems should be designed to heat a 4 to 5 ton ladle to over 1,100°C. This cannot be accomplished unless a cover or refractory wall which retains and reflects heat is used with an efficient high heat input burner. Gas is the best fuel since there is no chance for carbon deposits. Heavy oil is the least desirable.

7. Modernization and Expansion

7.1 Detailed and methodical planning of a new or expanded foundry layout is essential if an efficient well integrated operation is to be attained.

7.2 This must include a projection of the future demand for castings by type, size and weight. From this data plan can be developed for the molding equipment required for each size range and weight, the floor space needed for mold storage and handling, the metal requirements, and sand volume needed to maintain efficient mold production. With a classification of the projected casting load by weight groups, planning for needed facilities and work area in the cleaning operation can be developed.

7.3 While the above may appear to be complex and a lot of additional work, it is an essential step, in our opinion, to assure the development and installation of a modern foundry facility having balanced facilities, effective flow patterns of materials and product and efficient utilization of skilled and unskilled workers.

7.4 Without additional details, a full evaluation of the plan layout prepared by Ya Chou Steel Mfg. Co., Ltd. and supplied during our visit on March 27, 1972 is not possible. Certain comments and questions may be helpful before any major steps in the program are taken.

7.4.1 Mechanized molding using jolt squeeze type machines is only as effective as the material and mold handling system will permit.

7.4.2 Space for mold setout prior to pouring must be ample to provide flexibility and since continuous supply fa of metal cannot be maintained with batch type steel melting furnaces.

7.4.3 Since floor space under the overhead crane needed for pouring is always limited, it is advisable to locate all small and medium sized mechanized molding in side bay. Molds are to be delivered to h the main bay for pouring and shakeout and empty flasks returned to side bay for reuse.

7.4.4 An area must be set aside in the main bay for large floor molding.

7.8.5. The present layout and location of the foundry makes effective expansion and use of the existing main foundry bay difficult. Expansion is possible only to h the west of the main bay.

7.4.6 An investigation as to the possibility of erecting a small to medium casting molding area extending to the west and at right angles to the existing foundry may be advisable. This could provid an area for molding, sand preparation, and core making. The metal ladle could be transferred by car to the small foundry pouring area. Castings would be transferred by car to cleaning area.

7.4.7 The proposed cleaning building is too narrow in relation to its length. Too much space would have to be set aside for transportation of product. It is impossible to develop a good flow of product and to provide the best arrangement of the necessary equipment in a building of the dimensions (10 x 60) shown on the layout.

7.4.8 A more effective plan could consider the erection of a building for cleaning and heat treating in the new area south of the present factory area.

EXHIBIT F

Evaluation

of

Steel Foundry Industry

Taiwan

Metal Industries Development Centre

Mr. S. C. Chi, Managing Direc
Mr. M. L. Tsai, Engineer
Herbert E. Cragin, Jr.
U. N. I. D. O.

May 24, 1972

INDEX

1. SUMMARY

1.1 Modernization of the steel casting industry is essential to support the continued rapid economic advances being made by Taiwan.

1.2 On the other hand, unless early action is undertaken to develop sound and effective plans for foundry facility improvement and to initiate a program for implementation the condition of this industry will prove to be a serious handicap to general economic growth.

1.3 An efficient steel foundry producing standard quality castings can and will be able to develop a strong export trade.

1.4 With efficient use of the labor force thru mechanization, the capable and industrious workmen in Taiwan can meet competitive price and quality demands throught the world.

1.5 Thru comprehensive studies the economic feasibility of proposed modernization can be ascertained and sound judgements made as to the merit of any projected program.

1.6 Quality standards must be improved. However, the first step is better facilities, methods and equipment before more rigid controls can be imposed.

1.7 Concurrent with feasibility studies, practical research must be undertaken to develop consistantly good quality materials for use by the foundries.

1.8 It is also essential that standard procedures be established and foundries be encouraged to adhere to them in the production of a high quality product.

1.9 Since a substantial amount of foundry equipment can be constructed locally, it is considered that the purchase of engineering from foreign sources should be exploited where ever feasible.

OBJECT

2.1 The study and report are to cover an evaluation of the capability of the steel foundry industry to support and contribute to the essential growth of heavy industry in Taiwan, Republic of China.

2.2 Representative foundries are to be selected for visit and inspection.

2.3 Observation and evaluation is to be made of casting quality, foundry methods, productive equipment and facilities. A review of the availability and caliber of qualified technical personnel is to be made if possible.

2.4 The expansion and modernization plans presently being developed by each foundry are to be reviewed. A judgement as to the feasibility and practicality of the programs is to be made within the limited scope of the study.

2.5 Concurrent with the evaluation survey, it is expected the project team will offer consultancy advice and recommendations on any questions regarding quality, methods and materials.

3. S[illegible]

3.1 The limited time availability of the consultant from United Nations Industrial Development Organization has necessitated a only brief survey which will allow general conclusions to be drawn about the condition of the steel foundry industry.

3.2 It is believed that in general, the iron foundry industry, although of equal importance, has invested more heavily in modernization and is certainly ahead of the steel casting industry in this respect. A large part of the iron foundry industry has specialized and serves parent companies or specific industries. As a result there is a constant pressure on the foundry to improve quality, reduce costs and increase productivity. The deficiencies in the above factors in the steel foundry product act to restrict markets and prevent its effective growth.

3.3 During the brief visits the staff of each foundries listed was very cooperative and supplied all information requested. All foundries had methods and quality problems and submitted many questions. The replies have been confirmed in separate letters to each foundry. The information where pertinent to this study has been generalized and is the basis for many of the recommendations to be included.

DISCUSSION - The Place of the Steel Foundry in the Industrial Growth of Taiwan

4.1 The present limited localmarket for steel castings and the lack of a "product" which can be offered to the "world" represent handicaps to the modernization and growth of the steel foundry industry.

4.2 On the other hand heavy industry such as the proposed integrated steel mill, expanded shipbuilding, the electrification of the railroad system and present cement, mining, petroleum and chemical industries all depend heavily upon steel castings for original equipment as well as replacement parts.

4.3 With the development of modern steel foundry facilities, the capability will exist for the production of high quality steel castings in low and high alloy steels for every possible use. Modernization thru mechanization will increase productivity and consequently increase the capacity of an operation.

4.4 The concurrent improvement in consistent quality resulting from improved equipment will permit lower costs. Thus with competitive quality and pricing, a greater share of the world market is attainable.

4.5 It must be strongly emphasized that the first step must be the installation of modern facilities and the attainment of an acceptable quality level. Markets will follow. It just is not possible to reach for the market without the plant and equipment needed to assure quality at low operating costs.

5. MARKET APPRAISAL

5.1 The world production of steel castings for 1970 according to the Fifth World Census of castings production as reported in the December 1971 issue of Modern castings was 5,800,000 metric tons not including production from USSR, East Germany or Continental China. The Republic of China's share in the above was 27,156 tons or less than 0.5%. Of the total world output Asian countries, again excluding Continental China, produced nearly 1,600,000 tons of steel castings in which R. O. C. share was 1.7%.

5.2 The market is substantial and an increased share requires first that competitive quality be developed. Labor usage in the production of steel castings is the highest, on the average of all metals because of the greater cost for cleaning. Depending upon size and complexity one ton of steel castings will require from 60 to 80 man hours for melting, molding, cleaning and overhead, compared to 40 to 60 for iron castings.

5.3 It does not appear logical or even feasible to consider export markets until the full development of the local demand for steel castings has occurred. Once a competitive price structure and quality are attained the added volume of export markets can be readily exploited.

5.4 It is obvious that a substantial volume of steel castings are imported as parts of heavy machinery. Some of this tonnage should be within the capability of a modern steel foundry. Further, local supply would save heavy freight costs as well as foreign exchange. The amount of this volume which could be produced locally will depend upon capacity for complicated and accurate machining and assembly as well as on the policies of the vendor from whom the machinery is purchased.

5.5 Likely items for local foundry production are tabulated in Exhibit A.

[illegible] FACTORIES INSPECTED AND EVALUATED

Chou's Iron and Steel Co., Ltd. - April 12, 13 1972
187 Fatou Road
Keelung

Dah-Yung Steel Manufacturing Co., Ltd. - April 7, 1972
Kaohsiung

Nan Lung Steel and Iron Corp. - April 11, 12 1972
Taipei

Taiwan Machinery Mfg. Co., Kaohsiung

(Note: UN Expert assigned Sept. 6, 1971 to March 25, 1972)

Taiwan Shipbuilding Co. - December 16, 1971 & April 16, 1972
Keelung

Tang Eng Iron Works Co., Ltd. - March 31, & April 3, 25 1972
Kaohsiung

Ya Chou Steel Mfg. Co., Ltd. - March 27, 28, 1972
Kaohsiung

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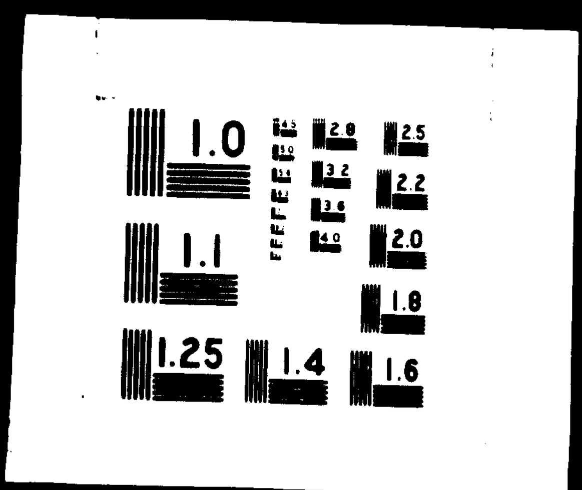

7. CONDITIONS OBSERVED WITH POSITIVE RECOMMENDATIONS TO IMPROVE PERFORMANCE

7.1 Since this report is to cover the entire steel foundry industry based upon our observation of the foundries listed in 6. no recommendations are made for any one foundry. It is understood that the conditions in other steel foundries are substantially the same as those observed.

7.2 Melting

7.2.1 Steel is produced in basic lined arc furnaces ranging from 3 tons to 10 tons capacity, with the average being about 4.5 tons. An increase in transformer capacity to at least 2500 kva for this size is desirable to improve the rate of output. A low rate per hour of metal production will necessitate more floor space for mold set out. This requirement then will place a restriction on the opportunity to expand production. Steel making practice can be improved with higher power and shorter times. Steel quality will also improve since carbon can be retained for a more vigorous boiling action.

7.2.2 Furnaces should be equipped with top charge capability and most essential with automatic electrode controls. The latter has an important bearing on metal quality.

7.2.3 All foundries must be equipped with more effecient ladle heating equipment. Additional electric power is required to superheat the metal to compensate for poorly heated ladles. This coupled with incomplete drying also will increase the chance of gas absortion and porosity in castings.

7.2.4 In general the quality of steel making for the foundry and the control of composition is good. Assurance of a vigorous boil is essential for gas free metal needed for alloy steel castings, Spectrographic equipment for analysis of composition and furnace control is desirable but not initially essential.

7.3 Mechanization of Molding

7.3.1 Molding must be mechanized and methods modernized. Progress toward better quality castings, more consistent dimensional control and commercially acceptable surfaces can result only thru the use of high efficiency automatic or semi-automatic molding equipment. While the type and size of machinery may differ for each foundry, the basic requirements will not: namely mechanized equipment to produce a mold of high hardness conforming consistently to pattern dimensions.

7.3.2 Much publicity has been given recently in major industrial countries to automated molding either in flasks or flaskless. Production rates as high as 300 molds per hour have been attained. But the steel casting industry here is not ready for either the individual productivity per pattern or the total capacity such equipment would develop.

7.3.4 Mechanized molding installations having flexibility, productivity consistent with the demand and assuring a mold of high quality and uniform dimensions are to be required for the present.

7.3.5 Conversion to clay bonded sands instead of continued dependence on the sodium-silicate-CO_2 binder system is essential for progress toward a modern foundry operation. Those foundries who have made the conversion have found clay bonded systems will produce better quality castings at lower cost.

7.3.6 Molding equipment alone will not yield the improved performance needed. Sand preparation, reclamation and delivery equipment is to be an integral part of improved molding systems.

7.4 Core Making

7.4.1 Separation of the core making operation from molding and the installation of equipment designed to produce cores of uniform quality at low cost must be part of the modernization process.

7.4.2 Adaptation of many of the new core bonding materials will be desirable and useful depending upon size and quantities need.

7.5 Rough Cleaning

7.5.1 One of the dividends obtainable thru good molding equipment and molding materials is a casting surface relatively free of burned on or fused sand. The cost of chipping sodium silicate sand from the surfaces of steel castings is substantial.

7.5.2 Heavy duty, high capacity shot blasting equipment is essential as the first step in the cleaning process. In addition, direct current powered carbon arc compressed air metal removal will provide a rapid low cost tool for the cleaning and shaping of steel castings.

7.6 Heat Treatment

7.6.1 Existing furnaces must be replaced or rebuilt. The installation of burners which will create uniform heat distribution, and controls to assure maintenance of temperature levels are essential.

7.6.2 Mechanical operation of doors and cars is required to permit rapid handling of austenitic manganese steel in quenching.

7.7 Environmental Control

7.7.1 Elimination of dust, gas and fumes from the inside of the foundries is necessary for the health of the worker. Collection of the solid materials and fumes is to be required to curtail the growth of pollution in the atmosphere. Both are possible with existing technical knowledge. Before the substantial investment is undertaken for pollution control, a master long range plan for each foundry is essential to integrate pollution control and modernization into an efficient program.

7.7.2 The major sources of dust and other air polluting substances emanating from the foundries inspected are:

- Arc Melting furnaces : This source of outside air pollution can be corrected with side draft hood or direct exhaust, fan and dry bag dust collectors.

- Sand shakeout and recovery system. Dust is primarily an in-plant nuisance. It is controlled by enclosing all transfer points and exhausting to a central cleaning system. Generally, wet collectors are used on shakeout system.

  This control is to be needed when return sand systems are installed as part of modernization. Present CO_2 sand system, except when sand is reclaimed, produce little outside dust.

- Fumes from pouring molds are not generally collected because of the large area over which molds are to be poured.

- Cleaning : Most dust conditions here are dangerous to worker health, and collection of dust and smoke from gas cutting, arc, air, welding, shot blasting and grinding is essential. When collected the dust may be cleaned in dry collectors.

- Core, mold ovens and heat treating furnaces using heavy oil as fuel may require after-burners and other controls on stacks to eliminate discharge to the atmosphere. Improvement of burner efficiency is also to be required.

7.7.3 In addition to air pollution control both inside and outside, concern must be given to the suppression or absorbtion of noise both as it affects workers and the surrounding community.

7.7.4 The use of filters, settling basins and closed circuit cooling water systems are some of the means to assure that the water discharged from the plant is clean.

7.8 HOUSEKEEPING - REFUSE DISPOSAL

7.8.1 While this is primarily a management function and responsibility, the lack of suitable facilities for storage and handling of materials makes good housekeeping difficult. While equipment would solve many of the problems involved, an awareness by mangement of the costs of a disorderly shop would do a lot toward correcting present conditions.

7.8.2 A clean, orderly work shop will contribute to better productivity and improved quality. Suggestions were made during our visits of specific action that would improve the floor space available and improve the flow of materials.

...TING QUALITY

8.1 Substantial improvement in casting surfaces is to result from conversion to clay bonded molding sand and the introduction of high pressure modern molding equipment.

8.2 Elimination of sodium silicate-CO_2 sand systems in both core making and molding is considered essential to obtain the improvement in surface appearance as well as to reduce the presence of many sand inclusions found in castings.

8.3 Conversion to machine molding will require construction of solid pattern equipment, mounted when required. The elimination of skeleton patterns and sweep molding will remove one cause of poor, loosely compacted molds.

8.4 While molding methods do not necessarily affect the internal soundness of a casting, the proper location of risers and gates is frequently modified because of the pattern design. In this situation compromises may be made because of pattern design, and type of flask available. As a result shrinkage under risers or at heavy sections occurs.

8.5 The quality of metal produced in electric arc furnaces appears to be adequate. Composition is supervised by chemical laboratories and in one instance spectrographic equipment provides rapid information to the melting operation. Compromises with good practice are made at times because of poor scrap or lack of proper alloys.

8.6 Improved ladle practice involving pre-drying of stopper assemblies and pre-heating of ladles to at least 1100°C would reduce leaking ladles and the irregular pouring action which results. Also, proper drying will minimize the chance of hydrogen absorbtion and porosity in castings.

8.7 The existing facilities and lack of good equipment in the steel foundries impose serious handicaps to the attainment of consistent quality. Also the absence of high quality materials for molding and core making create additional limitations to superior performance. Unfortunately, there is a frequent tendency to excuse poor performance on the above grounds, when good supervision careful planning and adherance to sound basic principles could overcome the quality deficiency.

9. LONG RANGE VERSUS SHORT RANGE PLANNING

9.1 The nature of most foundry equipment makes it essential that growth and modernization follow an orderly well planned pattern. As an example: A sand system with too little capacity will severely restrict the productivity of modern automatic molding equipment. An arc furnace with transformer and switch gear in the wrong location can be a barrier to an ideal expansion plan. It can't be moved because of cost and loss of production during relocation.

9.2 For the above reasons and because it represents good modern management, every foundry must develop a detailed long range plan for growth. This should be a comprehensive study with economic analysis including projected costs, markets, sales and profit.

9.3 A poorly planned program can only commit the foundry to an early demise. As other foundries modernize improving quality and lowering costs they will capture a greater share of the available market forcing the poorly planned operation to cut prices to retain business and lose money or lose business and also lose money. Either way the end is the same.

9.4 Effective analysis of the operations of a foundry and a factual evaluation of a projected improvement and expansion program can yield data upon which sound decisions can be made. A brief outline of the elements of a Feasibility Study is included as Exhibit C.

9.5 It should be emphasized that as with any important activity a long range plan will require competent and experienced foundry engineers. Since few foundries will have qualified personnel who can be separated from the demands of plant operations, it is necessary to retain consultants to develop the study, prepare engineering plans and specifications and finally suppervise the installation and frequently the start up and training of workers in the use of new equipment.

10. MARKETING AND CUSTOMER SERVICE

10.1 In addition to developing high quality standards, good productivity and competitive costing, foundries must learn to sell their product. The foundryman cannot wait in his plant for the customer to send in an inquiry, but must have knowledgeable engineers out calling on existing customers and seeking new ones.

10.2 The steel foundry operator must consider that he is a "problem-solver" providing a technical service to the casting using industry. With this attitude and competant engineers working with existing and potential customers there is little doubt that the operation can work to capacity.

10.3 One important aspect of the customer-foundry relationship, is in obtaining suitably designed pattern equipment. Since the foundry must accept responsibility for the quality of the casting, it should also have the perogative of specifying the type of pattern to be required and the design of the pattern.

11. RESEARCH AND DEVELOPMENT

11.1 An effective local steel casting industry will require assistance in solving many problems of quality methods, materials and equipment. None of the companies alone can afford the cost of even simple investigations. Remoteness from the more heavily industrialized countries places an even greater burden on the industry.

11.2 It is considered essential therefore that the foundry industry jointly with Government assistance if needed, support investigations to provide suitable solutions to the many practical problems encountered. Some of these projects are listed and described briefly below:

11.2.1 Molding sand:

Develop specifications and work with suppliers on the means to meet the standards.

11.2.2 Clay binders:

Evaluation of all available materials and the preparation of quality or performance limits to permit foundries to develop suitable sand mixes.

11.2.3 Core binders:

An analysis of all existing local materials such as oils, resins and other chemical binders. Cooperation with local chemical or petroleum product producers to develop suitable core binder blends.

11.2.4 Furnaces and ladle refractories:

Develop critical tests to supply the industry with a cost-product quality relationship for refractory grades needed in various foundry applications.

11.2.5 Hot top compounds:

Survey local materials in comparison with those available thru import with the goal of developing a low cost effective local product.

11.2.6 Evaluate in conjunction with abrasive grinding wheel producers the most effective grade and hardness of wheel for different metals produced in the foundry.

11.2.7 Investigate refractory core and mold coatings for availability and cost.

...ANDARD PROCEDURES

12.1 It is considered advisable that standard procedures be prepared covering various operations in steel casting production with some examples listed below. These procedures are to include melting, pouring temperatures, shakeout scheduling, heat treating with heating and cooling rates, welding and pre-and-post heat requirements.

12.2 Austenitic Manganese Steel

12.2.1 Charge make up, melting, and alloy additions - Composition limits.

12.2.2 Effect of pouring temperature on grain size and strength. Methods of evaluation and control.

12.2.3 Shakeout and heat treating schedules for crack control and full austenitization. Bend test evaluation.

12.2.4 Welding procedure
Weld rod specifications

12.2.5 Pre-hardening to reduce flow.

12.3 Alloy steels with high hardenability

12.3.1 Melting Practice - Limits on hydrogen and phosphorus and the procedures needed for control. Alloying practice.

12.3.2 Shakeout scheduling to annealing furnace - Riser Removal.

12.3.3 Weld repair - pre-and post-heat procedures.

12.4 Molding practice for heavy castings.

12.5 Application of alloy steels and irons for abrasion and impact service.

12.6 Molding, casting and heat treatment of austenitic manganese steel trackwork castings; as frogs and crossings.

13. COSTING AND SALES PRICING

13.1 Profitable operation in a competitive market will require accurate costing procedures.

13.2 Two elements are essential

13.2.1 A true measure of the actual direct work time needed to perform a job as molding, gas cutting, core making etc.

13.2.2 Significant cost centers must be established in the accounting procedure such as core department, heat treating, etc. All costs of labor and materials involved in the specific operation are then accumulated by cost center.

13.2.3 A rate can then be calculated per unit of direct labor, weight or piece.

13.2.4 Overhead, sales cost and profit can be applied as a percent of manufacturing cost.

14. CONCLUSIONS AND RECOMMENDATIONS

14.1 The steel casting industry (foundry) is to require a substantial investment for modernization if the industry is to have the capability of supporting the parallel growth of heavy industry.

14.2 A steel foundry industry separated from the rolling mill industry is to be more effective and probably stronger and more profitable than if it operates as part of the larger operation.

14.3 The limited local market alone cannot support extensive foundry expansion resulting from modernization.

14.4 It is not logical or sound economically for one foundry to attempt to produce too broad a product mix. Iron should not be mixed with steel. High alloy and stainless steel are most effectively produced in separate facilities. Large steel castings and high production small castings are not mixed easily.

14.5 Recommendations based upon the foregoing brief report are as follows:

14.5.1 The modernisation of the steel foundry industry receive high priority for needed funds for this work.

14.5.2 Detailed engineering studies be authorized for the steel foundries operated by government enterprises.

14.5.3 The private sector of the foundry industry each be encouraged to develop an orderly and properly planned modernisation program.

14.5.4 A comprehensive market study be authorized to ascertain the total local steel casting usage. This must include not only the castings now being produced for local use but primarily the castings imported as parts of machinery such as trucks, construction equipment, railroad track work and rolling stock, process equipment for petroleum, plastics, chemical industries and new steel mill.

14.5.5 It is also considered that coordination of all foundry improvement programs is essential to avoid the creation of over capacity in any type of casting or size range.

EXHIBIT A - Castings and Machinery Using Steel Castings for Future Markets

Railroad: Bogie castings for freight cars, couplers for freight and passenger. Hopper car frames and doors, miscellaneous other car castings. Special manganese steel trackwork for high speed electrified rail system.

Steel Mill: Steel and Iron Rolls

- Mill Guides
- Rolling mill frames
- Blast furnace castings
- Ore unloading and handling
- Coke oven and handling
- Mill gears and pinions
- Mill gear housings and frames

Construction Machinery - Tread shoes, rollers on all types of crawler equipment, dipper fronts and teeth.

Mining Machinery - Wearing parts for all types of crushers, reduction mills.

Frames and housings for the original equipment.

Automotive - Truck wheels, fifth wheels for trailer hitches, axle spindles, brake shoes for trucks.

Petroleum Industry - Valves and fittings for high temperature and high pressures in both low and high alloy steels.

EXHIBIT B-1

1. Chen's Iron and Steel Co., Ltd.
107 Patou Road, Keelung

- Chao Shan-Hsiang, Plant Manager
- Hsu, Steel Foundry
- Chang, Melting
- Yan, Quality Control

2. Melting

- 2 ton arc furnace - 600 kva
- 6 ton arc furnace - 1500 kva - Ingots
- 1 ton Induction Furnace - 300 kw
  Installation just started
- High manganese steel castings 50%
- Carbon steel castings 50%
- Stopper ladles
- Limited heating capacity
  4 to 5 hours per heat

3. Molding

- Floor some flasks; core molds
- Sodium silicate CO_2 molding sand
- Sodium silicate CO_2 core sand

4. Heat Treating

- Coal stoker fired; optical pyrometer for temperature control.
- Heating not uniform in annealing furnace (car type)
- Manual handling in manganese steel quench furnace.

5. Output 100 to 150 tons per month.

6. Workers - 48

7. Buildings are a combination of old and new. Heavy reinforced concrete supports for crane line in melting and pouring bay restrict available work space. Foundry consists of one main crane bay with two side bays. All three bays are narrow by modern standards.

8. New building construction for rolling mill ingot furnace and ferroalloy furnace has been located to the east of the foundry. Expansion appears to be limited if present foundry buildings are to be used. Some unused property is available for growth to the south west of existing building.

EXHIBIT B-2

1. Dah Yung Steel Manufacturing Co.
   2 Kao Shan 3rd Road
   Kaohsiung

   - Mr. Wu Kuo-Chu

   - Mr. Tsai Shin-I

   - Mr. Ho, Foundry

2. Primarily a rolling mill producing up to 7,000 tons of ingots per month. About 90 tons per month steel castings are produced in one small area of one ingot shop.

3. Using 10 tons arc furnace for steel castings pouring about 18 heats per month. Balance of furnace schedule is for ingots.

4. Molding and cleaning departments occupy about 500 M^2 each.

5. There is no space available for an efficient expansion of the foundry and at present there is no consideration being given to it.

6. The primary value of this operation is the melting capacity for large castings which is not available in other foundries visited.

EXHIBIT B-3

Han Lung Steel and Iron Corp.
63 Yuh Chon Street
Nan Kan Chui, Taipei

- Mr. C. H. Lee, General Manager
- Mr. C. H. Loh, Plant Manager

1. Melting

2 - 4 ton arc furnaces, manual control, manual charge

2 - 1 ton low frequency induction furnaces

2 - 1 ton high frequency induction furnaces

4 - ½ ton high frequency induction furnaces

Note (1): One arc furnace is used primarily for ingot production for bar mill rolling and forged grinding balls.

(2): High frequency induction furnaces produce high alloy heat and corrosion resistant steels.

2. Sand Preparation and Delivery

2.1 Five sand mullors loaded by hand in various locations in the foundry prepare both core and molding sands.

2.2 One sand system with shakeout, return conveyors, storage, mullor and belt delivery supply two molding machine installations.

2.3 Sand delivery system to a small molding machine installation is being installed.

3. Scrap Preparation

A new scrap shear and press is now being installed to produce a bale about 600 x 100 x 200.

4. Air Pollution Control

A fan and dust bag filter with a capacity of 220 M^3/min have been installed and a hood for one furnace is being designed for control of smoke and fumes. The equipment does not appear adequate for proper control of emissions.

5. Production Output

Castings 300 to 350 tons per month
Ingots 500 tons per month

6. Foundry Employment

Melting, Molding and Cleaning - 200.

7. 3 - 100 horse power air compressors provide air at 7.03 kg/cm^2.

8. Main Foundry Building is 20M x 128 or 3540 M^2

In addition cleaning area for small castings, machine shop, bar rolling mill and forge shop are located in other temporary structures. A new 3 story office building is now under construction.

9. Heat Treatment

1 - 5 x 4M annealing furnace car type
2 - 1.5 x 1.5 box type for quenching and draw

10. Laboratory : Hilger Watts spectrographic analysis equipment
Wet laboratory
Carbon and sulfur apparatus
Physical testing

11. Shell mold - special equipment, small castings.

EXHIBIT B-4

Steel Foundry
Taiwan Machinery Manufacturing Co.
25 Kung Yuan Road, Kaohsiung

1. Melting

1 - 4 ton arc furnace 1,400 kva, semi-automatic electrode control, top charge
1 - 3 ton arc furnace 1,200 kva, manual electrode control, top charge
1 - 1 ton high frequency furnace
1 - 600 kg high frequency furnace

2. Sand Preparation

Two - 2.00 M dia open mullers

3. Molding - Hand; sodium silicate-CO_2 sand

4. Heat Treatment

One cartype furnace - 1500 x 5000 x 3000

Two electric annealing - 1500 x 3000 x 2000

Two oil fired car furnaces for quenching treatment - 1000 x 2000 x 1000

5. Sand testing laboratory, well equipped.

6. Chemical Laboratory: Leco carbon analyser, wet chemical analysis, physical testing.

7. Available in Iron Foundry

Shot Blast table - 1 ton
Shot Blast room with car - 10 ton

8. Shell molding and shell core making equipment available.

9. Production

Steel castings 107 tons per month, 22% alloy steel
Ingots for forged steel grinding balls - 60 tons/ month

Taiwan Shipbuilding Co.
Keelung
- Mr. Liu, Foundry Manager
- Mr. Tsai

1. Melting

One 4 ton arc furnace 1200 kva, manual electrode control. Heat time 5 hours; Cupola and oil fired crucible furnace.

2. Sand preparation

Two open mullers, hand loaded, bucket delivery.

3. Sand practice

Bentonite, dextrine bonded steel facing sand with zirconite wash. Molds; oven or skin dried. Core sand uses tung oil and dextrine.

4. Heat treating

One - 1500 x 3500 car type coal stoker fired; optical pyrometer temperature control.

One - 1000 x 2000 inclined hearth furnace for quenching, also coal stoker fired and optical pryrometer control.

5. Pouring : Stopper ladles, all carbon and alloy steels including austenitic manganese.

6. Foundry to be relocated to present site of shipyard. Building 70 x 52 M planned for:

100 tons per month steel

100 tons per month iron

400 tons per month ingots

7. Present production at 100 tons

Steel Castings	30 T (10 ton own use)
High Manganese	20 T
Iron	50 T

8. Manning including melting and scrap preparation - 105.

EXHIBIT B-6

Tang Eng Iron Works Ltd.
69, Chung Hwa Street
Kaohsiung

- Mr. Lee Ching-Liang, Superintendent - Foundry

1. Melting

One - 6 ton arc furnace - 2100 kva
One - ¼ ton arc furnace for specialties
Note: Shop being used for casting
Rolls has two 15 ton arc furnaces

2. Sand Preparation

Open mullers - hand loaded
Sodium silicate - CO_2 binder

3. Heat Treating

Two - car type - 3 x 4 meter x 2 meter
high oil fired annealing furnaces

4. Molding

Floor: Hand molding, no flasks

5. Capacity, present

70 to 100 tons of steel
300 to 400 tons Iron Ingot molds

6. Buildings - Both Iron and Steel Foundry and Roll Foundry

Main bay - 120M x 22M with 18M crane runway and 35 ton cranes.
Two side bays 10 meters wide; Total 5040 M^2 each building.

7. Plans were developed by consultant from Japan for a combined foundry operation to include steel castings, steel and iron rolls, iron ingot molds and a mechanized molding system for engine and other production iron castings. Melting was to include two - 6 ton arc furnaces; Two - 1 ton high frequency induction furnaces and two each 6 ton and 3 ton low frequency furnaces.

8. Capacity was to be:

Ingot Molds	400 T
Rolls	400 T
Steel Castings	100 T
Engine Blocks etc.	100 T
	1000 T

Actual capacity would be closer to 1550 tons per month of iron and 900 tons per month of steel.

EXHIBIT D-7

Ta Chou Steel Manufacturing Co., Ltd.
11 Koo Shan 3rd Road
Kaohsiung

- Mr. C. T. Lin, Engineer

1. Melting

One - 3 ton arc furnace 1500 kva
4.5 ton charge

One - 5 ton arc furnace 2400 kva
6.5 ton charge

Exhaust on furnace doors with wet filter

2. Sand Preparation

3 - pan type mullers one meter diameter
Sodium silicate CO_2 sand for molds and cores. Reclaimed by crushing and re-used for backing.

3. Services

New electric power substation and distribution center
Air compressors

4 - RW 16 - 50 HP

1 - LW 15 - 25 HP

4. Laboratory

Sand laboratory well equipped

Analytical laboratory: wet method

5. Property and Buildings

Land about 22000 M^2 with about 23% occupied by buildings

Main foundry building: 55 meter x 14 meter with two side bays 6 meters each.

6. Capacity

Steel castings	100 tons per month
Ingots	200 tons per month

7. Expansion and modernization has been planned but with too little detail for effective evaluation.

8. Manning

40 employes in molding, core making and cleaning

14 workers melting dept.

9. Only laboratory heat treating equipment.

EXHIBIT C

Feasibility Study - Modernization of a Steel Foundry

1. Present Operation

1.1 Classify production in foundry by mold size.

1.2 Obtain average weight of castings produced by mold size and number of molds per month.

1.3 Obtain the percentage of the distribution of castings by composition.

1.4 Operating costs by departments and accounts as:

Direct Labor
Indirect Labor
Supervision
Indirect Materials
Direct Material (metal)
Overhead
Fixed Costs

1.5 Obtain percentage of gates and risers and scrap by different sizes of castings.

1.6 Classify production by number of castings in weight groups.

2. Proposed Expansion

2.1 Project new work by mold size, number of patterns per mold, average weight of mold.

2.2 Combine existing and projected work load by mold size and calculate number of molds per day needed to produce the demand.

2.3 Calculate the liquid metal from scrap and pouring percentage.

2.4 Calculate mold volume and weight of sand using a formula:
Vol. in M^3 x 1.2% x 1.590 T/M^3 x .85 = Tons sand/mold.

3. Design Criteria

3.1 Using the data set forth above: the number of molds, different sizes, the liquid metal and the weight of sand required, a daily demand for each element can be calculated.

3.2 Foundry molding is to be grouped into work loads and molding equipment selected for each group by size and based upon the productivity needed.

3.3 Molding production rate will determine the tons of sand needed per hour and the liquid metal requirements.

3.4 Floor space needed for mold set out will be established by the rate at which liquid metal can be supplied, the time required for mold cooling and the temperature at which castings can be removed from the mold. The need for storage space to accumulate molds for different compositions to be poured must also be considered.

3.5 Core Room

Core demand in weight and number of cores can be estimated from the patterns and past practice. Core production equipment and drying capacity will be developed from above data.

3.6 Cleaning

From the data developed in 1.6 above together with the proposed added work load the man power requirements can be calculated using factors for gas cutting, arc air, grinding and chipping in terms of man hours per ton developed from adjusted experience. With the number of work stations needed, space can be set aside and casting flow and handling means developed.

4. The arrangement and disposition of the above facilities and equipment is then to be developed using the parameters set by existing buildings, plant site etc.

5. Proposed Operating Costs

5.1 The new facility is to be manned based upon productive requirements which are usual in industry for the type of equipment planned.

5.2 Materials are estimated from new power usage, sand volume, fuel costs in new ovens and furnaces as well as projections from present costs.

5.3 With labor and material costs plus overhead, new depreciation and tax and interest on equipment loans, a projected total operating cost can be calculated at different production volumes.

5.4 In projecting sales value the existing work load plus an estimate at what price new work can be obtained will permit a profit figure to be estimated.

EXHIBIT C

ANALYSIS OF PLANS

FOR

STEEL MAKING PILOT PLANT

METAL INDUSTRIES RESEARCH INSTITUTE

1. FURNACE TRANSFORMER ROOM

1.1 Roof to be 7 meters high with a beam located directly over the center of the 1000 kva transformer to permit a hoist to be attached for removing core of transformer if required.

1.2 North wall of transformer room shall be located at least 5.050 meters north of the center line of furnace to provide space in the west wall of the transformer room for three furnace control and electrode control panels and one dust collection system panel. Total width of the four panels is 2.950 M. depth varies from 500 to 800. All panels should project about 10 - 20 mm from face of transformer room wall. After setting the space between the wall and cabinets should be sealed to exclude dust from transformer room and for a finished appearance.

1.3 Access to transformer room should always be thru a fire safety door. Generally, these are sliding doors on an inclined over head track. A counter weight is attached by fusible link which will fail in case of fire and close the door.

1.4 It is proposed the roof controls be located close to the furnace panels since all operating activity will take place here.

1.5 In addition a remote control for tilting the furnace should be mounted on the west side even with the spout to give the melter control over the rate at which the ladle is filled. This is considered essential for good operation.

ust collection furnace fume control

.1 It is suggested the dust collector be moved from the south end of the new building to the north end. Distance to the nearest building to the north will be about 20 meters instead of less than 10 meters on the south. In this location at least 30 meters of dust work is to be required which is sufficient to provide protection against sparks reaching the bag house. Also it is more accessible to the furnace operators.

2 I have resevations about the water cooled hood. Leakage on the roof will be critical if it occurs. Although the vendor guarantees 100% capture of fumes from electrode openings during the O_2 blow, this style of roof has been discarded in furnace applications in USA. One serious handicap in the use of a full roof hood is the restrictions imposed on electrode travel. It will be possible to design a side draft hood as a replacement if it is found to be necessary.

3 Entrance of dirty air to the dust collection thru two openings instead of one would provide more unform air distribution in the bag house and permit all bags to carry a more equal share of dust collections.

4 Since a description of the operating cycle of the dust collector system has not been provided a suggested sequence is listed below:

2.4.1 Exhaust motor should be interlocked electrically with the furnace power switch so that the furnace cannot be operated unless the fan motor is running.

2.4.2 Normally the bags in a bag type collector must be cleaned of dust on a regular schedule. For furnace operation an intermittant type of operation is suitable. When the furnace is shut down all bags are cleaned prior to restarting.

To be checked

2.4.3 From the drawings supplied, the proposed system appears to be a continuous filter in which one compartiment at a time is closed to dirty air and the bags cleaned. If it is found that there is insufficent cloth area to properly filter the air, it would be possible to convert the system to an intermittant operation.

2.4.4 Since usage will be small the timing of the cleaning cycle will not be critical.

2.4.5 Spare bags should be ordered in the event any are damaged during installation.

3. Charging bucket or basket

3.1 It is suggested the frame for the support of the charging bucket while it is filled be made a separate structure. There is only limited space between the exhaust duct work and the frame supporting the roof. A careless crane operator could cause damage. Without the frame clearances are greater.

3.2 Since most charging will be on a cold furnace it will be necessary to soak the rope in oil so it will burn.

4. Laboratory

4.1 The extent of vibration which can be tolerated by the spectro-analyzer should be ascertained. A vibration or shock survey should be made of forging hammers simlar to the one planned before it is installed so a decision can be made on the location of the laboratory and the degree of protection required.

4.2 Specimens for analysis should be ground and polished on a belt sander outside of laboratory. Specimen can be passed thru a sealed window with a "dark room type of door".

4.3 A double door is not thought to be needed if the above is done.

.4 Reports can be made on a display board to be viewed by the melting staff thru a window.

nce oxygen usage requires continuous application it is suggested platform be located outside near the furnace and several tanks connected to a manifold system for piping to the furnace area.

ectric service :

ince a direct 12000 volt high tension power supply must be provided by Taiwan Power Co. a study should be made as to the most ffective means for transmission. This will also involve decisions to supplementary power, transformer capacity, feasibility of nder ground or overhead delivery of 12000 volt power, location f substation if needed. It is possible that a location removed rom foundry would be desirable.

ince furnace is to be used for research and development of tandard procedures, it would seem desirable to have a scale ystem which would allow accurate weight of charge and subsequently hot metal scale for metal weight.

If an immersion pyrometer is to be part of the installation it is suggested that a portable unit be furnished with three stations for use:

Furnace
Ladle after tapping
Pouring area

Second furnace roof and at least one more ladle may be needed.

Ladle Preheating:

For most effective preheating it is advisable to set the ladle on its side (without stopper assembly) against a refractory wall or use a refractory lined cover with burner mounted on the frame. Gas is preferable if very low carbon steels are to be made, because of carbon pick up from unburned oil.

11. Overhead Bridge Crane

Although the items may be included but have not been mentioned in the specification they should be questioned with the supplier:

11.1 Crane must be fitted with a brake (generally foot) on runway travel.

11.2 Hoist must be equipped with an adequate brake on the hoist for holding the load.

too complicated

11.3 Stops but not limit switches are supplied generally on bridge cranes except on hoist. High limit switch is provided to prevent block from hitting drum.

12. Soaking Furnace

12.1 Furnace is to be relocated to the north and space provided on either side for oil burner adjusting and maintenance.

12.2 It is suggested the area around the furnace in this building can be left open to the main bay.

13. Structural supports must be provided to permit the installation of a heavy duty monorail for transfer of molds to and from foundr in the passage way south of transformer room.

The Importance of Production Equipment and Materials in Quality Control for Steel Making and Rolling

Quality is the essential element in the sale of any and all products. It is more important to the user of the product than price. A low price is soon forgotten if the desired quality was not in the product and failure or sub-standard performance results.

You cannot inspect quality in the product if the process does not put the quality there.

If the equipment cannot perform so as to produce the needed quality level, the most sophisticated inspection and measurement instrumentation will not change the quality level in the finished product.

In the paper, which my associate Mr. Karling Tsai will present, we will discuss the elements in quality which are controlled by production equipment and what is essential in the design and operation of the facilities to permit the development of a quality product.

DELIVERED IN CHINESE BY M.L. TSAI - M.I.R.I

The Importance of Production Equipment and Materials in Quality Control

For steel Making and Rolling

The establishment of realistic and attainable quality levels thru specifications has been accepted by industry as normal practice. Unfortunately, the disparity between the minimum specification and the maximum performance is substantial in too many plants here in Taiwan. While management and employe attitude toward quality is important, there are limitations as to what can be accomplished by education if equipment is substandard. It is somewhat like asking a workman to wash windows or paint a wall 10 meters high when he has only a 3 meter ladder. Either you obtain taller ladder or restrict the job to what can be reached from the short ladder. In too many plants the equipment or materials just will not permit the manufacture of products to restrictive limits.

It is important also to avoid undertaking the manufacture of products beyond the capability of the equipment or process. While this may be more prevalent in the foundry industry, the condition must also occur in steel making and rolling. To attempt to produce aircraft quality forging steel which is normally vacuum degassed without the equipment to do so, or to attempt the rolling of special alloy steels which require exact heating to a specific temperature before rolling without any temperature control of measurement on the furnace is to invite disaster.

Since quality is an essential element required in all saleable products, the means to accomplish the quality level desired or needed in the product must be analyzed in each plant. Naturally, the end use and the customer will determine the quality level required.

By quality level we mean here the sum of all measurements applicable to the product; as surface apperaance, and finish, internal soundness, composition limits, physical properties, and dimensional accuracy.

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If product specifications exceed your capability, you cannot share in that market. On the other hand, if you are now producing material to higher limits than required by the users at an increased cost you will price yourself out of the market.

Since equipment will control your ability to reach a desired quality level, it is essential that goals for quality up grading be set just as you have established goals for increased productivity, capacity or lower costs.

Actually, the long range planning for quality improvement and its implementation is far more important to growth than an increase in capacity at existing quality levels.

In the first place the market opportunity will expand as quality levels improve. Without a continuing increase in quality the market can actually shrink.

Planning should start with those elements in an operation which prevent an improvement in quality and establish the means to correct the conditions. If both quality and capacity can be improved at the same time a double benefit will occure.

Equipment and materials in the steel making process which have a bearing on the attainment of a desired quality will be discussed in some detail and suggestions will be made as to possible ways to improve the condition.

Scrap, as the major raw material in the steel making process, is the source as well for most of the indesirable elements affecting quality. Scrap is also costly to purchase and handle. Therefore, intelligent planning in scrap buying, storage and use should pay dividends.

Since a "scrap market" or "scrap industry" does not exist in Taiwan, each steel mill has developed its own scrap yard. Shears, baling presses, and cranes all add to cost. In addition unusually large stores of scrap are on hand in many of the mills.

It is suggested that if all mills producing liquid steel in an area could join together in scrap buying, preparation and distribution, a cost and quality advantage could result. Scrap could then be segregated, sheared or bundled and distributed to the mills according to their needs and specifications. Producers of higher quality alloy steels could obtain selected scrap at a premium which the product could afford. The reinforcing bar mills would "buy" scrap to meet their needs at a lower price.

Within each steel making operation, scrap storage bins and handling equipment will provide the means to sort and segregate different compositions and grades of scrap. Scrap usage should always be on a "first in, first out" basis so deterioration and oxidation can be minimized.

A properly planned scrap yard to provide efficient means to unload cars and trucks and deliver to storage will have an important influence on the quality that can be built into the charge. The entire quality procedure beings here and a good start is important.

Good steel making starts with an accurate measurement of the raw materials to be melted. Charge weighing is essential to provide the base weight for calculation of additions and losses expected. Scale maintenance is essential. For the severe service imposed on scrap or charge weighing scales a load cell type is simple and less subject to damage by impact when a worker neglects to lock a beam type scale.

Particularly when alloy steels are being produced the melting losses for each alloy must be accurately determined. A scale for weighing the liquid metal after tapping is a necessary item of equipment to provide information on melting losses for composition control and accurate costing of metal at the spout.

Preheating and drying of scrap has been introduced in many small operations. The primary reason was the reduction in melting time and an increase in total output. Naturally, if all scrap is stored outside, excessively wet scrap will create the possibility of excessive hydrogen absorbtion. Also, wet scrap can be dangerous when back charges must be employed.

Efficient scrap preheating requires costly equipment and will add to the cost of melting. The extra cost must be justified by reduced electric power usage or better assurance in quality control. Wet scrap necessitates a longer oxidizing boil, more oxygen and more time.

Arc Furnace and Transformer Equipment

The metallurgical process taking place in an electric arc furnace during melt down, oxidation and refining determines the quality of the steel and its adherance to desired specification. However, the efficiency of the furnace, the power characteristics, electrode control and refractories each have an influence in attaining the desired properties.

High powered transformers primarily provide faster melting and high heat input with lower refractory loss. They also contribute to the quality factor since with fast melt down there is no time for the slow oxidizing action promoted by rusty scrap and air. Carbon is thus high at melt down and a vigorous boil can be activated with oxygen lancing. Since heat input is more rapid the melt is exposed for a shorter time to the atmosphere and absorbtion of gases is minimized.

With automatic electrode control the chance of dipping an electrode during the refining period is reduced and sudden carbon pickup after final test prevented.

Since refractory loss results in an addition to the slag volume increased refractory life thru higher heat input will mean less slag to contend with and better control over the chemistry of the slag and its action on the metal.

One point in connection with the furnace controls which must be planned before the installation of new equipment, is to locate the control panels where they are easily accessible to the melter.

Tap voltages must be set so that maximum power (voltage) is available during the early melt down to drive the electrodes thru the scrap to the pool of metal forming in the bottom. Also, low voltage taps must be provided to assure a steady short arc to permit the slag blanket to protect the refractories and to assure maximum heat input during the finshing cycle of the heat.

Emmission control systems on the melting furnace will provide a cleaner atmosphere for the employee thus promoting a better attitude toward work and quality. However, the positive influence on quality will not be significant. The negative effect on quality however must be taken into account in the design of the fume control systems.

Even a slight negative pressure in the furnace during the refining period will permit the inflow of air, and change the furnace atmosphere from reducing to oxydizing. Carbon loss and gas pickup by the metal is possible. It is suggested here that the design of the emmission control system be developed by experience engineers in order to be sure that the system will not affect the steel making and the quality of the steel.

Furnace refractories are a significant element of cost in the steel making process and can exert a good or harmful influence on the quality of steel being produced.

It should be obvious that the use of acid or siliceous refractories will disturb the basicity of the slag in basic electric steel making practice, particularly if the refractories have low melting points.

Since low cost brick will have higher slagging rates, and will increase slag volume, the acid or basic characteristic of the refractory material will have considerable influence on slag control and metal quality. One step in the development of quality steel will have to be careful study and testing of available refractories as they affect slag control and the resulting composition and properties of the steel.

In general brick with a higher refractory index, will cost more but will have a lower loss rate and longer life while contributing less material to the furnace slag.

The quality of refractories used in pouring ladles will also have an influence on the cleanliness of the steel. Since ingots are all poured with a stopper ladle, the resistance to slagging of the nozzle and particularly the bottom and lower side wall brick or refractory lining is critical. Low melting materials will react with the hot steel and form liquid non metallic material which will be drawn into the mold by the fast flowing steel rather than float to the surface of the molten metal in the ladle. Good ladle refractories, well maintained will certainly contribute to improved quality.

In addition to installing good quality refractory lining in the ladle it is absolutely essential that the lining be free of moisture. the most careful steel making process is wasted by the presence of moisture which can be converted to hydrogen and absorbed by the metal. A newly lined ladle should be first dried slowly with a wood fire and then heated with a properly set, efficient oil or gas fired burner.

Practice on heating ladles will vary with the size of the heat. Most large ladles do not have to be heated if thoroughly dried.

However, small ladles holding 5 - 8 tons or less and particularly if special alloy steels are being produced should be thoroughly preheated.

Stopper make-up and nozzle also will affect the quality of the ingots being poured. A leaking stopper will dribble small amounts of metal into an ingot mold which will freeze and produce surface defects since they will not be remelted when the mold is filled.

Maintenance of all mechanical equipment on the stopper mechanism and gearing of the ladle is a must. Smooth, free action of the stopper lever will permit better control of stream and prevent jerking of the ladle. The same is true of the overhead crane equipment which must be inspected and kept in perfect running condition at all times.

Ingot molds designed for the type of steel being poured are essential for high quality rolled or forged products. Ingot should be as large as the handling, forging and rolling facilities will permit. Small cross section ingots in relation to length will have more tendency for centerline shrinkage or voids than larger ones.

Ingot practice and design should have as much care and planning as the application of risers in the steel foundry. If rimming or semi-killed steel is being produced ingots can be poured from the bottom with the large end down. However, killed or deoxidized steel should be cast in ingots having the big end up. An insulated or exothermic sleeve, and insulating compound on the top will maintain the feeding end open to the atmosphere and concentrate the shrinkage at the top where it can be removed before rolling. The use of bottom pouring with big end down will produce shrinkage voids almost thruout the length. Even with big end up, bottom gating will cause a hot spot and shrinkage near the in-flow of hot metal. Top pouring big end up with insulated or exothermic sleeves is the proper practice for killed steel to produce sound ingots.

For accurate control of composition at the melting furnace the Laboratory must be equipped to provide chemical analysis of carbon, manganese and other alloys rapidly. The smaller the furnace the more critical is the need for speed.

The influence of proper equipment at the rolling mill on quality is some what less critical than in the production of sound ingots to the correct properties and composition. However, reheating furnaces should be designed with non scaling atmosphere and accurate and sensitive temperature control in the final zone. Continuous furnaces will provide a more consistent heat schedule than batch furnaces.

Handling equipment between furnace and mill or forge hammer should permit rapid transfer of ingot and equally important in the same time cycle every time.

I have not had any exposure to rolling mill practice and therefore cannot comment in detail on the relation between equipment and the quality control function. I imagine that the same principles will apply as in any manufacturing operation. Mill equipment must be well maintained and in proper adjustment. Overloading, in addition to contributing to more rapid wear of machinery and more frequent break downs will produce wider variations from nominal dimensions, particularly as wear increases. Early replacement of worn rolls and guides will prevent occurrence of surface irregularities on the product.

I would not be consistent with my past industrial experience if I failed to emphasize the importance of housekeeping, safety and environmental control on the quality of your product and the productivity of the employe.

The returns on capital invested in any of the above elements are not immediate. On the other hand, the decrease in profit is like a small leak in a tank buried in the ground. The liquid disappears but you don't know where or how. There is too much evidence to support the importance of these factors for us ignore them.

Give a workman a clean, orderly, well lighted shop; give him clean air to breathe and a comfortable temperature in which to work and he will produce more, with fewer defectives. I know this because I've seen it happen. When I first started working in a foundry in 1934 it looked a lot like the foundries in Taiwan, Production equipment was limited, lights were poor, heat was supplied by coal fires in molding flasks, There was no exhaust equipment any where in the shop. During the 30 years I was with that company we invested over US$4,000,000.00 in modern production equipment, heat and lighting for the buildings. We included almost $500,000 for dust and fume exhaust equipment. Productivity and quality improvement was impressive.

The safety and health of your employes is also important in measuring future profit potential. Most industrial countries have strict laws in this regard. Workmans compensation costs can be substantial and have put companies out of business. And the high cost of workmans compensation does not result from current injuries, but the accumulated effect over many years of absorbing harmful dust in the lung, of excessive noise causing loss of hearing and of improper and heavy lifting promoting permanent back injury. Now is the time to take care of this. It will be too late in the future.

The growth of industry in Taiwan has been one of the modern wonders of the world. Your economic and political future will be assured to the extent that you develop the capability to produce a quality level equal to the world. With good equipment, high productivity and a dedication to this essential element of quality in every thing produced, the industry in this country can beat them all. Your future can be secure.

I have enjoyed my stay here as a member of the United Nations Technical Assistance group. I will be leaving next week for six weeks in Vienna, Austria to terminate my association with the U.N. I expect to return to Taiwan to continue my association with MIDC on another basis and to continue to assist the metals industry to grow.

I thank all of you for your help and the cordial welcome you have given me.

Good luck.

MOULDING SANDS - TEST PROGRAM

1. Catalogue all foundry moulding sands in use on Taiwan.

2. Prepare complete analysis of properties:

    Seive analysis
    Clay content
    AFS fineness No.
    Type of grain - under magnification
    Quality of grain
    Silica content
    Impurities.

3. Using a standard green sand composition - bentonite and cereal - make casting tests using test mould and evaluate.

4. Run life tests on reuse by screening to maintain approximately the same distribution and fineness. Rebond and reuse in making the same mould.

5. Compare Taiwan sands with available imported sands - U.S. - Japanese - Australian.

6. The goal is a set of specifications covering all desired properties.

7. Sand suppliers are to be involved in developing specifications since they must meet them. However, if attainment of specification limits requires processing, such as washing, classifying, blending and drying, it is possible a project should be set up with one or more sand suppliers to analyze cost of equipment and ultimate cost of product.

5-11-72

MOULDING SAND BINDERS

1. Catalogue all locally available clay binders.

2. Catalogue available imported clay binders as Japanese, and U.S. bentonite.

3. Set up an evaluation program covering laboratory tests and moulding and pouring tests. Standard physical properties must be obtained regardless of the amount of materials required.

4. Life tests must also be run to reflect the additions needed in a system sand to [illegible] in required physical properties and quality levels.

5. Naturally, the test program must be limited to one type of metal. Steel is suggested as having the most severe quality problem.

Approved
5-12-1?

CORE BINDERS

1. Catalogue all core binders by type rather than source of manufacture.

2. Select representative materials of each type and evaluate performance -- in workability and properties.

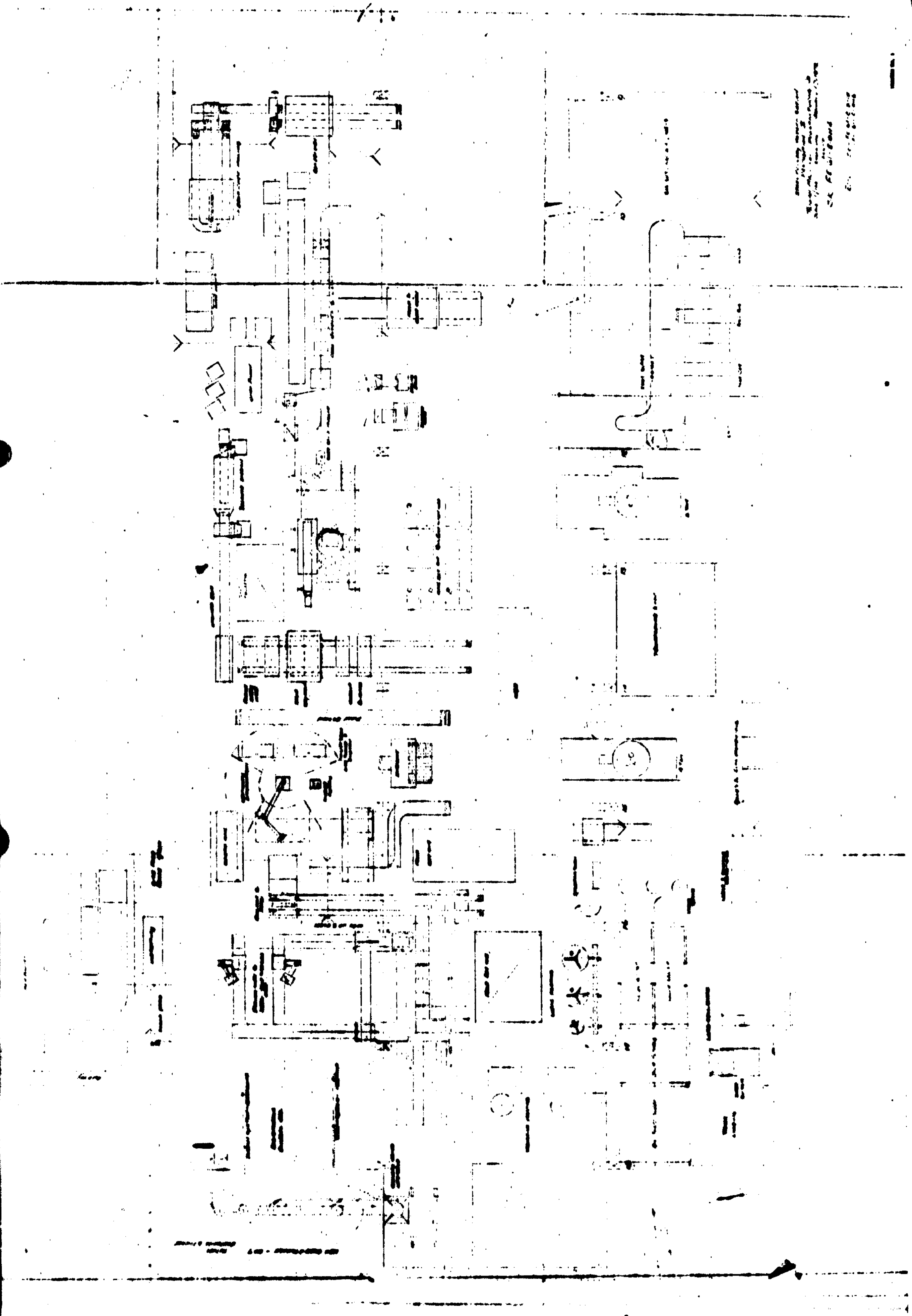
3. Since methods of making core vary, it is logical to select a method most in use for the preliminary program.

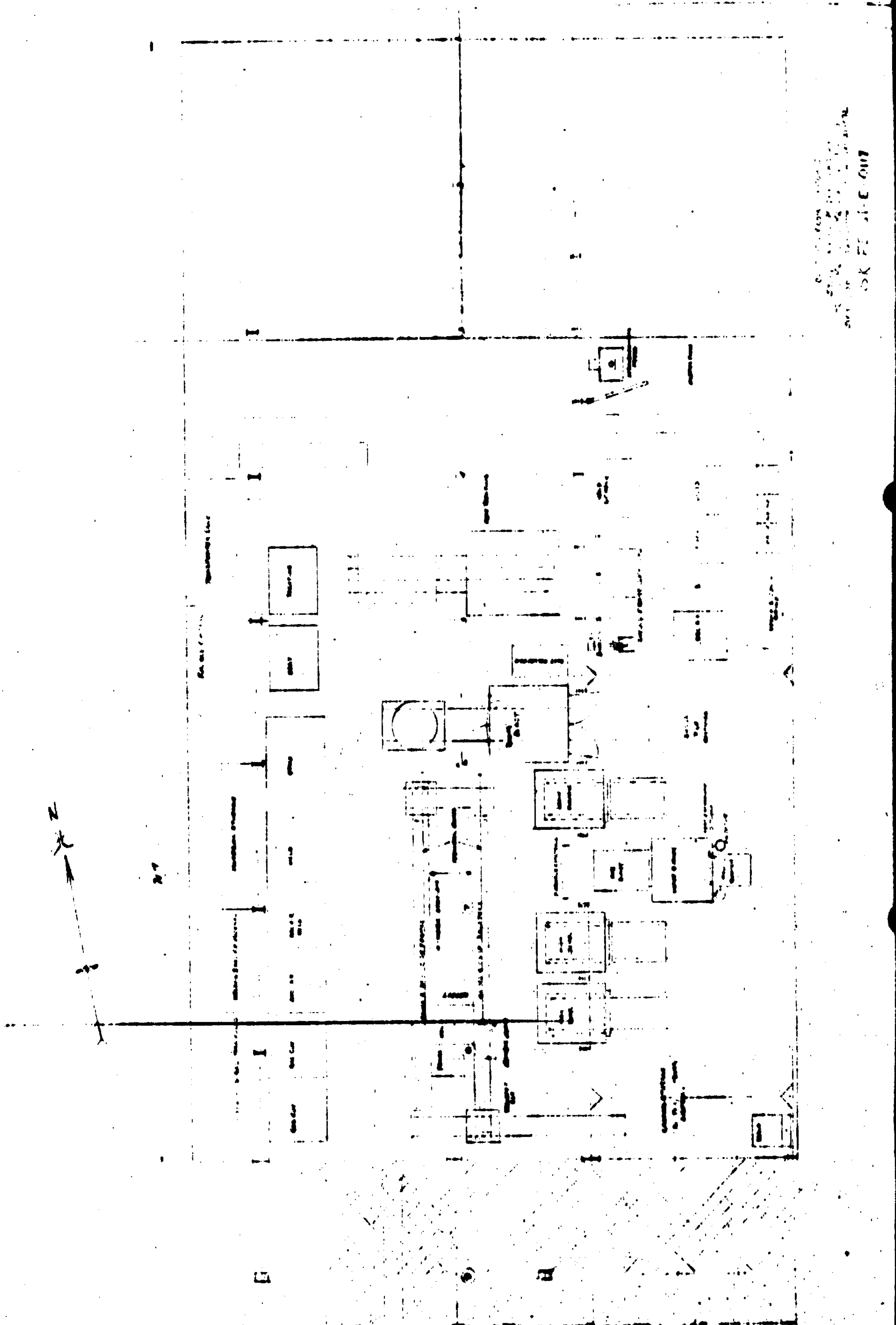
4. Binder types.

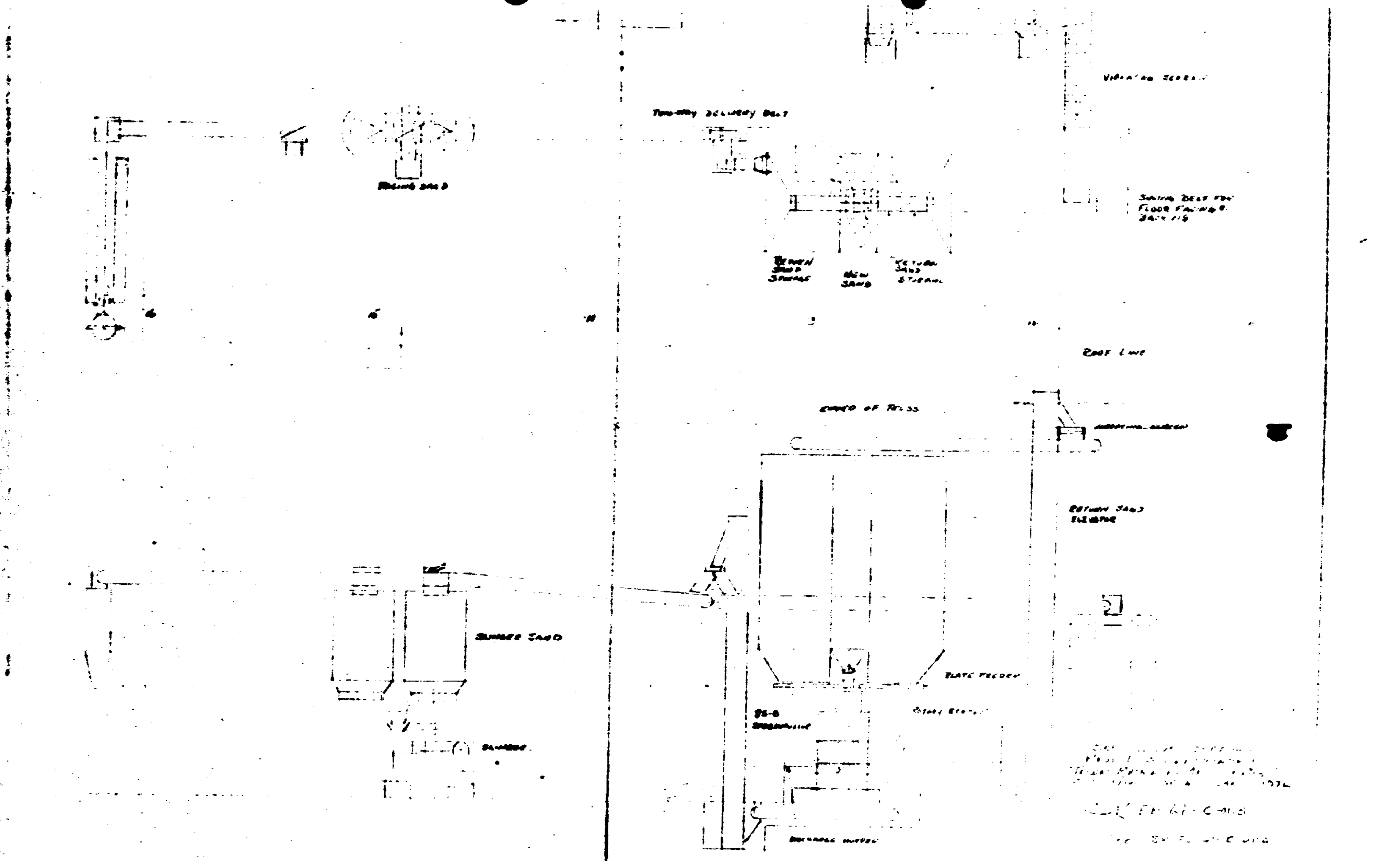
Baked cores	Oil
	Rozin
Air Hardening	
	Oxygenated
	CO_2
	Acid setting binders
	Polyurethane binders

5. Since the latter two items are not available here, a program may be needed to ascertain the possible use, the size of the market, the available manufacturing source, and whether or not raw materials can be obtained locally.

LIST OF DRAWINGS



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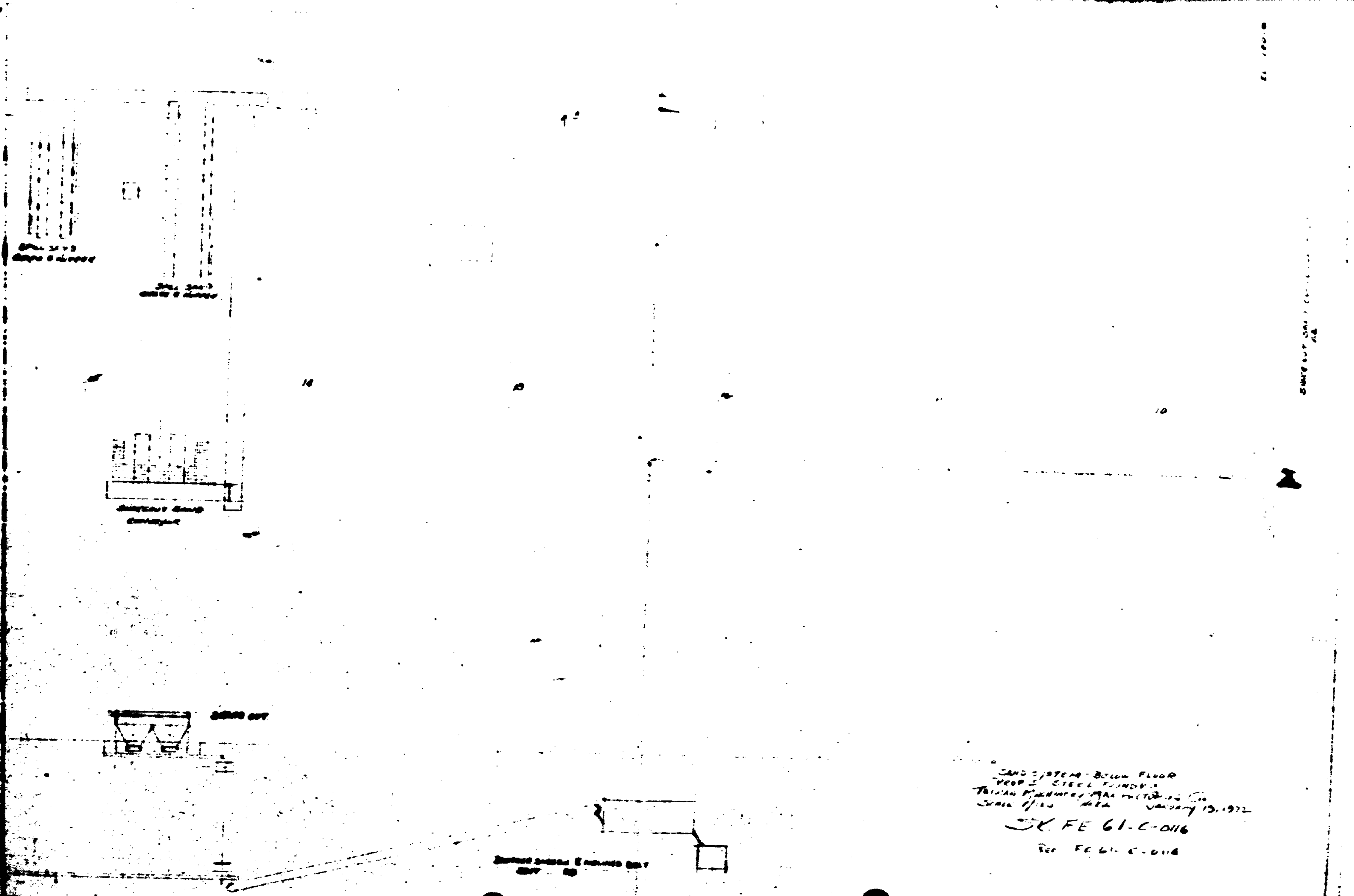
New Sand
Roof Line
Return Sand Elevator
Plate Feeder

DRAWING NO. 3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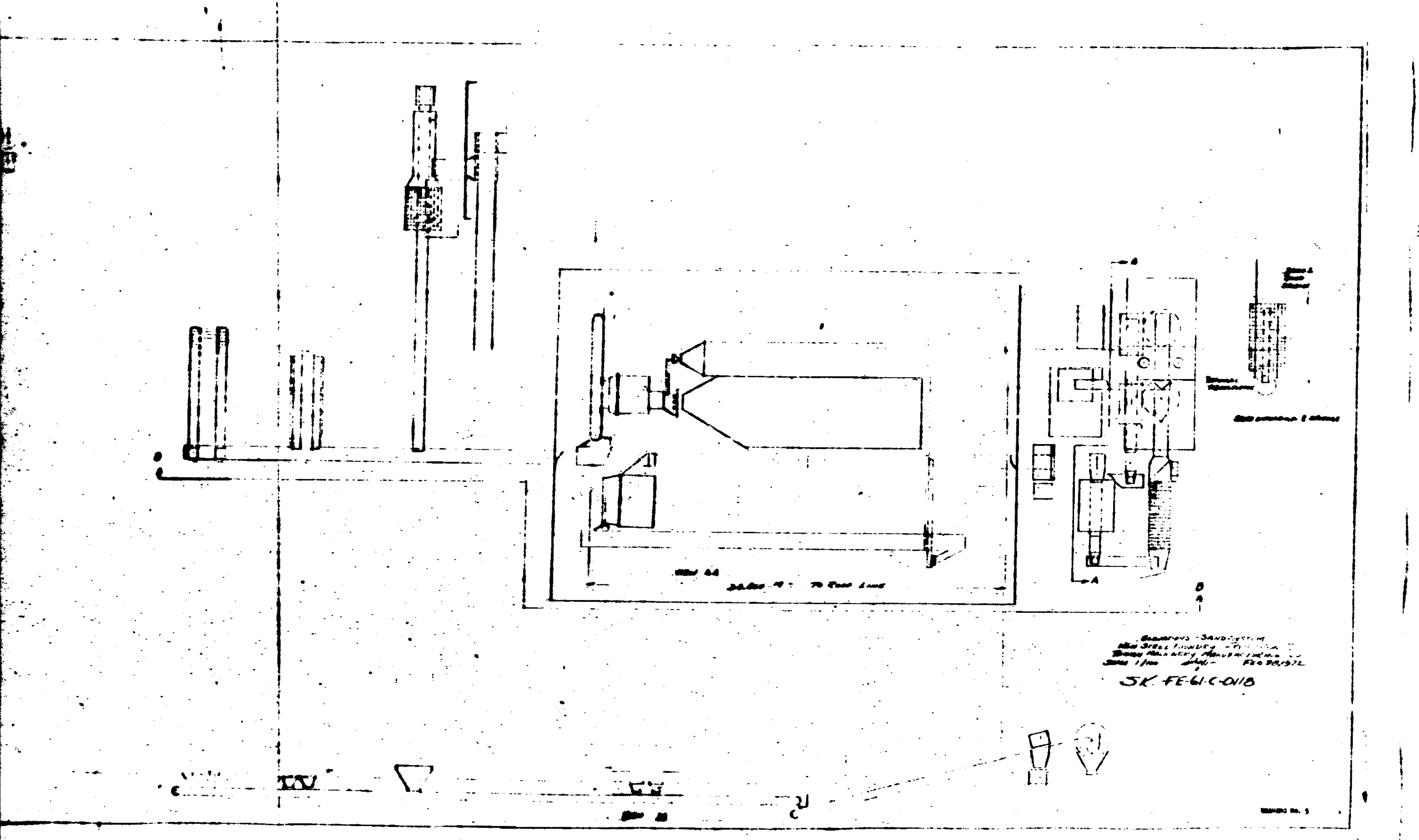
FE 61-C-0114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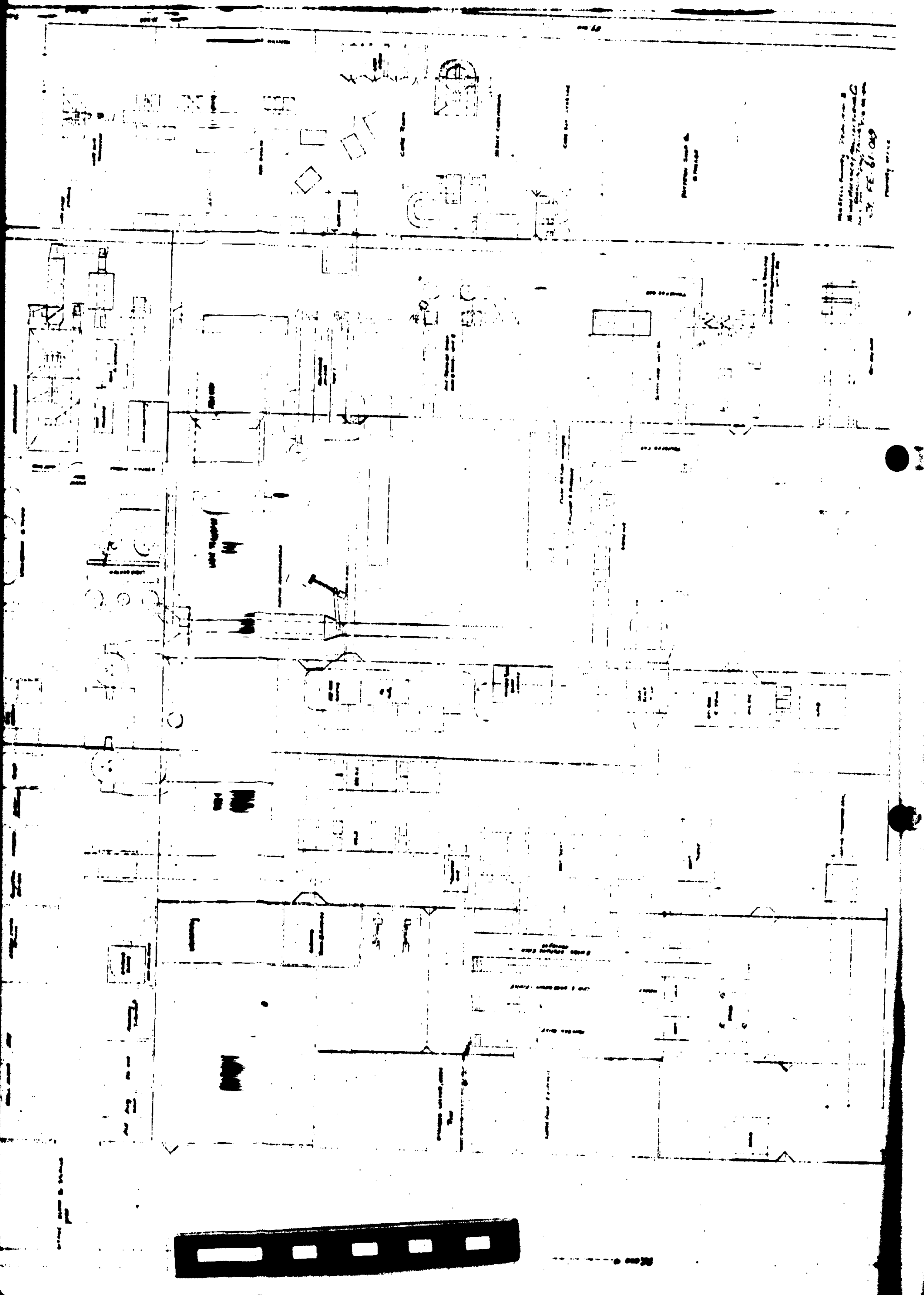

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