4-2 No.4 HI Diesel Engine Manufacturing Equipment

4-2-1 Outline of Production Processes

(1) Working equipment and its layout

The block layout plan for the inside the plant and number of equipment and devices is shown in Figures AI-4-2-1 (1) and (2).

Besides these the processing and assembly line for heavy parts, engine test line and storage facilities, etc. are provided with in line transportation and moving devices such as a garter crane, chain block, etc. (approx. 30 machines).

(2) Organization and personnel

Besides the No.4 HI production department which includes the diesel engine plant there is a Planning Department and Management Department. Required personnel are dispatched to the individual production areas from the posts in charge of inspection, quality control, or maintenance in the Planning Department. The organization and personnel arrangement of the diesel engine plant as shown in Fig.AI-4-2-2.

With regard to the level of technical expertise of personnel by line we see that unskilled work force makes up more than half of those working on the block, crankshaft and con-rod lines, all of which have a large number of equipment and processes. Because of this operating breakdowns occur and technical training presents difficulties.

(3) Supply performance for raw materials and parts

The supply performance for forging and foundry rough shaped materials and press parts for the past year period (1987) has been as follows:

1) Blanks by forging and foundry

Table AI-4-2-1 indicates supply figures for each month.

a) The monthly target outputs have not been realized in most cases. Judging from the number and amounts of received shipments the reason seems to be HIC's own insufficient production capacity for rough shaped materials (cf. Table AI-4-2-2).

b) There are months when the supply of cylinder blocks, cylinder heads, ring gears, and con-rods does not occur. Leaving aside forging, it does not seem that the reason for failure in supply of cast parts is due to an adjustment to over supply.

The supply performances are only one half of the target production output.

2) Component parts

As the press parts of No.1 HI are produced in lots, and after processed in No.4 HI, hindrance is sometimes caused to the engine assembly line. Recent hindrances to production are as follows:

1987 February : Delay in assembly of engine due to lack of oil pans and press parts

August : Lack of head cover parts

September: Lack of oil pans

1988 February : Press parts shown in Table AI-4-2-3 lacking at present

The quantities in stock and lacking vary extremely widely. This is due to unevenness of production on the supply side for press parts and not due to demands.

(4) Equipment capacity and production performance

The planned equipment capacity at the time of founding the department Diesel engine plant and the production performance at present (for the last 3 years) are as follows:

1) Production equipment capacity

Conditions established are as follows:

Actual daily working time (set time)	450 minutes
Average number of operating days per month	25 days
Production equipment capacity (set time)	4 machines/day (1,200 per annum)

2) Production performance

a) The engine assembly performance as evaluated by the plant at the time of the local inspection was as shown in Table AI-4-2-4.

The production performance for the diesel plant indicated completed quantities based on the production schedule indicated above. It is clear that the quantity of rough shaped materials in heading parts influences greatly the quantity completed. There are numerous factors obstructing production due to the rough materials and breakdown of equipment for parts and processing lines. However, many months have high performance results. So if the present state of rough material supply can be bettered it is judged that the diesel engine plant has sufficient foundation to realize sufficiently the equipment capacity planned.

b) Production performance for individual parts

Production figures vary greatly from month to month. This is because of insufficiencies in supply of rough material, delays, breakdown of processing line equipment, which results in a considerable fluctuation in operating rates. The operating rates and production output for the processing lines of the cylinder block and crankshaft and their frequency of breakdown are examined in the heading "4-2-2 (7) Problems and improvement of operating rates and balancing lines" to follow.

4-2-2 Analysis of Production Processing

(1) Outline analysis of processing

The outline analysis of processing is as shown in Fig.AI-4-2-3.

(2) Flow chart and process chains

The sub-assembly for the press parts sent from No.1 HI has the most diversified processing chains in actual operation (Refer to Fig.AI-4-2-4).

(3) Problems and improvement of operational methods and process chains

The DS70 Engine Line consists of general use equipment. Each part has its particular processing flow, and the number of equipment shared with other lines is small. If the present operational methods were standardized and observed problems should be minimal. As discovery of problem points by in shop observation is difficult for time reasons the problems of operational method listed below were taken from the results of a consideration of the results relating to defects in processing.

1) Problems

Present operational methods are not standardized. There is no standard operational manual for the various processes. Efforts and arrangements to ensure that correct operations take place are insufficient. The following areas of operations pose problems:

- inconveniences in the preparatory methods
- changing operations for the cutting tools and precision checks which take place after preparations
- increase in rejects due to over use of the cutting tools and drills
- inadequate transfer contact at the time of operator replacement
- damage to the quality of products due to carrying out operations on the floor

The implementation of inspection of workmen and quality checks by measurements is insufficient. In No.4 HI an inspector from the inspection department (quality control) is sent to each shop and a sample check is performed to prevent occurrence of rejects. This has had positive results. However, this is an ex post facto measure and not a preventative means to prevent production of rejects. Training and discipline of the line work force to instill a sense of quality control is very important.

2) Improvement measures

First it is important to make efforts and arrangements to set up standard operations. An operational manual is needed for this. This should be an operations instruction book including information on operation steps, product quality, dimensions, accuracy and confirmation methods, and handling of malfunctions. A manual just indicating the process dimensions for each production process and a precision diagram would not be enough. Much better would be a manual painstakingly compiled by the plant itself to include necessary topics. It is important that a manual be written in Burmese characters so that all of the Burmese personnel can understand it.

(4) Problems and improvement of operational methods and division of labor

1) Problems

The produce and stockpile method of production employed by HIC makes for easy working of management functions such as production control, quality control etc. For example, operations do not proceed on the basis of a production schedule. Production takes place controlled by supply aspects such as the supplying power of rough materials and parts. In other words production schedules for rough materials and parts cannot be kept up with. Ensuring production output is put before ensuring product quality. For example, even if a part is missing it is not seen as a problem by engine assembly or in the efficiency inspection. Reduction in quality caused by denting of the inside the engine, the danger of entry of alien substances, or occurrence of rust are largely ignored. We could not observe conditions for realizing the production schedule, for setting a foundation and sections responsible for aid.

2) Improvement measures

a) It is necessary to provide the managerial function of strengthening realistically the production system in the planning department of the Headquarters. An improvement of the supply system for rough materials and parts is needed for the processing department at present. Therefore an adjustment system to assure guidance for the grasping and improvement of production capacity and problems of each shop, assure a close liaison effort between aiding activities and the area helped, and to assure close network for separated shops is needed. Various policies such as the establishment of a tie up between the production planning department and its cooperating industries or permanent available organization are possible but this system needs to operate as a service function not as an authoritative organization. A regular examination of the stock inventory of each shop takes place to improve production output management and inspections of iron and steel raw materials rough shaped materials, processed goods in progress, processed finished goods, and assembled finished goods take place biannually. Production planning is lacking and stocking production from the producing side means if parts are made they rust if unmade engine assembly has to stop for want of parts. Regulatory guidance is needed. The aim is that parts should be kept only in quantities necessary for realizing assembly.

b) The normal working arrangement is one shift but a two shift system should be considered for increasing production output. Equipment investment in 2 lines is necessary to meet the production schedule of HIC and as a counter measure against bottlenecks also. In order to realize this it is necessary to undertake both the improvement of the present maintenance system and to set up a three shift system for the personnel in charge of maintenance.

(5) Problems and improvement of equipment layout and material handling

The layout itself is without problems. Increase in flow efficiency is desirable for dealing with a future expansion of production.

1) Flow of processing lines

In the first half of the cylinder block processing line it is necessary to consider installing a safe and efficient roller conveyer. On the crankshaft line it is necessary to improve moving between processes by replacing the crane method with the chute method.

2) Problems of material handling in the plant

All movements needing allocation of vehicles such as movement of rough shaped materials, disposal of rejects, movement of stock items, etc. involve request to the main store. As the Diesel department involves heavy objects, for safe, well timed and apt handling (including maintenance aspects) the present system of material handling needs improvement. Fig.AI-4-2-4 shows the sub-assembly for press parts.

Material handling in each shop of No.4 HI for each process involves a request for operational aid to the work force and vehicles of the diesel plant. It is necessary to promptly reconsider the present system of material handling.

3) Improvements

It is necessary to provide a fork-lift truck for exclusive use of the plant as there is a large number of heavy objects. As with the press sub-assembly it is the task of the supply progress department of the Planning Department of No.4 HI to take charge of the progress of processing and material handling in other shops

(6) Problems and improvement of working equipment

1) Problems (refer to Fig.AI-4-2-5)

a) Production line equipment which suffers from bottlenecks at present is as follows:

- B-12 MV vertical milling machine: for cylinder block processing

- B-08-1, 2, B-09-1, 2, B-10-1, 2 DR special use drilling machines: for cylinder block processing.

- H-04, 05, 02 DR special use drilling machines: for cylinder head processing

- R-21 superfinisher: for crankshaft processing

- R-21 measurement device, air micro device: for crankshaft processing

- T-01 vertical milling machine: for shared use with timing gear case, and clutch housing processing

b) The following equipment is shared in machine processing use with other parts at present:

- R-16 vertical milling machine: shared use for crankshaft and cam shaft processing

- A-05 gear hobbing machine: shared use for cam shaft and ring gear processing

c) Since operations in which coil burns are frequent caused by weakening of insulation for the high frequency wave transmission are dangerous the following spare parts and repair equipment is needed:

- R-09 high frequency quenching machine: crankshaft processing

d) Equipment needed to lengthen the engine life by high pressure removal by cutting or sanding are as follows:

- high pressure cleaning machine: for cylinder block and cylinder head processing

e) Equipment needed for improvement of the transportation of parts between processes is as follows:

- a roller conveyer: for the first half of cylinder block processing line and the crankshaft processing line.

- a chute : for the crankshaft processing line

2) Improvements

It is necessary to improve one device, 12 sets of machinery, 2 more devices and 2 sets of transportation equipment for inter-process transportation in order to solve the above problems.

(7) Problems and improvement of operating rates and balancing lines

1) Operating rates and problems for the main processing lines

Table AI-4-2-6 shows the operating rates of selected processing lines for the two main rough materials (blanks) from foundry and forging shop.

Operating rates are low with the present produce-and-stockpile system. The main reasons are the lack of rough materials and the delay in timing. Operating rates are particularly impaired by time wasted waiting for materials. The other main cause is equipment breakdowns. However this is not so decisive since recovery of production can be met by increasing the operating rates in this case.

A low operating rates of the crankshaft production equipment is due to equipment breakdowns. In the case of the cylinder blocks this is caused by both lack of supply of the blank and the breakdown of equipment.

The maintenance system is at fault for failing to prevent the breakdown of equipment or decrease the number of days with stoppages. The equipment users do not have any basic preventative measures for breakdowns, and then since the maintenance is not sufficiently informed by equipment users mutual contact to effect preventative measures does not take place.

If the calculated operating rates are correct it should be easy to realize the estimated production. In this evaluation we investigated whether operating rates and production performance are proportional by using the straight line return analysis. The results showed a significant correlation between the operating rates and production output for both lines. Consequently the reliability of this data seems high (Fig.AI-4-2-6).

On the basis of the individual operating rates and production output of the cylinder block and crankshaft over the past year period a prediction of the average production output for individual operating rates on the assumption of conditions similar to the past period is shown in Table AI-4-2-7.

That is to say that production equipment for the crankshaft with an operating rate of 74% will have a possible monthly average production of 100 items. In the case of the cylinder block this is only 98 items even with 100% operating rate. If one includes minus factors of defective processing and defect materials the yield will be somewhere around 90%. It is necessary to undertake prompt improvement measures.

2) Problems of line balancing

The state of line balancing between processes in the processing lines is explained in (6) "Problems and Improvements of Working Equipment". A comparison of the processing lines is given in Fig.AI-4-2-7.

3) Improvement of operating rate and line balancing

a) Operating rates

The lack of and delay in supply of rough shaped materials has been mentioned. Countermeasures based on the acquisition capacity of the rough shaped materials production departments (No.3 HI, No.2 HI and Headquarters Office Planning Department), and improvement of management of delivery dates, and strengthening of functioning of the responsible departments are necessary.

has been pointed out that the frequent occurrence of equipment breakdown and the number of days needed for repairs take too much time. It is necessary to implement a plan for Preventative Maintenance through measures to strengthen the organization and system of the maintenance dept. (through a reconsideration of organization, maintenance equipment, personnel, materials for repair, securing of locations, etc.) and the rigorous observance of daily checks (in particular basic countermeasures regarding oiling and wear through high temperatures).

b) Line balancing

There were a large number of processes and equipment with bottlenecks. A prompt improvement of these is desirable.

(8) Problems and improvement of reception of raw materials and parts

1) Problems

a) Problems of assuring the quality of parts received

It was felt that the inspection activities for received goods was weak. In the case of the forging of connecting rods sent from No.3 HI to No.2 HI a large number of rejects were put taken onto the line and troubles continued for nearly half a year. If the inspection of the rough materials received by No.4 HI had been sufficiently carried out this would have prevented the mistaken inclusion of reject blanks.

b) Problems of materials handling

As can be seen with the material handling of the sub-assembly press parts from No.1 HI, it seems inadvisable to have the Progress Group of the processing lines in charge of the material handling between shops (done with sheer force of numbers, using trucks and without any fork-lifts) and operational progress.

2) Improvements

a) Product quality

In No.4 HI quality control and inspection functions are divided. The task of quality control belongs to the Planning department and daily checks of general quality control, statistics administration, check for problems with the line inspection gauges, and checking devices (measuring devices) are carried out. Inspection duties are done by the diesel plant and checks of rough materials, press parts, checking on receipt of imported goods, and sampling checks of processed products from the lines take place. Formally, Japan had the same organization as that of HIC. Practical results of the visual check of process lines are small. So observation duties of the process lines have been incorporated into the production department and checks of receipts and line product quality take place.

b) Materials handling

It is desirable to have the Planning Dept. of No.4 HI in charge of material handling for the sub-assembly of press parts.

(9) Problems and improvement of finished product dispatch

1) Problems

The following problems have been identified with engine assembly and storage methods down to the stage of dispatch. The engine attachment, completion and storage condition at the time of inspection are as follows (unit:set vehicle):

- Total completely assembled (including missing press parts) 169
  - Efficiency test passed 86
    - Finished product 38
    - Having missing parts 48
  - Before test, parts missing 83

That is leaving aside the 38 units finished 78% of the total had missing press parts. The parts are stored in a manner which allows the openings to be soiled with dust and dirt and there is even the danger of alien substances getting into the opening to the air intake manifold.

2) Improvements

When completion is not possible because of missing parts, the best policy is to stop assembly, but if this cannot be realized because of HIC's production methods then the product including the part affected by missing parts should be wrapped in plastic bags to prevent entry of dust or foreign bodies. Moreover, it is necessary to guard the special cap and lid of the water and air pipes during storage and dispatch. Finished products should be handled on a first in first out basis. Many of the unpainted engine parts are already rusted at time of dispatch (cf. Fig.AI-4-2-8).

4-2-3 Analysis of Products Quality

(1) Occurrence of rejects

The past year was chosen as the evaluation period and Figs. AI-4-2-9 and AI-4-2-10 indicate the reject rate for blanks and the defective processing rate.

1) Raw materials reject rate

Reject Rates for raw materials received at No.4 HI:

The reject rate for castings of No.3 HI was 3.3% (= 119/3,597).

The reject rate for forged products of No.3 and No.2 HI was 4.7% (= 197/4,196).

The reject rate for imported forged products was 1.1% (= 13/1,136).

The reject rate of the complex core parts for the cylinder block and head of cast products vary greatly. Despite a recent trend to decrease in these should not cause complacency. The average reject rate is not high. It is desirable to keep the monthly reject rate for all materials of any given product below 3%. Modifications of the shop for forged connecting rod production (change of process methods) involves problems. There is likely to be a problem with the metal molds for the ring gear. In No.3 HI it is rather inspection of rough materials that should be seen as a problem.

2) Defective processing

Figure AI-4-2-11 shows the main causes of defective processing.

Defective processing caused by defective equipment is twice that of operational misses. If this is the true cause then high monthly rates should continue to occur. However, this is not so. So it seems that the cause of defective processing is not defective equipment. In fact, there is no checking, maintenance or reform of defects in precision. When measures to reform operations are not taken rejects will continue to occur. Unless efforts are made to search out the causes of processing misses instead of defective equipment, the already poor state of rough shaped materials will be worsened further.

(2) Analysis of relation with preceding and following processes

If modifications of the essential production conditions of the connecting rod take place frequent occurrence of mistakes could arise. Therefore, it is necessary at that time to set down rules for the implementation of data routes, measurements for first products test processing, etc. The forging destination was changed from No.3 HI to No.2 HI. And the forging method changed from the air drop hammer used in No.3 HI to the 2,500 ton forging press of No.2 HI. As the forging methods differ new patterns are being made by the mold design and production department of No.3 HI. The connecting rod supply to No.4 HI began in June of 1987. These product lines passed the process lines with a reject detection rate of 0-0.9% until material rejects were noticed (cf. Table AI-4-2-8).

After this, a follow up investigation was made but collection of rejects proved difficult. It is unclear which standards were enforced by No.3 HI as pass criteria for quality confirmation before mass forging was begun. In the lot delivered every kind of reject occurred, and it is necessary to reconsider the check of received goods carried out by No.4 HI. Rules for "The modification of important production conditions" are necessary at HIC.

It is necessary to improve the management of materials in the forging shop of No.3 HI. And though the cramped space of the forging shop work areas is the original cause of these problems, hammer, heating furnace, cutter, area for bar materials (long materials, cutting materials, end materials) are not demarcated and confusion and mingling of materials is to be feared. HIC should implement the reforms in material management through supervising, arranging and organizing (cf. Figs. AI-4-2-12 (1) and (2)).

Anti-rust painting of the cast rough materials in No.3 HI is desirable. The main aim of anti-rust painting of the rough materials for the cylinder block, head, timing gear case, and clutch housing is both one of preventing rust on the inside of the casting and also to attach and hold any sand present which cannot be sent through the trimming hole. It is therefore desirable to undertake painting after finishing of the casting. This occurs in Japan for the case holding the rotary part, coating the anti-rust on the inside and outside of the holes is desirable during the previous process in No.3 HI from long term maintenance considerations. Attachment of special guard caps or plates to meet the need to prevent entry of foreign bodies or dust at the time of engine dispatch (including undesirable conditions during storage), and when dispatches to No.1 HI occur should be followed. The danger of foreign bodies entering into the ventilation opening of the air intake manifold is especially high (Refer to Fig.AI-4-2-13).

(3) Problems and improvement of quality standards and inspection methods

The quality standard is indication (refer to Fig.AI-4-2-14) of processing accuracy for the various production processes of each line drawn up according to the technical standards for each process established on the basis of the design specifications.

The inspection methods for lines also follow the technical standards and take place according to these. However, the quality checks done by operators have problems in their conditions of practice.

The inspection and quality control department of No.4 HI has implemented the following systematic inspections for the accuracy check by measuring devices together with the accuracy check for processed products:

1. Weekly inspections of testing gauges daily inspections of test equipment (measuring devices).

2. Daily inspections of test equipment (measuring devices)

3. Sampling inspection of rough shaped materials (blanks) and processed products.

The formation of the members located in the diesel plant are the engineering staff and 10 other staffs (skilled 8 and unskilled 1). However, judging from the causes of defective processing, unless the line quality checks (self check type) are strenuously undertaken and their procedure thoroughly standardized, it will be difficult to stop the occurrence of rejects by sampling checks.

4-2-4 Maintenance of Equipment and Buildings

(1) Maintenance system

Of the 84 total personnel of the maintenance group of No.4 HI except for the 39 members involved in water treatment and power resources these are stationed in the individual production departments and practice the generalized management in the planning departments (Refer to Fig.AI-4-2-15). The personnel responsible in the Diesel Engine Plant possess the technology and knowledge necessary to the maintenance of equipment except for a small number of specialized machinery. Because the main emphasis of HIC's maintenance is on general repairs and not on preventative maintenance (PM) the present state of equipment maintenance, parts for repair, materials and areas is extremely inadequate and the same is true of No.4 HI.

(2) Supplement performance

The performance for the past year (Feb.1987 - Jan.1988) is as shown in Fig.AI-4-2-16.

The number of breakdowns was 110, of which those for the crankshaft, and cylinder block lines totaled 73, being 66% of the total. Both lines had a high rate of 73% for serious breakdowns. Occurrences of serious breakdowns tend to be higher in the upper ranks but since ratio of the number of occurrences and amount of equipment held corresponds it cannot be said that the upper ranks are particularly affected by deterioration or deterioration. The rate for the types of breakdowns are equally divided between those caused by mechanical and those by electrical faults (cf. Fig.AI-4-2-17).

A straight line return analysis of the present state of the crankshaft line was done in order to show the correlative relations between the operating rates of line equipment and number of breakdowns. Referring to Fig.AI-4-2-18 the result gave the significantly high result of correlation showing r=0.78.

Therefore, if the crankshaft line be operated in a operation rate of

100% 7.8 items per month not including variables and since there would obviously be a certain unevenness one could predict the occurrence of a greater number. It is necessary to confront the problem posed by the fact that with its present organization and system maintenance is unable to cope with the burden represented by the crankshaft line. The cylinder block line also showed a similarly significant coefficient of correlation of $r=0.566$ expressing a correlation between the number of breakdowns and operating rates (cf. Fig.AI-4-2-19).

The estimated number of breakdowns for the cylinder block line with 100% operation would be an average of 3.1 machines per month without unevennesses. Breakdowns for the two lines of worst 1 and 2 alone would be 7.8+3.1=10.9 machines per month, giving a ratio equivalent to the simple breakdown performance of 66% of all lines. Therefore if all lines were operated at 100% this would give an average monthly breakdown rate of 16.5 machines. Therefore to raise operating rates in present circumstances would only further the vicious circle of "increasing breakdowns > unused lines > reduction of operating rates".

Principle causes of breakdown

Mechanical breakdown: damage or wear etc. to bearing, shaft, tap, gears due to deterioration over the years or lack of lubricating oil.

Electrical breakdown: defects in or damage to operation of controls, cable wiring (rat damage), due to deterioration over the years or high temperatures.

There is considerable unevenness depending on period, and the contrast is given as reference since the comparative relation with production figures does not seem appropriate with regard to production methods (cf. Table AI-4-2-9).

(3) Problems and improvement of maintenance

1) Problems

There are inadequacies of organization and system, whose source is the lack of policies for the realization of production schedule. From the organization side the scale of the existing diesel plant should justify the provision of a maintenance group in the plant. Although the store room functions can be shared with the central maintenance group, as far as handling of equipment breakdown is performed by maintenance personnel in dispatch to the production plant, there is no way to separate breakdowns and repairs. In an integrated organization acting as a production department with its function of maintenance the cooperative relation of preventative measures leading to reduction in breakdowns should arise. Whatever be the organizational structure, the maintenance system is very poor and work areas, equipment and materials for maintenance works are all practically non existent while the personnel fewer than in other posts nevertheless keep necessary competence.

(Maintenance work area)

There is no space allotted maintenance in the layout plan. A small area was finally secured by the stationed staff but this is not a work area. It seems that enthusiasm is low and organization and staff though of as makeshift.

(Equipment)

There is no grinder or electric drill and parts production for repairs is done by appropriating processing lines. It is inevitable that repair is lengthened out.

(Spare Parts and Maintenance Materials)

There is a lack of raw materials, and even of spare parts. There are almost no component parts for the line working equipment.

2) Basic maintenance policies for improvement

If breakdown occurs then repairs are done. These are postponed until parts necessary are made. This policy of waiting on events appears in the development of breakdowns. It is essential to consider the causes of breakdowns, perform daily checks, and promptly ensure machinery is kept in good repair in order to stop breakdowns. Therefore clear countermeasures are needed. It is unrealistic to think that particular policies suited in detail to the needs of the individual work areas to which staff are sent could be made. Countermeasures to the causes of breakdowns examined earlier are:

- Daily inspection of equipment, and strict enforcement of maintenance:

As there is a general lack of lubricating oil applied to machinery a group responsible for this should be organized.

For electrical parts daily checks of switches and buttons, and inspection of areas sensitive to temperature increases and establishment of cooling methods of them.

- Preventative maintenance for machines with serious and chronic breakdowns.

Unless the present system of de facto repairs is replaced by preventative policy the poor operating rates of processing lines and the low level of production can not be remedied. As the problem affects the whole of HIC though it involves various problems perhaps the first step is to have production sections create their own organization, system and policies for safeguarding their lines.

Fortunately the full maintenance staff of the diesel plant is enthusiastic and management is done using a simple control bulletin board drawn up under guidance of the stationed officer to show preventative maintenance schedules and breakdown records. Working on this foundation will lead on to improvements (refer to Fig.AI-4-2-20).

Table AI-4-2-1 PROCUREMENT OF MATERIALS FOR DIESEL ENGINE PRODUCTION

	Year:	1987												Year Total	Monthly Average
	Month:	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
	Production Plan	100	100	120	96	120	120	100	100	80	96	54	43	1,129	94
Actual	(C) Block	75	64	87	48	47	0	0	--> 24	67	87	29	31	559	46
	(C) Head	85	85	57	76	49	--> 13	56	0	44	56	38	43	602	50
	(C) T/G Case	47	0	158	57	14	58	--> 20	43	34	59	61	75	626	52
	(C) Clutch Housing	97	113	54	91	48	--> 19	31	34	58	79	57	67	748	62
	(F) Con-rod	54	70	137	34	110	260	26	0	0	0	0	4	695	57
	(F) Ring Gear	120	102	0	0	--> 104	0	69	100	0	54	67	0	616	51

Notes: ---> Show arrival of material at the end of the month.
(C) Cast parts
(F) Forged parts

Table AI-4-2-2 FREQUENCY OF MATERIAL ARRIVAL AND NUMBER OF MATERIAL RECEIVED PER ARRIVAL IN 1987

Month:			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cylinder Block	Frequency of Arrival		7	6	10	7	5	0	0	3	6	7	6	3
	Number of Material Received /Arrival	Max.	15	15	15	16	10			10	20	20	6	14
		Min.	5	4	3	3	5			3	4	4	4	5
Cylinder Head	Frequency of Arrival		4	7	6	6	4	1	3	0	3	4	3	3
	Number of Material Received /Arrival	Max.	79	50	31	40	37	26	40		46	41	36	40
		Min.	13	9	11	9	15		35		20	16	7	17
Ring Gear	Frequency of Arrival		1	1	0	0	1	0	1	1	0	2	2	0
	Number of Material Received /Arrival	Max.										39	49	
			120	102			104		69	100				
		Min.										15	18	

Table AI-4-2-3 EXAMPLE OF DELAY OF COMPONENT PARTS ARRIVAL
- DIESEL ENGINE PLANT, NO.4 HI -
(FEBRUARY, 1988)

(Unit: Number)

Component Parts	Number of Delayed Parts in the Preceding Months	Requirement in the Month	Total Reqirement in the Month	Number of Arrived Parts in the Month
Manifold Sub Ass'y	206	20	226	-
Head Cover Ass'y	10	20	30	-
Head Cover Ass'y	55	20	75	-
Cover, Valve Push Rod	113	20	133	-
Oil Pan	-	20	20	32
Strainer Sub Ass'y	-	20	20	124
Strainer Cover	-	20	20	109
T/G Cover Sub Ass'y	-	20	20	34
Strainer Cover	-	20	20	378
Cover, Tappet Chamber	-	20	20	72

Table AI-4-2-4 PRODUCTION RECORD OF DEISEL ENGINE

(Unit: Number)

Month:		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Total
1985/86	Actual	85	36	87	80	100	100	100	33	50	50	0	150	871
1986/87	Actual	40	104	90	100	100	100	100	80	52	75	12	32	885
	Planned	100	100	120	100	100	100	100	80	75	60	100	120	1,155
1987/88	Actual	67	100	100	79	50	60	42	11	14	9			
	Planned	96	120	120	100	100	80	96	54	43	29			

Table AI-4-2-5 PRODUCTION RECORD OF COMPONENT PARTS FOR DIESEL ENGINE PRODUCTION

Component Parts	1987											1988	Total
	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	
Cylinder Block	80	105	66	58	74	16	73	86	88	36	21	0	703
	(90.9)	(113.1)	(61.7)	(59.5)	(63.0)	(14.5)	(75.7)	(76.6)	(83.2)	(36.3)	(20.4)	(0)	
Cylinder Head	83	57	46	49	18	68	0	12	54	46	10	0	443
T/G Case	0	120	101	70	116	116	24	0	10	56	46	0	659
Clutch Housing	0	120	96	125	0	50	36	20	88	0	48	67	650
Bearing Cap	100	120	96	108	75	120	78	0	0	0	0	0	697
Crankshaft	34	61	59	96	46	57	58	57	61	35	32	0	596
	(39.8)	(38.7)	(40.8)	(60.6)	(40.4)	(45.5)	(34.9)	(43.8)	(51.0)	(24.5)	(22.3)	(0)	
Con-rod	47	120	90	69	37	64	37	23	46	22	5	21	581
Ring Gear	101	120	39	0	88	72	15	99	23	59	161	56	833
Cam Shaft	52	120	92	60	61	32	75	16	0	0	0	32	540

Note: 1) Unit: Equivalent number of DS engine produced.
2) Figures in the parentheses show the operation rate of the line (%).
3) Number of produced cylinder block sometimes exceeds that of material procured because of use of the imported materials.

Table AI-4-2-6 CAPACITY UTILIZATION RATE OF SUB-ASSEMBLY LINES OF CYLINDER BLOCK AND CRANKSHAFT

(Unit: %)

		1 9 8 7											1988	Monthly Average
		Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	
Cylinder Block	Days Not Operated					B-06 7d.	B-09-1 7d.	B-16 1.5mo.		B-15 5d.				-
	Operation Rate (%)	90.9	113.1	61.7	59.5	63.0	14.5	75.7	76.6	83.2	36.3	20.4	30.9	60.5
	Number	80	105	66	58	74	16	73	86	88	36	21	28	60
	Accumlated Number		185	251	309	383	399	472	558	646	682	703	731	
Crankshaft	Days Not Operated	R-12 20d.	R-09 8d.	R-09 3d.	R-15 3d.	R-09 10d.								-
	Operation Rate (%)	39.8	38.7	40.8	60.6	40.4	45.5	34.9	43.8	51.0	24.5	22.3	0	36.5
	Number	34	61	59	96	46	57	58	57	61	35	32	0	54
	Accumlated Number		95	154	250	296	353	411	468	529	564	596	596	
Production of DS Engine	Actual	12	32	67	100	100	79	50	60	42	11	14	9	48
	Planned	100	120	96	120	120	100	100	80	96	54	43	29	88

Note: 100% refers to 450 minutes/day operation.

Table AI-4-2-7 EXPECTED NUMBER OF PARTS PRODUCTION AT DIFFERENT LEVEL OF OPERATION RATE

(Unit: Number/Month)

Operation Rate		60%	80%	100%
Expected Number to be Produced	Cylinder Block	60	79	98
	Crank Shaft	81	108	136

Table AI-4-2-8 FREQUENCY OF OCCURENCE OF INFERIOR PARTS AT CON-ROD PRODUCTION LINE

		1987												1988
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Number of Con-rod Supplied to DS Engine Plant	From No.3 HI	324	425	825	289	660	84	113	-	-	-	-	-	-
	From No.2 HI	-	-	-	-	-	1,477	45	-	-	-	-	23	N.A.
Frequency of Inferior Parts (%)		0	0	0	0	0	0	0	0.9	0	6.4	40.9	46.6	0

Table AI-4-2-9 RECORD OF FREQUENCY OF MACHINE TROUBLE

Period	Total Frequency	% of Total at the Production Line:			
		Crank Shaft	Cylinder Block	Cam Shaft	Con-rod
Feb./1983-Jan./'84	150	25	23	12	
Feb./1984-Jan./'85	82	28	23	13	
Feb./1985-Jan./'86	111	41	26	14	
Feb./1986-Jan./'87	92	28	37		12
Feb./1987-Jan./'88	110	39	27	12	

Figure AI-4-2-1(1)   LAYOUT OF DIESEL ENGINE PLANT

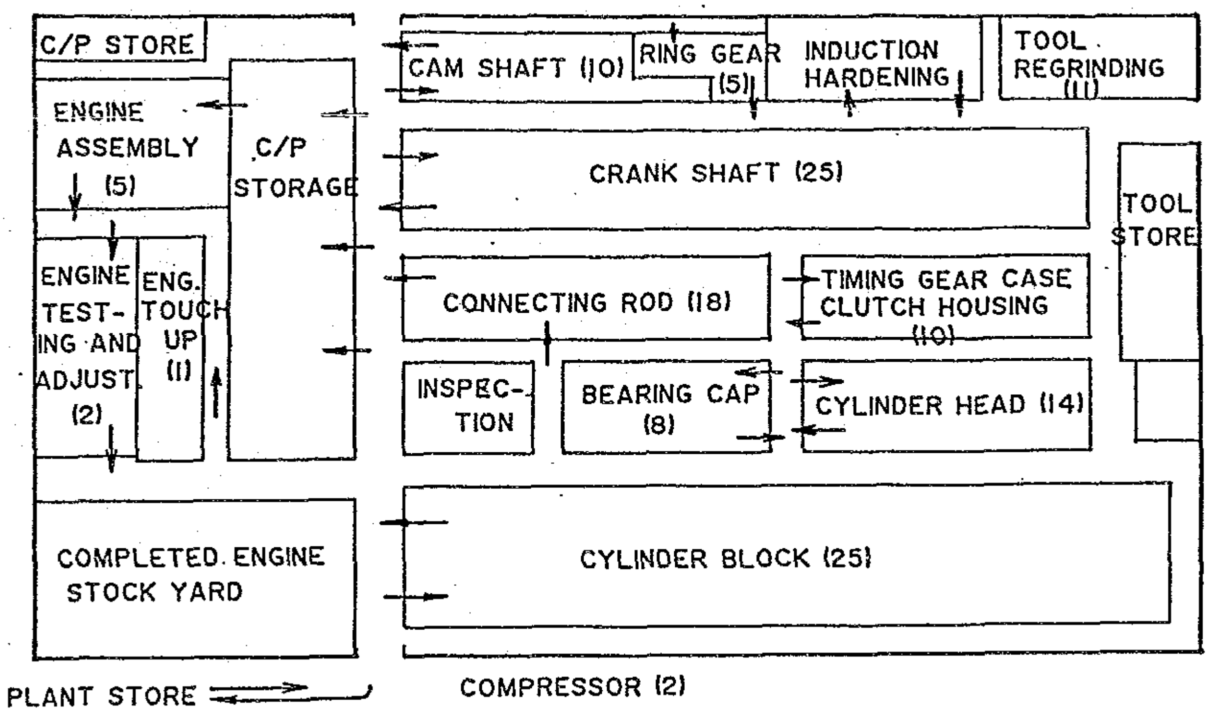


Figure AI-4-2-1(2) LAYOUT OF DIESEL ENGINE PLANT

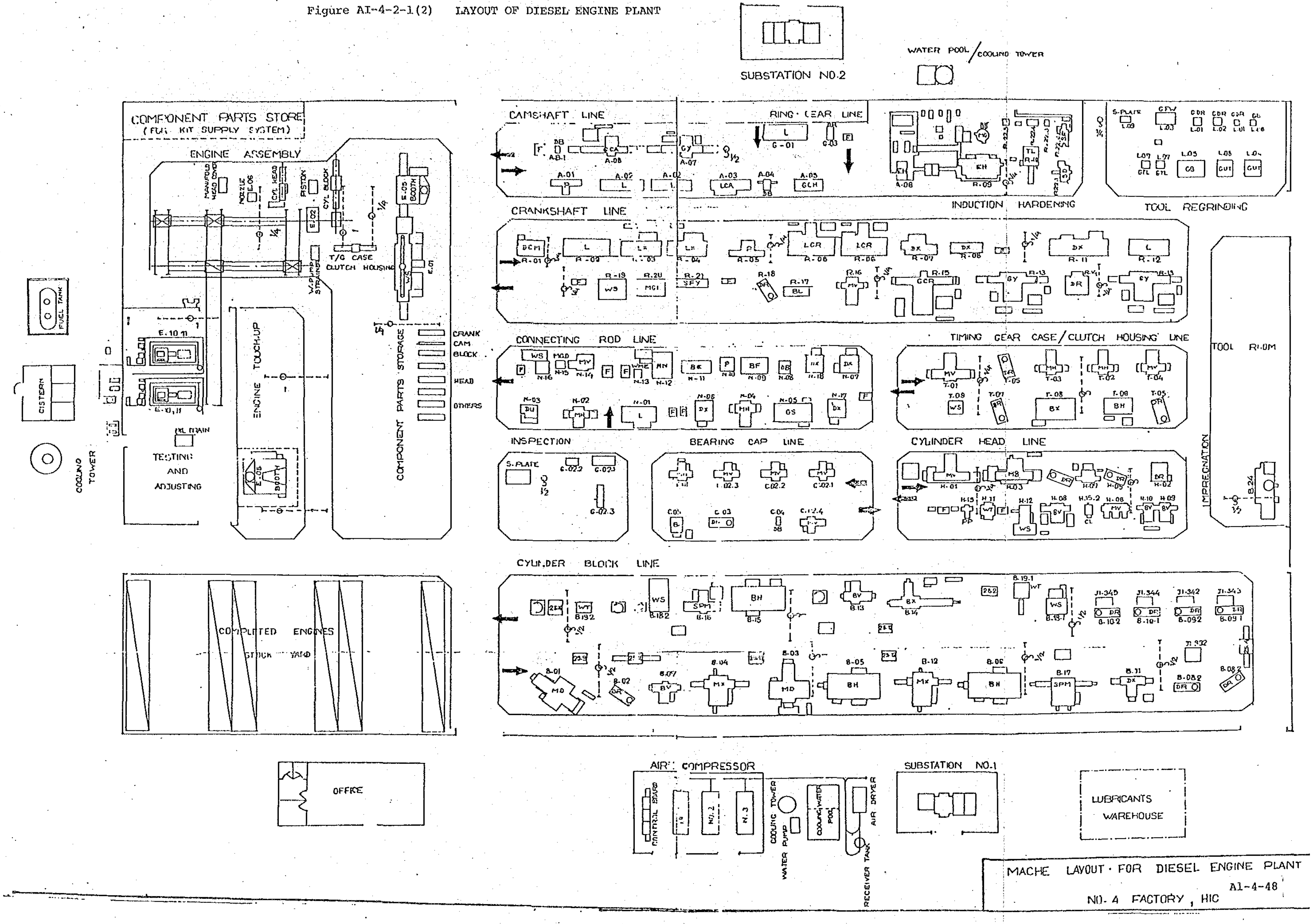
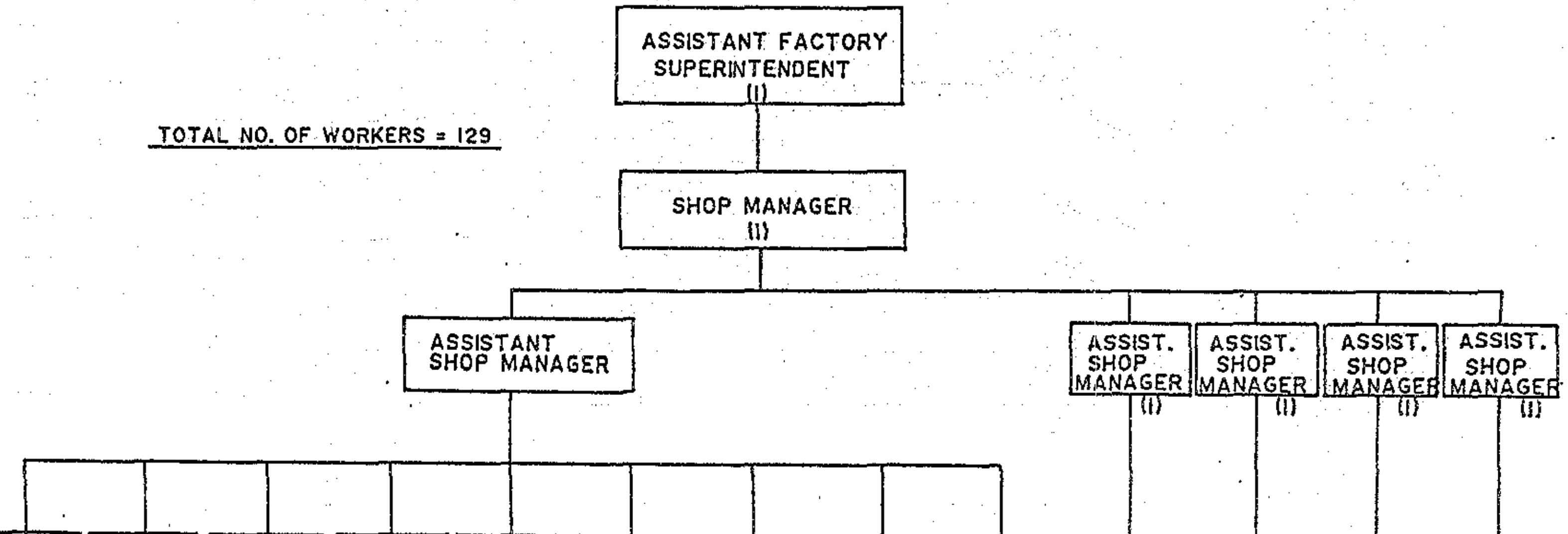


Figure AI-4-2-2 ORGANIZATION AND STAFFING, DIESEL ENGINE PLANT NO.4 HI

TOTAL NO. OF WORKERS = 129



	CYLINDER BLOCK LINE	CYLINDER HEAD LINE	TIMING GEAR CASE AND CLUTCH HOUSING LINE	BEARING CAP LINE	CRANK SHAFT LINE	CAM SHAFT AND RING GEAR LINE	CONNEC-TING ROD LINE	ENGINE ASSEM-BLY LINE	TOOL REGRI-NDING	ENGINE TESTING	COMPO-NENT STORE	TOOL STORE	PROGRESS AND PRODUC-TION CONTROL
	19	9	8	6	15	8	9	15	6	7	7	4	9
Admin. Staff	1	1	1	—	1	1	1	4	—	—	7	4	9
Foreman	—	—	—	—	1	—	—	—	—	1	1	1	1
Skilled Labor	9	4	6	5	7	5	4	5	5	4	—	—	—
Semiskilled Labor	5	3	1	1	3	1	2	5	1	—	—	—	—
Unskilled Labor	4	1	—	—	3	1	2	1	—	3	—	—	—

Figure AI-4-2-3 PRODUCTION PROCESS FLOW OF DS-70 ENGINE

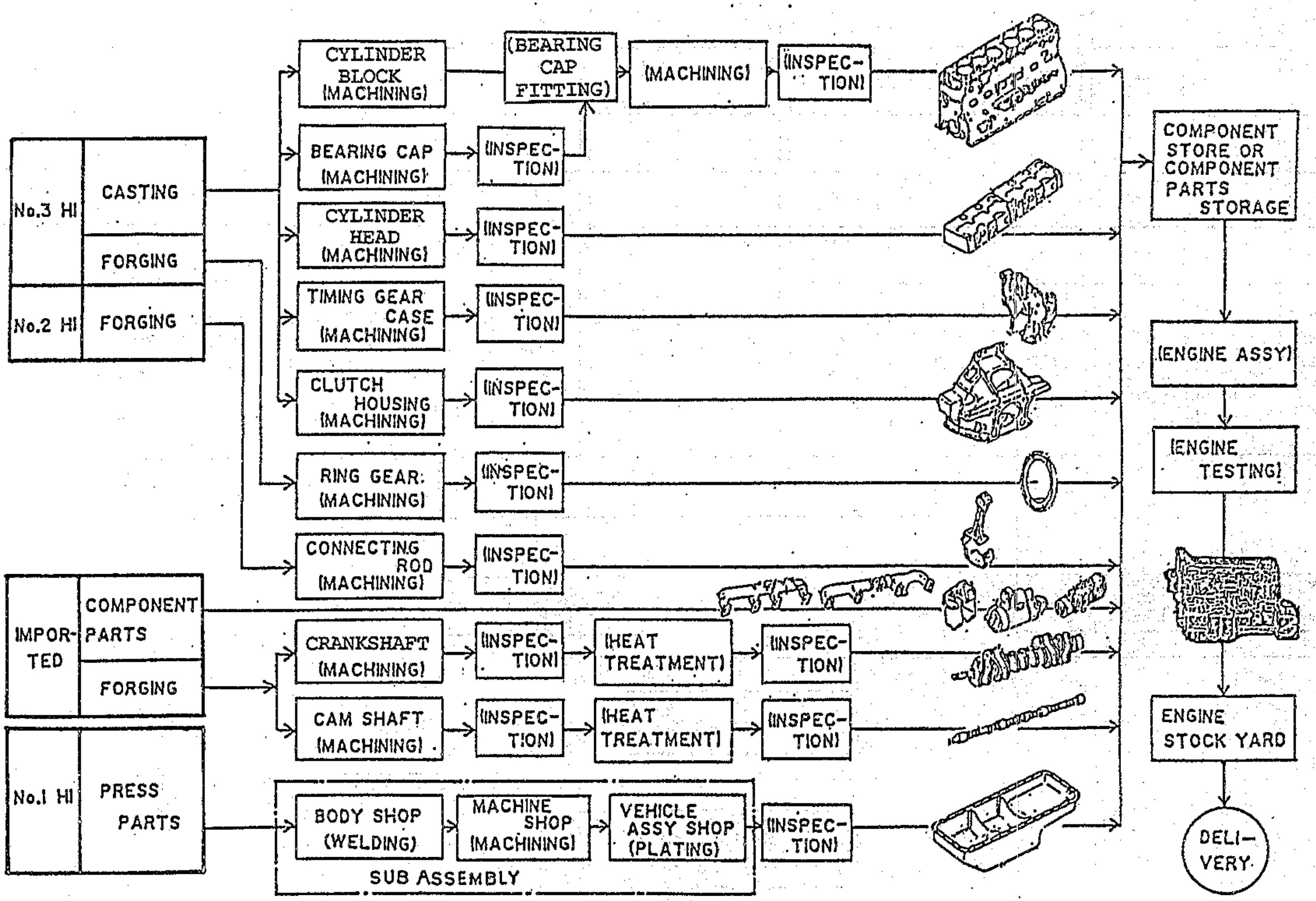
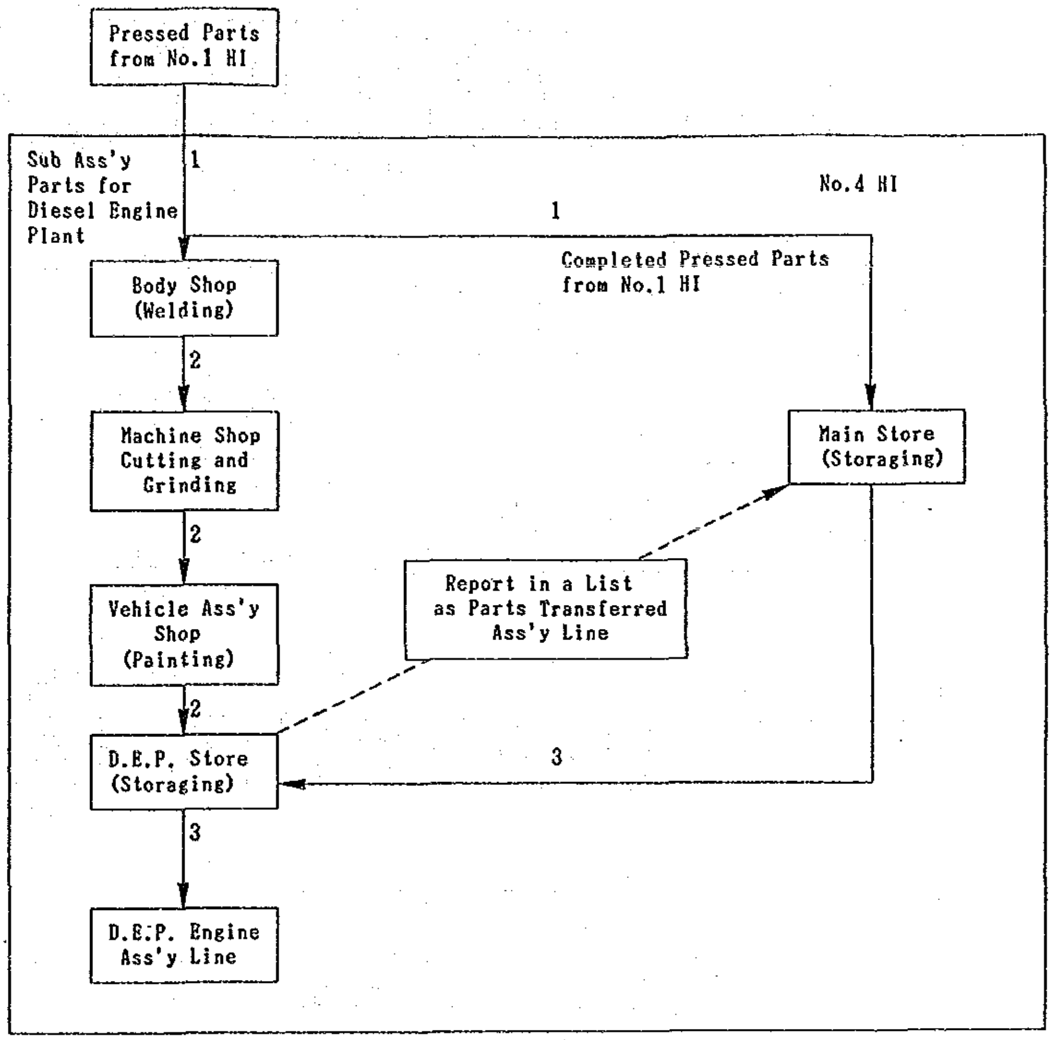


Figure AI-4-2-4 PHYSICAL DISTRIBUTION OF PARTS FOR DIESEL ENGINE PLANT, NO.4 HI



Legend: 1: Off-taking by the main store, No.4 HI.
2: Transfer by truck or by human power of diesel engine plant.
3: Shipping/transfer by truck of the main store, No.4 HI at the request of the Plant Manager.

Figure AI-4-2-5 PROCESSING TIME AND PROCESSES WITH TROUBLE BY LINE, D.E.P., NO.4 HI

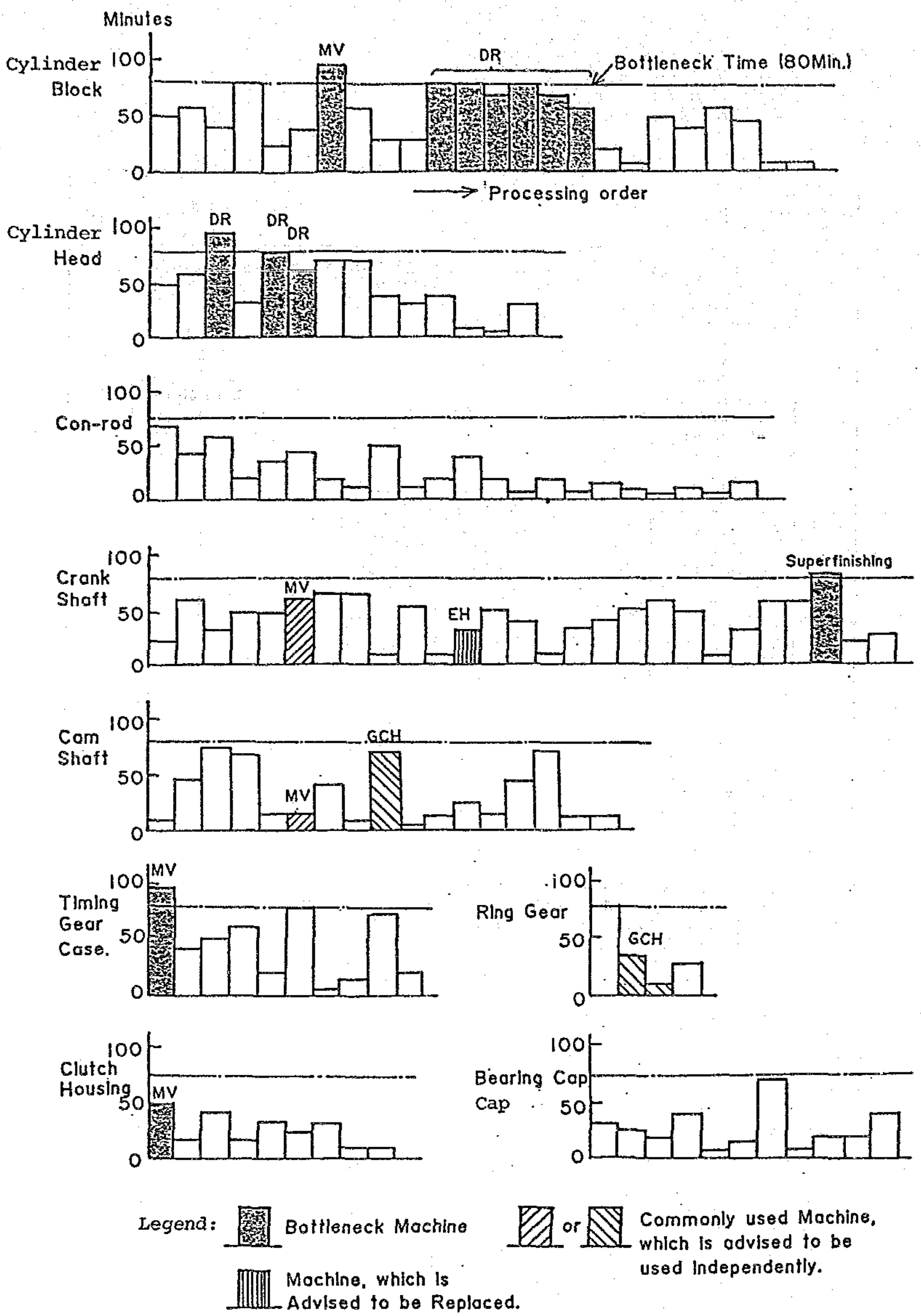
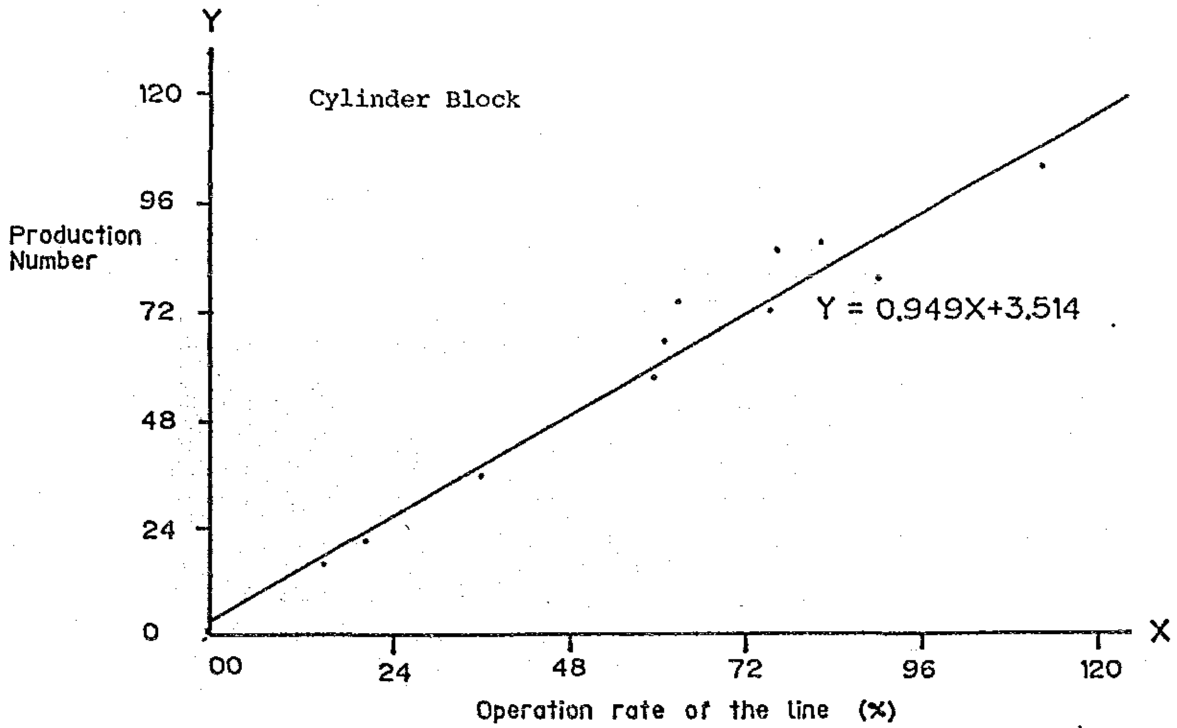


Figure AI-4-2-6 RELATIONSHIP BETWEEN OPERATION RATE OF THE LINE AND PRODUCTION NUMBER



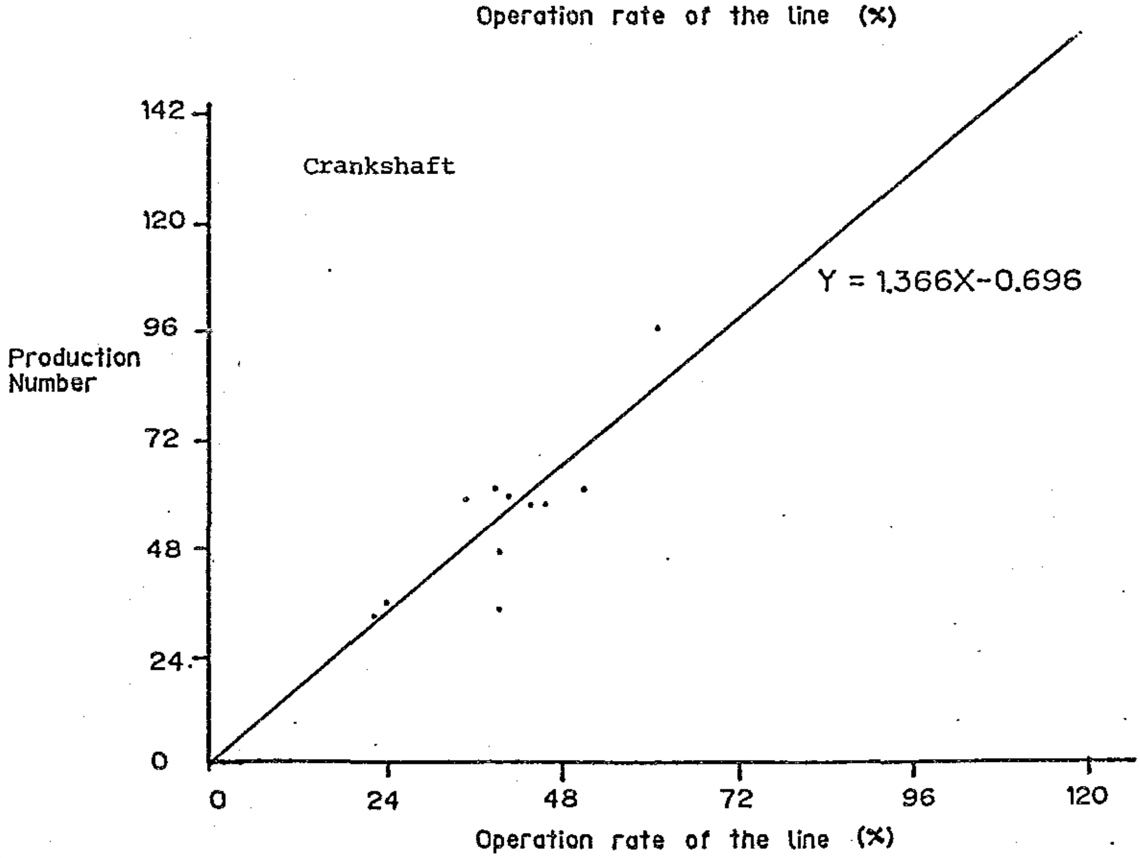


Figure AI-4-2-7 DISTRIBUTION OF PROCESSING TIME AMONG THE INDIVIDUAL LINES, D.E.P., NO.4 HI

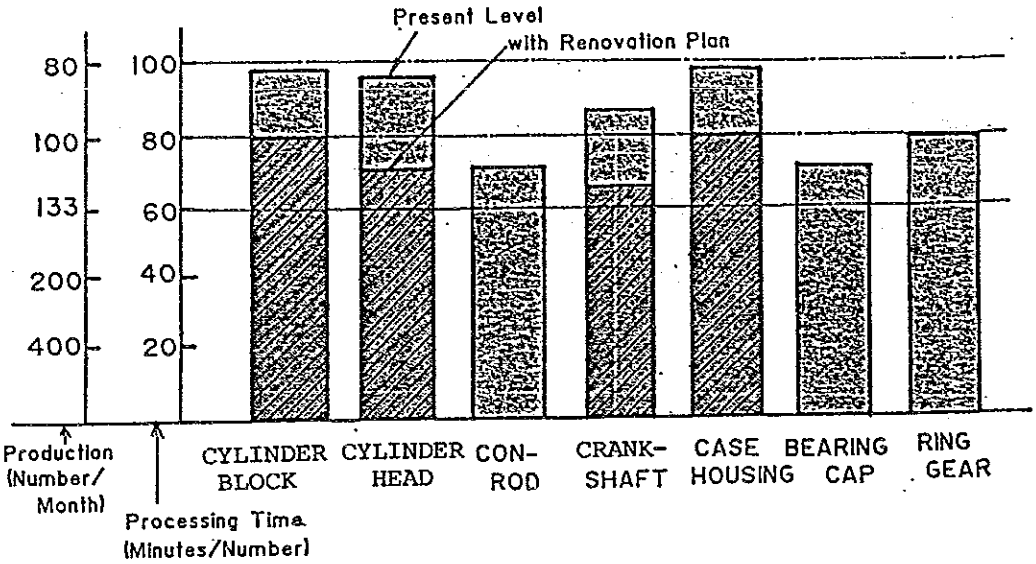
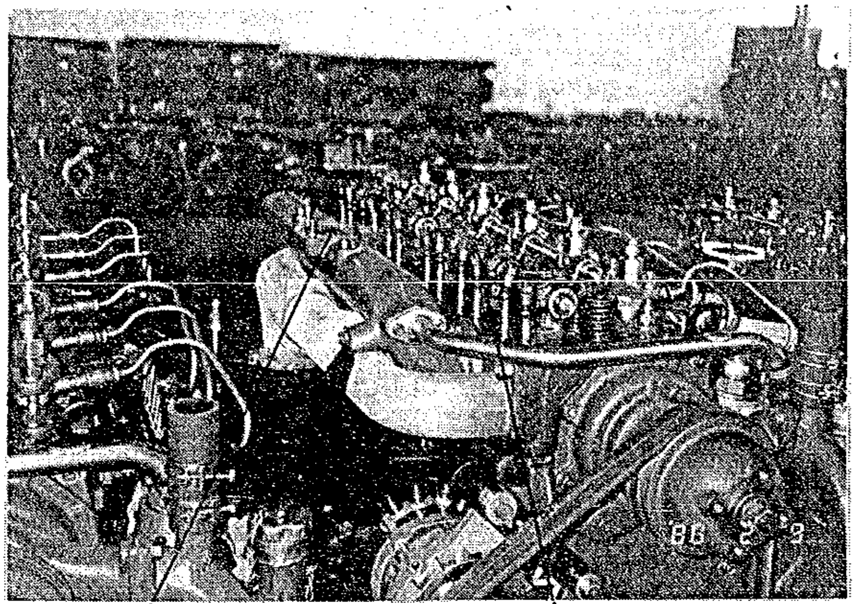


Figure AI-4-2-8   AN ENGINE KEPT IN SHOP AREA WITH SHORTAGE OF PARTS



Connection nozzle for air cleaner
(Prone to be contaminated with
dust and debris)

Head cover missing (Internals
are tainted by dust and rubbish)

Figure AI-4-2-9 REJECTION RATE OF MATERIALS

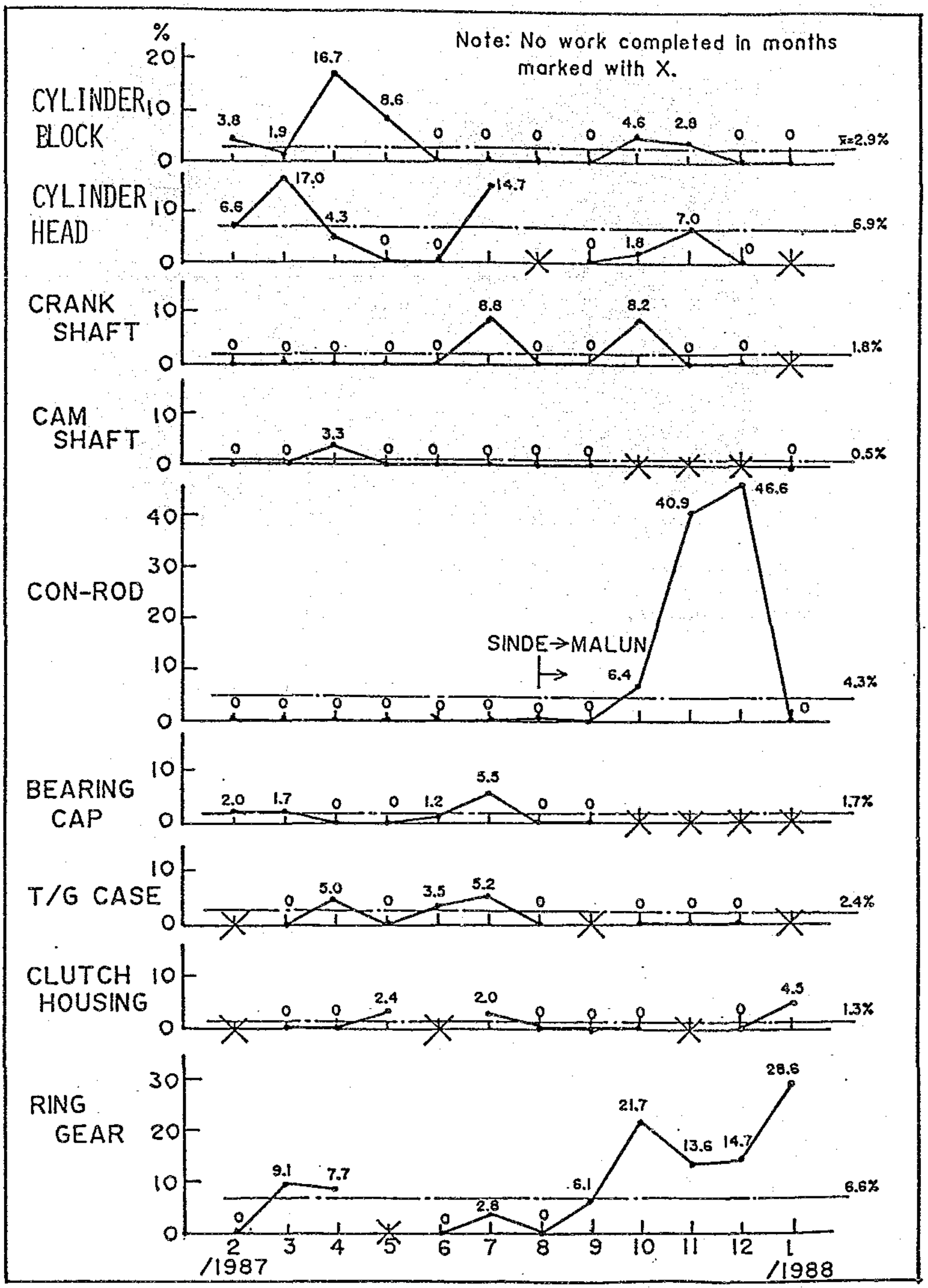


Figure AI-4-2-10 RATE OF POOR MACHINING

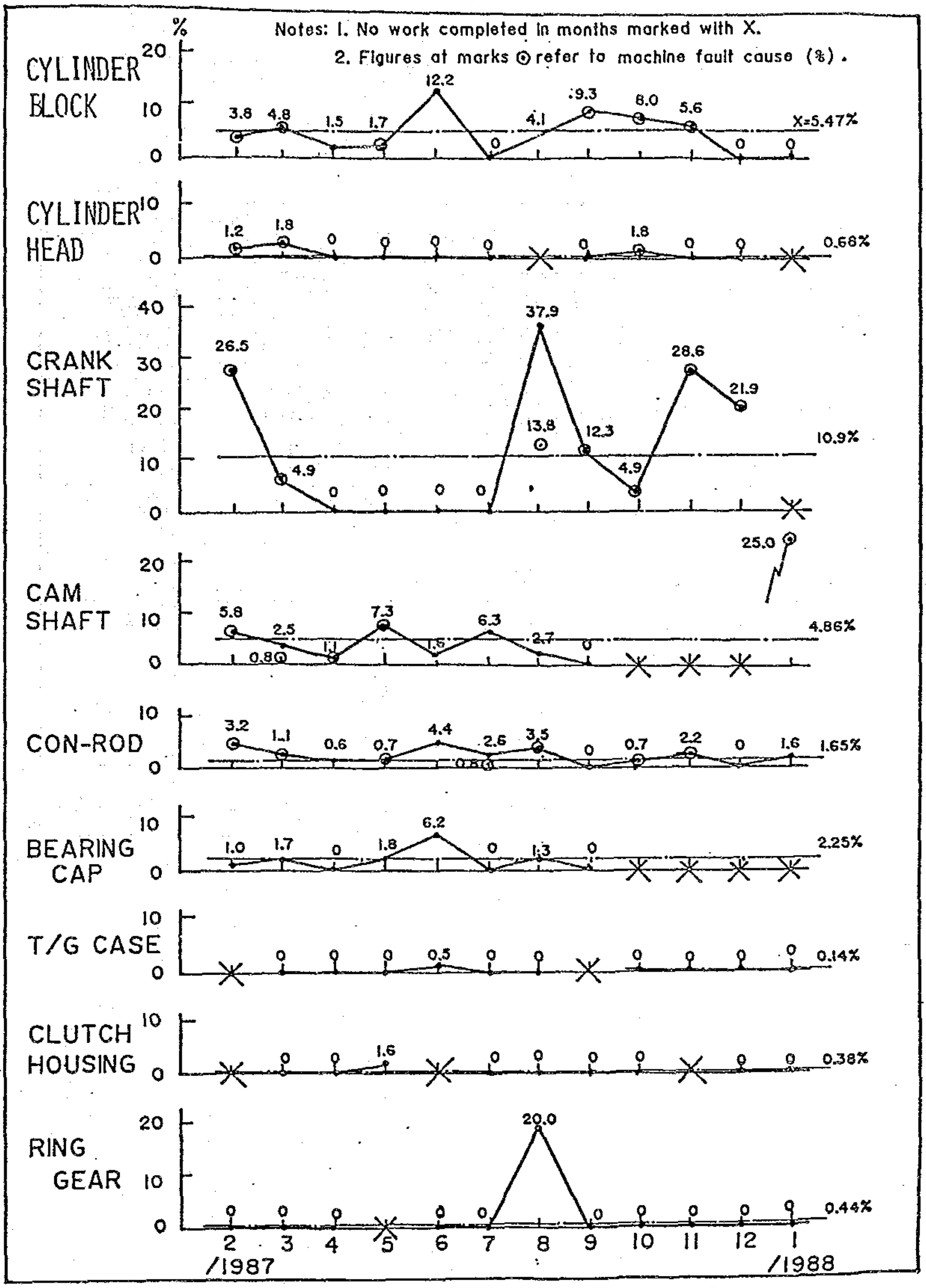


Figure AI-4-2-11 POOR MACHINING ITEMS AND CAUSES

Machining Line	Poor Machining Items	Causes of Poor Machining	
		Machine Faults	Work Faults
CRANK SHAFT	61 (10.9%)	47	14
CON-ROD	58 (1.65%)	38	20
BLOCK	40 (5.47%)	26	14
CAM SHAFT	28 (4.86%)	20	8
BEARING CAP	16 (2.25%)	10	6
HEAD	6 (0.68%)	6	0
RING GEAR	4 (0.44%)	0	4
CLUTCH HOUS.	2 (0.38%)	2	0
TIMING GEAR CASE	1 (0.14%)	0	1
Total	216 (2.42%)	149 (1.67%)	67 (0.75%)

Figure AI-4-2-12(1) STEEL BAR DEPOT INSIDE FORGING SHOP

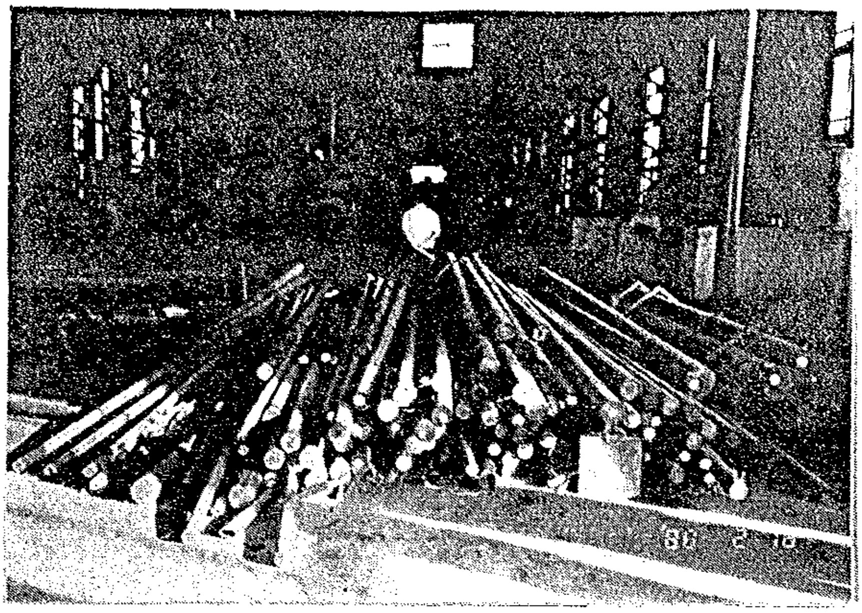


Figure AI-4-2-12(2) MIXED DEPOT OF CUT BARS (FRONT) AND FRAGMENTS (BACK) - MATERIALS WITH DIFFERENT LENGTHS ARE LAYED TOGETHER

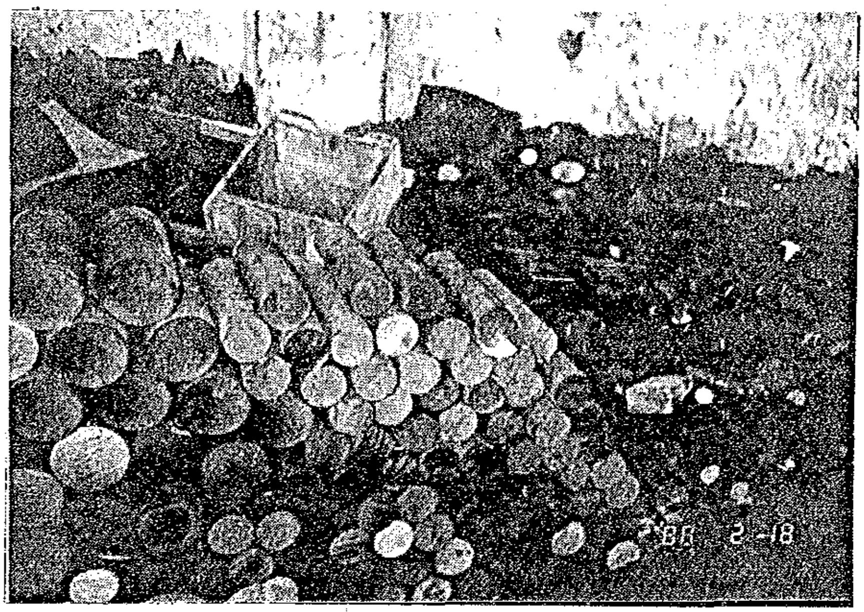
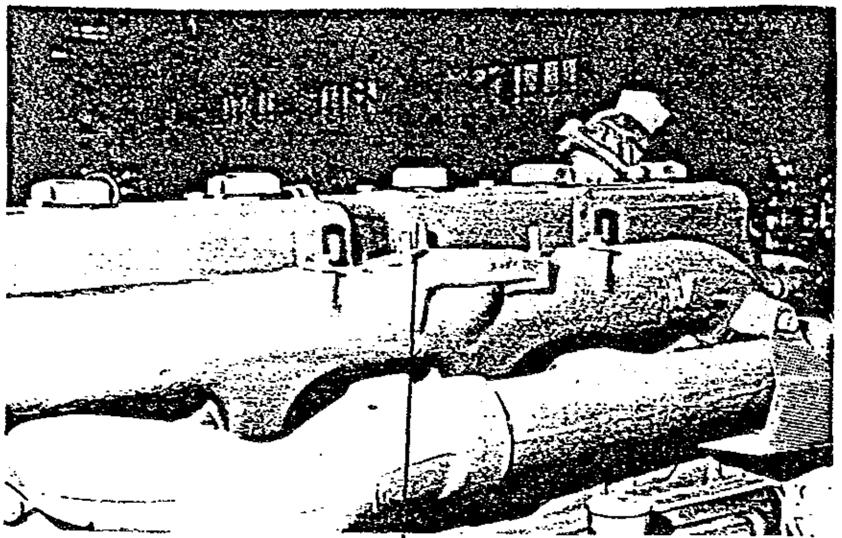


Figure AI-4-2-13 AIR INTAKE MANIFOLD PORT



Air Intake Port

Figure AI-4-2-14   STANDARD ACCURACY OF WORK ON SIGN BOARD

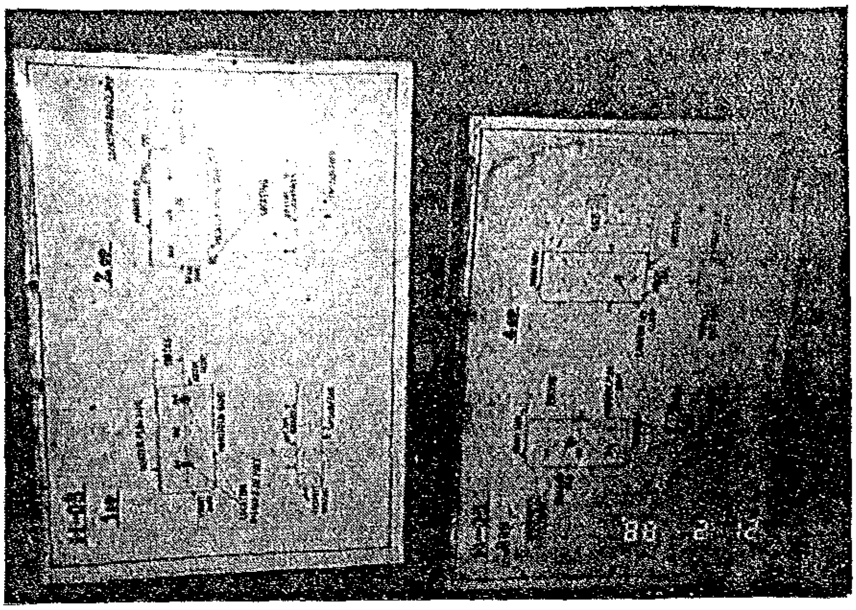


Figure AI-4-2-15 ORGANIZATION CHART OF NO.4 HI

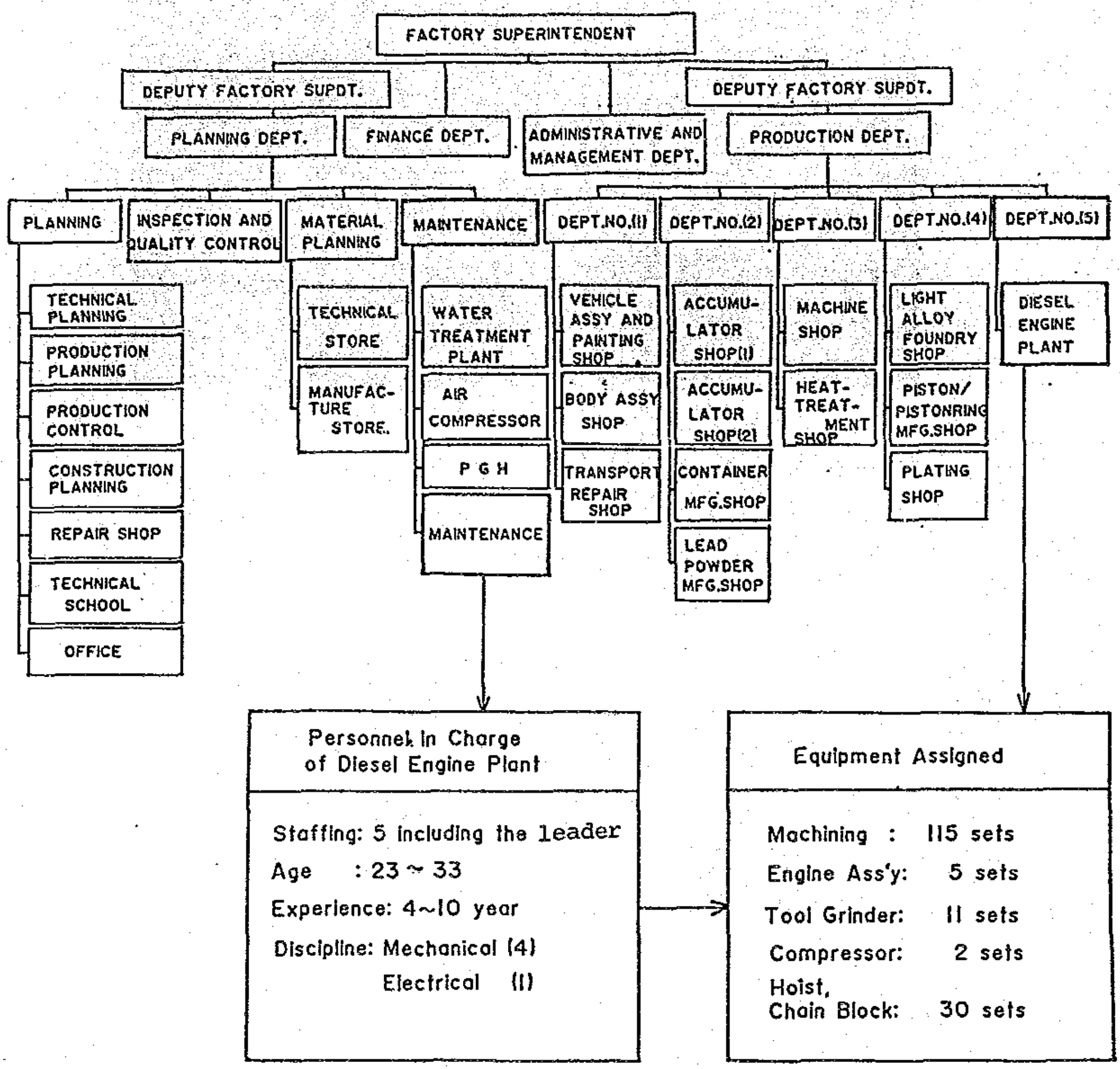


Figure AI-4-2-16 RESULT OF MAINTENANCE (FEB., 1987 TO JAN., 1988)

Machining Line	Total Frequency of Failure (10 20 30 40 50)		Heavy Failures: Frequency	Heavy Failures: No. of Equipment	Heavy Failures: Nature of Failure M	Heavy Failures: Nature of Failure E	Heavy Failures: Duration of Maintenance
CRANK SHAFT	M: 23 E: 20	43(39%)	5	3	2	3	3 to 20 days
BLOCK	M: 19 E: 11	30(27%)	6	6	5	1	5 days to 1 month
CAM SHAFT	M: 5 E: 8	13(12%)	1	1		1	1.5 months
CON-ROD	M: 2 E: 6	8	1	1		1	2 months
HEAD	M: 4 E: 2	6	1	1		1	1.6 months
ENGINE ASSEMBLY	M: 0 E: 4	4					
T/G CASE C/L HOUSING	M: 1 E: 1	2					
TOOL REGRIND	M: 2 E: 0	2					
RING GEAR	M: 0 E: 1	1	1	1		1	More than 5 months
BEARING CAP	M: 1 E: 0	1					
Total	M: 57 (52%) E: 53 (48%)		15 times	13 sets	7 times	8 times	—

Notes: M---Mechanical, E---Electrical

Figure AI-4-2-17 FREQUENCY OF EQUIPMENT FAILURE ACCORDING TO MONTH

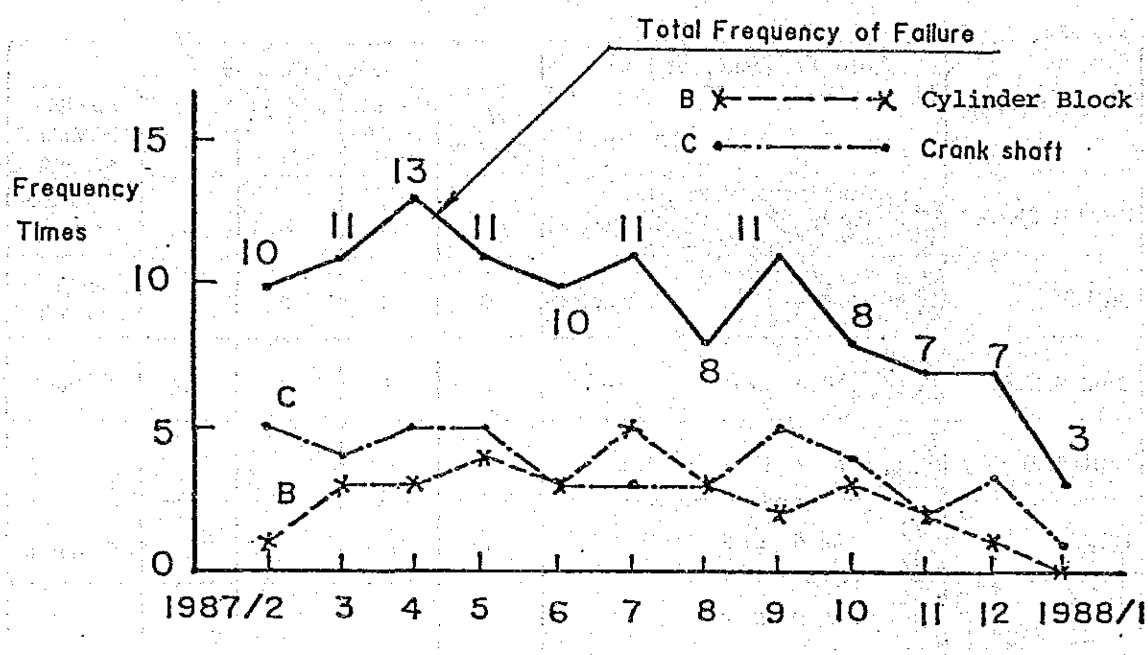


Figure AI-4-2-18 CORRELATION BETWEEN LINE OPERATION RATE AND FAILURE FREQUENCY

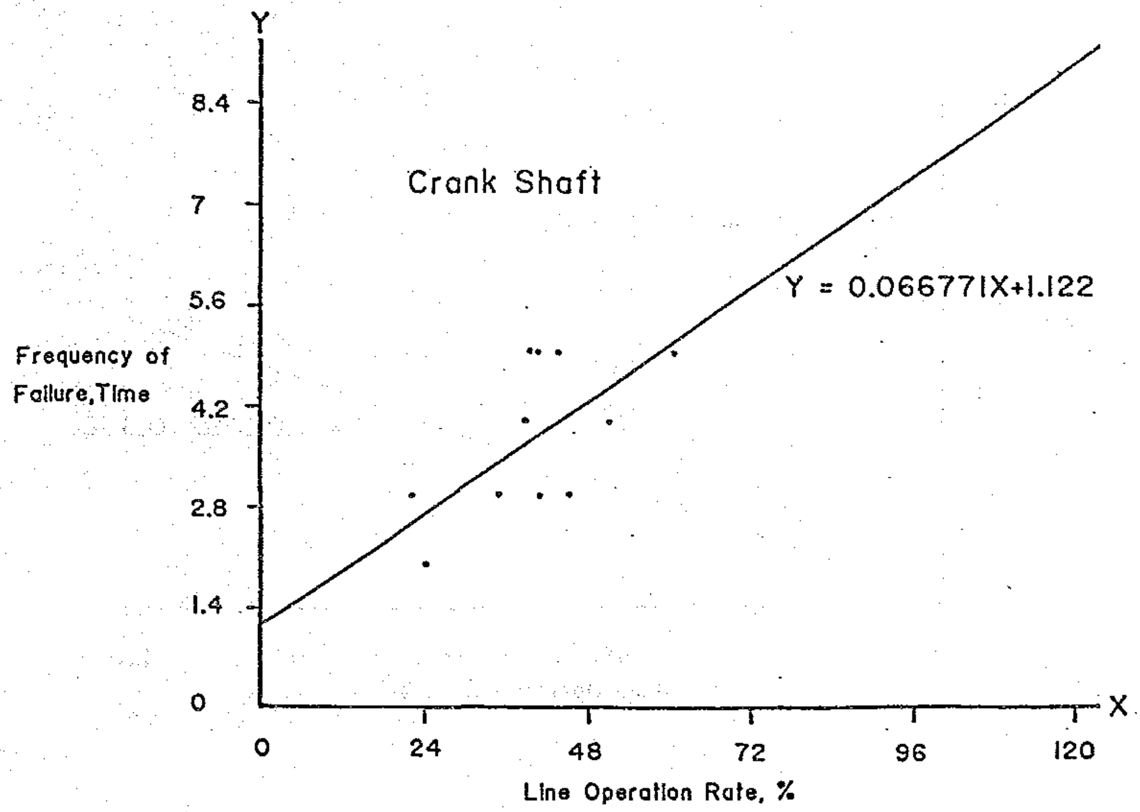


Figure AI-4-2-19 CORRELATION BETWEEN LINE OPERATION RATE AND FAILURE FREQUENCY

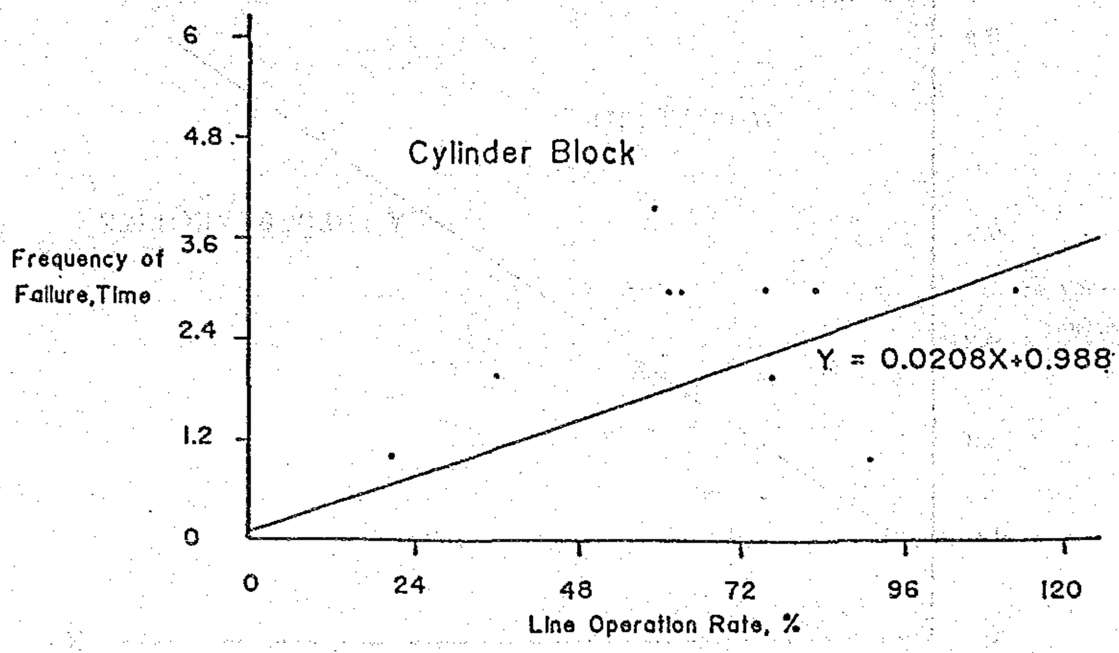


Figure AI-4-2-20 DIESEL ENGINE PLANT MAINTENANCE SCHEDULE FOR 1988

◸ : Maintenance Schedule

◢ : Machine Trouble

SR NO.	MACHINE NAME	M/C NO.	JAN					FEB					MA	
			1	2	3	4	5	1	2	3	4	5	1	2
1	PRODUCTION MILLING	B-01	◸											
2	SPECIAL BORING	B-07	◸											
3	RADIAL DRILLING	B-02		◸										
4	SPECIAL MILLING	B-04		◸			◢							
5	PRODUCTION MILLING	B-03		◸										
6	HORIZONTAL BORING	B-05		◸										◢
7	SPECIAL MILLING	B-12		◸										
8	HORIZONTAL BORING	B-06			◸									
9	SPECIAL MILLING	B-17			◸									
10	DRILLING	B-11			◸									
11	RADIAL DRILLING	B-08-1			◸									
12	RADIAL DRILLING	B-08-2			◸									
13	RADIAL DRILLING	B-09-1				◸								
14	RADIAL DRILLING	B-09-2				◸								
15	RADIAL DRILLING	B-10-1				◸								
16	RADIAL DRILLING	B-10-2		◢		◸				◢	◢			
17	WASHING	B-18-1				◸								
18	LEAKAGE TESTER	B-19-1					◸							
19	SPECIAL LINE BORING	B-14					◸							
20	VERTICAL BORING	B-13					◸							
21	HORIZONTAL BORING	B-15		◢	◢		◸							
22	SPECIAL VERTICAL REAMING	B-16					◸							
23	WASHING	B-18-2						◸						
24	LEAKAGE TESTER	B-19-2						◸						
25	IMPREGNATION EQUIPMENT	B-21						◸						
26	VERTICAL MILLING	C-02-1						◸						
27	VERTICAL MILLING	C-02-3						◸						
28	VERTICAL MILLING	C-02-2							◸					
29	HORIZONTAL MILLING	C-01							◸					
30	VERTICAL BORING	C-05							◸					
31	RADIAL DRILLING	C-03							◸					
32	RADIAL DRILLING	C-04							◸					
33	VERTICAL MILLING	C-02-4								◸				
34	VERTICAL MILLING	T-01	◢		◢					◸				
35	RADIAL DRI[illegible]	T-05-1								◸				

Chapter 5

METAL WORKING FACILITIES

Chapter 5 METAL WORKING FACILITIES

5-1 Foundry

5-1-1 Outline of Production Processes

(1) Working equipment and its layout.

As shown in Fig.AI-5-1-1.

(2) Organization and personnel

1) Organization

Organization is shown in Fig.AI-5-1-2.

2) Personnel

Personnel arrangement is shown in Table AI-5-1-1

(3) Supply performance of main raw materials

The supply performance is shown in Table AI-5-1-2.

(4) Production performance and productivity of individual molding line

Annual casting production performance and productivity is shown in Table AI-5-1-3.

5-1-2 Analysis of Production Processing

(1) Processing and flow chart.

As shown in Fig.AI-5-1-3

(2) Problems and improvement of operation methods and process lines

The D-line of the No.3 HI Foundry produces heavy machine tools, using a low productivity cement bonded method having a 50% reject rate. Reasons for this high rate include sand inclusion, sand burning, blowholes and imperfections in dimensions. These problems almost all entirely due to defects in the mold. In order to improve the mold strength, reduce the reject rate, ensure improvement of product quality and better productive capacity it is necessary to consider employing a new production method, such as the VRH CO_2 method. Domestically produced materials for the binder such as water glass, and carbon dioxide gas used in this method are available.

The Pepset Process is used for mold and core when producing the engine castings in the B-line of the No.3 HI foundry. However the Pepset resin is expensive and the possible employment period is limited. Therefore, introduction of the VRH CO_2 method is advisable since use of Burmese raw materials can be made. Assembly of the engine block core is also extremely time consuming and so consideration must be given to introduction of a core assembling jig for this.

Deterioration of the Jolt Molding Machine used with the green sand in the line of D-shop of No.3 HI foundry. Decrease in the operating air pressure and imperfect sand treatment in turn leads to a reduction of quality of the cast products and a decrease in productivity. Introduction of a good cost performance flaskless automatic molding line suited to the small scale castings is advisable.

For the A-Line production of the No.3 HI Foundry a cope roll-over device is necessary. Further, in order to increase productivity, respond to production of ductile cast iron products and and produce larger castings an increase in current flask dimensions needs to be considered in so far as this is possible without unduly upsetting the line operations.

To provide the coated sand material for shell molding high cost sea sand is washed and screened for use. However, the yield of the coated sand operations is low and the used sand is thrown away after. Also the sand taken from the Irrawaddy River which is used for green sand molding and self hardening molds has a poor grain shape and impurities abound so that a large number of rejects are caused by the sand condition. Consequently, consideration of a comprehensive sand treatment system to include reclaiming and recycling operations for the coated sand thrown away is desirable. The sea sand washing facilities in current use are deteriorated and replacement is required.

(3) Problems and improvement of working equipment

At present, a large number of equipment is lacking in spare parts. It is necessary to supplement these with a sufficient quantity of spare parts.

The ventilation for the coated molds of B-line is extremely bad, and an offensive smell results. Moreover, dust thrown up in the fettling shop is very bad, resulting in a very poor working environment. It is necessary to consider installation of a dust collector device to improve the work environment. Also the installation of a fettling machine for improvement of the finishing work efficiency is needed.

The deterioration of the shot table blast used in the No.3 HI Foundry is advanced and this requires replacement.

As there is no sizing facility it is impossible to deal with defective heavy machine tool castings. The handling of defective products and return materials needs considering.

If the thick wrought iron trimming scraps could be made into press blocks these could be used as the raw material for the low frequency melting furnace. Further, the scrap from the silicon steel plates left over in the AME-1 Generator Plant could easily be recycled by .pa using press blocks. Consequently, the installation of a scrap bailing press needs consideration.

The wooden casting patterns used in the foundry crack easily. Some of them are largely warped. There is a high possibility that these defects will have an adverse effect on product quality. The use of resin type patterns needs consideration.

Malfunctioning due to broken wiring is common with the sheathed tubular heater attached to the shell core box used in the casting of the crank case for the C-line of No.3 HI. Improvement of materials quality of the heater and a better method of attaching the heater need consideration.

Establishment of a shop responsible for repair and maintenance of working equipment at the foundry needs to be considered generally for the entire No.3 HI.

(4) Problems and improvement of operating rates and line balancing

The melting equipment of the A-line of the No.3 HI foundry consists of three power sources and three low frequency melting furnaces. Normally, however, only two of the furnaces are in operation. One set furnace structure only has already been delivered to the site. Shortage of melting capacity is anticipated due to progress of the renovation plan. Therefore, the system should be changed to that with four power sources and four furnaces or that with three power sources and four furnaces utilizing the aforesaid spare furnace body.

There are needs for solving problems of insufficient area for materials storage and the method of charging at present. Further, the increase of melting capacity will cause higher requirement for enhancing the present system. Therefore provision of a more extensive deposit area and mechanization of the charging system is required.

Because of scarcity of diesel oil the rotary diesel furnace, installed as the melting furnace for D-line of the No.3 HI foundry, cannot function. As a result, the D-line is supplied with molten metal from the low frequency induction furnace of A-line. This means that the melting capacity of A-line is insufficient. It is necessary to install a new low frequency induction furnace for the particular use of D-line.

During casting operations of the lathe beds and other heavy castings produced in the D-line foundry of No.3HI two five ton overhead traveling cranes are sometimes simultaneously used. In order to circumvent the danger involved in these operations and prevent crane breakdown through overloading it is necessary to consider installation of an overhead traveling crane with appropriate load capacity and strengthening of buildings.

The air pressure used for operating the the molding machine on A and D lines in foundry No.3 HI does not even reach its minimum tolerance level of 5 kg/cm^2. Not only does the low air pressure lead to a lowering of the mold making efficiency and cause inferior mold it also results in inferior cast products. Together with measures to supplement the compressed air deficiency also taking into account the quantity of compressed air required for the modernization plan expansion of compressor facilities must be promptly carried out.

(5) Problems and improvement of reception of raw materials and components and dispatch of finished products

Materials handling is very poor. Together with expansion of fork lift truck and introduction of transportation facilities it is necessary to undertake the systematic management of these transportation facilities.

In the No.3 HI foundry the stockpiling of finished products monopolizes a large amount of space. In order to maximize efficiency in the handling of finished products a warehouse for finished products needs to be secured.

As the storage conditions of the metal patterns for casting in No.3 HI foundry are poor there is a danger of damage to these. They need to be stored on the racks in the wooden pattern warehouse and carried to and fro using a fork lift truck.

There is no yard for raw materials which can be used in the foundry. The establishment of a materials yard and the introduction of sizing facilities for heavy casting return scrap must be considered.

5-1-3 Analysis of Products Quality

(1) The occurrence of rejects

Average ratio of defective castings in the last 3 years is shown in Table AI-5-1-4.

(2) Causes of the occurrence of rejects

Average ratio of defective castings by cause in recent 3 years is shown in Table AI-5-1-5.

60% of inferior products are due to defective molds, and 30% due to faulty molten metal. It is possible to obtain a substantial reduction in the rate of occurrence of defective products by improving the molding sand treatment, and maintaining the operating air pressure of the molding machine at more than 5 kg/cm^2. Further, it is necessary to rigidly control the mixing of materials and melting operations in order to ensure an appropriate supply of molten metal.

(3) Problems and improvement of standards of quality control and inspection method

In order to improve the precision of the dimensional measurements for the wooden patterns, metal patterns and test products and establish a quality control system it is necessary to provide an inspection area for castings and supplement measuring devices. Moreover at the same time the introduction of a spectrometer to ensure more rigid control of chemical composition of the molten metal is desirable.

5-1-4 Maintenance of Equipment

(1) Repairs performance

Repairs performance of the No.3 HI foundry shop for July to September 1986 as shown in Table AI-5-1-6.

(2) Problems and improvement of maintenance system

The foundry shop is provided with a repair shop, whose work mainly consists of replacement of parts and machinery, as can be seen from the record of repair performance. However, as there is no working equipment for the production of parts and machinery large scale reparation cannot be undertaken. The establishment of a machine shop which could repair and make machine spare parts must be considered.

(3) Finished product design

It is necessary to increase the competence of the foundry's pattern shop to design and manufacture the wooden patterns, metal molds and core boxes and improve casting design. The installation of a Machining Center for producing wooden patterns and metal molds needs consideration.

Table AI-5-1-1 FOUNDRY SHOP MANPOWER SCHEDULE

Shop	Manager	Engineer-ing Staff	Admin. Staff	Foreman	Labor	Total
A Shop	1	1	-	3	39	44
B Shop	1	-	-	2	32	35
C Shop	1	-	-	1	37	39
D Shop	-	-	-	1	58	60
Inspection Shop	1	2	-	2	14	19
Fettling Shop	-	-	-	3	36	39
Pattern Shop	-	1	-	1	15	17
Repair Shop	1	-	-	-	11	12
Sand Preparation Shop	1	-	-	1	16	18
Planning	1	-	5	2	21	29
Total	7	4	5	17	279	312

Table AI-5-1-2 ACTUAL RECORDS OF MAIN RAW MATERIAL

Principle Raw Material	Specification	Unit Price	Domestic/ Imported(IP)	Annual Consumption (1986)
1 Pattern Making				
(a) Wood (HNAW)			Domestic	1,025 ton
2 Molding				
(a) Silica Sand (River Sand)		K70/ton	Domestic	605 ton
(b) Silica Sand (Sea Sand)		K335/ton	Domestic	1,043 ton
(c) Bentonite			Domestic	465,000 kgs
(d) Graphite Powder (Sea Sand)		¥93/kg	KUBOTA (IP)	4,500 kgs
3 Pep-Set				
(a) Molding Material Part (R)		¥550/kg	KUBOTA (IP)	31,780 kgs
(b) Molding Material Part (M)		¥580/kg	KUBOTA (IP)	32,270 kgs
(c) Molding Material Part (K)		¥1,400/kg	KUBOTA (IP)	3,200 kgs
(d) Okasuper No.550		¥310/kg	HINO (IP)	17,150 kgs
4 Shell Molding Resin				
(a) Flake Resin		¥727/kg	TOYOKOGYO (IP)	18,000 kgs
(b) Hexamethylene Tetramine		¥519/kg	TOYOKOGYO (IP)	2,000 kgs
(c) Calcium Stearate		¥557/kg	TOYOKOGYO	550 kgs
5 Melting				
(a) Steel Scrap		K1,000/ton	Domestic	464,190 kgs
(b) Pig Iron		K3,000/ton	Domestic	1,726,485 kgs
6 Ferro Alloy				
(a) Fe-Mn		¥282/kg	MAZDA (IP)	5,320 kgs
(b) Fe-Si		¥432/kg	MAZDA (IP)	21,250 kgs
(c) Fe-Cr		¥340/kg	MAZDA (IP)	150 kgs
(d) Fe-Mo		¥753/kg	MAZDA (IP)	150 kgs
(e) Fe-Ni		-	-	-
(f) Ca-Si		¥413/kg	HINO (IP)	8,725 kgs
(g) Si-Mg		¥612/kg	MAZDA (IP)	1,600 kgs
(h) Refractory Mortar		¥33/kg	KUBOTA (IP)	3,000 kgs
7 Fettling				
(a) Steel Shot SB-17		¥178/kg	KUBOTA (IP)	14,000 kgs
(b) Grinding Wheel (405x50x38)		¥11,950/P	HINO (IP)	6 nos.
(c) Grinding Wheel (455x50x51)		¥21,000/P	HINO (IP)	62 nos.
8 Common Material				
(a) Heavy Oil		K2.45/gal	Domestic	43,400 gals
(b) Alcohol		K18.65/gal	Domestic	4,124 gals

Table AI-5-1-3 ACTUAL FOUNDRY PRODUCTION ANNUAL AND PRODUCTIO EFFICIENCY BY EACH MOUDING LINE

	A-Line (Green Sand Mold)	B-Line (Pep Set Mold)	C-Line (Shell Mold)	D-Line (Cement and Green Sand Mold)	Total
Production Capacity (t/y)	3,000	1,000	600	1,000	5,600
Planed Production (1987, t/y)	2,308	673	422	261	3,664
Actual Production (1987, t/y)	1,233	263	282	242	2,020
Production Eff (%)					
(actual/planed)	53	39	67	93	55
(actual/capacity)	41	26	47	24	36
Casting Products	(KMB-200) Gear Case Cover etc. (KND-5B) Cylinder Frame Fly Wheel Gear Case Cover etc. (KND-7) Cylinder Frame Fly Wheel Gear Case Cover etc. (SC4C, SV0102) Casing Suction Cover Impeller etc. (HINO) Cylinder Head Clutch Housing etc. (Export) Manhole Cover Weight	(HINO) Engine Block	(MAZDA) Engine Block Cylinder Head Crankshaft etc. (KND-5B) Cylinder Head (KND-7) Cylinder Head	(BSK120,140) Pulley etc. (MATSUSHITA) Motor Case (Machine Tool) Lath Parts Shaper Parts Hack Saw Parts etc. (Export) Hose Joint etc.	

Table AI-5-1-4 AVERAGE REJECT RATIO IN RECENT 3 YEARS

Type of Foundry	REJECT RATIO (%)		
	1985	1986	1987
1. Ordinary Cast Iron	20.3	20.0	19.7
2. Ductile Cast Iron	21.3	19.5	19.2
3. Alloy Cast Iron	20.3	19.9	19.8

Table AI-5-1-5 CAUSES OF REJECT IN RECENT 3 YEARS

Order of Frequency	1984/1985		1985/1986		1986/1987	
	Description of Inferiority	Rate (%)	Description of Inferiority	Rate (%)	Description of Inferiority	Rate (%)
1st	Penetration	19.6	Penetration	18.4	Penetration	19.8
2nd	Sand Drop	17.1	Sand Drop	17.3	Sand Drop	18.7
3rd	Mis-run	15.8	Cold Shut	16.7	Mis-run	16.4
4th	Cold Shut	14.3	Mis-run	13.3	Cold Shut	13.8
5th	Core Broken	8.6	Blow Hole	13.2	Mis-match	11.4
6th	Sticker	7.3	Sticker	5.6	Blow Hole	10.8
7th	Slag Inclusion	4.2	Core Broken	7.3	Shrinkage	9.6
8th	Blow Hole	3.9	Mis-match	6.2	Sticker	9.3
9th	Shrinkage	2.7	Shrinkage	5.3	Core Broken	7.8
10th	Others	2.2	Slag Inclusion	3.7	Core Shift	5.0

Table AI-5-1-6 LIST OF MAINTENANCE WORKS IN NO.3 HI FOUNDRY SHOP (JULY TO SEPTEMBER, 1986)

Order of Frequency	A-Line	B-Line	C - Line	D - Line	Corted Sand	Fettling
1	Upper Molding (Clamp)	Mixer (Roller)	TVB (Heater 1 Unit)	Core Dryer (Heater)	Sand Heater (Igniter)	SB (Link)
2	Upper Molding (O-Ring)	Mixer (Scraper)	TVB (Heater 2 Units)	Core Dryer (Fuse)	Bucket Elevator (Pillow Block)	SB (Impeller)
3	Lower Molding (Air Pipe)	Dust Collector (V-Belt)	TVB (Heater 1 Unit)	5 Ton Crane (Wheel Bush)	Dust Collector (Air Filter)	STB (V-Belt)
4	Lower Molding (Bush)	Vibrate Conveyor (Spring)	TVB (Heater 1 Unit)		Belt Conveyor (Changing Belt)	SHB (Impeller)
5	Roller Conveyor (Roller)	3 Ton Crane (Wire Rope)	TVB (Heater 2 Units)		Belt Conveyor (Changing Belt)	Cutter (Molded Case Circuit Breaker)
6	Roller Conveyor (Roller)		TVB (Heater 1 Unit)			Cutter (Ammeter)
7	Pusher Air (Magnet Valve)		THC (Heater 1 Unit)			Hand Lifter (Pillow Block)
8	Sand Hopper (Level Switch)		THC (Heater 1 Unit)			
9	Dust Collector		THC (Heater 1 Unit)			
10	Sand Cooler (Bearing)		THC (Heater 1 Unit)			
11	Oscillting Conveyor (V-Belt)		THC (Heater 1 Unit)			
12	Belt Conveyor (Roller)		THC (Heater 6 Units)			
13	3 Ton Crane (Wier Rope)		VFC (Heater 1 Unit)			

Figure AI-5-1-1 NO.3 HI LAYOUT OF FOUNDRY

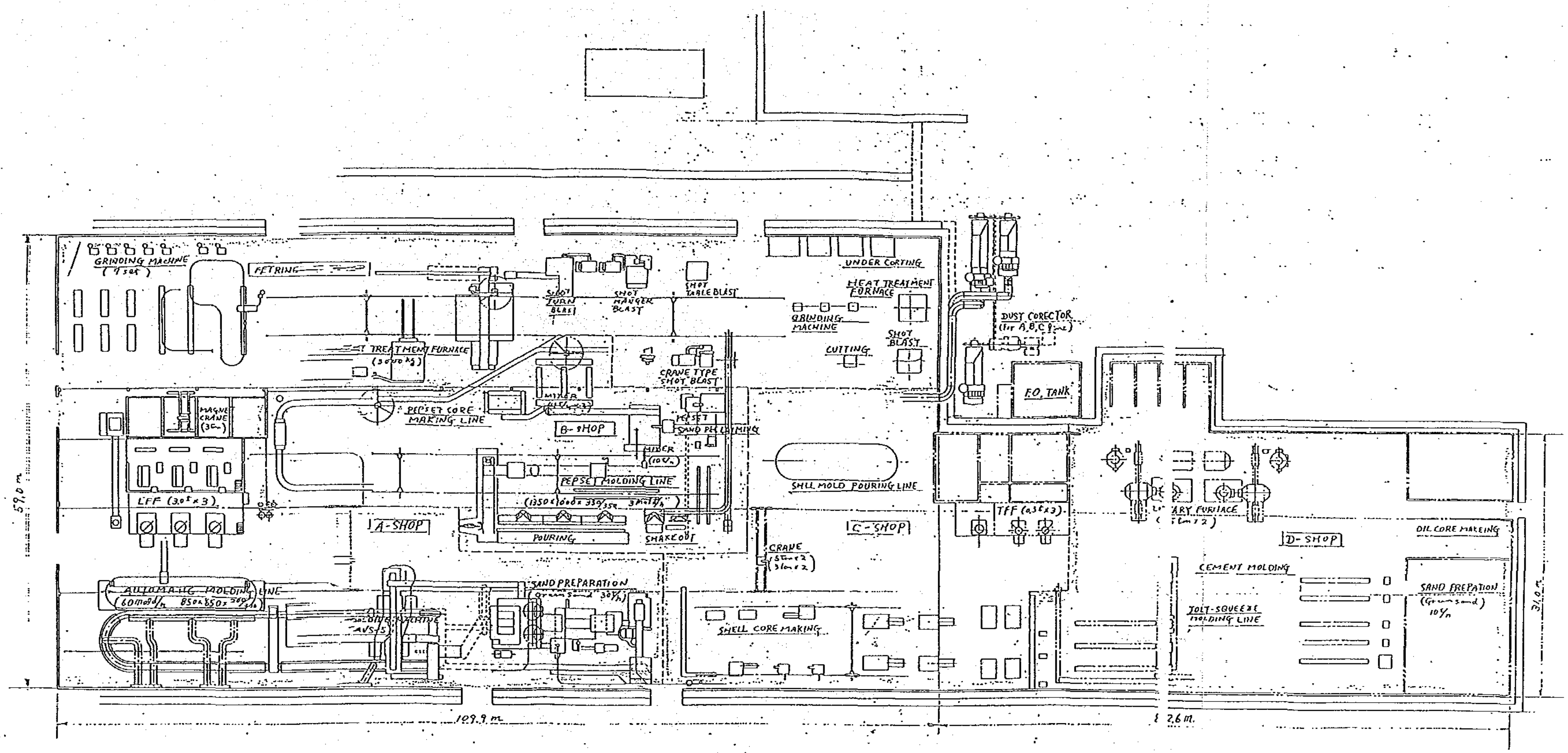


Figure AI-5-1-2 ORGANIZATION CHART FOR FOUNDRY SHOP

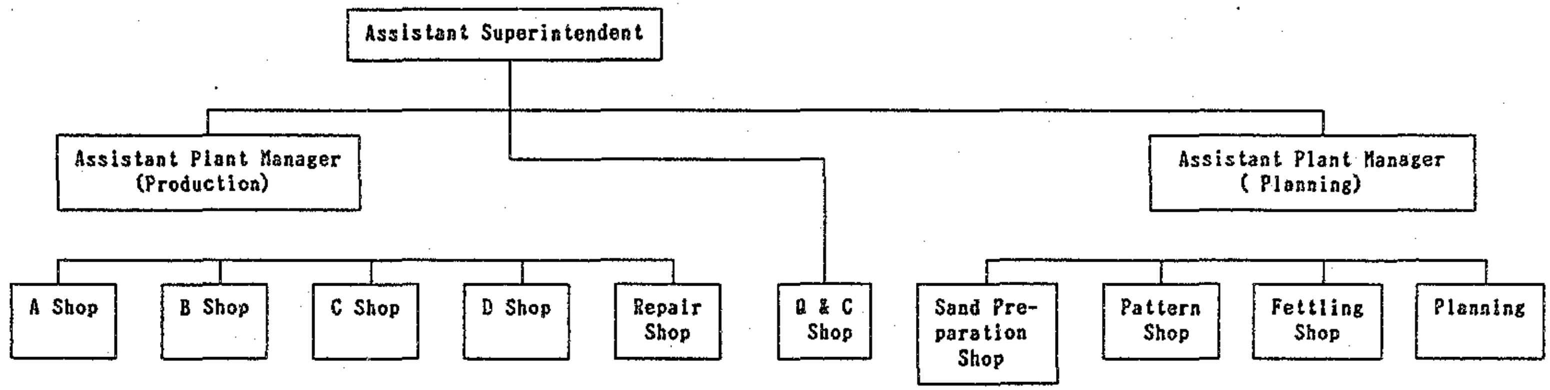
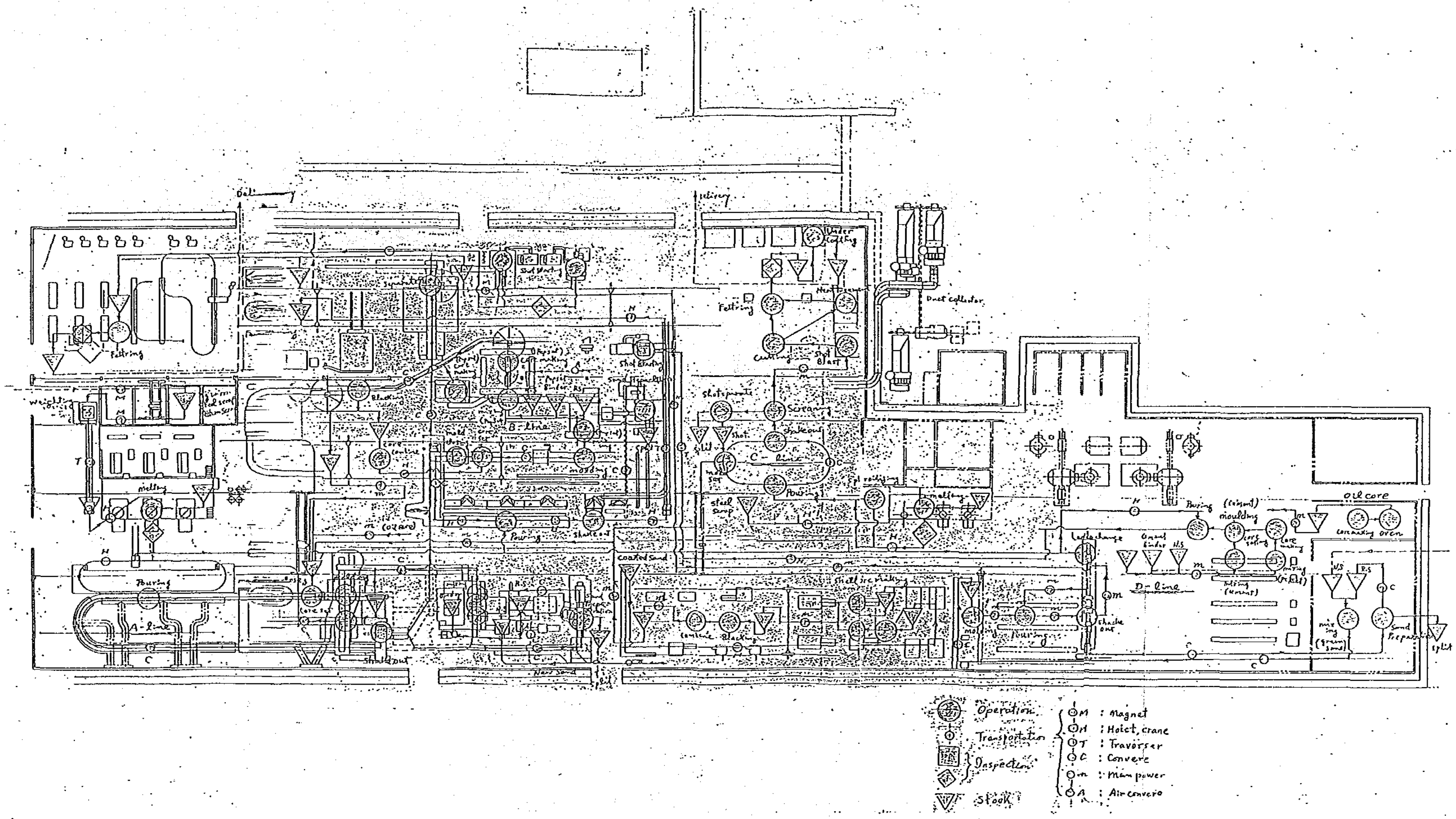


Figure AI-5-1-3 NO.3 HI FOUNDRY FLOW CHART



5-2 Press Shop

There are three press shops serving the HIC. Of these the Press Shop No.1 of No.1 HI (Rangoon) handles the small sheet metals for electric products.

As the present survey was concentrated on heavy vehicles and agricultural machinery a shop diagnosis of Press Shop No.1 was not conducted and the results of the survey of the two shops is as follows (refer to Table AI-5-2-1):

	No.1HI(Rangoon) Press Shop No.2 Shop	No.3HI(Sinde) Press & Welding Shop
Surface Area of Shop	128m x 38 m	54m x 18m
Working Equipment of Press	14 units	14 units
Personnel	51 employees	44 employees
Product Concerned	LV and HV	AME
Design Capacity (units)	390,000	100,000
Actual Production (units)	130,000	20,000

5-2-1 Outline of Production Processes

(1) Working equipment and layout

Working equipment and layout is shown on Table AI-5-2-2, Figs.AI-5-2-1 and AI-5-2-2.

(2) Organization and personnel

Organization and personnel is shown on Table AI-5-2-3.

(3) Finished products and components

Finished products and components is shown on Tables AI-5-2-4 to AI-5-2-7.

(4) Production performance

Product performance is shown on Tables AI-5-2-8 and AI-5-2-9.

5-2-2 Analysis of the Production Processes

(1) Problems and improvement of the operating rates and line balancing

The operating rates are extremely low. As can be seen from the production performance in the previous heading the performance ratio for one year using the example of the press shop No.1 of No.1 HI can be calculated as 33%, as follows:

(No. of product) / (equipment capacity) x 100
= (130,000/ 390,000) x 100
= 33 (%)

The major reason for this reduction in operating rates is the time expended in changing the metal dies followed by other reasons, equipment deterioration and hand-operating system.

At present, the changing of one metal die requires 1.5 to 3.0 hours. Since it is not possible to use a fork lift and die handler all operations are done using a crane.

At present changing of the dies takes place twice daily on average so that the average time expended on changing of dies is 4 hours (two changes x 2 hours = 4 hours).

The ratio of time used for die changing and actual operational time is as follows:

Die changing	4.0 hrs	(50%)
Working time	3.2 hrs	(40%)
Free time	0.8 hrs	(10%)
Total	8.0 hrs/day	

Time for die changing requires 50% of the total working time.

Another significant problem with the present situation is the division of annual production into two lots. As a result of this system finished products rust or are lost during the storing period.

Claims have been made that defects or losses which arise in this way then cause stops or long delays in the succeeding production processes of the assembly line.

An improvement measure which must be considered is the addition of a quick die changer to the present main press.

Thereby the time for die changing could be shortened from the present 2 hours to 20 minutes per operation. A considerable increase of productive operating time could be thus gained. Also in order to balance production the present load production of 2 times a year should be changed to 6 times a year (one load every 2 months). Thus the number of die changing would be increased threefold. It is therefore necessary to reduce the die changing time.

If die changing time were 20 minutes per operation and production load 6 times a year the working time would be 4.8 hrs or 60 %; an improvement over the present 3.2 hrs (40%).

Die changing	2.0 hrs	(25%)
Working time	4.8 hrs	(60%)
Free time	1.2 hrs	(15%)
Total	8.0 hrs/day	

(2) Problems and improvement of operational methods and materials handling

At present, the insertion and extraction of shaped parts (panels) into the press are all done by hand. These operations are dangerous and physically demanding and cause a reduction in productivity.

A semi-automatic system with a loader and unloader supplementing the main press currently used should be considered as a possible improvement.

A 50% increase in productivity could be anticipated from the semi-automation as follows:

	At present	After improvement
Stroke number per minute, of press operation	3 items	5 items
Production output per hour, for actual operating time	180 items	300 items (60% up)

Handling of blanks, panels and dies is inefficient as this done completely by crane. Since blanks, panels and dies are piled up as a result this causes a lowering of production speed.

In order to improve matters the introduction of handling devices such as a die handler, fork lift, and conveyer should be considered. The following is a list of actual possibilities

1. No.1 HI Press shop No.2 : repair 2 fork lifts
2. No.1 HI Press shop No.2 : repair 1 die handler
3. No.1 HI Press shop No.2 : new pallets
4. No.1 HI Press shop No.2 : new conveyer
5. No.3 HI Press and Welding shop: repair 2 fork lifts and new press dies racks

5-2-3 Analysis of Products Quality

(1) Problems and improvements of accuracy of panel parts

Because of abrasion occurring to the dies during the drawing process defective dimensions and damage to dies result. During the trimming process the use of a manually operated vibro shear M/C results in defective dimensions. Since the dimensions do not meet those required in the succeeding assembly processes this results in an increase in corrective operations and man-hour requirement.

As an improvement measure the addition and repair of a draw die and the introduction of new dies or a laser cutter for trimming process must be considered.

5-2-4 Maintenance of Equipment

(1) Problems and renovation of deterioration of equipment

The following pieces of equipment have halted operation completely and urgently require repair or replacement:

No.1 HI Press Shop No.2

1.	Roller leveler	1
2.	Shearing machine	2
3.	Stretch forming machine	1
4.	Press brake	1

No.3 HI Press Shop

1.	Single crank press	2

(2) Problems and improvement of equipment maintenance

Despite insufficient manufacturing accuracy the following equipment has to be used. A regular system of maintenance checks is required.

No.1 HI Press Shop No.2

1.	Big press (over 100 tons)	8
2.	Shearing machine	3

No.3 HI Press Shop

1.	Big press (over 55 tons)	13
2.	Press brake	1

5-2-5 Products Design

(1) Problems and improvement of design

To realize the following improvements the training of engineering design experts is necessary:

1) To reconsider the employment ratio of blanks from the basis of metal

mold designing (since at present the square sheets imported are used and approximately 40% are scrapped).

2) In order to proceed with semi-automation of the press the attachment of a loader and unloader to present presses is necessary.

3) The attachment of a quick die changing device to the present presses in order to go ahead with automation of the die changing process.

4) Components design for purposes of die repair.

5) Components design for purposes of machine maintenance and repairs.

5-2-6 Changeover to Domestic Production

(1) Problems and improvement in changeover to domestic production

The following need to be considered in view of increasing production of heavy and light vehicles, expanding the variety of vehicles, introducing new car models and strengthening the changeover to domestic production in the middling and long term:

1) Installation of a new press shop
2) Installation of a new die making shop
(cf. tables AI-5-2-10 and AI-5-2-11).

Table AI-5-2-1 OUTLINE OF EXISTING PRESS SHOPS

	No.1 HI (Rangoon) Press Shop No. 2	No.3 HI (Sinde) Press & Welding Shop
Area	128m x 38m	54m x 18m
Equipment	Press: 14 sets	Press: 14 sets
Personnel	51	44
Products	Panels for Body of Heavy & Light Vehicles	Panels for Body of Agricultural Machinery
Installed Capacity	390,000 pcs	100,000 pcs
Actual Production	130,000 pcs	20,000 pcs

Table AI-5-2-2 EQUIPMENT AND LAYOUT OF HIC'S PRESS SHOPS

	No.1 HI (Rangoon) Press Shop No. 2	No.3 HI (Sinde) Press & Welding Shop
Area	128m x 38m	54m x18m
Layout Drawing	Figure AI-5-2-1	Figure AI-5-2-2
Production Equipmnet	Mechanical Press 500-ton: 1 set 400-ton: 1 set 300-ton: 1 set 200-ton: 2 sets 150-ton: 2 sets 120-ton: 1 set 80-ton or less: 6 sets Sub-total: 14 sets Press Brake, 200-ton: 1 set Bending Machine, 200-ton: 1 set Stretch Forming, 150-ton: 1 set Shearing: 5 sets Roller Leveler: 1 set Total: 23 sets Others: Vibro Shear Drilling Machine, etc.	Mechanical Press 150-ton: 1 set 100-ton: 2 sets 50-ton or less: 11 sets Sub-total: 14 sets Hydraulic Press, 150-ton: 1 set Press Brake: 1 set Gap Press: 2 sets Roll Forming: 3 sets Total: 21 sets Others: Hand Press Welding Machine, etc.

Table AI-5-2-3 ORGANIZATION AND NUMBER OF PERSONNEL

	No.1 HI (Rangoon) Press Shop No. 2					No.3 HI (Sinde) Press & Welding Shop				
	Engi-neer	Fore-men	Skilled Worker	Semi-skilled Worker	Un-skilled Worker	Engi-neer	Fore-men	Skilled Worker	Semi-skilled Worker	Un-skilled Worker
Plant Manager	1					1				
Shop Manager	2						2			
Office			4	3			1	1	1	3
Shearing			1	3	2					
Heavy Press		1	3	4	2					
80-ton			2	3	2					
50-ton			1	4	2					
Welding			1	1						
Vibro Shear			2	2	2					
Die Store				3						
Press							1	1	1	10
Turning							1	1	1	3
Welding							2	2	2	10
Total	3	1	14	23	10	1	7	5	5	26
Total Number of Personnel at Shop			51					44		
HIC Data No.			HO-5/5-2					66-3(2)		

Table AI-5-2-4 PRODUCTS AND COMPONENT PARTS

	No.1 HI (Rangoon)		No.3 HI (Sinde)
	Press Shop No. 1	Press Shop No. 2	Press & Welding Shop
Products	Small press parts for electric machinery, equipment and electronic products	Panels for body of heavy and light vehicles	Panels for body of agricultural machinery
Quantity of Component Parts	265	536	(265)
Quantity of Dies	796	1,028	530

Note: Figure in the parentheses refers to assumed number.

Table AI-5-2-5 MANUFACTURED COMPONENT PARTS AND DIES FOR H.V. AND L.V. AT PRESS SHOP NO .2

		Quantity of Component Parts			Quantity of Dies		
	Vehicle Model	Under 100-ton	100-ton or More	Total	Under 100-ton	100-ton or More	Total
Heavy Vehicles	Trucks						
	6.5-ton (TE21)	(30)	(20)	(50)	(60)	(40)	(100)
	3.5-ton (KM600)	(30)	(20)	(50)	(60)	(40)	(100)
	Passenger Busses						
	33 (BX)	(62)	(28)	(90)	(139)	(29)	(168)
	25 (BM600)	62	28	90	139	29	168
Light Vehicles	Vehicles						
	2000cc (X-2000)	83	25	108	152	55	207
	600cc (B-600)	(83)	(25)	(108)	(152)	(55)	(207)
	Trucks						
	2-ton (T-2000)	23	17	40	41	37	78
Total		373	163	536	743	285	1,028

Note: Figures in the parentheses refer to assumed numbers.

Table AI-5-2-6 LIST OF COMPONENT PARTS (OVER 200-TON PRESS)

Vehicle Model	Comonent Parts	Quantity of Dies	Press Used
	1. Stay Mud Guard	1	Dies for Presses over 200-ton
(H.V.)	2. Frame Upper Battery Case	1	
	3. Frame Lower Battery Case	1	
	4. Side Wall Battery Case	1	
	5. Angle Battery Setting	1	
Passenger Bus	6. Outer Panel Side Skirt	1	
	7. Outer Panel Side Skirt	1	
	8. Outer Panel Side Skirt	1	
(25-BM 600)	9. L.Member	1	
	10. L.Member	1	
	11. L.Member	1	
	12. L.Member	1	
	13. L.Member	1	
	14. Stopper	2	
	15. Riser	1	
	16. Riser	1	
	17. Riser	1	
	18. Edge Iron Front Stop	1	
	19. Edge Iron Rear Stop	1	
	20. Cover	1	
	21. Inner Panel side LH	1	
	22. Inner Panel side LH	1	
	23. Inner Panel side LH	1	
	24. Inner Panel Side Pillar	1	
	25. Inner Panel Side RH	1	
	26. Under Cover Radiator	1	
	27. Setting Plate A	1	
	28. Setting Plate A	1	
	Total (28 pcs)	29 Dies	

Table AI-5-2-7 LIST OF COMPONENT PARTS (OVER 100-TON PRESS)

Vehicle Model	Comonent Parts	Quantity of Dies	Press Used
	1. Board Floor	1	Dies for Presses over 100-ton
(L.V.)	2. Angle Floor Board	2	
	3. Plate Corner RH	4	
	4. Plate Corner LH	4	
	5. Member Floor	1	
	6. Member Floor	1	
	7. Angle Floor Board RH	1	
Truck	8. Channel Rear Door	2	
	9. Plate Front Grill	1	
(2-ton T-2000)	10. Member Side Corner	4	
	11. Member Side Corner	3	
	12. Member Side Corner	4	
	13. Member Side Corner	3	
	14. Angle Lower	2	
	15. Stiffener Rear Door	2	
	16. Hinge Bar Door	1	
	17. Member	1	
	Total (17 pcs)	37 Dies	

Table AI-5-2-8 PRODUCTION OF VEHICLES AND AGRICULTURAL MACHINERY

	No.1 HI (Rangoon) Press Shop No. 2	No.3 HI (Sinde) Press & Welding Shop
Products	Vehicles, H.V. & L.V.	Agricultural Machinery, Tiller & Thresher
Production Capacity, units	2,400	1,100
Production, 1986/87		
Scheduled, units	2,187	1,100
Actual, units	1,855	775
Actual Component Parts Production	994,280 (1,855 x 536)	205,375 (775 x 265)
Actual Steps in Production, steps	1,906,940 (1,855 x 1,028)	410,750 (775 x 530)
Installed Capacity, steps/year	4,032,000 (5spm x 60min x 4hrs x 20days x 12months x 14units)	2,016,000 (2.5spm x 60min x 4hrs x 20days x 12months x 14units)

Table AI-5-2-9 PRODUCTION FOR H.V. AND L.V., PRESS SHOP NO. 2

		Production Capacity, Units (A)	Production Schedule, 1986/87, Units (B)	Actual Production, 1986/87, Units (C)	Capacity Utilization (C/A)
Heavy Vehicles	Trucks	1,100	907	771	70.0%
	6.5-ton (TE21)	(800)	(757)	(552)	
	3.5-ton (KM600)	(300)	(150)	(219)	
	Passenger Busses	100	70	75	75.0%
	33 (BX)				
	25 (BM600)				
Light Vehicles	Vehicles	1,000	910	669	66.9%
	2000cc (X-2000)	(400)	(390)	(236)	
	600cc (B-600)	(600)	(520)	(433)	
	Trucks				
	2-ton (T-2000)	200	300	340	170.0%
	Total	2,400	2,187	1,855	77.3%

Table AI-5-2-10 PRESSED PARTS FOR HEAVY VEHICLES TO BE CONVERTED TO DOMESTIC PRODUCTION

Vehicle Model		Component Parts	To be Converted	By Existing Press	By New Press
6.5-ton Truck (TE21)	1.	Side Frame	o		o
	2.	Axle Housing	o		o
	3.	Disc Wheel	o		o
	4.	Radiator	o	o	
	5.	Roof Cabin			o
	6.	Rear & Front Cover Cabin			o
33 Passenger Bus (BX)	1.	Side Frame	o		o
	2.	Rear Axle Housing	o		o
	3.	Disc Wheel	o		o
	4.	Radiator	o	o	
	5.	Front Construction	o		o
	6.	Rear Construction	o		o
	7.	Door Panel	o		o
	8.	Roof Construction	o	o	

Table AI-5-2-11 PRESSED PARTS FOR LIGHT VEHICLES TO BE CONVERTED TO DOMESTIC PRODUCTION

Vehicle Model		Component Parts	To be Converted	By Existing Press	By New Press
Vehicle, 2000cc (X-2000)	1.	Side Frame	o		o
	2.	Axle Housing	o		o
	3.	Disc Wheel	o		o
	4.	Radiator	o	o	
	5.	Roof Cabin			o
	6.	Panel Side			o
	7.	Floor Board			o
	8.	Bonnet			o
	7.	Fender			o
Vehicle, 600cc (B-600)	1.	Rear Axle Housing	o		o
	2.	Roof Cabin			o
Truck, 2000cc (T-2000)	1.	Side Frame	o		o
	2.	Rear Axle Housing	o		o
	3.	Disc Wheel	o		o
	4.	Radiator	o	o	
	5.	Cabin	o	o	
	6.	Side Panel (for Rear Body)	o		o
	7.	Floor Board (for Rear Body)			o
	8.	Roof			o

Figure AI-5-2-1 MACHINE LAYOUT OF PRESS SHOP NO.2

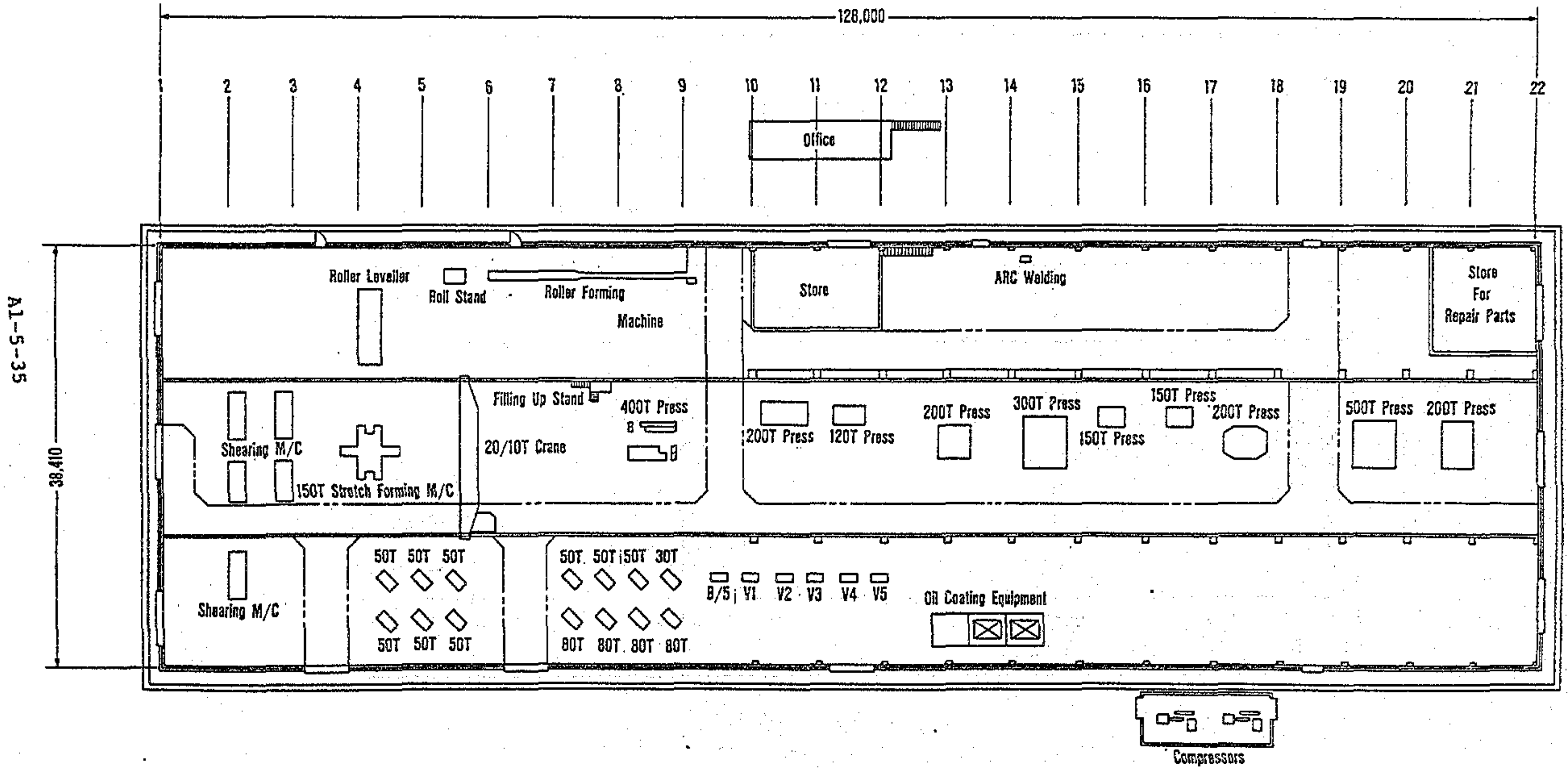
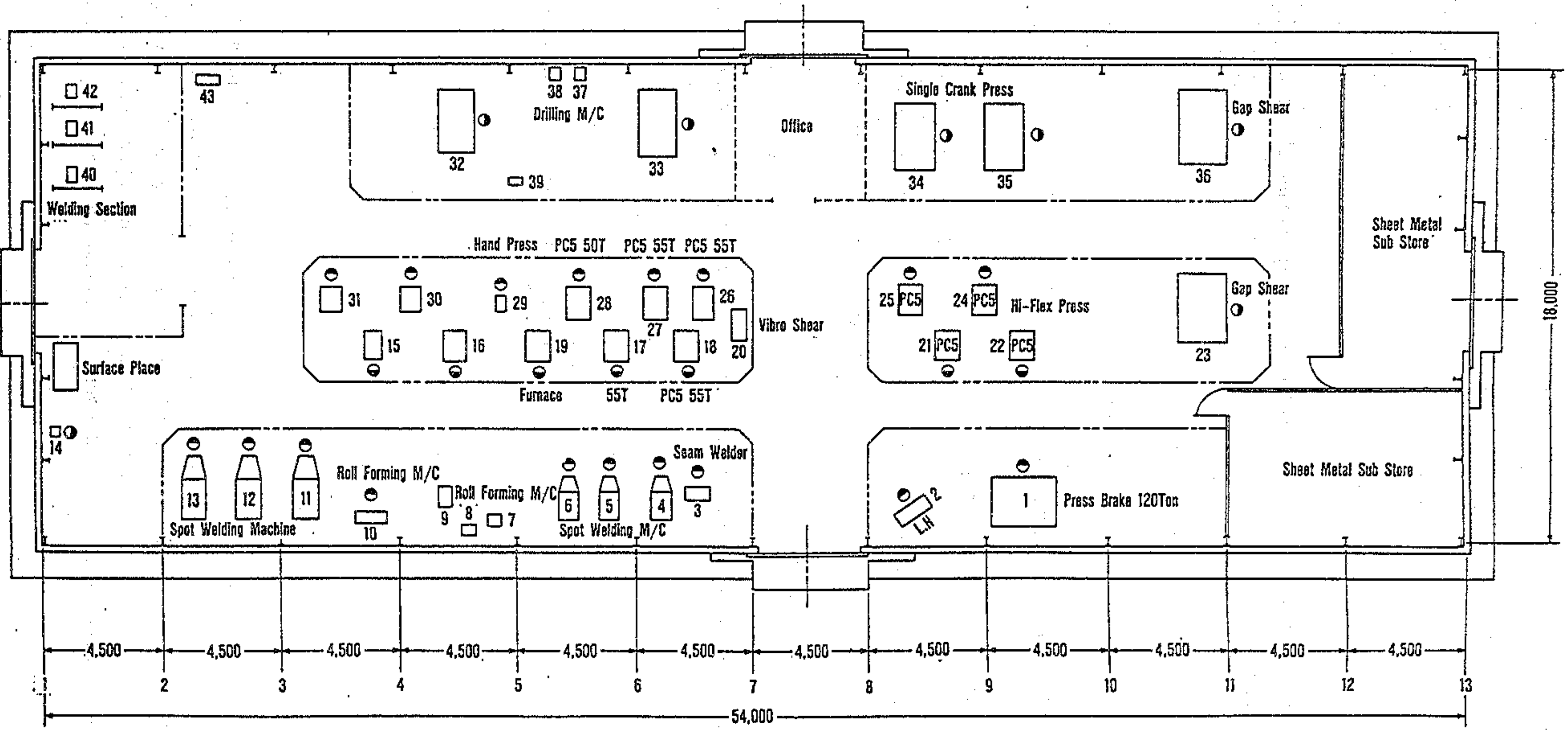


Figure AI-5-2-2 MACHINE LAYOUT OF PRESS AND WELDING



5-3 No.3 HI Forging Shop

5-3-1 Outline of No.3 HI Forging Shop

(1) Layout of the forging shop

Production of forged products takes place in three shops at the No.3 HI (cf. Fig.AI-5-3-1), as follows:

1. Light vehicles forging shop
2. Hand tools forging shop
3. Hoes and shovels forging shop

(2) List of forged items produced

1) Light vehicles forging shop

Production of forged items for use in light and heavy vehicles together with forged items for use in agricultural machinery

2) Hand tools forging shop

Production of such forged hand tool items as drivers, spanners, pliers, etc.

3) Hoes and shovels forging shop

Production of forged items for agricultural use such as hoes, shovels, pickaxes, axes, etc.

5-3-2 Light Vehicles Forging Shop

(1) Outline of production processes

1) Working equipment and its layout

The layout of working equipment in the forging shop for light vehicles is shown in Table AI-5-3-1. The main equipment consists of one each for 3 ton, 1 ton, and 1/2 ton air drop hammers which is each equipped with a heating furnace and trimming press as accessories. Further materials shear, grinder, and overhead crane (5 ton) are installed.

One set of 3 ton air drop hammer was recently installed, but the accessory trimming press and air compressor have not yet been installed.

The light vehicles forging shop is 15 m (Width) by 72 m (Length, which includes the recent extension by 18 m). The above listed equipment is arranged here. The layout is shown in Fig.AI-5-3-2.

2) Organization and personnel of the light vehicles forging shop

The light vehicles forging shop belongs to the Production Dept. No.2 of No.3 HI, and total personnel is 53. However, as yet there is no organization for the operating of the new 3 ton hammer. Organization is as follows:

a) Group operating the 1/2 ton and 1 ton hammers (the first shift) and the 3 ton hammer (the first and the second shifts).

b) Group supervising the reception and dispatch of materials

c) Group operating the 1 ton hammers (the second shift) and 3 ton hammer (the third shift).

The organization and personnel arrangement for these are shown in Fig.AI-5-3-3 and Table AI-5-3-2.

3) Materials and parts of the light vehicles forging shop and their procurement performance

The raw material used for forging is all imported. There were no problems of stoppages caused by the lack of received raw materials on the side of the forging shop.

4) Equipment capacity and production performance of the light vehicles forging shop for 1986 and 1987

output schedule and percentage achievement for the forging shop are shown in Table AI-5-3-3.

Actual performance is much lower than the production schedule. It would seem necessary to plan the output schedule after grasping the actual conditions of the shop.

(2) Analysis of production processes

1) Outline diagram for analysis of processes

Outline diagram is shown in Fig.AI-5-3-4.

2) Flow chart and diagram of process chains

The flow of forged products in the light vehicles forging shop is as indicated in Fig.AI-5-3-4. The flow chart for forging done inside the shop with a 3 ton air drop hammer is shown in Fig.AI-5-3-5.

3) Problems and improvement of manufacturing methods and process chains

Dies are at present placed directly on the ground near to each forging hammer. As a result problems of adhesion of dirt, oil, scale, etc. occur and this in turn means that the accuracy of the dies at setting is lowered. As the presence of the dies near to the forging hammers limits the means of escape in emergencies.

Following the production plan only the minimum essential dies should be kept at hand. It is necessary to consider installation of a store room where these could be ranged on racks and inserted and extracted by fork lift with ease.

The present forging shop is cramped. Materials, dies, scrap, and products are stacked here and there. It is necessary to limit to a minimum objects in the work area and stack these in racks. The repair of floor needs consideration.

As punching scrap is piled outside rust develops and since its chemical composition is unclear regeneration is difficult. It is advisable to divide the punched materials by material type and store these in the shop in scrap boxes. This will help to reduce the importing of Fe-Cr and Fe-Mn alloys. It is necessary to consider a roofed storage yard and sizing facilities.

Workers do not always wear safety protection while operating. HIC must ensure safety control and the thorough use of the safety protection.

4) Problems and improvement of manufacturing methods and division of labor

The heating furnace in present use runs on diesel fuel and is of the batch type. As the future supply of diesel oil will encounter difficulties it is necessary to consider the switch over to either LPG, electricity or natural gas.

As a crane is used when changing the metal dies this involves much time. The introduction of a fork lift truck or a die changer should be considered.

Forging of the ring gear (diameter: approx. 400 mm) is done with the 3 ton hammer. The product size fills up the metal die and because of frequent forging use the edge of the metal die suffers damage. This forging requires two heating phases one for the rough forging and another for finish forging so that forging involves considerable time. If large die forging machinery is introduced as part of the modernization plan it is necessary to consider using this equipment for production.

The extension forging of the rear axle shaft (approx.28 mm diameter x 500 - 600 mm length) involves a large number of stretching operations and the forging operations require considerable time. If an upset method of forging is introduced as part of the renovation plan then consideration should be given to the appropriate size.

5) Problems and improvement of equipment layout and materials handling

Since the materials cutting area and the materials stock are at a distance materials require conveyance by crane for cutting (however, as the shop was recently extended there is now one extra material stock which is near to the cutting area). In order to bring the cutting area closer to the materials stock yard changing of the layout for the cutting area requires consideration.

The heating furnace is near to the forging hammer in order to prevent any reduction in the temperature of heated material once extracted.

The working environment of the operator forging is very bad because of excessive heat from the furnace door. Measures to block the heat require consideration.

6) Problems and improvement of the working equipment

At present there are two cutting machines for materials in operation. Cutting of large materials (diameter larger than 180 mm) takes considerable time. Further, wear of the blade is advanced. While replacing and repairing defective or broken parts, the installation of a high speed cutter must be considered.

Of the two grinders one is not operating because of lack of spare parts for a broken switch. Prompt purchasing of the parts needing replacement is necessary.

There are cracks in the frame of the 1 ton air drop hammer. But for the present these do not interfere with operations. A detailed report on the present occurrence of cracks and the periodical checks is needed. Replacement should be considered.

The die cushion or gum cushion for the 500 ton trimming press is defective. Spare parts should be promptly obtained and repairs made.

No.3 HI is equipped with a small scale metal die repair area.

However the capacity of this for repairs of the metal dies is not sufficient. Metal dies requiring repair are thus left to the side unrepaired. A comprehensive repair shop for urgent metal dies is needed.

The compressed air supply used in the forging shop is shared with the foundry. When both forging shop and foundry use the compressed air this results in a drop in air pressure and problems arise. There are two compressors for forging but at present these are not employed. First the necessary quantity of compressed air for forging shop should be re-evaluated and an overhaul of the existing compressors should be carried out to make these usable. If there are deficiencies the required equipment should be installed and the establishment of an independent supply system for the forging shop is desirable.

There are no crates (boxes) for carrying cut materials or finished products. Crates for transportation and arranging are needed in order to manage both materials and finished products.

7) Problems and improvement of operating rates and line balancing

Since the trimming press (500 tons) related to the new 3 ton air hammer was not installed at the same time the 3 ton air drop hammer is not able to operate. The 3 ton hammer is operated at present in 3 shifts. To lighten its work loads the prompt introduction of related equipment is needed.

8) Problems and improvement of the reception of materials and parts

Forging materials (round bars) are carried by truck from the store room to the entrance of the forging shop. The materials are carried into the shop once they have been unloaded from the truck. In order to make it possible for the truck to drive into the shop and carry out unloading of materials directly by crane it is necessary to reconsider the position of the office in the shop.

9) Problems and improvement of dispatch of finished products

Finished goods are piled up inside the shop itself. It is necessary to use a fork lift to carry finished goods immediately to the finished goods storeroom.

(3) Analysis of quality control

1) The occurrence of rejects

The record for the occurrence of defective goods for the period between April, 1987 and January, 1988 in the forging shop is as follows:

No. of goods examined	No. of goods defective	Reject Rate
62,977	3,175	5.04 %

The reject rates for individual parts vary between 0-20%. Parts having a high reject rate are the connecting rod, gear transfer drive, spline shaft, yoke flange, gear counter shaft, etc.

An survey of the quantity of rejects is made for purposes of requests for substitute materials and it was not apparent that this was done as part of quality control activities. A system for clarifying the causes of rejects and preventing these is needed.

2) Analysis of the relation with preceding and following processes.

All the materials for forging are imported and it is considered that there are almost no quality problems. There is a danger that production mistakenly using materials of differing quality could take place and products with different specification might result. Therefore, a system of identifying the each material for use is important.

It is advisable that the forging operator responsible should check the quality of forged products himself.

A system of sampling inspection is needed for each lot when production for the purposes of temporary stocking takes place.

3) Problems and improvement of quality standards and inspection methods

The present quality standards are not sufficiently known by the shop workers.

It is necessary to create a system which will ensure the setting of final standards for products, and quality standards for each manufacturing process, as well as the actual quality of each process, ensure that these are reflected in the operating manuals, and undertake the training of operators. By these measures a system to assure the quality of products for each process is to be established.

(4) Maintenance of equipment and buildings

1) Maintenance system

A maintenance group is under the control of the Planning Dept. of the No.3 HI.

2) Repairs performance

The repairs performance for a 3 months period in 1986 is as follows:

No.	Machines and Equipments	Repairs
1	200 ton Press EIS 200	Change of solenoid valve
2	100 ton Press EIS 100	Change of solenoid valve
3	Grinder WG3AC	Change of push button

3) Problems and improvement of maintenance

It is necessary to train the operators to undertake fundamental maintenance checks themselves. Also the maintenance group must establish standards for its regular inspections and a system for their certain implementation must be set up.

(5) Product design

The designing of metal dies is important to advances of product development in the forging field. As, at present, this ability is lacking the Molds must be imported. In order to create an system of dies design engineering and improve processing of dies establishment of a technical center is required.

5-3-3 Forging Shop for Hand Tools

(1) Outline of production processes

1) Working equipment and its layout

The main equipment for the hand tools forging shop is as indicated in Table AI-5-3-4. Main equipment consists of a total of 7 forging hammers including drop hammer and free forging hammer, 10 presses of various type (30-250 tons), and 7 heating furnaces, 2 material cutters, 3 grinders, 1 shot blast, 1 tempering furnace, and 2 overhead cranes (5 ton) are installed.

The hand tools forging shop is 18 meters wide by 63 meters long and the equipment listed in Table AI-5-3-4 is located here. The layout is shown in Fig.AI-5-3-6.

2) Organization and personnel of the hand tools forging shop

This shop belongs to the second production division and the personnel totals 32 members. Organization is made up of :

a) The pneumatic hammer group
b) The air drop hammer/press group
c) The grinder group

The organization and personnel arrangement is indicated in Fig.AI-5-3-7, and Table AI-5-3-5.

3) Raw materials and parts and their supply performance in the hand tools forging shop.

The steel materials used in the hand tools forging shop are all imported. The stock and purchasing figures for this by year are indicated in Table AI-5-3-6.

There are 13 different kinds of the steels and 37 different diameters of steel material. If the number of diameter types were reduced this would simplify purchasing procedures and stock handling. It is necessary to consider reducing the number of diameter types for steel materials.

4) Equipment capacity and production performance

The production schedule, production performance and percentage achievement for the hand tools forging shop are indicated in Table AI-5-3-7.

(2) Analysis of processing

1) Outline analysis of processing

The table for the outline of production processes of the hand tools forging shop is shown in Fig.AI-5-3-8.

2) Flow chart and process chains

The process flow of forged products in the hand tools forging shop is as shown in Fig.AI-5-3-8. The figure showing process flow for forging involving the use of the free forging hammer and drop hammer in the hand tools forging shop is shown in Fig.AI-5-3-9.

3) Problems and improvement of operating methods and process chains

a) Maintenance of forging metal dies

As was the case in the light vehicles forging shop metal dies are placed directly on the floor, but this is not advisable from the standpoint of maintenance of quality and accuracy. The installation of racks for storage of the dies needs consideration.

b) Handling of punching and scrap material for forging

Scraps from the punching material for forging is placed outside. If punched material could be classified by material then it could be re-used in either the steel or iron foundry.

It is necessary to provide scrap boxes so that punched material can be divided by material type easily as it occurs. The provision of a roofed scrap yard also needs consideration.

4) Problems and improvement of manufacturing methods and division of labor

a) Heat source for the heating furnace

At present a batch type of heating furnace using diesel oil as fuel is used. Since the supply of diesel fuel is difficult conversion to fuel sources such as electricity, LPG or natural gas need consideration.

b) Production of forged products

Production of the agricultural machine part main bush for the KND 55 is done with a 1\2 ton pneumatic hammer and 1 ton drop hammer. As the parts are large forging involves much time. Use of the 3 ton drop hammer of the light vehicles forging shop needs consideration.

5) Problems of equipment layout and materials handling

Nothing of note.

6) Problems and improvement of working equipment

a) Material cutter

As the circular saw presently used takes much time supply of cut materials tends to be delayed. Introduction of a high speed cutter needs consideration

b) Spare parts

Equipment cannot operate satisfactorily because of lack of spare parts. Purchasing cannot take place unless some breakdown actually occurs. However, it takes 5-6 months to receive parts if ordered from the time of breakdown.

A system whereby spare parts for the main equipment would be available ordinarily in sufficient amount needs consideration. Spare parts urgently needed are as follows:

O-ring and spring for the 55 ton press
Ball bearings for the 75 ton press
O-ring for the 1\16 air hammer

7) Problems and improvement of operating rates and line Balancing

Stoppages of the hammers and presses are frequent. Daily inspections need to be introduced.

8) Problems and improvement of reception of materials and parts

Nothing of note.

9) Problems and improvement of finished product dispatch

The dispatch of manufactured products to the finishing shop does not run smoothly at present. Introduction of a fork lift truck needs consideration.

(3) Analysis of quality control

1) Occurrence of rejects

The occurrence of rejects in the hand tools forging factory is shown below in Table AI-5-3-8.

According to Table AI-5-3-8, the reject rate is not high. Conditions relating to quality control and maintenance of equipment are roughly the same as those mentioned for the light vehicles forging shop.

5-3-4 Forging Shop for Hoes

(1) Outline of production processes

1) Working equipment and its layout

Working equipment for the Mamootie hoe forging shop is as shown in Table AI-5-3-9.

The breakdown of one line is as follows:

a) Rotary heating furnace (initial heating of material)
b) Re-heating furnace
c) Crankless press (1600 tons): rough forging
d) Roll forging machine : stretching of flat surface of hoe
e) Crankless press (400 tons) : trimming and piercing
f) crankless press (210 tons) : marking and coining

Besides the above, 2 shearing machines for cutting material, 8 grinders, and cranes of 25 ton,5 ton and 3 ton capacity each are installed.

The hoe forging shop is 27 m. wide by 90 m long and the equipment listed in Table AI-5-3-9 is located in this area. The layout figure is shown in Fig.AI-5-3-10.

2) Organization and personnel of the hoe forging shop

The hoe forging shop belongs to the Production Dept. No.2 the No.3 HI, and personnel totals 79 members whose organization is divided as follows:

Production line : 3 lines, 1 shift
Production line : 3 lines, 2 shifts
Machinery repairs group
Dies repair group
group
Management

Organization and personnel arrangement are shown in Fig.AI-5-3-11 and Table AI-5-3-10.

3) Materials and parts and their supply performance in the hoe forging shop

Burmese domestic metal (49 mm in diameter, equivalent to JIS S53C) is used as material for the hoe, and all other materials are imported. The figures of stock and purchasing by year are shown in Table AI-5-3-11.

4) Equipment capacity and production performance

The production schedule, production performance and production achievement rate for the hoe forging shop are shown in Table AI-5-3-12.

(2) Analysis of processing

1) Outline analysis of processing

The table outlining the process analysis of the hoe forging shop is shown in Fig.AI-5-3-12.

2) Flow chart and process chains

The flow of forged products in the hoe forging shop is almost the same as the figure above for operational processes. The flow chart for the hoe forging shop in the case of hoe forging is shown in Fig.AI-5-3-13.

3) Problems of operation methods and process chains

a) Maintenance of metal dies

There is sufficient space for the placing of metal dies but, as with other forging shops, these are placed directly on the floor.

As indicated with the light vehicles forging shop it is not advisable for the maintenance of the precision of the dies and their quality to place these on the floor directly. The installation of racks for the placing of metal dies needs consideration.

b) Handling of the punched scrap of the hoe, etc.

The punched scrap is placed outside. To facilitate the conveyance of and use of scrap material as melting material for the furnace it is necessary to adopt measures for the breaking up of punched material, as follows:

Cutting up using a joint cutter attached to trimming die
Cutting up with a scrap shearing machine
Making compressed blocks with a bailing machine

4) Problems and improvement of the manufacturing methods and division of labor

a) Fuel of the materials heating furnace

At present, the fuel source of the heating furnace is diesel oil. As the supply of diesel oil in Burma is difficult at present conversion to either the LPG, electric, or natural gas fuel source needs consideration.

b) Forging of shovels

Forging of shovels is done with the 55 ton press of the hoe forging shop and the 75 ton press of the hand tool forging shop.

As conveyance equipment is insufficient the carrying in and out between shops does not take place smoothly.

The installation of a 55 ton press and a 75 ton press in the hoe forging shop is not economical. Rather the consideration of introducing transportation equipment such as a fork lift truck, etc. is needed.

5) Problems and improvement of equipment layout and material handling

Nothing of note

6) Problems and improvement of working equipment

a) Roll forging machine

The roll forging machine of line No.1 is undergoing an overhaul. Because of lack of spare parts, when a breakdown occurs this results in a long term stoppage of the group of related equipment while repairs are under way. It is necessary to have a system whereby sufficient spare parts are kept available for maintenance.

b) Repair of metal dies

Metal dies requiring repairs are left without repair. At present, the repair shop of No.3 HI is both small in scale and capacity and is unable to undertake sufficient repairs of the metal dies.

The implementation of a comprehensive metal dies repair section needs consideration.

c) Compressor breakdowns

There are two compressors but both of these are out of use. One is being overhauled. As there are no spare parts there is a long delay from the time of order to finishing of repairs. It is necessary to create a comprehensive supervision system to ensure availability of sufficient spare parts.

d) Breakdown of slat conveyer

The breakdown of the slat conveyer used to send the material from the heating furnace to the forging press has not yet been repaired. A chute system used instead is much less efficient, and the repair or replace of the conveyer is necessary.

7) Problems and improvement of operating rates and line balancing

As the equipment used in the hoe forging shop is interrelated the breakdown of one piece of equipment brings the entire line to a standstill. Since the heated material must be forged immediately it is not possible as with machined products to move the material to another machine. Consequently, it is necessary to undertake systematically daily and periodical inspections and overhauls.

8) Problems and improvement of reception of raw materials and parts

Nothing of note.

9) Problems and improvements of dispatch of completed products

Due to the lack of transportation equipment for the dispatch of completed products dispatch operations do not proceed smoothly. Introduction of exclusive forging shop fork lift trucks needs to be considered.

(3) Analysis of quality

1) Occurrence of rejects

The occurrence of rejects in the hoe forging shop are as indicated below in Table AI-5-3-13.

The reject rate as shown in Table AI-5-3-13 is low. If one includes the products for local use as rejects then the reject rate would be as follows:

2 1\2 lb. hoe	6.8 %
3 lb. hoe	2.2 %

Matters of quality control, maintenance of equipment, etc. are almost the same as those for the light vehicles forging shop.

Table AI-5-3-1 MAJOR EQUIPMENT IN LIGHT VEHICLE FORGING SHOP

No.	Equipment	Qt'y	Model No.	Year of Mfrg.	Mfr.
1	3T Air Drop Hammer	2			NITTAN
2	1T Air Drop Hammer	1			NITTAN
3	1/2T Air Drop Hammer	1			NITTAN
4	Furnace	3			
5	500T Trimming Press	1	EIS 500	1969	KOMATSU
6	200T Trimming Press	1	EIS 200	1969	KOMATSU
7	100T Trimming Press	1	EIS 100	1969	KOMATSU
8	Saw	1	CRA 300	1963	AMADA
9	Saw	1	H-250-SA	1970	AMADA
10	Saw	1	H-250-SA	1980	AMADA
11	Grinder	1	WG3AC	1969	YOSHIDA
12	Grinder	1	WG3AC	1969	YOSHIDA
13	O/H Crane	1			

Table AI-5-3-2 PERSONNEL LIST OF LIGHT VEHICLE FORGING SHOP

(Unit: Persons)

	Manager	Engineering Staff	Administrative Staff	Foreman	Skilled Worker	Semiskilled Worker	Unskilled Worker	Total
Manager and Staffs	2	2	1					5
Materials Cutting						1	1	2
1/2T Hammer (1 Shift)					2	1	2	5
1T Hammer (1 Shift)				1	1	2	1	5
1T Hammer (2 Shifts)				1		4	1	6
3T Hammer (1 Shift)				1	3	2	1	7
3T Hammer (2 Shifts)				1	3	1	2	7
3T Hammer (3 Shifts)				2	1	2	2	7
Grinder					1	1	2	4
Materials Acceptance				1	1			2
Dispatch						3		3
Total	2	2	1	7	12	17	12	53

Table AI-5-3-3 PRODUCTION PLANNING AND RESULT FOR LIGHT VEHICLE FORGING SHOP

	Actual Production (pcs)	Production Plan (pcs)	Performance (%)
B600 (MAZDA)	27,309	43,665	62.5
X2000 (MAZDA)	13,920	38,547	36.1
TE21 (HINO)	28,061	30,358	92.4
AME (KUBOTA)	3,918	16,200	24.2
TOTAL	73,208	128,770	56.9

Table AI-5-3-4 MAJOR EQUIPMENT IN HAND TOOL FORGING SHOP

No.	Equipment	Qt'y	Model No.	Year of Mfrg.	Mfr.
1	1/16T Air Hammer	2	NB		NITTAN
2	1/8T Air Hammer	1	NB		NITTAN
3	1/2T Air Drop Hammer	3	A.D.H		NITTAN
4	1T Air Drop Hammer	1	A.D.H		NITTAN
5	30T HY-Flex Press	1	PPXGE-30SU II		AIDA
6	55T HY-Flex Press	3	PPXGC-55SU II		AIDA
7	75T HY-Flex Press	1	PPMGC-75SU II		AIDA
8	75T Press	1	PPMGC-75SU II		AIDA
9	100T HY-Flex Press	1	PPXGE-100 II		AIDA
10	100T HY-Flex Press	1	PPXGE-100 II		AIDA
11	250T HY-Flex Press	1	PPVK 250 (8)		AIDA
12	150T Friction Screw Press	1	YE 150		YOSHIDA
13	Heating Furnace	7			
14	180T Billet Shearing Machine	1	BS-70S		
15	Circular Saw	1	KLN-2		TSUNE-SEIKI
16	Two-head Grinder	3		1969	
17	Shot Turn Blast	1		1969	SINTO-KOGYO
18	Heating Furnace (500Kg)	1			SIKOKU-KENMA
19	Overhead Crane (5T)	2			HITACHI
20	Cooling	1			

Table A1-5-3-5 PERSONNEL OF HAND TOOL FORGING SHOP

(Unit: Persons)

	Manager	Enginnering Staff	Administrative Staff	Foreman	Skilled Worker	Semiskilled Worker	Unskilled Worker	Total
Manager and Staffs	1	4		1				6
Air Hammer					1	3	1	5
Air Drop Hammer					1	8	1	10
Press					1	4	2	7
Grinder					1	1	2	4
Total	1	4	-	1	4	16	6	32

Table AI-5-3-6 STOCK AND PROCUREMANT OF STEELS FOR HAND TOOL FORGING SHOP

	Material	Diameter (mm)	Unit	1985-1986		1986-1987		1987-1988		Price (JY/Kg)	Remarks
				Stock	Purchase	Stock	Purchase	Stock	Purchase		
1	SS41	9	Kg	9,038	-	9,038	-	9,038	-	114	
2	S50C/48C	28	Kg	-	-	-	-	-	232	97	
3	S50C/48C	36	Kg	-	-	-	-	-	450	97	
4	S50C/48C	38	Kg	-	-	-	-	-	2,150	97	
5	S45C	25	Kg	-	-	-	-	-	1,130	97	
6	S45C	28	Kg	-	-	-	-	-	2,960	97	
7	S45CD	40	Kg	8	-	5	-	5	2	232	
8	S45CD	4.763	Kg	-	-	-	-	-	2	217	
9	S45CD	6.35	Kg	-	-	-	-	-	3	217	
10	S45CD	11.1125	Kg	-	-	-	-	-	22	188	
11	S45CD	12	Kg	100	-	-	-	-	215	174	
12	S45CD	12.7	Kg	-	-	-	-	-	7	174	
13	S45CD	15.1	Kg	-	-	-	-	-	8	171	
14	SCM3	13	Kg	4,928	-	2,928	-	-	5,198	-	
15	SCM3	16	Kg	8,818	-	5,500	-	5,500	-	-	
16	SCM3	19	Kg	34,070	-	31,570	-	26,840	-	205	
17	SCM3	22	Kg	4,890	-	2,400	-	-	293	131	
18	SCM3	25	Kg	7,500	-	600	-	-	3,223	126	
19	SCM3	26	Kg	507	-	-	-	-	260	126	
20	SCM3	26.5	Kg	628	-	-	-	-	675	-	
21	SCM3	39	Kg	2,260	-	-	-	-	224	126	
22	SCM3	36/34	Kg	4,500	-	10,000	-	10,000	-	-	
23	SWRH4A (Wire)	6	Kg	370	-	-	-	-	238	-	
24	SWRH4A	8	Kg	850	-	-	-	-	996	-	
25	SWRM	2.6	Kg	25	-	18	-	18	-	-	
26	SWRM	2.8	Kg	90	-	80	-	80	-	-	
27	SPC-3 (Plate)	THK 0.5	Kg	-	-	-	-	-	204	-	
28	SS41BD (HEX Bar)	10 HEX	Kg	90	-	-	-	-	200	-	
29	SS41	22	Kg	4,576	3,000	4,303	580	4,303	-	104	
30	SS41BD	25	Kg	4,636	304	3,528	-	1,820	2,396	109	
31	S45C	28	Kg	15,908	4,000	12,719	-	12,719	-	141	
32	S40C	38	Kg	10,939	10,000	17,859	-	17,859	-	141	
33	S45C	38	Kg	40,448	20,000	56,973	-	56,973	-	141	
34	S43C	38	Kg	1,720	-	-	2,000	1,014	3,906	141	
35	S45C	34	Kg	3,376	-	-	5,000	5,000	-	109	
36	SS41	46	Kg	48,808	6,000	46,001	-	46,001	-	108	
37	S43C	60	Kg	-	-	-	-	-	11,517	109	
38	S43C	25	Kg	-	-	-	12,000	11,437	6,496	109	
				209,083	43,304	203,552	19,580	208,607	43,007		
				252,387		223,132		251,614			

Table AI-5-3-7 PRODUCTION AND PERFORMANCE (1986-1987) FOR HAND TOOL FORGING SHOP

	Product	Actual Production (pcs)	Production Plan (pcs)	Performance (%)
1	Double Offset Wrench	1,500	7,000	21.4
2	KND5B	5,000	5,000	100.0
3	KND7	1,100	1,100	100.0
4	KMB-200	400	500	80.0
5	Treadle (L & R)	10,500	18,000	58.3
6	Open Ended Spanner (Double)	52,164	33,000	158.0
7	Pliers	6,680	10,000	66.8
8	Adjustable Angle Wrench	1,960	2,000	98.0
9	Hammer and Claw Hammer	4,000	3,000	133.3
10	Screw Driver	22,220	16,000	138.8
11	Ring Spanner	3,993	3,000	133.1
	Total	109,517	98,600	111.0

Table A1-5-3-8 RATE OF REJECTION OF FORGED HAND TOOLS

	Product	Nos. Inspected (pcs)	Nos. Rejected (pcs)	Rejection Rate (%)
1	Open End Spanner (Double)	104,280	762	0.73
2	Pliers Body	64,400	480	0.75
3	Hammers	132,400	-	-
4	Treadle	20,000	290	1.45
5	Spanners	13,203	282	2.14
	Total	334,283	1,814	0.54

Table AI-5-3-9 MAJOR EQUIPMENT IN MAMOOTIE FORGING SHOP

No.	Equipment	Qt'y	Model No.	Year of Mfrg.	Mfr.
1	1600T Crankless Press	3	LKM-1600		KURIMOTO
2	50HP Forging Roll	3	RF-50		KURIMOTO
3	400T Crankless Press	3	S2-400		KURIMOTO
4	210T Crankless Press	3	S2-210		KURIMOTO
5	Rotary Heating Furnace	3	TF-400		
6	Reheating Furnace	3			NIHON-KOGYO-RO
7	Billet Shearing Machine	2	SB-350		KURIMOTO
8	Grinder	8		1969	
9	Overhead Crane (25T)	1	OFCH		HITACHI
10	Overhead Crane (5T)	1	OFCH		HITACHI
11	Overhead Crane (3T)	1	OFCH		HITACHI

Table AI-5-3-10 PERSONNEL LIST OF MAMOOTIE FORGING SHOP

(Unit: Persons)

	Manager	Enginnering Staff	Administrative Staff	Foreman	Skilled Worker	Semiskilled Worker	Unskilled Worker	Total
	1	1	1					3
Production <1>				1	2	18	10	31
Production <2>				1	2	17	11	31
Equipment Maintenance		4					2	6
Die Maintenance		2					2	4
Grinder					2		2	4
Total	1	7	1	2	6	35	27	79

Table AI-5-3-11 STOCK AND PROCUREMENT OF FORGING MATERIALS FOR MAMOOTIE, SPADE, PICK-AXE, AXE, ETC.

	Material	Diameter (mm)	Unit	1985-1986		1986-1987		1987-1988		Price (JY/Kg)	Remarks
				Stock	Purchase	Stock	Purchase	Stock	Purchase		
1	Special Alloy Steel Bar for Mamootie	49	Kg	-	-	-	43,000	40,000	293,000		Local
	Materials for Spade, etc.										
1	S53C	46	Kg	332,506	630,000	305,144	-	-	-	128	Imports
2	S53C	48	Kg	7,555	420,000	-	-	-	-	128	Imports
3	S55C	50	Kg	15,690	53,000	35 000	-	35,633	-	150	Imports
4	S45C	Steel Plate 1.8tx1219x2438	Kg	-	60,000	-	-	-	-	176	Imports
5	S45C	Steel Plate 1.8tx1000x1829	Kg	-	-	-	19,930	-	-	166.4	Imports
				355,751	1,163,000	340,777	62,930	75,633	298,800		
				1,518,751		403,707		374,433			

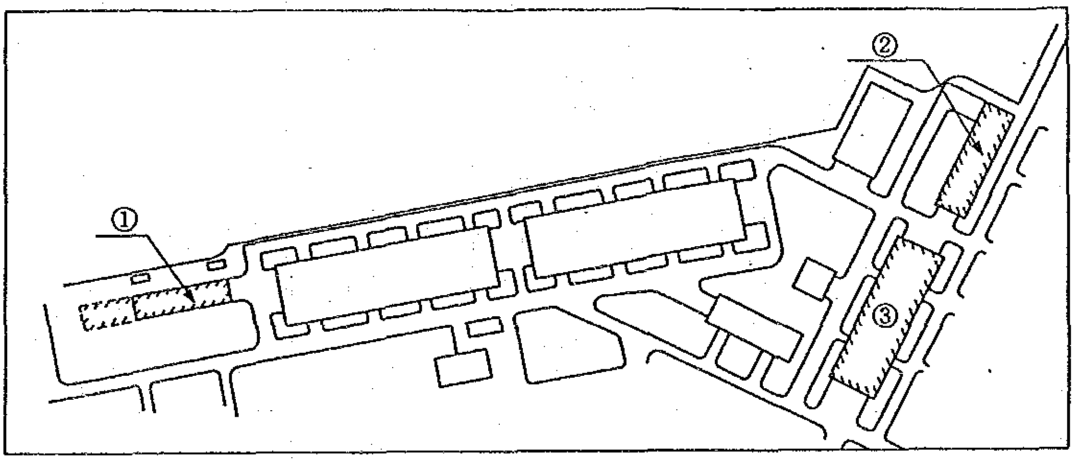
Table AI-5-3-12 PRODUCTION AND PERFORMANCE FOR MAMOOTIE FORGING SHOP

	Product	Actual Production (pcs)	Production Plan (pcs)	Performance (%)
1	Mamootie (2 1/2lb)	206,000	240,000	85.8
2	Mamootie (3lb)	151,650	180,000	84.3
3	Spade	20,383	50,000	67.9
4	Pick-axe	8,600	10,200	84.3
5	Axe	140	-	-
	Total	386,773	480,200	80.5

Table AI-5-3-13   RATE OF REJECTION IN MAMOOTIE FORGING SHOP

	Product	Nos. Qualified (pcs)	Local Product (pcs)	Nos. Rejected	Rate of Rejection (%)
1	Mamootie (2 1/2lb)	20,000	1,210	152	0.8
2	Mamootie (3lb)	30,000	502	157	0.5
3	Spade	2,000	-	-	
4	Pick-axe	2,000	-	-	

Figure AI-5-3-1 RELEVANT SHOPS IN No. 3 HI



① Light Vehicles Forging Shop

② Hand Tool Forging Shop

③ Hoe (Mamootie) and Shovels Forging Shop

Figure AI-5-3-2 MACHINE LAYOUT PLAN OF LIGHT VEHICLE FORGING SHOP

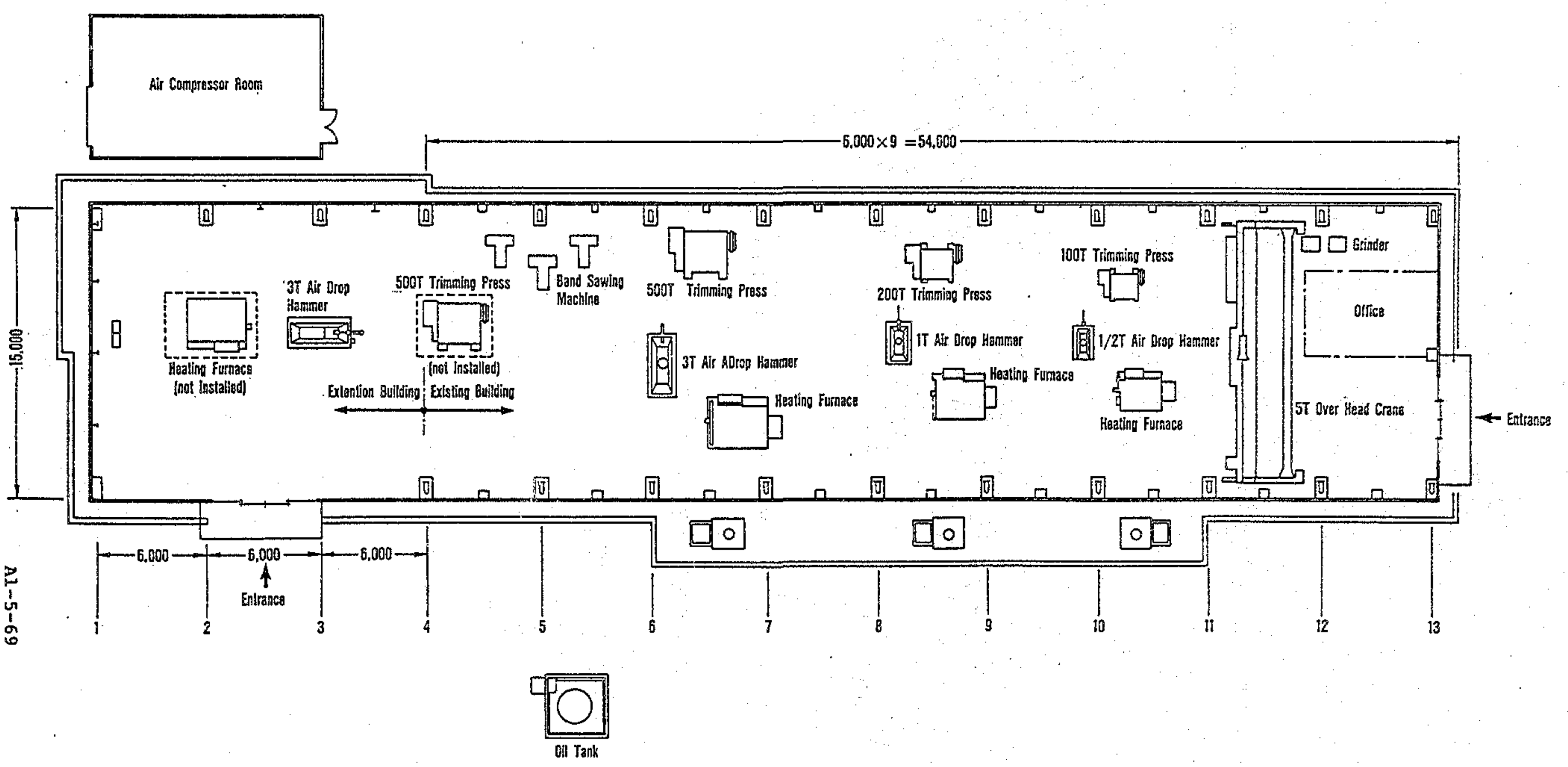


Figure AI-5-3-3 ORGANIZATION OF LIGHT VEHICLE FORGING SHOP

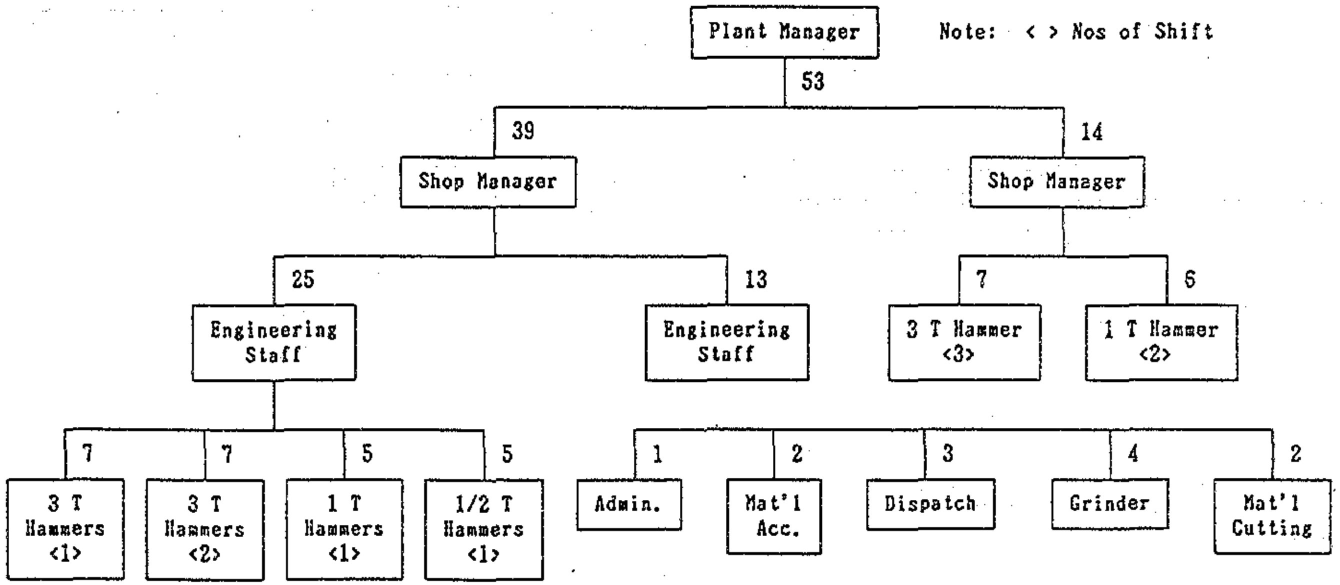


Figure AI-5-3-4 OUTLINE OPERATION PROCESS CHART IN LIGHT VEHICLE FORGING SHOP

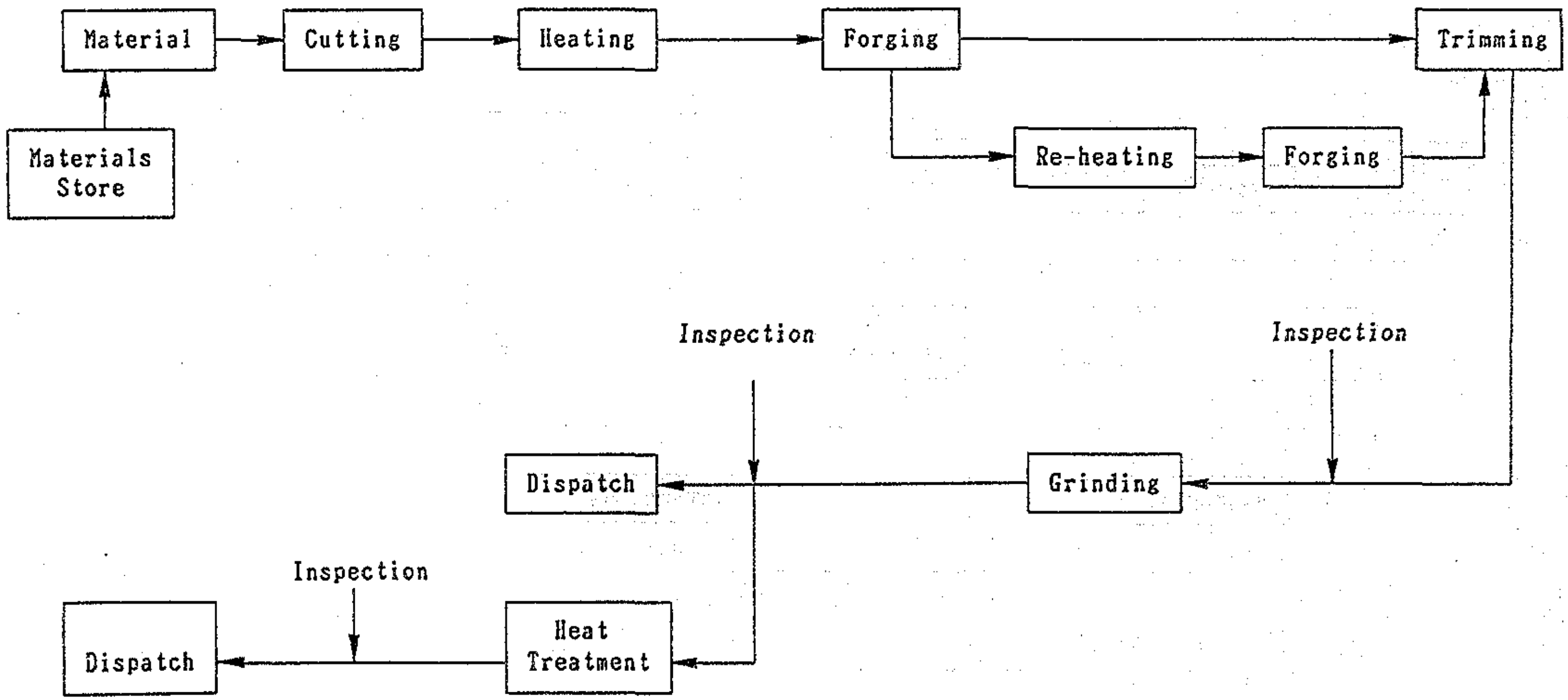


Figure AI-5-3-5 MACHINE LAYOUT AND FLOW CHART OF LIGHT VEHICLE FORGING SHOP

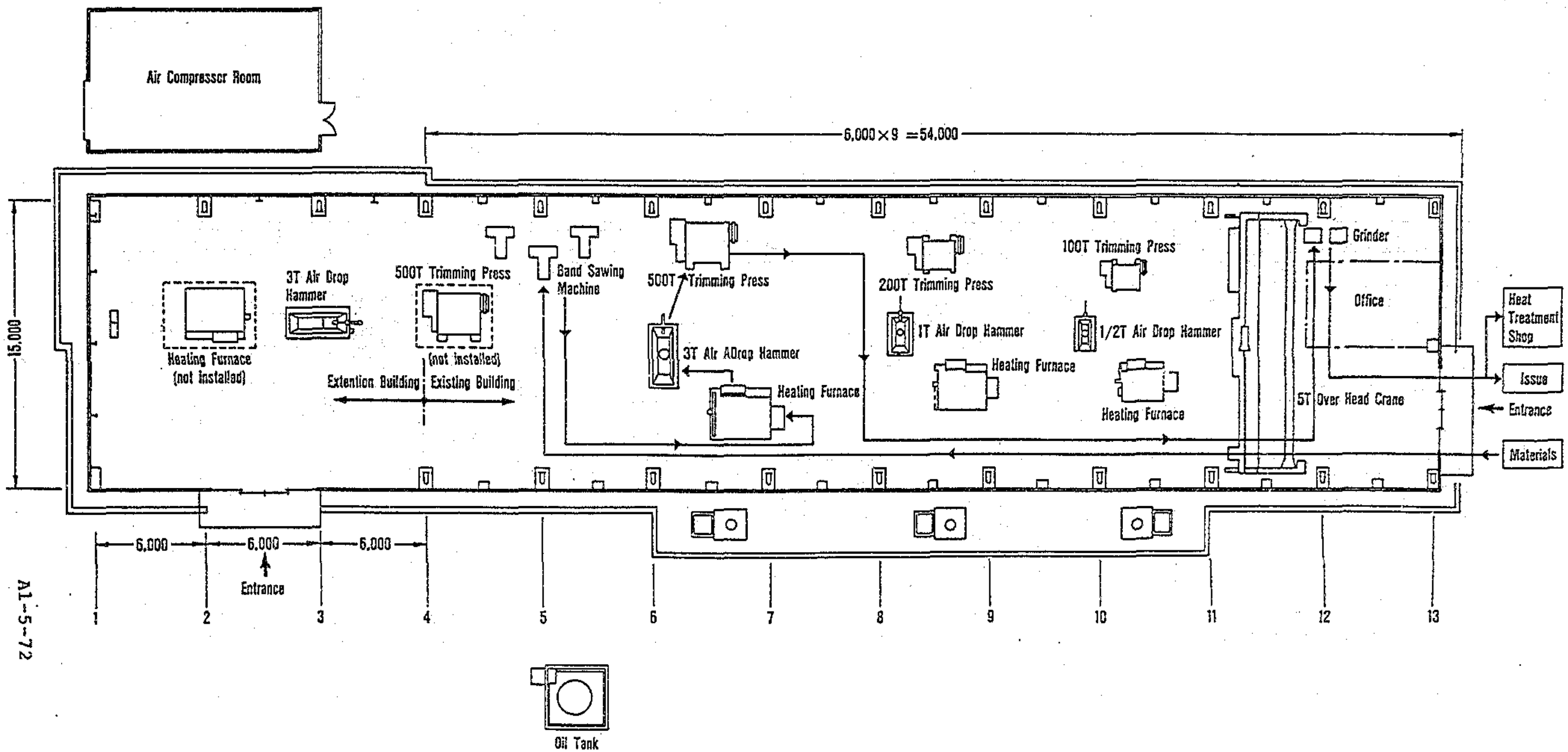


Figure AI-5-3-6 MACHINE LAYOUT PLAN OF HAND TOOL FORGHIG SHOP

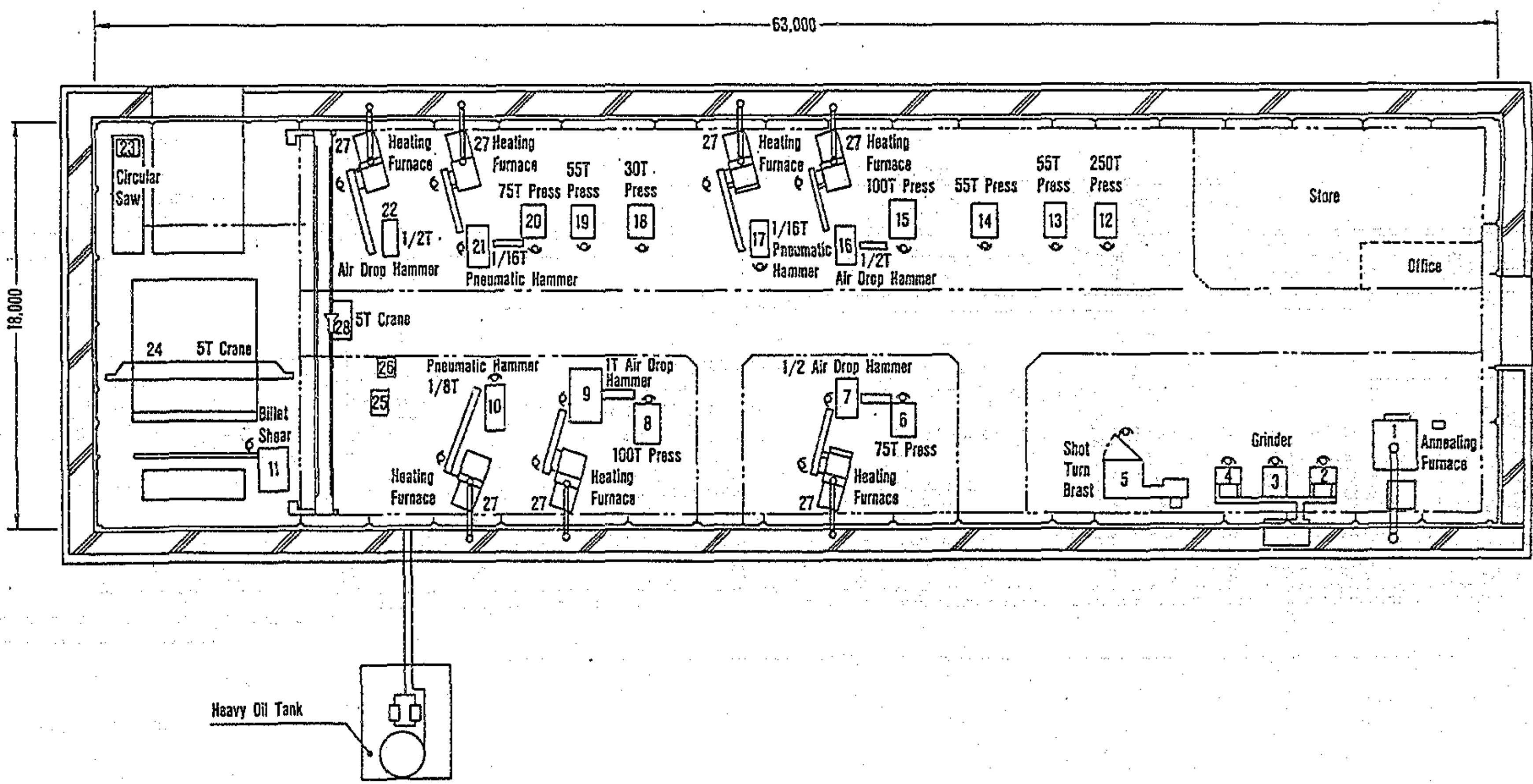


Figure AI-5-3-7 ORGANIZATION OF HAND TOOL FORGING SHOP

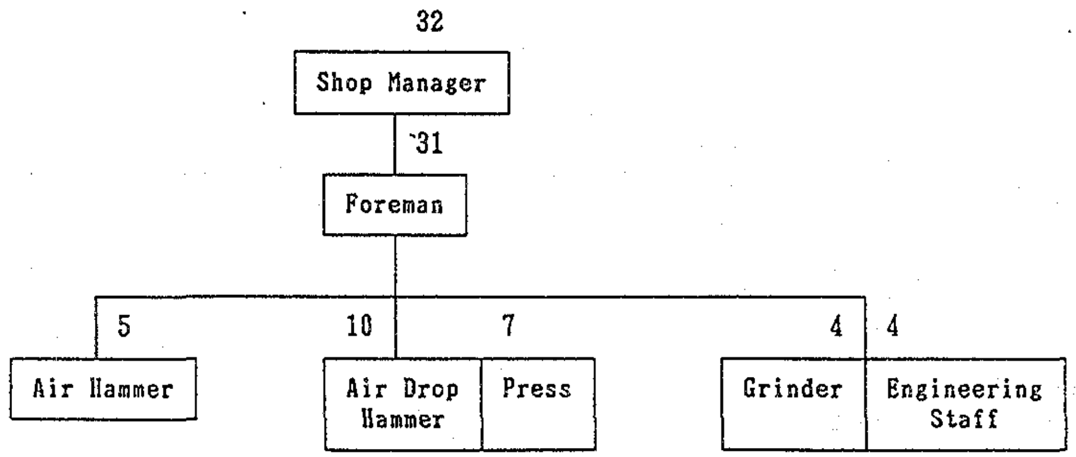


Figure AI-5-3-8 OUTLINE OPERATION PROCESS CHART IN HAND TOOL FORGING SHOP

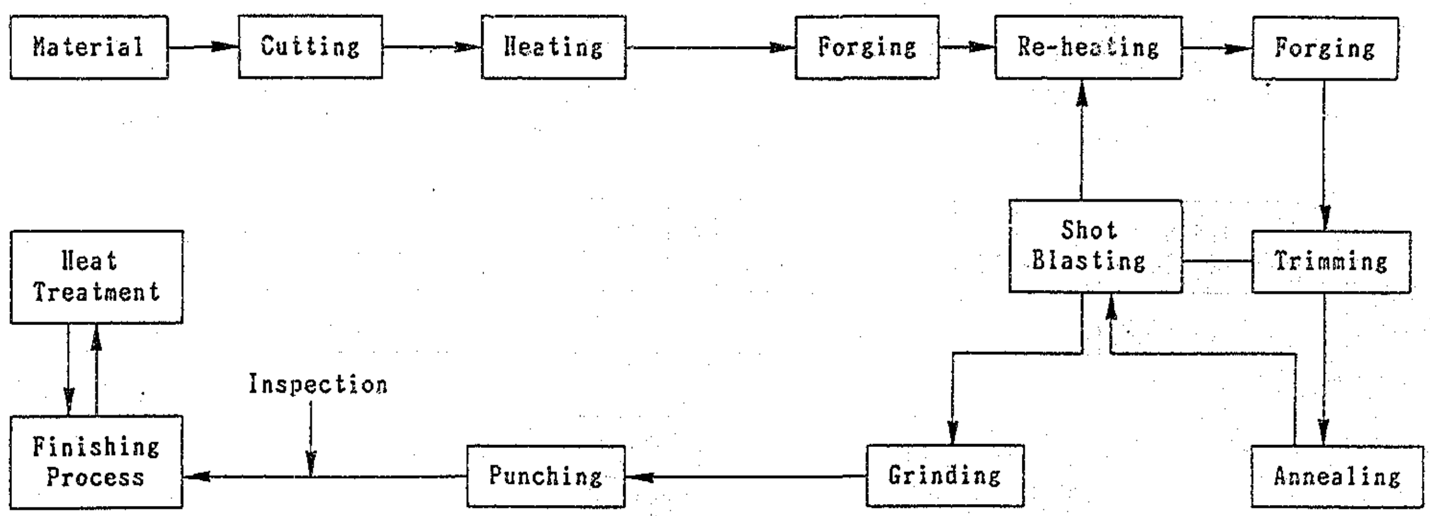


Figure AI-5-3-9 MACHINE LAYOUT AND FLOW CHART OF HAND TOOL FORGING

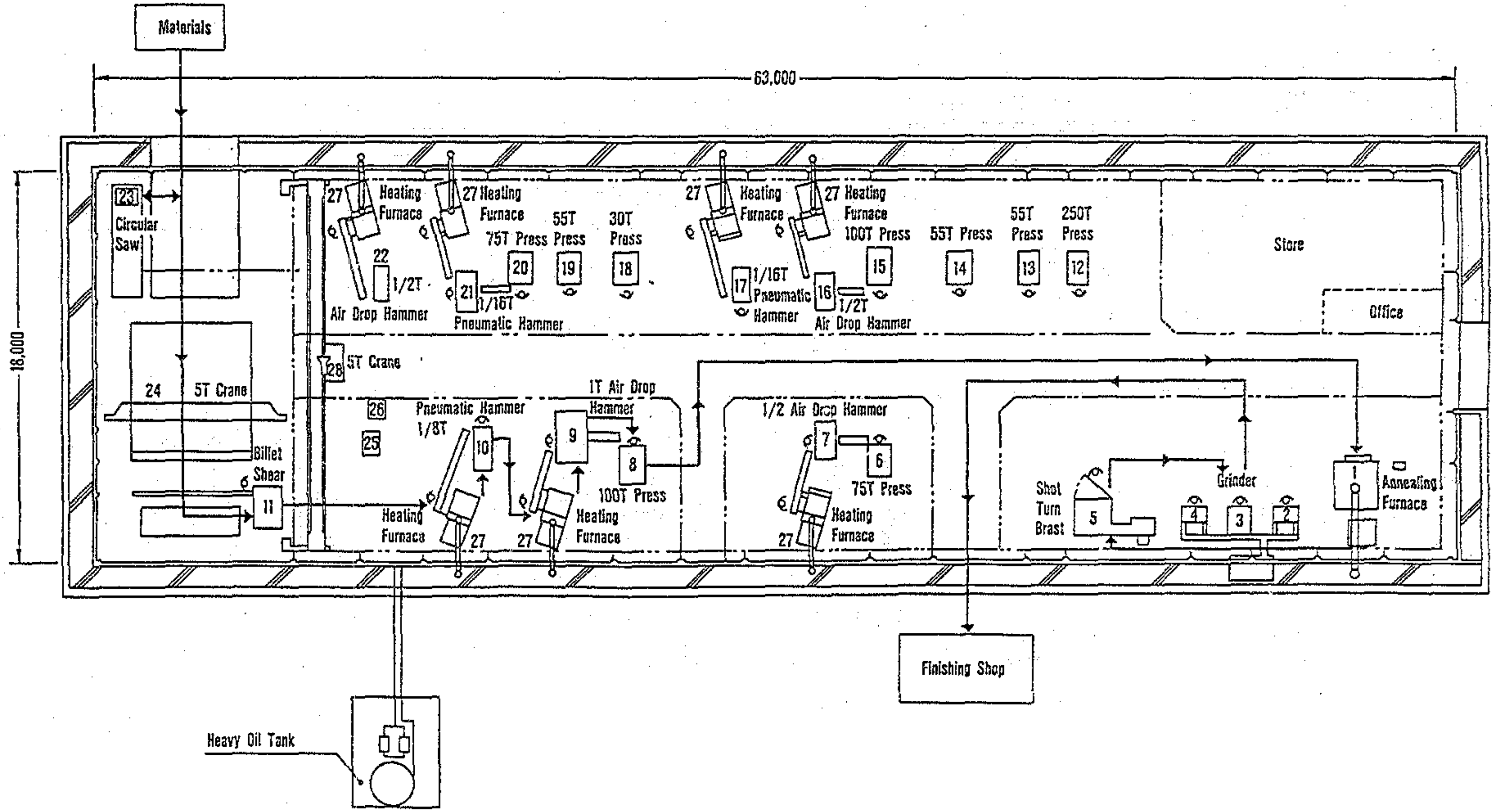


Figure AI-5-3-10 MACHINE LAYOUT PLAN OF MAMOOTIE FORGING SHOP

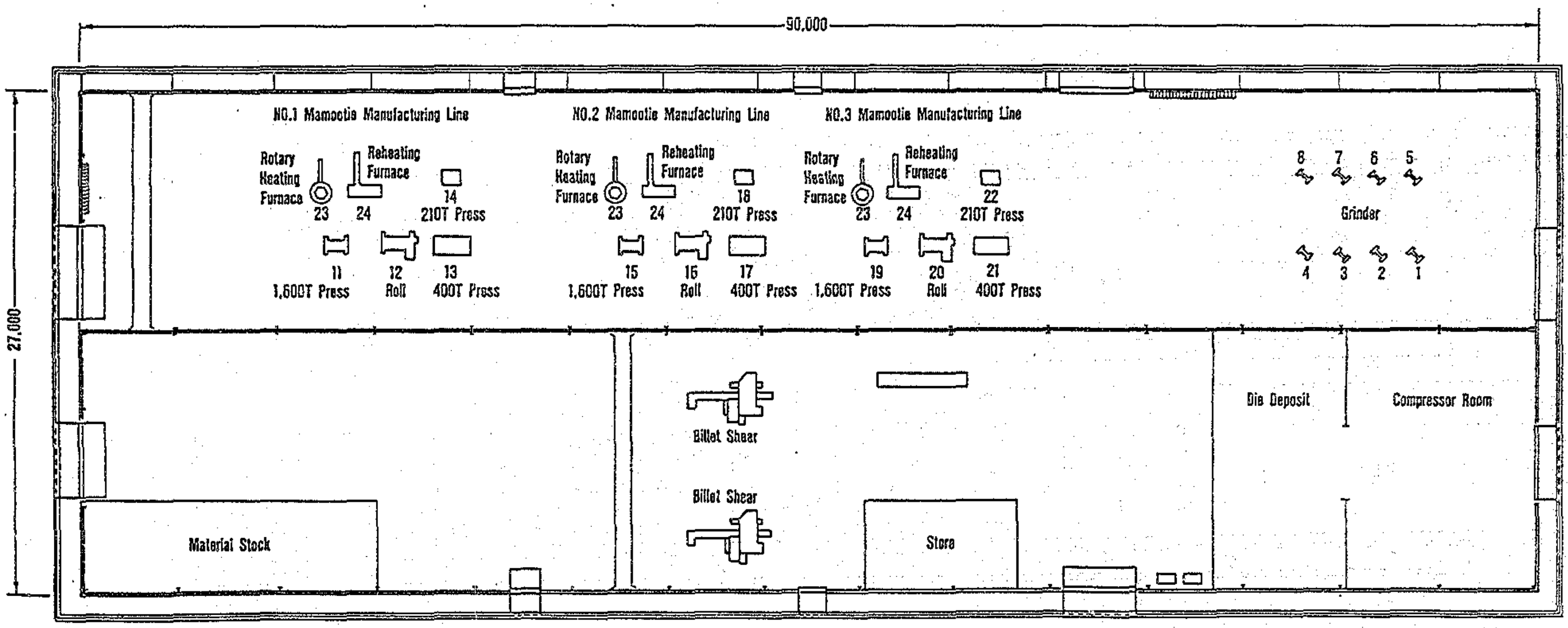


Figure AI-5-3-11 ORGANIZATION OF MAMOOTIE FORGING SHOP

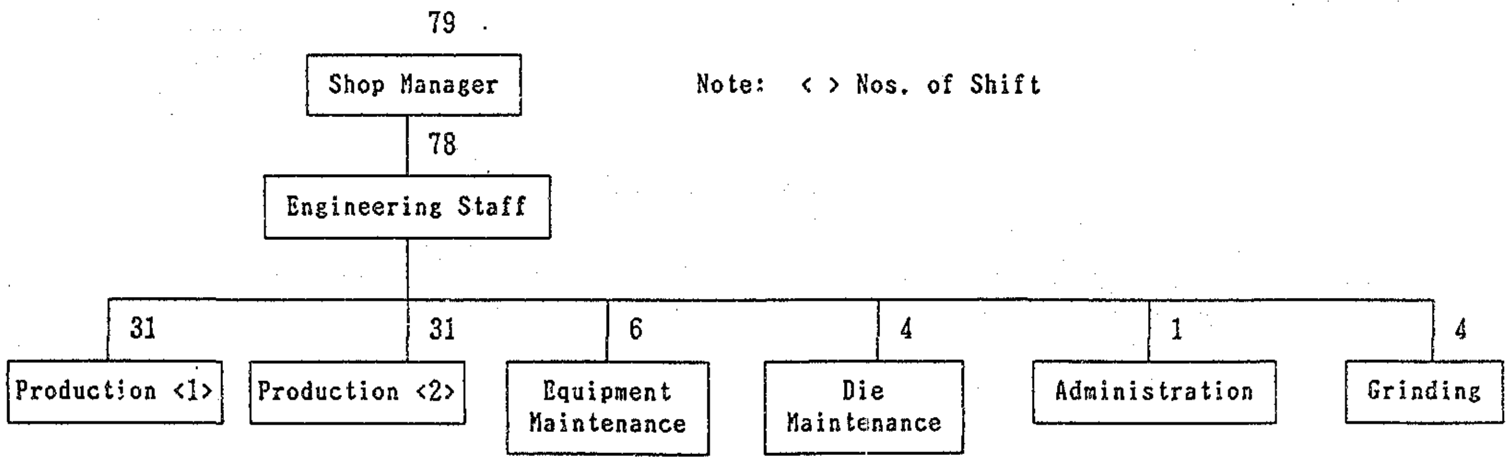


Figure AI-5-3-12 OUTLINE OPERATION PROCESS CHART IN MAMOOTIE FORGING SHOP

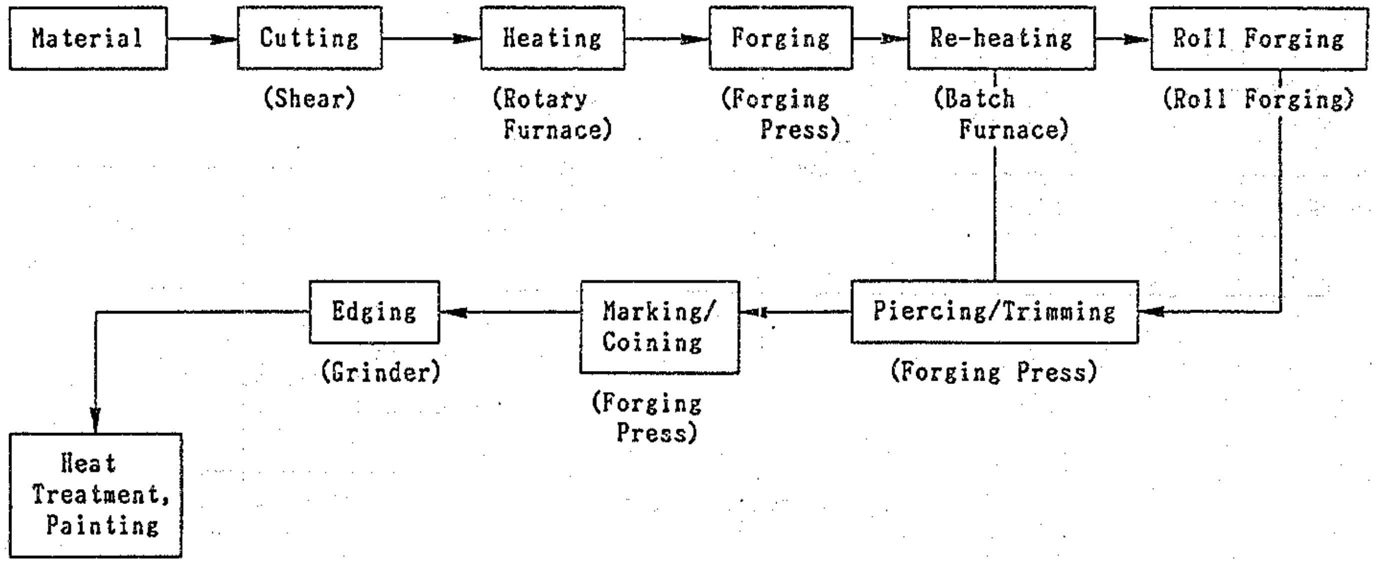
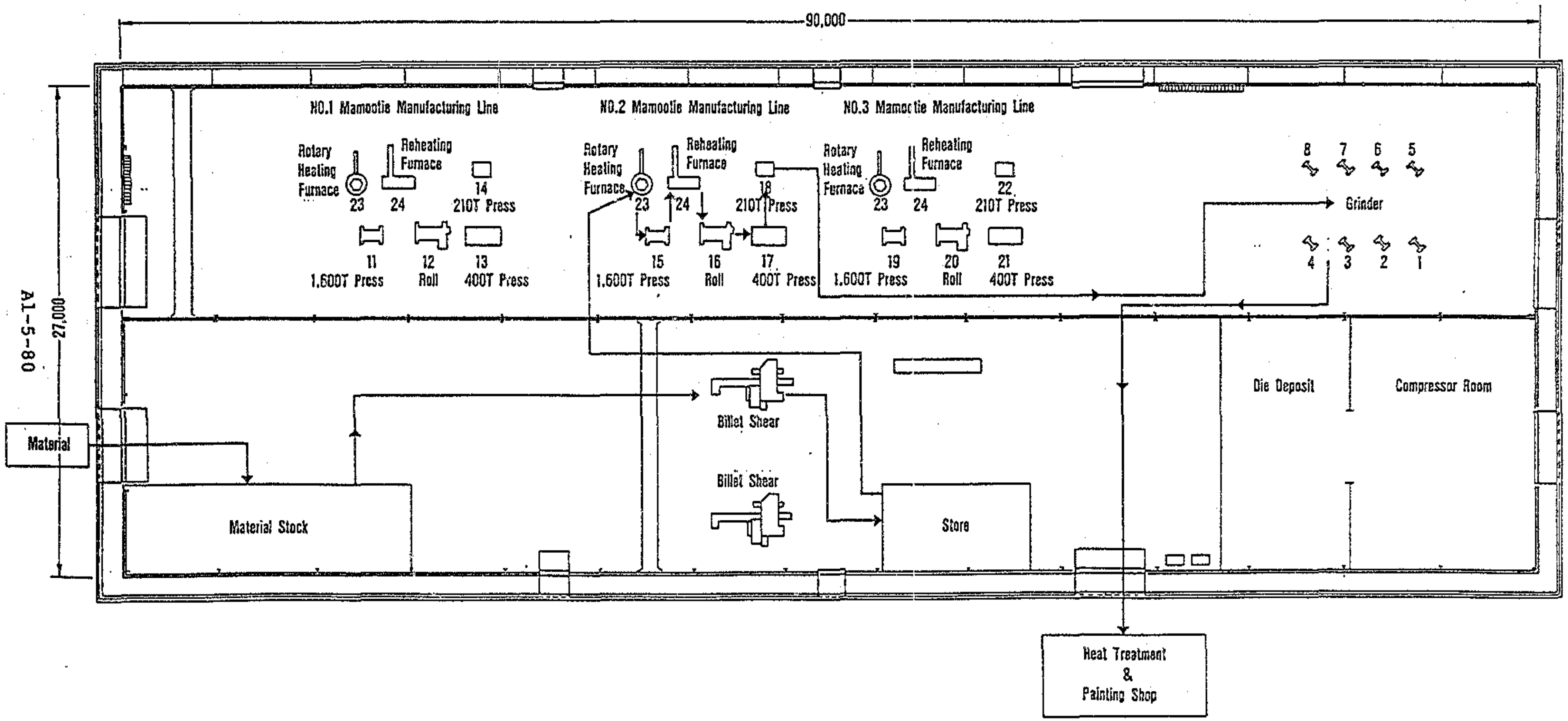


Figure AI-5-3-13 MACHINE LAYOUT AND FLOW CHART OF MAMOOTIE FORGING SHOP



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