3-4 Foundry for Light Alloys, Pistons and Piston Rings

3-4-1 Outline of Processes

(1) Working equipment and its layout

Table AI-3-4-1 and Fig.AI-3-4-1 shows the working equipment and its layout.

(2) Organization and personnel

Table AI-3-4-2 shows the organization and personnel.

3-4-2 Analysis of Production Processes

(1) Outline table of the process analysis

This is shown in Figs.AI-3-4-3 and AI-3-4-4.

(2) Flow chart and process chains

This is shown in Fig.AI-3-4-5

(3) Problems and improvement of operational procedures and process chains for main finished products and parts

 There are trial-and-error operations in adjusting the right mold to the left when arranging the molding tools for piston casting. Changing of the molds is time consuming and loss of materials is great. Conversion to adjustable molds should be considered.

2) Gate cutting on piston

and the second second

As the ingate residue is large cutting has to be continuous and this shortens the life of the cutting device. It is necessary to reexamine the cutting method for the piston gate.

3) The finishing allowance is 2.5 - 3 mm and this shortens the service life of the cutting device. Improvement of the mold precision should be considered.

- 4) The quantity of piston dead head is too great. As the finishing allowance is too large great stress is placed on the processing blade. Materials and energy loss is great. Re-consideration of the metal mold is needed.
- 5) As the insert for the cut ingate is wire gauze it is easily snagged. Conversion from the wire gauze to an iron plate should be considered.
- (4) Problems and improvement of operational procedures and division of labor

Because of the electric situation night working is done but there are work areas where lighting is insufficient. Particularly the lighting for the piston ingate cutting area is poor. The safety cover for the band saw is not completely secured. Increasing lighting equipment and safety measures should be considered.

The throwing away of sand after use in shell molding is a waste of raw materials. Methods for its retrieval should be considered.

(5) Problems and improvements of layout and material handling

Nothing of note.

(6) Problems and improvement of equipment

Molten metal for the piston ring casting is carried by manpower with a ladle to supply to the casting mold.

There is danger of scalding. In order to ensure the safety of operations it is necessary to consider use of an automatic supply system in the future.

3-4-3 Products Quality

(1) Occurrence of rejects due to changing of the casting sand

Rejects due to blowholes occurring at the time of casting sand changing are frequent. These become evident during the various machining processes. Not only this shop but all the shops receiving products from here are affected. It is necessary to investigate the causal relations of casting sand changing and reject occurrence and the economic repercussions of this.

(2) Lack of awareness with regard to occurrence of rejects

When the reject rate is within a 102 margin the causes are not seriously followed up. Further, it is considered sufficient if rejects are melted down and re used. The policy of investigating the origins of rejects must be established and strengthened in the future.

Table AI-3-4-1 - PISTON & PINTON RING FOUNDRY -

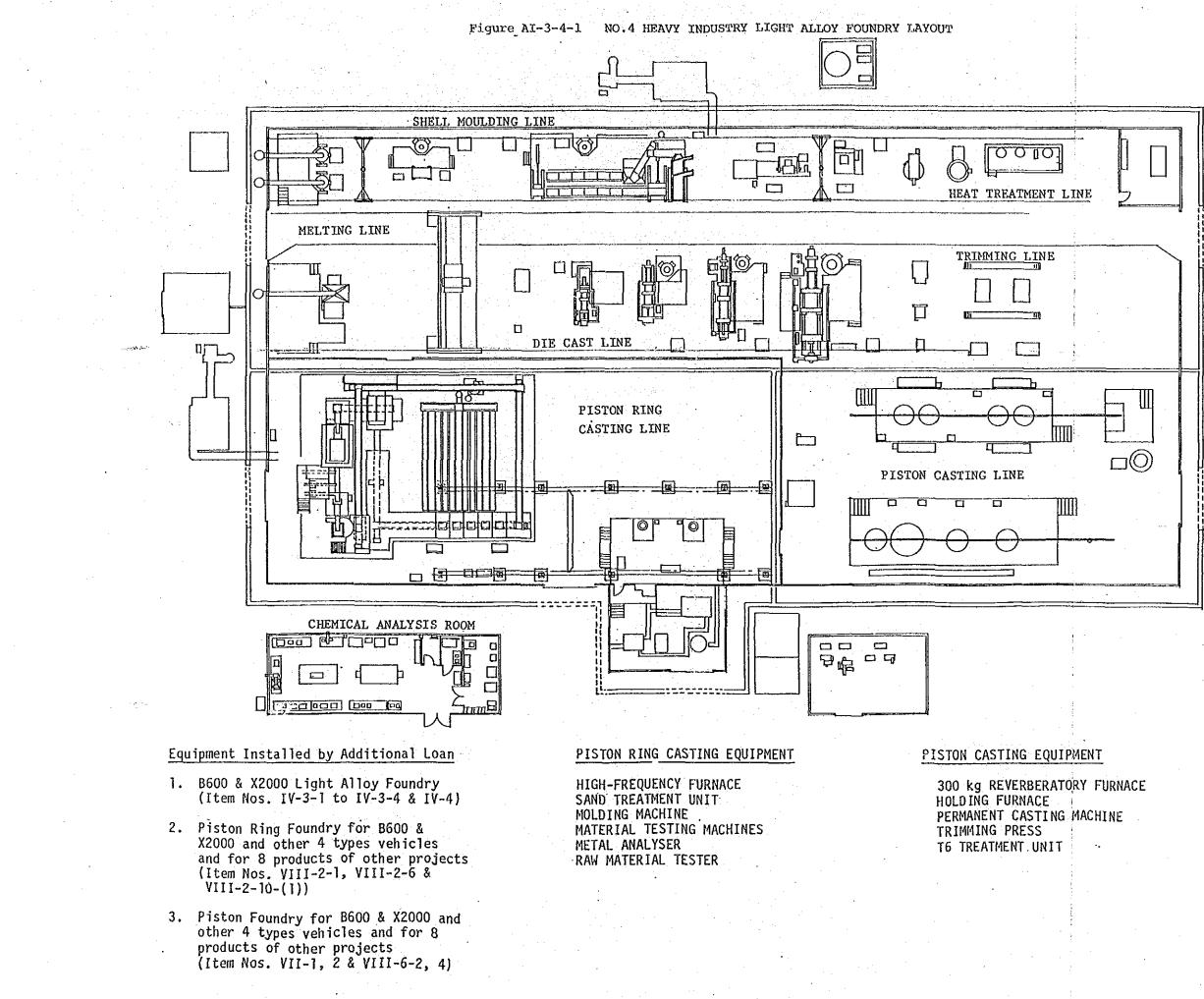
Pist	ton Foundry		
No.	Description	e de volte de la composition de la composition	Q'ty
1	Reverberating Furnace	300kg	1
2	Holding Furnace	200kg	4
- 3	Permanent Molding Machine		4
4	High-speed Hydraulic Press	s 20t	. 1 .
5	Trimming Press		1
6	Ladle Crane	11	1

Piston Heat Treatment System

1	Solidification Treatment Furnace	1
2	Artificial Ageing Furnace	2
3	Quenching Tank	1
4	Mono Rail Hoist	1

Piston Ring Foundry

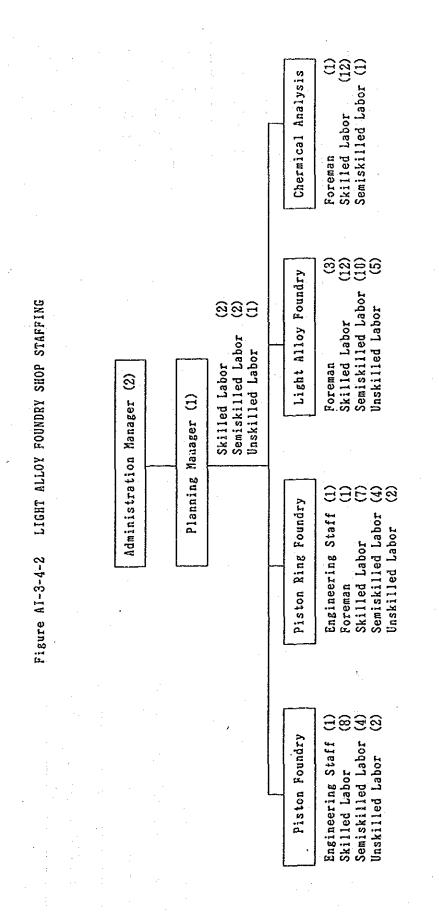
1	High Frequency Induction Furnace	1
2	Semi-automatic Molding Machine	1
3	Moulding Flask	1
4	Hopper	. 1
5	Traverser	1
6	Sand Testing Equipment	1
7	Tumbler	1
8	Semi-automatic Internal Grinder	1
9	Internal Grinder	1
10	External Grinder	1

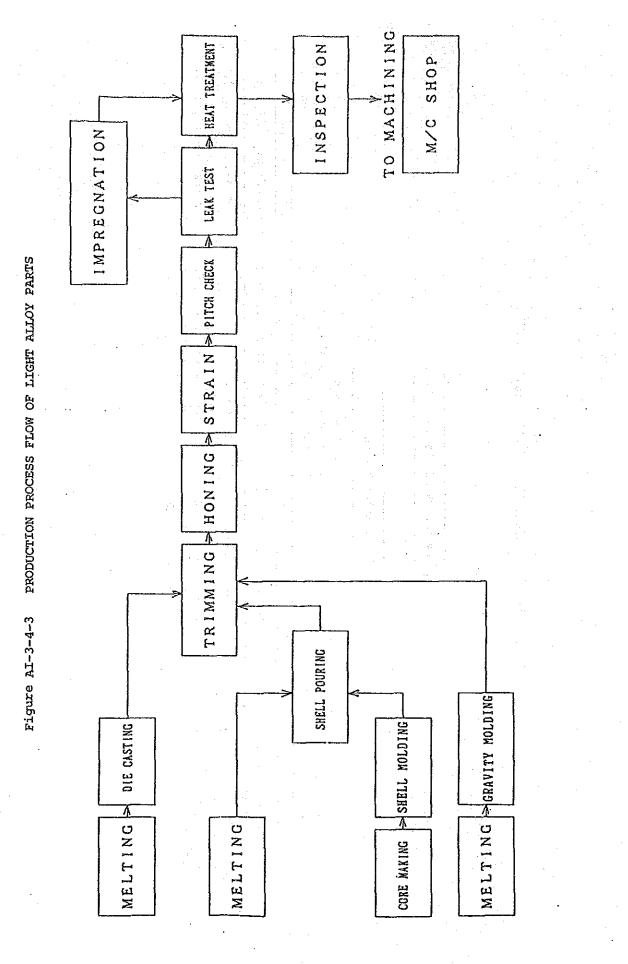


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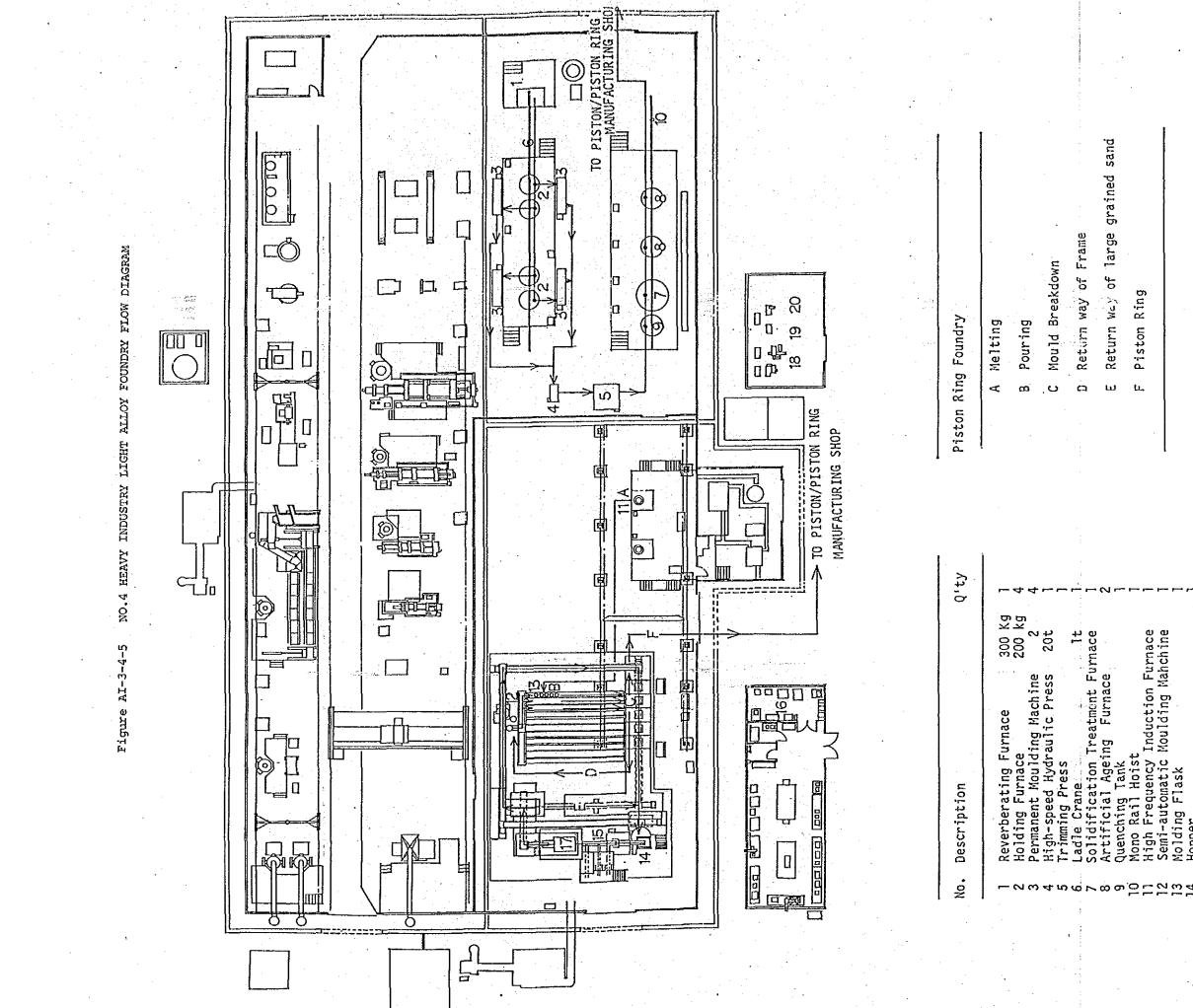


X0.4.71 KANUFACTURE SOTRE SURFACE IXSPECT 10K INSPECTION SURFACE TREATMENT PACETRO INTERALL FINISHED COOR CHAKERING FINISHING GC005 INTERALL FINISHING FIXISHING FINISHED CAP -ALAXING 0000 ¥ SIDE ROUCH GRINDING. - SIDE FINISHING - SETTING - CAN TURNING - CAP CUTTING FINISHING - LLPPING H LUPIKG đ٢ Figure AI-3-4-4 PRODUCTION PROCESS FLOW OF PISTON RING FLIKESHING A MARING TYXEBLAN FLKISHED FIKISHING SIDE CODIS ች 1 CAP FINISHING SLOTTIXC H LIPPING DATIAN Ą CHANFERING - PITT CHAKFÉRING FINISAINC . INTERNAL KARKING 510E PLATING T INTERNAL-FINISHING FINISHER FIXISHING FINISHED CHROKE CAP. 30)5 0000 TO MACHINING SHOP EXTERNAL FINISHING FINISHING CAFERAL - INTERALL EXTERNAL CHANFERING CAP CAP CHROME CHROME CHROME CHROME CHANTERNAL PLATERNAL PLATERNAL CHANTERNAL CHANTERNAL CHROME CHROME CHROME C LAPPING A LAPING Å EXTERNAL CAP CHAMPERING CHANFERING EXTERNAL CAP LANSING INTERNAL T Ţ FINISHING FINISHING FINISHING SLOTTING ZOUCH CALKOING đ NEAT TREATNENT CROCTING STO PLATERING FINISHING CROOVING SUPER ALL TAPER ALL POURING - TUNBLING Y Δ CHANFERING XARXING EXTERNL TEXPORARY NARCING XARCINC XARLING CONPRESSION RING (TLAPER VITH PLATE DIL CONTROL COXFRESSION RING (TAPER) CUMPRESSION RING (FLAT TITH CHROXE) PLATE COXPRESSION RING (FLAT) OIL CONTROL SAND TREATING > NOULDING (KON PLATING) (CHROKE PLATE) REXAUNTING PROCESS NELTING ٨

A1-3-78

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Piston Ring Ц. Traverser Sand Testing Equipment Tumbler Semi-automatic Internal Grinder Internal Grinder External Grinder Hopper 2387755432730987654327

- 3-5 Machine Shop for the Piston and Piston Ring
- 3-5-1 Outline of Processes
- (1) Working equipment and its layout
 - and the second second
 - The working equipment and its layout is shown in Fig.AI-3-5-1
 - Table AI-3-5-1 shows the machine processing equipment for the piston
 - Table AI-3-5-2 shows the machine processing equipment for the piston ring.
- (2) Organization and personnel

Total personnel numbers 94. The Fig.AI-3-5-2 shows the organization and personnel formation.

(3) Supply performance of the raw materials and parts

Table AI-3-5-3 indicates the raw materials and parts together with their supply performance.

(4) Production estimates and performance

Table AI-3-5-4 shows the production estimates and performance. Table AI-3-5-5 indicates the production capacity for the processing of the large piston. Table AI-3-5-6 indicates the analysis of processes for the small piston.

- 3-5-2 Analysis of Production Processing
- (1) Outline analysis of processes

Analysis of processing of the large piston is shown in Fig.AI-3-5-3, and analysis of processing of the large piston is shown in Fig.AI-3-5-4.

The flow chart for the piston and piston ring is as shown in Fig.AI-3-5-5.

- (2) Problems and improvement of the operational procedures and process chains of the main finished products and parts
- The layout of equipment for the machine processing line of the B-600 piston is poor. The equipment is not laid out according to the order of processes. This hinders the flow of products and increases the number of intermediate parts. Walking distances of the operators are long and this decreases production output. The arrangement of equipment should be changed to fit the order of processes.
- 2) The oil holes of the large piston are not appropriate. The six table boring machines require one operator each for operations. This leads to differences in processing time and performance. Flow is interrupted by stations which have a large number of intermediate parts or products on hand. The installation of a new special oil hole processing machine should be considered.
- 3) There are too many working lots. Some processes have exclusive carts others involve carrying by hand by one or two items. This leads to an increase of parts in process and hinders the flow. Possible improvements are as follows:

- change to a send as you make policy

- installation of chute, and abolition of the placing of parts on the floor after stopping of the chute of the necessary parts in process (this is done to adjust the time differences of the various processes).
- 4) As the cutting tools for changing are not at hand the operators must stop equipment if broken or when grinding to fetch replacements. This results in decrease of production output. Operators should ensure that an appropriate quantity of replacements should be at the side of the equipment.
- 5) Since cutting oil is not used during processing of the oil holes the life of cutting tools is short and damage frequent. This can be expected to lead to an increased expense for cutting tools and a reduced productivity. A collection tank should be provided so that cutting oil can be obtained.

- 6) The placing of the piston ring processing machine is poor. Overcrowding and bottlenecks occur and this results in increase of parts in process and wasteful operations. The layout of equipment should be considered.
- 7) As the piston rings are supplied individually their arrangement is time consuming. The use of a chute for the transportation of the piston rings should be considered.
- 8) The chips from the piston processing are all thrown away. As this is wasteful of resources those which are dry should be separated from those wet and re use should be considered.
- (3) Problems and improvement of equipment layout and material handling

The process layout mixes the flow of the inspection and production processes in the piston and piston ring shop and involves wasteful transportation. A change of layout should be considered.

(4) Problems and improvement of working equipment

Rapid falls in the air pressure of the shop occur. As the special machine for piston hole opening will not function at pressures of 3 kg/cm_2 operations cease. The rapid falls in air pressure also cause damage to the cutting tools. An air checking apparatus is needed. Supply capacity with the requirements at present and with an air blow cleaner installed should both be considered.

The use of the piston ring duplex head grindstone is limited and there are no spares in stock. The maintenance of consumable cutting tools is insufficient and should be considered.

3-5-3 The Occurrence of Rejects

 The reject rate for the piston and piston ring are high. There are 5,506 processes per month for the piston. Of these 4,705 are superior and 801 are rejects giving a reject rate of 14.5%.

There are 18,217 piston rings processed per month, and of these 15,272 are superior and 2,945 are rejects. The reject rate is 167. This results in waste of materials and expenses due to re-processing. It is necessary to investigate the causes of the rejects and undertake their prevention.

- (2) Problems and improvement of product quality standards and inspection methods
- As there are no standards for checking lines there is a danger of repeated occurrence of rejects. Standards must be set and implemented and training take place.
- 2) Checking devices on the processing lines of the piston ring were not in evidence. It is necessary to provide these.
- Raw data is collected but this is not analyzed. The use of inspection data is insufficient. Methods of quality control and analysis of data must be carried out and proceeded with actively.
- 4) No documents for standards of the piston ring processing were seen. Standard manuals must be placed at the side of equipment and operations take place in accordance with these.

A1-3-83

 $(\underline{z}, \underline{z}_{i})_{i \in \mathbb{N}}$, we can also show that the second second

Table AI-3-5-1 EQUIPMENT LIST - PISTON MACHINING

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÷ Remarks Deterioration None Damage None ₽°.ty. 200004 é – 20 ----28 Single Purpose Machine-Skirt End and Skirt Inside Single Purpose Machine-Outside Single Purpose Machine-Pin Hole Single Purpose Machine-Ring Grooves Single Purpose Machine-Circlip Grooves Single Purpose Machine-Crown Head Bench Drilling Machine 011 Nole Automatic Drilling Machine Pin Nole Fine Boring Machine Car-Copying Machine Slit Cutting Machine Pin Hole Lapping Machine Mashing Tank Description Total Code **BSAL** BSAL IISAL HSAL HSAL HSAL FBN SHFB IIC-2 LPF 80 DPU NCE ۰, Purpose Machines Category Drilling Machines Machines Single Purpose Special Others

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Table AI-3-5-2 EQUIPMENT LIST - PISTON RING MACHINING -

Remarks Deterioration Confirmed Confirmed Not Confirmed Confirmed Not Confirmed Confirmed Confirmed Confirmed **Confirmed** Confirmed Confirmed Confirmed Confirmed **Confirmed Confirmed** Confirmed Confirmed Confirmed Confirmed Not Confirmed Not (Not | Not Not lot. Not Not Not 10 Not Not Not 0 õt ío: o, 5 -+ 0 lo t <u>s</u>t öt 0 흐 ğ i o 6 <u>6</u> Damage 0° ty ŝ Setting Machine for Cam Lathe Automatic Gap Finishing Machine furning Lathe (External Groove) lutomatic Machine for Keystone Urning Lathe (External Rough) urning Lathe (Internal Rough) Milling Machine for Oil Slot Gap Cut off Machine for Angle Drilling Machine for Notch Automatic Hole Punching Press urning Lathe (Super Finish) Automatic Printing Machine irinder for Gap Adjustment Ring Receiver for Grinder nside Chamfering Machine urning Lathe (Finishing) Lathe (Finishing) External Lapping Machine Rotary Surface Grinder urning Lathe (Taper) Gap Cutting Machine **Bouble Disk Grinder** resetting Machine Double Disk Grinder Cam Turning Lathe Marking Machine Jegreasing Tank Counting Scale **Brying** Oven Description Hand Press Turning Total Code 싎 -----Ы 3933 Ca tegory Grinders **Machines** Milling Purpose Special Lathes M/C's

Table AI-3-5-3 RM AND CP PROCURED

				16	1987					1988	ŧ	Ē
	Apr.	. May	Jun.	Jun. Jul.	Aug.	Sep.	Aug. Sep. Oct. Nov.	Nov.	Dec.	Jan.	Total	lotai Ketarks
liston	5, 060	5,060 5,060	5,060	5,060	5,060	5, 060	5,060	5,060	,060 5,060 5,060 5,060 5,060 5,060 5,060 5,060 5,060 50,000	5,060	50,600	Total of Large and
Piston Ring	27,500	27,500 27,500	27,500	27,500	27,500 27,500 27,500	27,500	27,500	27,500	27,500 27,500 27,500 27,500 275,000	27,500	275,000	SHALL 51205.

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Table AI-3-5-4 SCHEDULED AND ACTUAL PRODUCTION

					÷4	1987					1988	e
		Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	10101
Piston	Scheduled Actual	4, 500 806	4,600 1,500	4,600 2,175	4,600 5,000	4,600 5,000	4,600 5,000	4,600 4,000	4,600 2,776	4,600 3,511	4,600 5,000	46,000 34,762
Piston Ring	Scheduled Actual	25,000 12,987	25,000 15,227	25,000 21,117	25,000	25,000 20,117	25,000 6,582	25,000 24,127	25,000 24,099	25,000 24,405	25,000 19,327	250,000 199,505

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Table AI-3-5-5 PRODUCTION CAPACITY - LARGE SIZED PISTON MACHINING (LINE B) -

Equîpment	HSAL-1	HSAL-1 HSAL-3 HSAL-2	HSAL-2	BD	HSAL-4	FBM	SHFB	SHFB HSAL-5 HSAL-6	HSAL-6
Line Capacity, pcs/min (Machine Time + Human Time)	1.67	1.73	1.61	1.65	1.38	1.41	1.16	0.97	0.81
Production, pcs/day	229	221	237	231	277	273	328	394	472
Production, pcs/month	5,038	4,862	5,225	5,082	6,094	6,006	7,216	8, 568	10,388
Production, pcs/year	60,456	58, 344	58, 344 62, 700	60,984	73,128	73,128 72,072	86, 592	86,592 104,016 124,656	124,656
Production, vehicle/year	15,114	15, 114 14, 586	15,675	15,246	15,246 18,282	18,018 21,648 26,004 31,164	21,648	26,004	31,164

On the Current Layout Bases Used: Working Time = 7.5 hour/day Working Day = 22 Day/Month Operation Rate = 85% .

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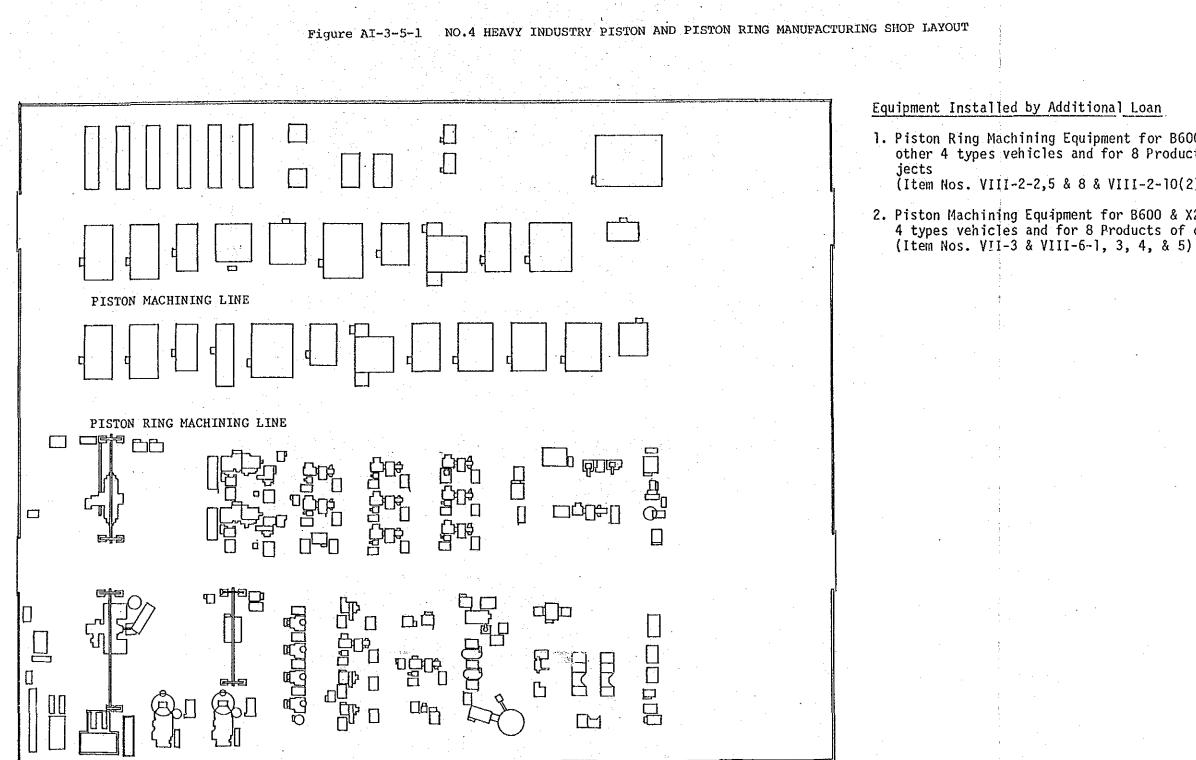
PRODUCTION CAPACITY - SMALL SIZED PISTON MACHINING (LINE A) -Table AI-3-5-6

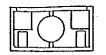
Equipment	1 HSAL	2 HSAL	3 HSAL	4 NC-2	5 DPU	6 FBM	7 MSAL	8 SHFB	9 MSAL
Line Capacity, pcs/min (Machine Time+Human Time)	1.00	1.14	0.96	0.99	0.83	0.84	0.69	0.60	0.48
Production, pcs/day	360	346	375	363	. 433	428	521	600	750
Production, pcs/month	7,920	7,612	8,250	7,986	9,526	9,416	11,462	13,200	16,500
Production, pcs/year	95,040	91,344	99,000	95,760	95,760 114,312 112,992	112,992		137,544 158,400 198,000	198,000
Production, vehicle/year	23,760	22,836 24,750	24,750	23,940	23,940 28,578	28,248	28, 248 34, 386	39,600	49,500

On the Current Layout Bases Used: Working Time = 7.5 hour/day Working Day = 22 Day/Month Operation Rate = 85%

A1-3-89

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Piston Ring Machining Equipment for B600 & X2000 and other 4 types vehicles and for 8 Products of other pro-

(Item Nos. VIII-2-2,5 & 8 & VIII-2-10(2) & VIII-2-11)

2. Piston Machining Equipment for B600 & X2000 and other 4 types vehicles and for 8 Products of other projects

Foreman (1) Skilled Labor (3) Semiskilled Labor (3) Plating Shop 9999 Skilled Labor Semiskilled Labor Unskilled Labor Store Poreman ଷ୍ଟ୍ରତ୍ତ Э Line Manager Engineering Staff (Admin. Staff (Semiskilled Labor (PISTON, PISTON RING SHOP Piston and Piston Ring Shop Piston and Piston Ring Line Shop Manager Foreman (1) Skilled Labor (3) Semiskilled Labor(3) Unskilled Labor (4) Packing -Total 97 Table AI-3-5-2 Engineering Staff (1) Foreman (1) Skilled Labor (22) Semiskilled Labor (4) Unskilled Labor (5) Piston Ring Production 12 25 55 17 25 55 Foreman Skilled Labor Semiskilled Labor Line Nanager Engineering Staff Admin, Staff Shop Manager Engineering Staff (1) Foreman (1) Skilled Labor (16) Semiskilled Labor (8) Unskilled Labor (5) Foreman Skilled Labor () Semiskilled Labor (Unskilled Labor **Piston Production**

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Unskilled Labor

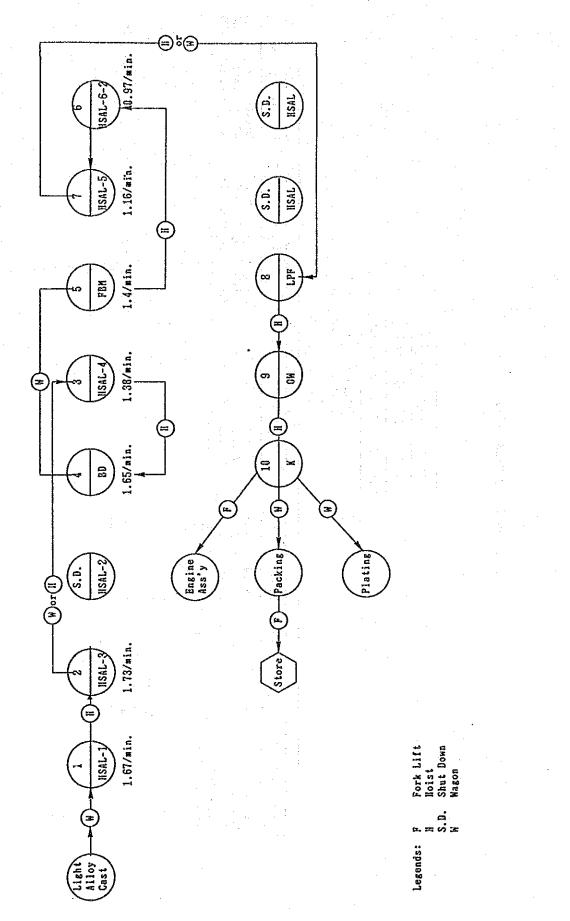
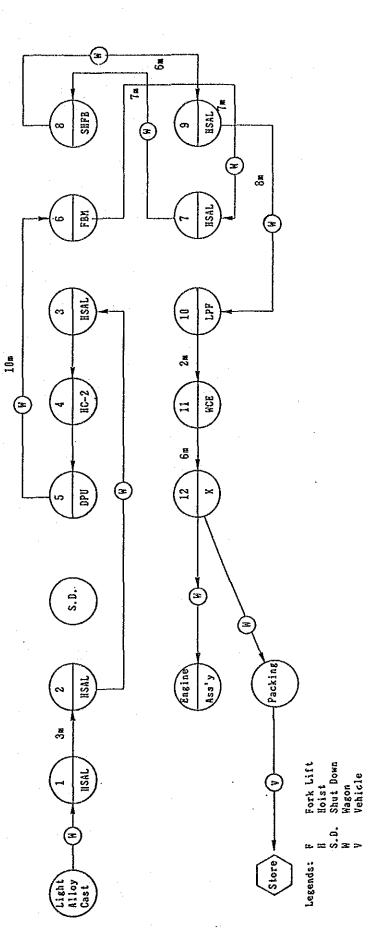


Figure AI-3-5-3 LARGE SIZED PISTON PRODUCTION PROCESS FLOW (B Line)

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Figre A1-3-5-4 SMALL SIZED PISTON PRODUCTION PROCESS FLOW (A Line)

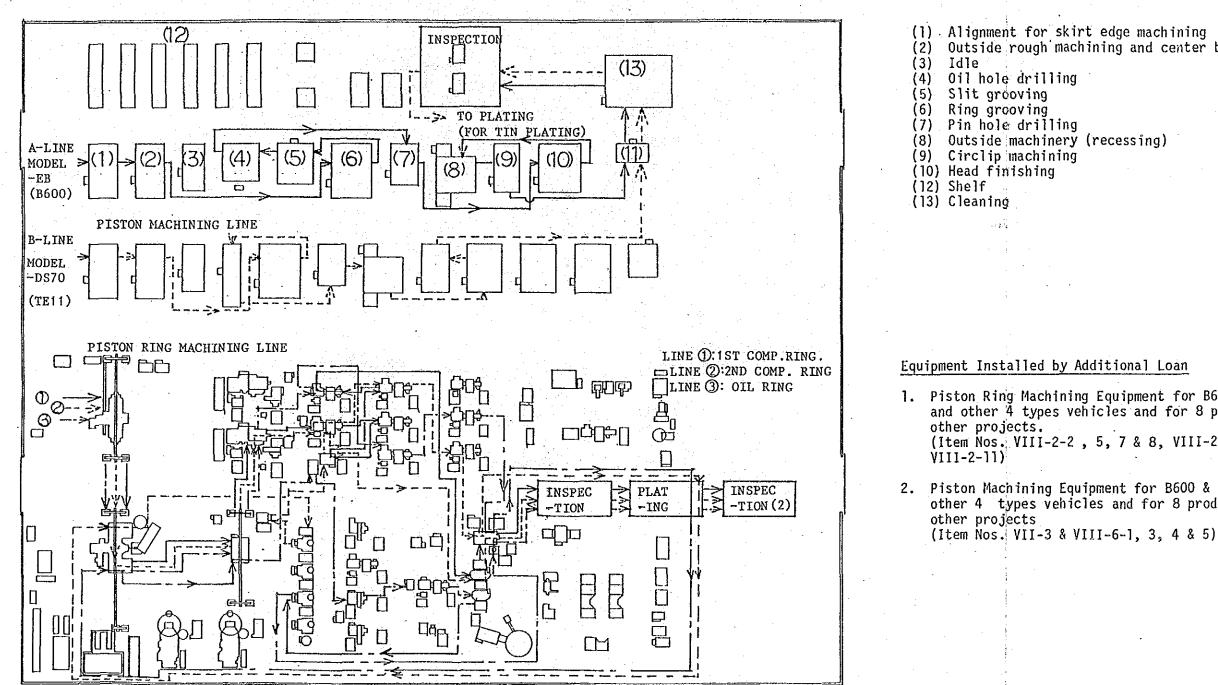


Figure AI-3-5-5 NO.4 HEAVY INDUSTRY PISTON AND PISTON RING MANUFACTURING SHOP FLOW DIAGRAM

(1) Alignment for skirt edge machining(2) Outside rough machining and center boring

1. Piston Ring Machining Equipment for B600 & X2000 and other 4 types vehicles and for 8 products of

(Item Nos. VIII-2-2, 5, 7 & 8, VIII-2-10(2) &

2. Piston Machining Equipment for B600 & X2000 and other 4 types vehicles and for 8 products of

3-6 Machine Shop

3-6-1 Outline of Processes

(1) Working equipment and its layout

Fig.AI-3-6-1 shows the working equipment and its layout. Table AI-3-6-(1)(2) gives a list of the equipment in stock of the machine shop.

(2) Organization and personnel

Shown in Fig.AI-3-6-2.

(3) Raw materials and parts and their supply performance

The supply performance for raw materials and parts is shown in Table AI-3-6-2.

(4) Production performance and capacity

1) Production performance

Production performance is shown in Table AI-3-6-3.

2) Production capacity

The obligation rate for the above production performance is between 19.8% and 76.8%.

As is shown by Tables AI-3-6-4 and AI-3-6-5 if the equipment burden rate is to be leveled out, the highest burden rate is 65.3%. So that one supposes equipment operating rate 85% that is 1.3 times the production of 1987 should be possible.

A1-3-95

3-6-2 Analysis of Production Processing

(1) Outline analysis of processing

Shown in Tables AI-3-6-3 and AI-3-6-4.

(2) Flow chart

The flow chart is as shown in Figs.AI-3-6-5 (1) to (3).

(3) Problems and improvements of operating procedures and process chains

 Screw drilling processing at present involves the connected processes of tapped drilling, tap holding, reamed hole processing and the cutting tools employed in each phase must be changed. This hinders productive efficiency.

The use of a cutting tool with a multiple spindle attachment which would reduce the changing operations should be considered.

- 2) There is only one hoist on the line for the setting and taking off of products, which therefore is done by hand. This causes back strain and lowers efficiency. Increase of hoisting tools or installation of a roller with lifter should be considered.
- 3) As the line is not in series processes are at a distance and carts are used for loading and carrying. It is difficult to have a sense of progressive processing. Conveyance is time consuming and operational efficiency hindered. It is necessary to reconsider layout and strengthen line production system.
- 4) As finished parts are left with chips hanging for a long time these are knocked off from the holes using a bar. This is time consuming. Use of an air hose to knock off chips, etc. should be considered.
- 5) Jigs with guide bush attachment are used for drilling. This causes shaking of the arm which makes aligning difficult. Further the guide bush touches the end of the drill. This causes break damage and wear to both the drill and the guide bush. The jig should be made into a dividing index jig by fixing the arm.
- 6) As the fixing position for the product is low drilling operations are done squatting and this causes back strain. It is necessary to raise the fixing bench.
- 7) The center hole processing for the X-2000 crankshaft is done with a drilling M/C according to a marking-off. As the front and rear sides

are not balanced roughnesses remain. A regular centering machine should be used. Since the precision of the present centering machine can not be guaranteed because of superannuation replacement is necessary.

8) As the chips are all thrown away it is necessary to examine ways to collection and classify these for re use.

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

- The bolts, nuts and pins are processed using a turret lathe. This requires a large number of cutting tools and a large variety of sockets. So the making of one bolt requires more than five minutes and is inefficient. It is necessary to improve the cold header and aim for mass production results through intensive production.
- 2) As the number of processing lots is large this results in a large number of products in process and waiting, and lowers the efficiency and increases transportation steps. Line production system for the main parts should be considered.
- 3) Screw operations for the X-2000 locker cover cap are divided so that brazing is for the car frame and screw cutting for the machinery. Conveyance wastes much time. It is necessary that brazing operations take place in the welding area of the machine shop.
- 4) The blanking operation of the transfer idle gear is done in the No.1 HI after annealing operations in the No.4 HI heat treatment shop have finished. Gear cutting takes place in No.4 HI after this. Waste of time in transportation is great. So it is necessary to perform blanking operations in the No.4 HI.
- (5) Problems and improvements of equipment layout and material handling
- The grinding area is located at the far end of the shop and so the transportation from heat treatment using a fork-lift is bothersome. Further the assembly areas for the engine and transmission are distant. Conveyance involves wasted time. Also damage is done during carriage. This results in increase of products in process. If it is necessary to move grinding near to the processes which require this.

If grinding machines are centralized this should be close to the assembly areas and where transportation is easy.

- 2) Operation loads are concentrated on the No.5 radial boring machine. So there are a large number of cylinder blocks and crank shaft parts in progress near to the two No.5 radial boring machines. This speeds up equipment deterioration and is a cause of equipment breakdowns. The rapid introduction of a multi- purpose machine should be considered.
- 3) There is too much distance between crank shaft processes The approx. distance is 60 m and time loss due to transportation great. The positioning of the main equipment on the crank shaft processing line should be re examined and distanced equipment moved to create a line.
- 4) There are not enough carts. This leads to hand carriage over long distances in some cases. Also transportation wastes time and reduction of productivity results. Increase of the number of carts should be considered.

 $\{i_1, j_2, \dots, j_n\}$

- 5) As there are no placement racks for placing finished products these are placed on the floor temporarily. This results in soiling, scratching, and flawing of products and is tiring for the operators. The installation of racks should be considered.
- 6) The completed individual parts are carried into the store and then sent from their to the assembly shop and this makes the lack of carts worse. Further the store management is complicated. A direct supply route to the assembly shop should be considered.
- 7) There is no direct pathway from the machine shop or engine and transmission assembly shop to the vehicles or car frame shops. Conveyance involves a considerable detour. The creation of a direct route to save transportation time is necessary.
- 8) As the ring gear drive pinion for the B-600 and X-2000 fall apart when these are sent in pieces form the No.1 HI. Further flaws from banging occur. Since they are likely to cause poor fit that result in noise special boxes for placing the set should be made for their transportation.

- (6) Problems and improvements of working equipment
- 27% of the equipment in shop is out of order. Great confusion in the line arrangements results, and special machinery is over burdened. This leads to chain breakdowns. So it is necessary to quickly set up a maintenance system to assure the repair or replacement of deteriorated equipment.

2) It is difficult to obtain spare parts such as electrical repair parts, bearings and seals, so repairs of broken equipment cannot be carried out and parts of the turret lathe, thread rolling machine, boring machine, milling cutter, etc. are taken and used for ad hoc repairs. Substitute machinery for machines which have parts that cannot be produced domestically or which manufacturers no longer produce should be considered.

- 3) The maintenance of jigs is poor and so time is wasted in getting them out. It is necessary to decide on a storage area, indicate jig names clearly, and introduce carts for exclusive use with the jigs. Jig racks should also be installed.
- 4) In order to get the temperature of the heating furnace of the sheet ring of the cylinder head to 100 degrees centigrade requires two hours. Waiting time is long and efficiency poor. introduction of a high performance furnace should be considered. Using a solar system to preheat the water should also be considered.
- 5) As there are no standards for the fitting of jigs the fitting position alters with each changing. There are no standard keys or pins. So the extracting is time consuming. In order to assure that fitting to the same place is achieved meet marks and standard keys and standard bosses must be observed.
- 6) As washing capacity is insufficient the cylinder blocks, cylinder heads, transmission cases, and crank case still have chips attached after washing. Blocking of the oil holes by chips causes seizures when the engine is running. The introduction additional washing devices and air blowers should be considered.
- 7) As the gear cutting machine is an old model processing takes time. If this breaks down obtaining spare parts will be difficult and this may

cause future bottlenecks. Introduction of a more efficient machine should be considered.

- 8) 5 or 6 damaged parts of the formed cutters were thrown behind the machine but there were no thread rolling dies spare parts. Further two broken parts were found left on the rack at the side of the machine. As the particular cutting blades, shaped blades, thread rolling screws, shaping cutters, gear cutters, diamond dressers, and grindstones are difficult to obtain it is necessary to manage them strictly.
- 9) As the checks of equipment precision and jig precision are inadequate they are at present judged by reference to product precision. So it requires time before the actual state of reject occurrence can be grasped and early measures cannot be taken. Preventative maintenance is needed.

4.

- 10) There are about 10 spring balancers kept on the shelves. These are not used, it is necessary to make these usable.
- (7) Problems and improvements of the reception of raw materials and parts The delay of forging products is one problem for the reception of parts. Delay in these forged parts results in delay of the parts of the following process, and this delay in turn results in hindrances to the progress management.

Delayed blank materials and dispatched finished goods are shown in Table AI-3-6-6.

- 1) When the output of completed products (including the 10% reject rate) exceeds the scheduled output the surplus output is stored inside the shop for the following dispatch. The accumulation of the surplus output is one cause of the increase of parts in process. This is linked perhaps to the low awareness of quality control. An examination of the occurrence of rejects and measures for their quick reduction are needed.
- 2) There is no check system of parts delivered. A system for assuring product quality is needed.

3) There are delays in the reception and issuance of parts. However, as causes of these are not investigated the introduction of a system of production management is needed.

3-6-3 Analysis of Product Quality

- (1) The occurrence of rejects
- 1) A reject rate within 10% is treated as acceptable and there is very little quality control training implemented. So it is necessary to introduce quality control.
- 2) The number of rejects increases the further along the process chain one proceeds. In order to avoid reject occurrence products are processed which are outside of the allowable specifications leaving more work for the later processing. Training so that processing is done according to the specifications for each process must be carried out.
- 3) The right and left balance of the X-2000 crank shaft is not maintained during center hole buffing and so the hole is off center. Processing residue leads to rejects. Repair or replacement of the centering machine should be considered.
- 4) There is no special area for rejects. Superior products are marked with a blue paint and rejects with a red but no products marked red were to be seen. Further as there is no special area it is possible that inferior goods will be mixed with superior if the paint rubs off. So it is necessary to set aside an area for rejects.
- (2) Relation with preceding and following processes
- There are a large number of cast and forged parts i.e. the large end of the connecting rod, the outside diameter of the gear parts of B-600 and X-2000, or the outside circumference of the X-2000 cylinder block. When delivered the parts with a large finishing allowance are selected and machined. These operations put a burden on machine processing and lead to early wear of cutting tools. The repair of molds is needed.
- 2) When loose shape cast and forged products are delivered these are classified and on rare occasions sent back. As these are machine

processed for cutting intermittently this causes damage to cutting tools. The repair of molds is needed.

- 3) Forged products with blowholes or with impurities cannot be discovered with external observation alone. When these are discovered during processing the material is disposed of as unusable. The loss due to processing is large. So it is necessary to prevent the entry of foreign bodies through management of raw materials.
- (3) Problems and improvements of quality standards and inspection methods

The following problems can be indicated:

- 1. The operational standards are not clear. Standards are not clearly indicated at the operational areas
- 2. The manual indications for the arrangement of operations are all stored with the person in charge of the line but these are not indicated at individual sections where operations take place.
- 3. The system of self checking is not regulated. There are plate gauges at processing points. There is no ruling as the check period or check records.
- 4. On the spot inspection by the inspectors is only done on request of the line. However, 5 continuous inspections are implemented at the line's request during changing of arrangements.
- 5. Due to lack of all checking instruments at present checks are performed by attaching standard blocks to the products and centering and measurements are taken with
- There are devices to compare the positioning of bulb sheets, but it seems that these have not been used.
- 7. Regular checking of inspection instruments does not take place.
 - 8. There is a shortage of inspection records and analysis reports.

The above are all defects of the inspection system. These should be promptly remedied and the inspection system organized.

3-6-4 Production Equipment and Maintenance

There is a general maintenance system for No.4 HI. This however is well below the level actually required by the individual shops. For example simple breakdowns such as detached springs on the radial drilling machine of the machine shop are left unrepaired and so the machine is stopped. The broken machines cause confusion to processing arrangements and over burden specialist equipment, thus creating a vicious circle. Repair parts are used and produced by the line equipment. This hinders the actual production of the line. So it is necessary to set up a system in No.4 HI whereby a maintenance shop is installed and with maintenance personnel being stationed at the level of the individual shops.

Category	Code	Description	Qt'y	Qt'y Out of Service	ut'y Deteriorated غور (۳)	ut'y Deter riorated in	
			(¥)	(8)	(C)	(D)	
	41 61	4° Lathe 6° Lathe	10	\$4	ເດີ		Parts Used for Other Machines
Ē	81. 171	8' Lathe No.1 Turret Lathe	16 5	5	5	9	2, Nos. Being Repaired in No.5
l uranıng Machines	31L	No.3 Turret Lathe	42	14	12	2	
	4TL 5TL	No.4 Turret Lathe No.5 Turret Lathe	11 %	en A	~		
	4COL 7COL	4° Profiling Lathe 7° Profiling Lathe	Q) (2)	च्न्न भ्य	1		Parts Used for Other Machines
Milling Machines	2PN 2VN 4VN DSN SLN	No.2 Plain Milling Machine No.2 Vertical Milling Machine No.4 Vertical Milling Machine Dual Boad Milling Machine Spline Milling Machine	85195 1	en e	ç	7	
Drilling Machines	300 300 300 300 300 300 300 300 300 300	Bench Drilling Machine No.3 Upright Drilling Machine No.4 Upright Drilling Machine Centering Machine No.3 Multi-Spindle Drilling MC No.5 Radial Drilling Machine No.5 Radial Drilling Machine	00000008	~~~~~	on است است م		Parts Used for Other Machines
	ЦТР	Tapping Machine	9	e	3		Parts Used for Other Machines
Grinders	306 506 316 2856	Cylindrical Grinder Cylindrical Grinder Internal Grinder Face Grindiag Machine Centerless Grindiag Machine	n⊢ n n n	87	8		
	RNF CMG SCG	Honing Machine Cam Grinder Centerless Grinding Machine	1 69 - 1 - 1	-	1	. .	

Table AI-3-6-1(1) EQUIPMENT LIST - LV MACHINE SHOP

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A1-3-104

		Table AI-3-6-1(2)		IUI PMENT LIST	EQUIPHENT LIST - LV MACHINE SHOP		
Category	Code	Description	0 t'y (A)	01'y Out of Service (B)	Qt'y Deteriorated in (B) (C)	<pre>dt'y Dete- riorated in Operation (D)</pre>	Remarks
Gear Cutting and Finishing Machines	HGS 4GS VNGS RNGS SGS TGS	Gear Hobbing Machine Gear Shaping Machine Gaar Tooth Chamfering Machine Gear Tooth Chamfering Machine Gear Shaving Machine Gear Tester	~~~~	und und	F		
0 thers	272 2712 2712 2712 2712 712 712 01 415	Roll Forming Machine Balancing Machine Roll Forming Machine Roll Forming Machine Broaching Machine Oil Groove Cutter Saming Machine	~~~~~~		prod prod	-	Parts Used for Other Machines Power is Insufficient.
	C M MGK B R K H B R C C M C C M M C K H B R C C M M C C M M C K H B R C C M M C M C C M M C C M M C C M M C M C C M M C C M M C C M M C M C C M M C M C C M M C M	Meating Furnace Merizontal Drilling Machine Gear Tooth Chamfering Machine Mydraulic Press Magnetic Flaw Detector Cutting Tool Grinding Machine Mashing Tank Gas Welder Engine Tester		7 7	P-4	1	Vacuum Bulb is Missing.
Simple Purpose Machines	MHFB s SPU HBPU VBPU	Fine Drill Combined Unit Horizontal Drilling Unit Upright Drilling Unit	P-90-	1 2	2		Lube Oil Pump Failure Drilling Oil Trouble
		Total	275	61	47	14	

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A1-3-105

Table AI-3-6-2 PROCUREMENT RECORD OF CP (ENGINE COMPLETE)

-						1987					1988	e	
Tapou	•	Apr	Apr Nay	Jun	Jul	Aug	Sep	£	Oct Nov	Dec	lan	16101	Kerarks
B600	for Vehicle for Repair Parts	33 110	55 110	55	- 66	66 110	55 110	55 110	- 22	55 55	55 55	550 605	
X2000	for Vehicle for Repair Parts	55	66 55	88 165	66 165	66 55	77 55	77 55	77 165	67 110	67 88	705 968	

Table AI-3-6-3 SCHEDULED AND ACTUAL PRODUCTION (ENGINE COMPLETE)

						1987					1988	÷
		Åpr	May	Jun	Jul	Åug	Sep	Oct	Nov	Dec	Jan	10101
B600		130	150	50	60	160	150	50	50	50	100	950
	Actual	12	64	37	92	62	111	101	76	108	83	752
X2000	X2000 Scheduled	101	112	233	213	113	123	123	122	163	148	1,451
	Actual	34	41	39	48	74	23	30	26	37	31	115

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Table AI-3-6-4 MACHINES WITH HIGHER LOAD

No.	No. Code	Descriprion	Load, X	Remarks	
	4L	4' Lathe	76.8	50% Loaded when Shared by 6'	Lath
~	NGS	Gear Robbing Machine	72.4	65% Loaded when Shared by 46S	S
ო		Gear Shaving Machine			÷
4	3UD	No.3 Upright Drilling Machine	65.2	52% Loaded when Shared by 40D	00
ഗ		No.5 Turret Lathe		•	
ى		No.2 Vertical Milling Machine			
r-		Gear Shaping Machine			
ω		Spline Milling Machine			
თ		No.2 Plain Milling Machine			
2		No.5 Radial Drilling Machine			

Note: Loads on No.1, 2 and 4 are possibly shared by 6L, 4GS and 4UD, respectively.

Equipment	Qt'y in Operation (Unit)	Total Time of Loading (hr.)	Opratin Rate (%)
No.1 Turret Lathe	7	4,373	37.9
No.3 Turret Lathe	36	25,380	42.7
No.4 Turret Lathe	10	8,017	48,5
No.5 Turret Lathe	2	1,921	58.2
4' Lathe	5	6,338	76.8
6' Lathe	13	8,611	40.1
8' Lathe	3	1,798	36.3
No.2 Plain Milling Machine	12	10.378	52.4
No.2 Upright Milling Machine	6	5,734	57.9
No.4 Upright Milling Machine	1	690	41.8
Bench Drilling Machine	8	2,620	19.8
No.3 Upright Drilling Machine	. 8	8,602	65.2
No.4 Upright Drilling Machine	5	2,597	31.4
No.3 Multi-Spindle Drilling M/C	4	2,468	37.4
Radial Drilling Muchine	8	6,674	50.5
7' Profiling Lath?	2	1,660	50.3
Spline Milling Machine	2	1,802	57.6
Gear Hobbing Machine	1	1,195	72.4
Gear Shaping Machine	2	1,190	57.9
Gear Tooth Chamfering Machine	1	429	26.0
Upright Tooth Chamfering M/C	1	631	38.2
Gear Shaving Machine	1	1,078	65.3
Face Grinding Machine	2	1,450	43.9
Note: Basis of Calculation			·
Working Time 7.5 H/D Working Day 22 Ds/M Actual Production for 10	Months, Ap	r.,1987 - Ja	n.,1988
Production			
B600			
Engine and Transmission	Complete f	or Vehicle =	400 Uni
Engine Complete for Spar	e Parts = 3	352 Units	
X2000			
AZUUU Engine and Transmission Engine Complete for Spar	Complete f	or Vehicle =	187 Uni

Table AI-3-6-5 OPERATING RATE OF EQUIPMENT FOR B600 AND X2000 ENGINE AND TRANSMISSION

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A1-3-109

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· · ·	Table AI-3-6-6 CP IN DELAY AS OF FEB.	OF SUPPLY, THE WORST FIVE, 16, 1988
		(Unit: pc
Vehicle	Component Parts	Qt'y in Origin of Dispatch Delay
Materials	s Supplies in Delay	
B600	Connecting Rod	440 No.3 HI
	Universal Joint	660 No.3 HI
	Clamp	880 No.3 HI
	Arm Shaft Upper	440 No.3 HI
	Main Drive Gear	220 No.3 HI
X2000	Connecting	880 No.3 HI
	Sliding Joint, Inter	440 No.3 HI
	Yoke	440 No.3 HI
	Nuckle Spindle, Front	440 No.3 HI
	Universal Joint Yoke	880 No.3 HI
Component	t Parts Supplies in Delay to	Ass'y Shop
B600	Connecting Rod	100 No.3 HI
	Reverse Gear	70 No.4 HI Machine Shop
	Cylinder Head	40 No.4 HI Machine Shop
	Valve Guide	120 No.4 HI Machine Shop
	Crank Case	60 No.4 HI Machine Shop
X2000	Cylinder Block	99 No.4 HI Machine Shop
	Tappet Follower	139 No.1 HI
	Counter Shaft	139 No.1 HI
	ldle Gear Transfer	98 No.4 KI Machine Shop
	Rocker Arm Cover Ass'y	139 No.4 HI Body Ass'y Shop

Table AI-3-6-6 CP IN DELAY OF SUPPLY, THE WORST FIVE, AS OF FEB. 16, 1988

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and the state of the

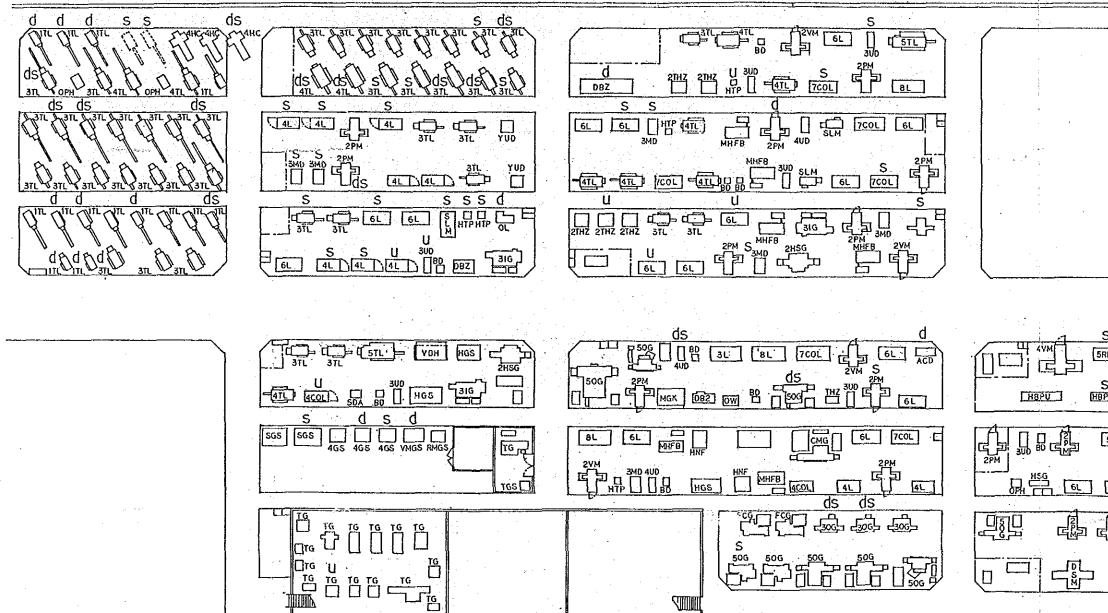


Figure AI-3-6-1 NO.4 HEAVY INDUSTRY LAYOUT OF MACHINE SHOP

s: Out of Serviced: Deterioratedu: Unable to Repair

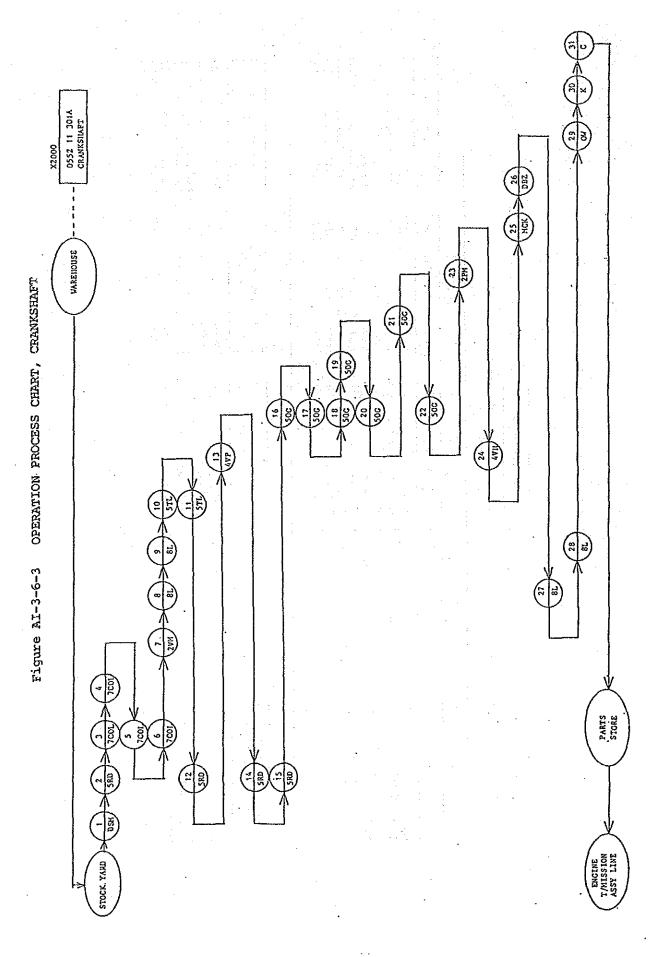
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<u>S</u>
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Al-3-111

999<u>3</u>9999 966686 Material Planning Engineering Staff Admin. Staff Foreman Skilled Labor Semiskilled Labor Unskilled Labor Semiskilled Labor Unskilled Labor Total Engine Shop Foreman Skilled Labor Manager Manager Total Gear. M/T and Axle Shop ତ୍ତଚ୍ଚତ୍ତ୍ର Production and Tech. Planning Skilled Labor Semiskilled Labor Unskilled Labor Engineering Staff Admin, Staff Foreman Foreman Skilled Labor Semiskilled Labor Unskilled Labor Total Manager Manager Total Shop Manager (1) Figure AI-3-6-2 MACHINE SHOP STAFFING 3838<u>8</u> 9999<u>8</u>995 . Administrative and Skilled Labor Semiskilled Labor Unskilled Labor Total Managemen t Machine Shop Engineering Staff Foreman Unskilled Labor Total C. Shop Admin. Staff Admin. Staff Foreman Manager Manager Foreman Skilled Labor Semiskilled Labor Unskilled Labor , Shop Admin. Staff Manager Total <u> ତ୍ରେକ୍ଟର୍</u>ଟ୍ରର୍ଚ୍ଚ Welding, Grinding, Die & Jig Shop Foreman Skilled Labor Semiskilled Labor Unskilled Labor Total Semiskilled Labor A. Shop Unskilled Labor Total Skilled Labor Manager Admin, Staff Admin. Staff. Forenan Manager

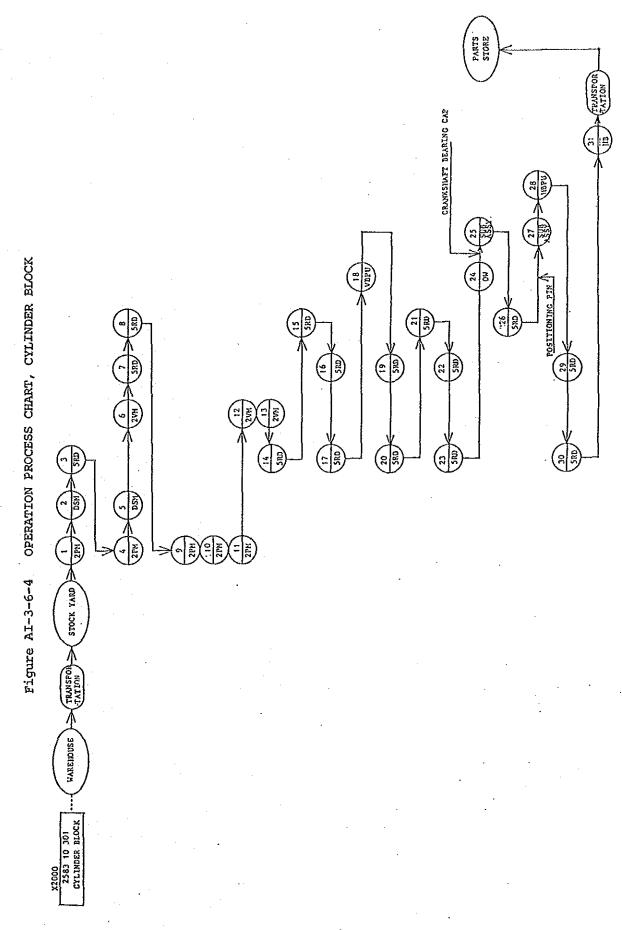
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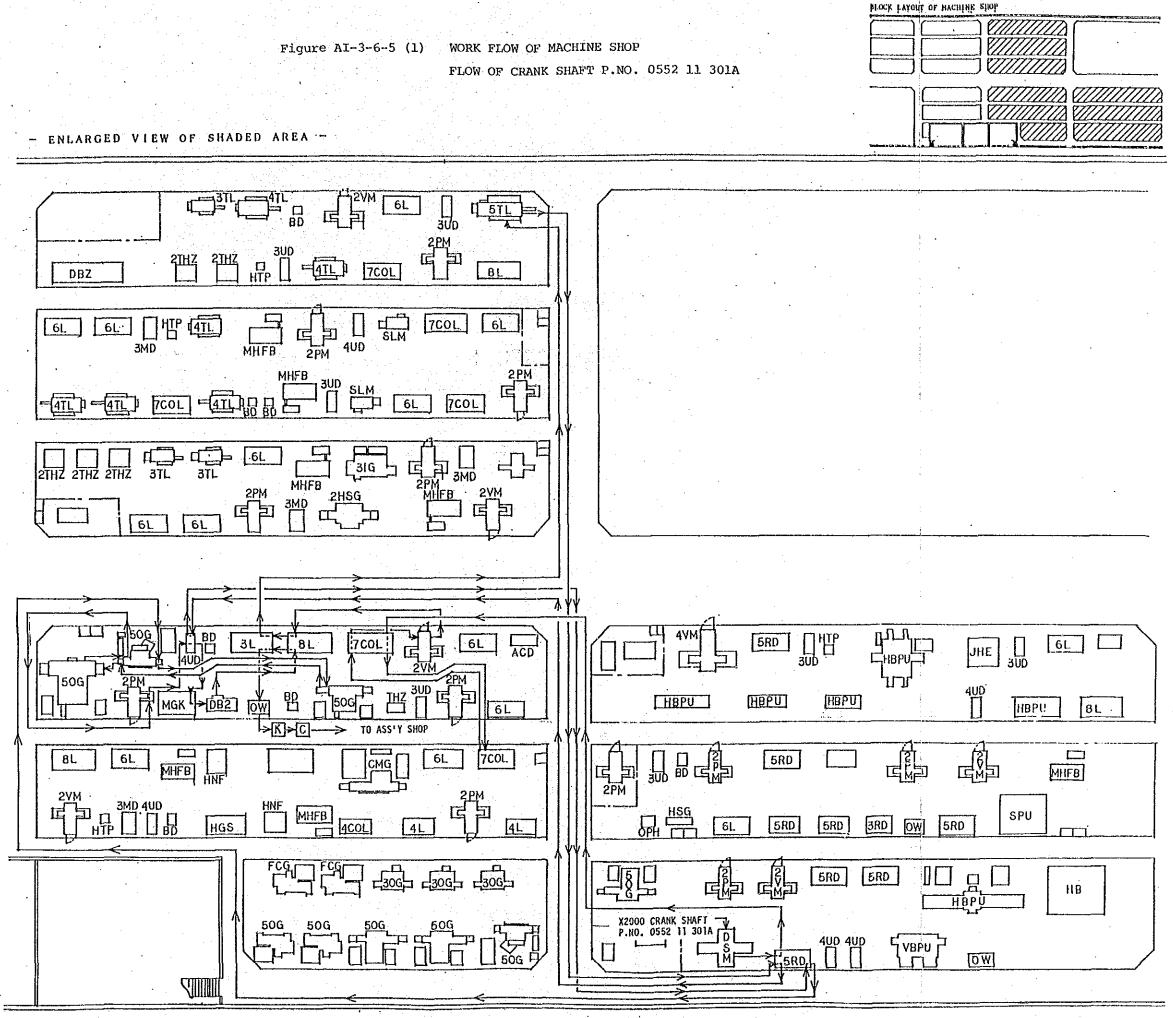


A1-3-113

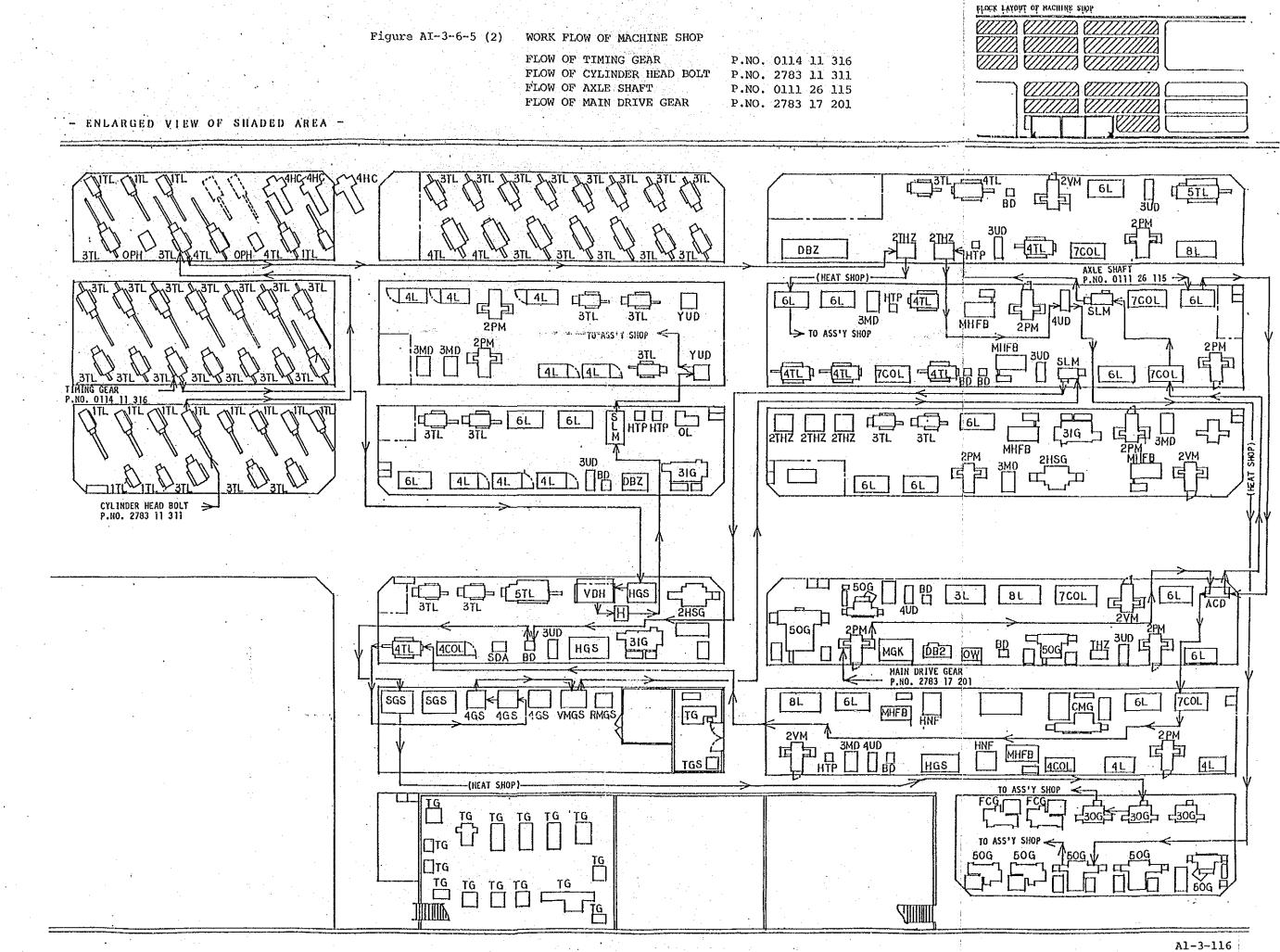
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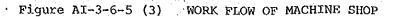


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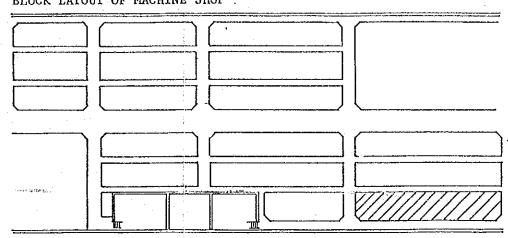
Al-3-115



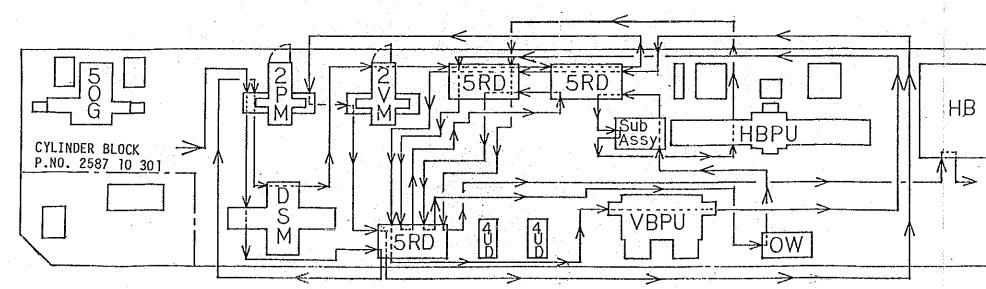


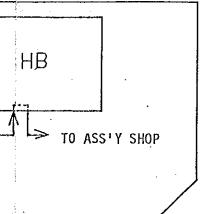
FLOW OF CYLINDER BLOCK P.NO. 2587 10 301

BLOCK LAYOUT OF MACHINE SHOP .



- ENLARGED VIEW OF SHADED AREA -





3-7 Heat Treatment Shop

3-7-1 Outline of Processes

(1) Working equipment and its layout

Fig.AI-3-7-1 shows the equipment and its layout. Tables AI-3-7-1 (1) to (3) show the equipment.

(2) Organization and personnel

Fig.AI-3-7-2 shows the organization and personnel

3-7-2 Analysis of Processing

and the state of the

(1) Outline analysis of processing

Tables AI-3-7-2 (1) and (2) together with Fig.AI-3-7-3 outline the process analysis for the main parts

The following processes can be done in this shop:

- 1. gas carburizing
- 2. bright quenching
- 3. bright tempering
- 4. water quenching
- 5. press quenching
- 6. refining
- 7. selective tempering
- 8. annealing
- 9. liquid carburizing
- 10. lubricating

(2) Problems and improvement of operational procedures and process chains Nothing of note

(3) Problems and improvements of operational methods and division of labor Nothing of note.

- (4) Problems and improvements of the layout and material handling of equipment
- As carts are scarce transportation of products between processes is done by hand. This results in wasted time. It is necessary to consider the introduction of a product bench with an attached roller and of flat palettes and pallet trucks.
- As the number of product benches is limited piling on the floor occurs. Time is wasted through moving piles. Increase of the carts should be considered.

(5) Problems and improvements of working equipment

The following problems with working equipment can be indicated (Refer to Fig.AI-3-7-4)

化过敏 医二氏结核病素 机械机

- The dust collector duct of the salt furnace is deteriorated resulting in poor collecting performance. This will affect the human operators if left unresolved and it is necessary to repair or replace this promptly.
- Because of the under capacity of the shot blast there is not enough capacity to handle the large items. Operations are spread over a number of times. It is necessary to increase the shot blast equipment.
- As the cyanic drainage is out of order salt bath carburizing treatment cannot be done and operations are done with gas carburizing instead. But the load for gas carburizing has increased. Repair is required promptly.
- 4) Salt does not dissolve at specified temperatures so a low temperature tempering furnace is used instead. The load for this is very heavy, and tempering is time consuming. It is necessary to increase the temperature of the salt bath regularly in order to prevent interior clumping.
- 5) Management of cyanic is poor, and open cyanic cans are left lying about. This is a fatally toxic substance. Provision of a store room should be considered.

- 6) Diesel oil is used as fuel. But the supply of the diesel oil used for both the boiler and the salt bath is difficult. Change of the heat source should be considered.
- 7) As the high speed cutting machine is out of order hardness testing is not possible by cutting. This must be promptly repaired.

Table A1~3-7-1 (1) EQUIPMENT LIST OF HEAT TREATMENT SHOP

7-reduction Facility 1 Sector Facility 1 1 Reinformed 2 Degreating Math Tank 1 8 1 Sector 1 Sector 1 Sector 1 8 1 Sector 1 Sector 1 Sector 1 9 1 Sector 1 Sector 1 Sector 1 10 1 Sector 1 Sector 1 Sector 1 11 Sector 1 Sector 1 Sector 1 Sector 1 11 Sector 1 Sector 1 Sector 1 Sector 1 11 Sector 1 Sector 1 Sector 1 Sector 1 11 Sector 1 Sector 1 Sector 1 Sector 1 11 Sector 1 Sector 1 Sector 1 Sector 1 11 Sector 1 Sector 1 Sector 1 Sector 1 11 Sector 1 Sector 1 Sector 1 Sector 1 11 Sector 1 Sector 1 Sector 1	Ka.	-			Bescription	011d	u		ut y	Specification	Lost	kemarks	2
Equipment for Gas Carburians [] Workbanch Hardening and Teapering [] Workbanch Hardening and Teapering [] Set (with Oil Separator Habter Pan) (alth Ethners Equipment) (alth Ethners (with Dolly) (alth Dolly Olecon) (alth Ethners) (alth Dolly Press (alth Dolly) (alth Dolly Press) (alth Presson (alth Ethner) (alth Presson (alth Ethner) (alth Presson (alth Ethner) (alth Presson (alther Pan) (alth Presson (alther Pan) (alth Presson (alther Pan) (alth Presson (alther Pan) (alth Presson (alther) (alth Presson (alther) (alth Presson (alther) (alth Presson (alther Pan) (alth Presson (alther) (alth Presson (alther Pan) (alth Presson (alther) (alth Presson (alther) (alther) (alth Presson (alther) (alther) (alther) (alther) (alther) (alther) (alther) (alther) (alther) (alther) (alther) (alther) (alther) (alther) (alther) (alther) (al	Prod	sction Fac	111	ĥ	-								i i
Hardening and Tempering (2) Degreasing Mash Tank [1 Set (1) 101 Separator 4 Mater Pan) [5 Set (1) Electric Pit Furnace (1) Electric Pit Furnace (1) Electric Pit Furnace (1) Electric Pit Furnace (2) Electric Pit Furnace (3) Electric Pit Furnace (4) Electric Pit Furnace (4) Electric Pit Furnace (4) Electric Pit Furnace (4	-	Jquipment	for	Gas Carb	urizing	a			1 Set				
Continuous Realing Formace Continuous Realing Formace 1 Set Continuous Realing Furnace 1 Set Continuous Realing Furnace 1 Set S Electric Filt Furnace 1 Set S Set		lardeniar	pue	Tangerin		2			1 Sat				
 2) Everticing Ferrance 4) Oli But for Quenching 5) Continuous Healing Ferrance 6) Continuous Healing Furnace 6) Continuous Healing Furnace 7) Hater Cooling Basin 8) Electric Hit Furnace 9) Electric Hit Furnace 9) Electric Hit Furnace 10) Monorali 11) Honorali 12) Chanber Turnace 13) Honorali 14) Honorali 150 150 150 151 <l< td=""><td>-</td><td></td><td></td><td></td><td></td><td>2</td><td></td><td>Water Darl</td><td></td><td></td><td></td><td></td><td></td></l<>	-					2		Water Darl					
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4 011 Bath for dunning 1 Set 5 Continuous Heating Furnace 1 Set 7 Hater Cooling Basin 1 Set 8 Bioching Equipment 1 Set 9 Electric Inst (with Spare Parts) 1 Set 10 Monter Cooling Basin 1 Set 11 Electric Inst (with Spare Parts) 1 Set 12 Gantry Craes 1 Set 1 Set 11 Electric Inst (with bolly) 1 Set 1 Set 12 Gantry Craes 1 Set 1 Set 1 Set 13 Chabor Crass (with bolly) 1 Set 1 Set 1 Set 13 Chabor Crass (with bolly) 1 Set 1 Set 1 Set 13 Gantry Crass 0 Lonsching Franses 1 Set 1 Set 13 Bath Furnace 1 Set 1 Set 1 Set 13 Bath Furnace 1 Set 1 Set 1 Set 1 Set 13 Bath Furnace 1 Set 1 Set 1 Set 1 Set 1 Set 13 Bath Furnace 1 Sat 1 Sat 1 Set <td< td=""><td></td><td></td><td></td><td></td><td></td><td>• 1</td><td></td><td></td><td></td><td>-</td><td></td><td></td><td></td></td<>						• 1				-			
Guilh Etheust EquipmentSet5) Electric Pit Furacce1 Set7) Mater Cooling Basin1 Set7) Mater Cooling Basin1 Set7) Mater Cooling Basin1 Set7) Mater Cooling Basin1 Set7) Monorali1 Monorali7) Monorali1 Monorali7) Mater Cooling Basin1 Set7) Monorali1 Monorali7) Monorali1 Set7) Monorali1 Set7) Monorali1 Set7) Monorali1 Set7) Mater Cooling Prase1 Set7) Mater Paris1 Set8) Mater Paris1 Set7) Mater Paris1 Set8) Mater Paris1 Set <t< td=""><td></td><td></td><td></td><td></td><td></td><td>Ş</td><td>0</td><td></td><td>1 Set</td><td></td><td></td><td></td><td></td></t<>						Ş	0		1 Set				
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 Continuous Realing Furnace Continuous Realing Furnace Electric Ecoling Basin Electric Eloist (with Spare Parts) Equipment for Fress Luenching Equipment for Shot Blast Equipment for Shot Blast Equipment for Liquid Carburing Equipment for Liquid Carburing Equipment for Liquid Carburing Solt Elector and Duct) Equipment for Liquid Carburing Solt Elector Eloist function Equipment for Liquid Carburing Solt Elector Eloist function Equipment for Frees Cooling Fan Solt Electric Eloist (with Dolly) Equipment for Fartial Temperature Equipment for Fartial Temperature Equipment for Fartial Temperature Equipment for Fartial Temperature Equipment for Lubrite Treating Equipment for Lubrite Treating Lubrite Treating 						പ			1 Set				
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Table Al-3-7-1 (2) EQUIPMENT LIST OF HEAT TREATMENT SHOP

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 3) Shrinkase Fit Fress for Ring Gear 1 Set 4) Oil Mist Collector (with Dolly) 5) Antl-Rust Liquid Tank (with Dolly) 5) Antl-Rust Liquid Tank (with Dolly) 5) Antl-Rust Liquid Tank (with Dolly) 6) Oil Tank for Queenbing 7) Center Nole Grinding Machine 1) Surface Flate 1) Magnetic Flaw Detector 1) Set 1) Magnetic Flaw Detector 1) Set 1) Set 1) Set 1) Set 1) Set 1) Set 2) Suckwell Machine 1) Set 1) Set 1) Set 1) Set 2) Suckwell Machine 1) Set 1) Set 1) Double Nadess Tester 1) Set 1) Set 1) Set 1) Set 2) Suckwell Machine 1) Set 2) Suckwell Machine 3) Suckwell Machine 3) Suckwell Machine 3) High Speed Cutting Off Machine, 1 Set 3) High Speed Cutting Off Machine, 2) Set 3) High Speed Cutting Off Machine, 1 Set 3) High Speed Cutting Off Machine, 1 Set 3) High Speed Cutting Off Machine, 1 Set 3) Sucker Blick, Paper, Cioth and Cutting Oil 	~	Equipment for Nigh Froquency Induction Hardening Apparatus		1 Set 1 Set	80kh-200khz 150kh-10kkz		
 4 Ull Mist Collector (with Dolly) 5 Anil-Rust Liquid Tank (with Dolly) 6 (i) 1 Tank for Quenching Machine 7 Center Hole Grinding Machine 1 Set 2 Hydraulic Straightoning Press 3 Surface Pisto 4 Measuring Instruments 5 (Gauge Block, Micrometor, V-Block, Dillo Guee, Vernier Caliper and Uthers) 7 (Gauge Block, Micrometor V-Block, Dillo Guee, Vernier Caliper and Uthers) 8 Section 1 Magnetic Flaw Detector 1 Magnetic Flaw Detector 2 Rockwell Mardness Tester 3 Rockwell Mardness Tester 8 Fineli Hardness Tester 9 Fineli Hardness Tester 9 High Speed Cutting Off Machine, Set (with Speed Cutting Off Machine, Large-strated) 9 High Speed Cutting Off Machine, Machine, Mith Mich, Paper, Cioth and Cutt-Wath View Standards and View) 9 High Speed Cutting Off Machine, Math With With Speed Cutting Off Machine, Math With With Speed Cutting Off Machine, Math With With With Speed Cutting Off Machine, Math With With With Speed Cutting With Machine, Math With With With With Speed Cutting With With With With Speed Cutting With With With With With With With With				1 Set			
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Table AL-3-7-1 (3) EQUIPMENT LIST OF REATHENT SHOP

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 15) Analysis instrument 15) Birdness Tosting Instrument 17) Master Gauge for Clutch Hub 18) Nand Fools & Hossuring Tools 19) Nand Fools & Hossuring Tools 20) Jig for Press Quenching 20) Portable Pump 20) Portable Pump 20) Portable Pump 			011	e .		1 Set			
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e Paret 3 • Paret 1			ស) Jigs Shelf		S Sets			
e Lini			හ) Tool Cabinet		3 Seta			
e Pump			5) Hanger		1 Set			
			8) Portable Pump		1 Set			
1 3146			6) Hand Lift		1 Jul t			
10) Fire Extinguisher, 2 Sets ABC 100			(0)T	Pire Extinguisher		5195 7	ABU IUU Type		

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Table AI-3-7-2(1) MAJOR PROCESSES OF HEAT TREATMENT

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Major Part	Process	Equipment	Remarks
Transmission Gear Transfer Gear Spider Side Gear	1 Degrease Washing 2 Carburizing Hardening 3 Gegrease Washing 4 Tempering 5 Shot Blast 6 Lubrite	Washing Tank Blectrically Neated Granulate Gas Carburizing Furnace and Oil Tank Mashing Tank Electric Pit Furnace Shot Blasting Machine Lubrite Treating Instrument	Transfer Gear and Spider Only
Ring Gear Low Gear	1 Degreese Mashing 2 Carburizing 3 Heating 4 Heating 5 Degress Mashing 6 Tempering 7 Shot Blast	Washing Tank Electrically Neated Granulate Gas Carburizing Furnace Chamber Furnace Press Quenching M/C Washing Tank Electric Pit. Furnace Shot Blasting Machine	
Drive Pinion Ball Stud Steering Pinion	 Degrease Washing Carburizing Hardening Degrease Washing Tempering Tempering Frequency Induction High Frequency Induction Hardening Tshot Blast Renter Grinding Hydraulic Straightening 	Washing Tank Electrically Heated Granulate Gas Carburizing Furnace and 0il Tank Washing Tank Bashing Tank Electric Pit Furnace Lead Bath Furnace Lead Bath Furnace Lead Bath Furnace Shot Blasting Machine Center Grinding Machine Center Grinding Machine	Drive Pinion and Steering Pinion Only
Washers and Swall- sized Parts	1 Degrease Mashing 2 Preheating 3 Carburizing 4 Heating 5 Heating 5 Degreas Mashing 7 Tempering 8 Washing 9 Anti-Rust Treatment	Mashing Tank Preheating Furnace Liquid Carburizing Furnace Salt Bath Oil Tank Mashing Tank Salt Bath (Low Temperature) Mashing Tank Tank for Anti-Rust Liquid	

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Water Cooling Only for Socket For Parts with Length more Shift Fork Rod Only Remarks than 100 mm Table AI-3-7-2(2) MAJOR PROCESSES OF HEAT TREATMENT Reating
 150kW Nigh Frequency Induction Hardening Apparatus
 2 Tempering
 Biectric Pit Furnace
 3 Hydraulic Straightener Salt Bath Oil Tank (Hater Tank) Mashing Tank Salt Bath (High Temperature) Mashing Tank 80kW High Frequency Induction Nardning Apparatus Tank for Anti-Rust Liquid Equipment Washing Tank Salt Bath 2 Kydraulic Straightening Hammer 6 Cooling Washer 7 Hydraulic Straightening Nammer Degrease Washing Degreas Washing Process Tempering 1 Tempering 8 Anti-Rust Heating Heating Joint Yoke, Shaft 1 Heating Socket, Shift Fork, 1 Heating Shift Pork Rod Major Part Bolts (Socket) Spring 1

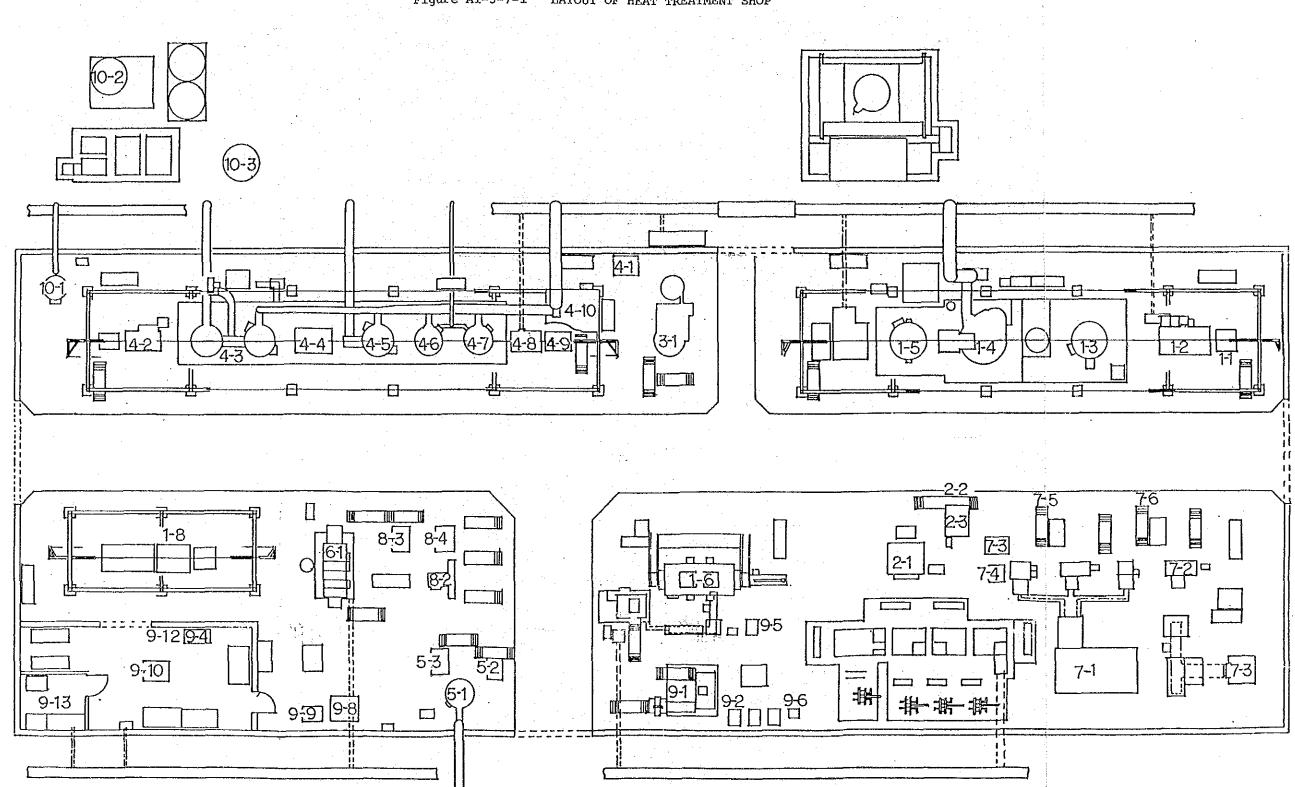
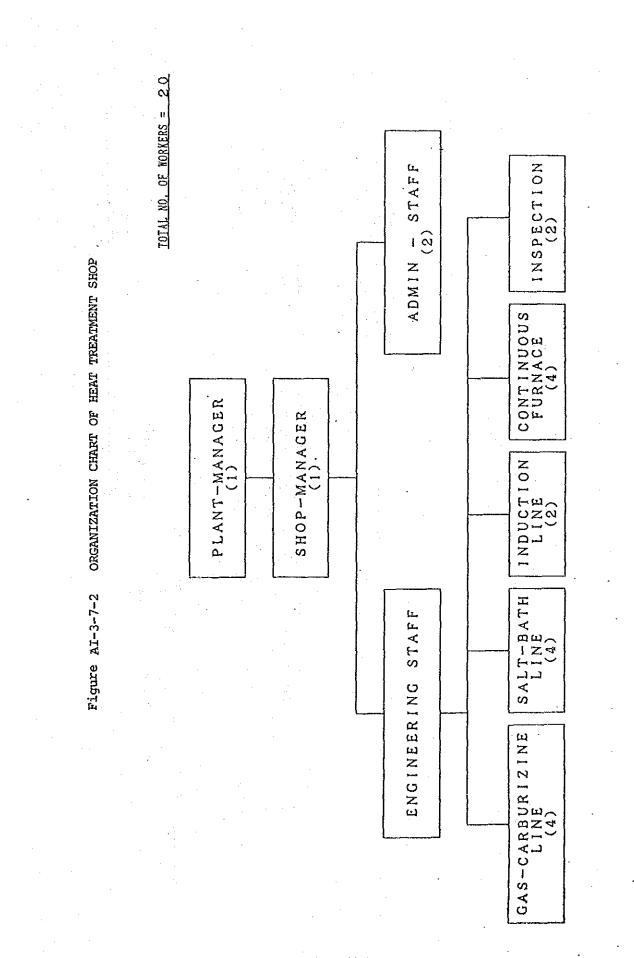


Figure AI-3-7-1 LAYOUT OF HEAT TREATMENT SHOP



A1-3-127

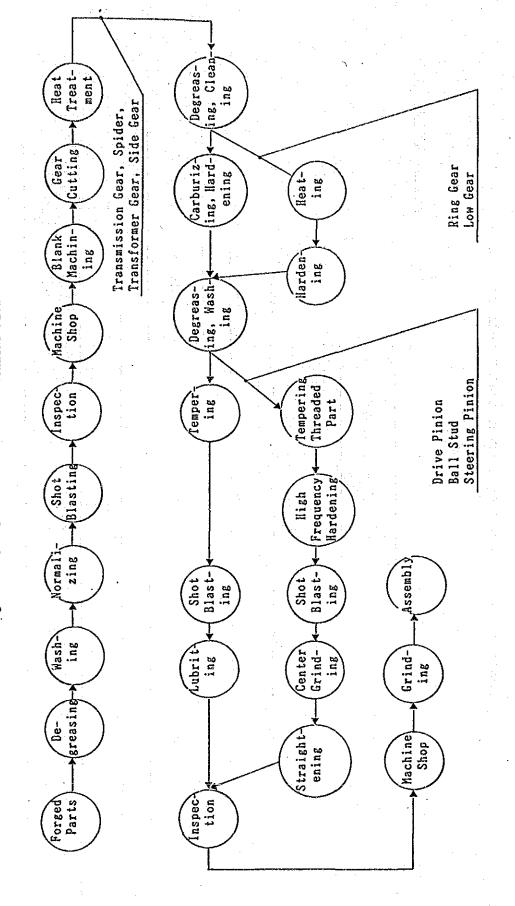
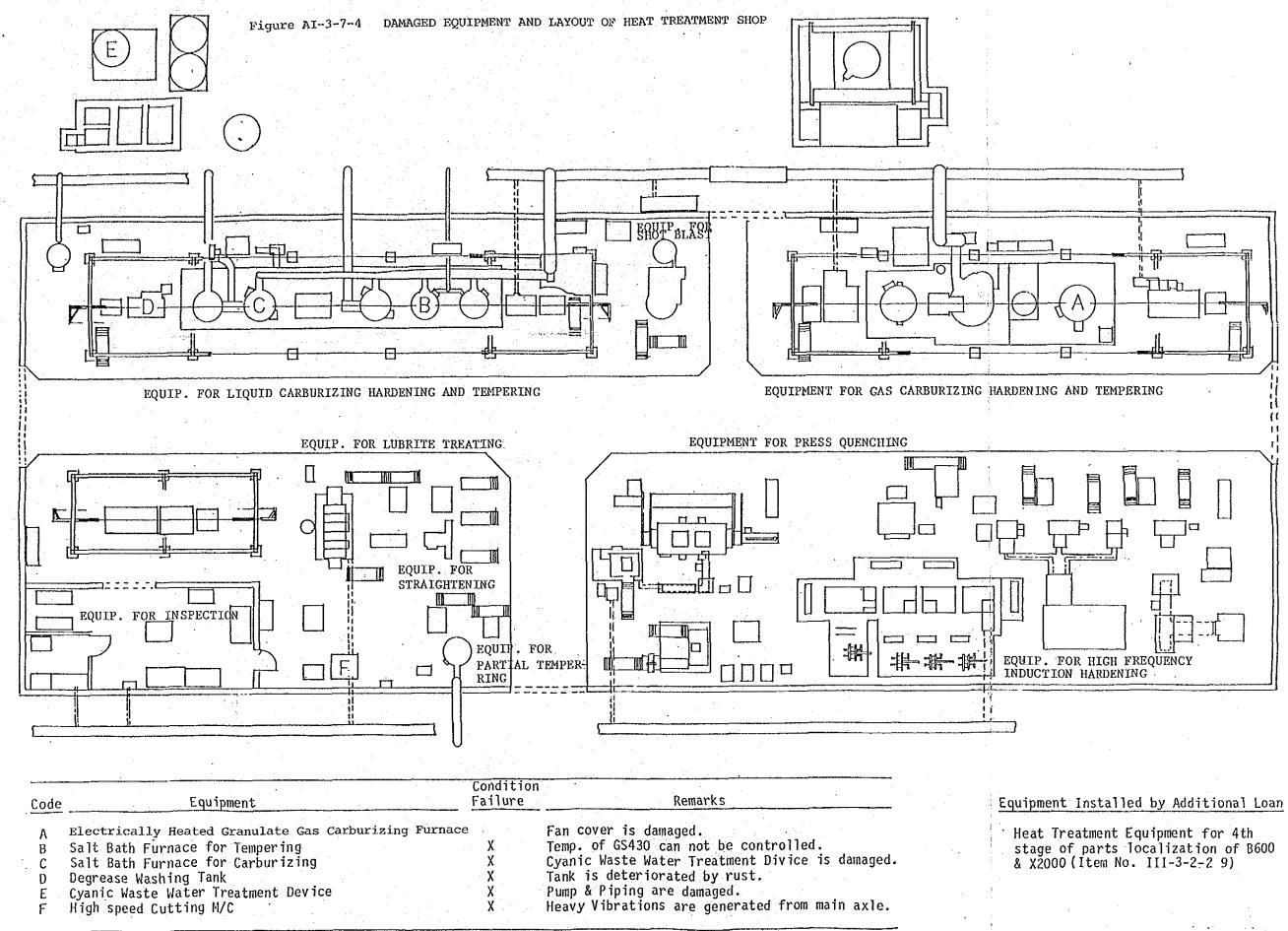


Figure AI-3-7-3 OUTLINE OF GEAR WORKING FLOW



Al-3-129

Chapter 4

HEAVY VEHICLES MANUFACTURING FACILITY

Chapter 4 HEAVY VEHICLES MANUFACTURING FACILITY

4-1-1 No.1 HI Heavy Vehicles Production Equipment

(1) Equipment and its layout

The equipment and its layout for each of the shops for Heavy Vehicle Production Equipment is indicated in the following documents:

Heavy vehicle assembly shop	Fig.AI-4-1-1
Htaukkyant shop	Fig.AI-4-1-2
Press shop No.2	Fig.AI-4-1-3
Transmission and heat treatment shop	Fig.AI-4-1-4
Bolt and nut shop	Fig.AI-4-1-5
Leaf spring shop	Fig.AI-4-1-6
Rear body shop	Fig.AI-4-1-7

(2) Organization and personnel

Organization and personnel are as shown in Table AI-4-1-1.

(3) Supply Performance of Raw Materials and Parts

The supply performances are shown in Table AI-4-1-2.

(4) Production performance and equipment capacity

Production performance and equipment capacity are shown in Table AI-4-1-3.

4-1-2 Heavy Vehicles Assembly Shop

In this shop, an assembly shop for 6.5 ton and 3.5 ton trucks, the assembling operations for the top parts, cab and frame of dumping trucks, wreckers, and tankers take place.

In regard of layout it is necessary to consider this together with and evaluation of the secondary extension plan for the Htaukkyant plant and other related shops.

(1) Problems of line balancing

The drilling operations for the side frame are done with the two radial drilling machines and jigs placed at the both sides of the line. Production figures for frame drilling are less by one unit than the production figures for the chassis final assembly line. If a breakdown occurs it is difficult to devise a substitution.

To improve the frame assembly line the following require consideration:

- 1. move the cross member work area to the east side of the paint booth
- 2. move the radial drilling machine, column drilling machine, arc welder and other processing equipment.
- 3. installation of another radial drilling machine for side frame drilling and one more set of drilling equipment.

Two riveting guns share a generator for frame assembling operations and as a result when both are in operation at the same time generating power is sometimes insufficient. It is necessary to have one generator for each gun.

(2) Quality control measures

1) Installation of vehicle inspection devices

Heavy vehicles, such as the trucks and buses, are not inspected with the tester devices when they come off the line, but are immediately dispatched. The testing devices for vehicle inspection were placed during the initial installation of the present line in the present service shop. However, placed on the shop floor these devices are now unusable due to damage caused by rain flooding of the sunken shop floor.

In order to ensure the safety and quality of the vehicles it is necessary to consider the installation of inspection testing devices at the point where vehicles come off the final assembly line of the heavy vehicles assembly shop.

As domestic production of transmission proceeds the installation of a speedometer tester needs consideration.

2) Improvement and enlargement of the component parts area and integration of service shops

At present, engine repair equipment such as the engine dynamo-meter, etc. is installed in the Heavy Vehicle Assembly Shop. It is necessary to consider the transfer of this engine repair equipment to the service shop or the north-east of the service shop of the fuel tank and muffler area in order to enlarge the component parts area, storage and unpacking of packing cases, and assure the improvement of product quality.

(3) Enlargement of the work area for changeover to domestic production of metal sheet parts

In order to assist the domestic production of sheet metal small parts it is necessary to consider creation of a work space in the service shop.

(4) Equipment needing replacement

There is equipment requiring replacement in this shop which were not mentioned in the HIC list.

4-1-3 Htaukkyant Bus Shop

- (1) The upper part assembly line for dump truck, wrecker, etc. is located here and since space is necessary for installing vehicle inspection equipment and for retouching of vehicles coming off the inspection line it should be moved to the Htaukkyant Bus shop in order to allow for this installation.
- (2) Installation of vehicle inspection equipment in addition to machine and equipment for bus production needs consideration.

4-1-4 Press Shop No.2

(1) Quality control

Trimming operations taking place after the Press operations are at present by hand. However, trimming by hand tends to result in loose parts and numerous problems such as poor fitting of the cab door develop. The following points need to be considered when mechanizing to improve product quality:

1. Production of trimming patterns

2. Installation of an automatic trimming machine

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(2) Overcoming bottlenecks

A ratio comparison of the time required for die changing of the large size press in the No.2 press shop and operating time (stamping time) at present is as follows:

Operating time 30Z Die changing time 70Z

In order to shorten the time required for the die changing of the large press it is necessary to consider the mechanization of die changing.

4-1-5 Machine and Heat Treatment Shop

(1) New installation of re-grinding machine for shaving cutter

Normally after production of every 1,000-3,000 products the toothed blade of the shaving cutter is measured and re-sharpened. The present shop has 2 cutter machines. As the production output per machine is 3,500 it is necessary to sharpen the blades.

Introduction of shaving cutter re-grinding machines should be considered for purposes of re-sharpening.

(2) New equipment for replacement and overcoming bottlenecks

Processing of the main shaft, counter shaft, drive pinion shaft with present equipment requires respectively 25, 70 and 15 minutes.

Production of 4 of each the the shaft types in one day requires 440 minutes. Programming time is 180 minutes. Therefore the total of production and programming time is 620 minutes per day, so that operating time involves overtime. Introduction of a Gear Shaping machine to improve productive efficiency and shorten working time should be considered. Equipment requiring replacement because of deterioration is listed in Annex 3.

(3) Equipment for fuel conversion

To meet shortage of fuel resources consideration of changing fuel for the heat treatment shop is required.

4-1-6 Bolt and Nut Shop

(1) Equipment needed for overcoming bottlenecks

1) Thread rolling machine

This is used for production of bolt screws of each type besides those for vehicles. The machine has the highest operating rate in this shop. In the event of a breakdown there is no substitution available. It is therefore necessary to consider adding another thread rolling

2) Plating equipment and waste treatment

machine unit to current facilities.

This is an electric zinc plating machine with a maximum handling capacity of 250kg per day and an actual performing capacity of some 150kg per day. Due to expansion of facilities for each of the different nut and bolt type equipments output exceeds 300kg per day. Therefore the increase of the plating equipment's capacity is necessary.

(2) Equipment increases

1) Wood screw producing machine

There are ten of this machine in the present shop. These facilities are all badly aged and 6 are beyond repair. The machinery, of the cutting type, has only one tenth of the productivity of modern rolling type equipment. In order to enable the production of tapping screws and wood screws of each type and dimension the elimination of the ten present machines and the introduction of 3 new rolling type models should be considered.

2) Long size bolts

Present equipment cannot produce long bolts of $M12 - M20 \ge 95 - 180$ mm length. However, this is necessary to the expansion of productive capacity of M6 - M10 $\ge 55 - 95$ mm length bolts. Introduction of one large and one small size bolt homer each should be considered.

4-1-7 Leaf Spring Shop

(1) Expansion of equipment to overcome bottlenecks

As the leaf spring shop involves much hot working and heat treatment handling of the machinery is rough and deterioration of equipment takes place easily. Pieces of equipment are requiring consideration as to replacement or expansion to overcome bottlenecks.

(2) Expansion of the U-Bolt manufacturing equipment

The equipment installed in the Leaf Spring Shop is judged to be appropriate because U-bolt is manufactured by forming with heating like leaf spring.

(3) Heat source conversion equipment

It is necessary to consider the conversion of the heat source of furnace facilities in the Spring Shop to meet the future changes of fuel resources.

4-1-8 Rear Body Shop

There is equipment requiring either replacement or repair.

(1) Maintenance of blanks

4-1-9 Others

Thin plates for press use, blanks (rough materials) for spring use, and wires and rods for bolt and nut use are all left outside in their packing crates. Because of seeping of rain during the monsoon and temperature differences between day and night in the dry season (some 20 degree c) condensation inside the crates develops. The rough materials develop rust and this results in an impoverishment of quality. Storage measures for the packing crates are urgently required.

It is necessary to supply according to planning packing crates of the component parts and raw materials from unloading from ship, unpacking, use and up to production. However, as the raw materials are shipped to Burma at a rate of one or two times yearly the provision of a large number of packing crates is difficult to assure. Materials are stored outside because deterioration of quality is difficult to observe and judge by eye in the case of thin iron plates, materials for springs, and wire rod material for bolts and nuts. As a result, quality of products was far below the expected levels. The following countermeasures are recommended to improve the present condition of storing the blanks:

Countermeasure 1:

Storage of thin plates for press

Reception of packing cases for press use thin plates should be considered for the storage area of Press Shop No.2 to make the movement of the storage area for the press patterns.

Countermeasure 2:

Storage of blanks for bolt and nut use and for spring use The introduction of a crane (3 tons) for storage and for use in realizing the material handling plan for the spring shop should be considered.

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Further, an overhead crane could be installed on the runway of steel frame materials of this raw materials area. Roofing and side wall construction should employ local products.

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Table AI-4-1-1 STRENGTH SITUATION OF PRODUCTION DEPARTMENT NO.3

	Manager & Engineers	Foreman	Skilled Labor	Semi- Skilled Labor	Un- Skilled Labor	Total
Oepartment Office	~	сл	3	40	31	62
Heavy Vehicle Manufacturing Plant	4	5	60	70	18	161
Heavy Vehicle Components Manufacturing Plant	64	8	23	107	g	149
i	4	ю	26	45	24	104
Bolt & Nut Manufacturing Shop	2		6	24	2	37
Spring Manufacturing Shop	د بط	•	F-	16	б	33
Bus Manufacturing Plant (Htauk Kyant)	ന	ى م	25	36	11	80
Rear Body Manufacturing Shop		4	25	25	2	62
Keavy Vehicle Repair Shop	+1		ື ຕົ	10		20
Light Vehicle Repair Shop	~	4	16	32	6	63
Service Station No.1	2	0	12	26	ŝ	17
Service Station No.2	8	63	ې م	10	t	30
	26	42	224	441	132	865

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Table AI-4-1-2 PROCUREMENT RECORD OF RM AND CP

(Unit: Set Vehicle)

Vehicle	Year:	1984	4	1985	35	1986	9	To	Total
	TE 6.5 Ton	566		450		450		1,466	
Truck	WA	50	PLL	50	630	1	630	100	2,034
•	KN 3.5 Ton	158		130		180		468	
	BM 25 Pass.	100		100		50	C T	250	
883	BX 33 Pass.	4	60 T	185	011	22	2	44	624
	Total	878	8	12	748	702	12	2,	2,328

Table AI-4-1-3 PRODUCTION AND PRODUCTION CAPACITY

Production

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Year	Model	Apr	May	Jun	Jul	Aug	Sep	0ct	Nov	Dec	Jan	Feb	Mar	Total
	TE	50	72	56	7	46	44	43	58	80	44	32	86	618
	WA	· . - .	-		-	-	÷	-		-	-	-	-	-
	KM -	-			-		-		5	-	22	55	6	88
1984	BM	3	11	11	-	-	-	1		1	13	14	15	69
	BX	-		· · ·	-	-	. –	-	-		-		-	-
	• Total	53	83	67	7	46	44	44	63	81	79	101	107	775
	TE	32	44	76	97	25	98	103	86	85	17	45	74	782
	WA	-	· -	_	-	· -		-	-	1	45		-	46
	KN	. 2	-	~		76	2	2	-	-	34	48	4	168
1985	BM	4	8	2	-	-	6	20	13	÷.	6	5	5	69
	BX	-	.	-	-	-		-	-	-	~	-	-	. –
	Total	38	52	78	97	101	106	125	99	86	102	98	83	1,065
•••••	TE	34	77	79	80	42	66	18	75	10	10	1	69	561
	WA	· · –		-	2	-	-	50	-	-		-	-	52
	КМ	41	4	~	-		-		, -	50	90	40	-	225
1986	BN	2	- 3	1	10	10	8	-	5	10	15	9	3	76
	BX	-			-	-	1	3	4	-	-	-	4	12
	Total	77	84	80	92	52	75	71	84	70	115	50	76	926

Nodel		Established Capacity
TE	Potential Original	4 Vehicles/8hr x 20ds = 80 Vehicles/month 4 Vehicles/8hr x 25ds = 100 Vehicles/month
ви	Potential Original	1 Vehicle /8hr x 20ds = 20 Vehicles/month 1 Vehicle /8hr x 25ds = 25 Vehicles/month

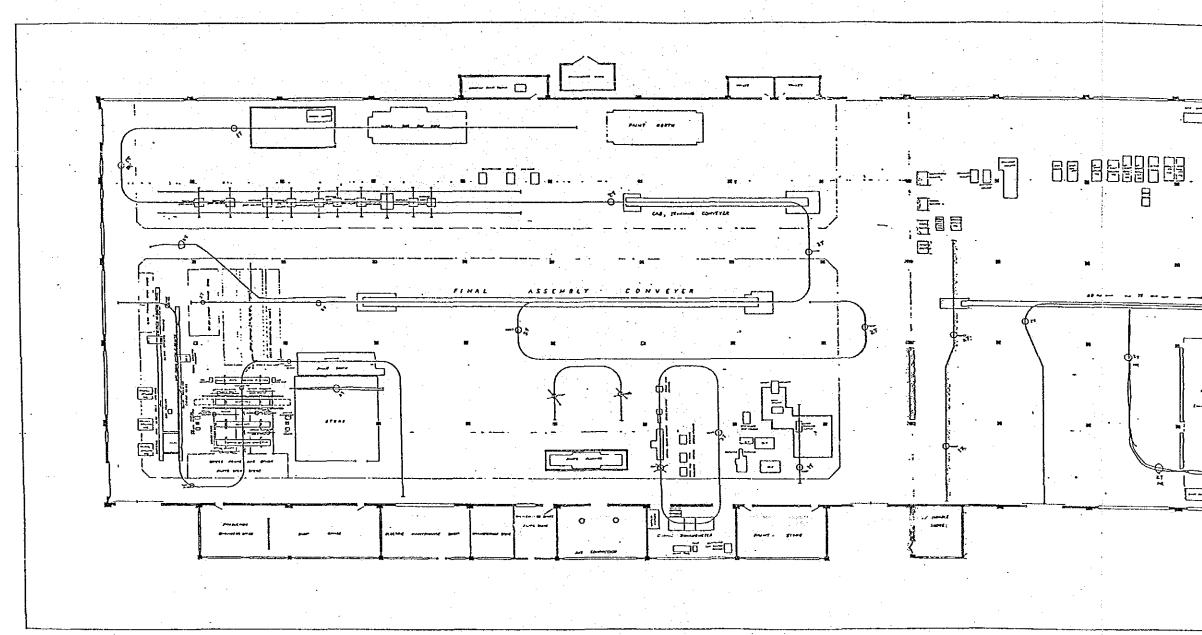
Notes: Production Capacity

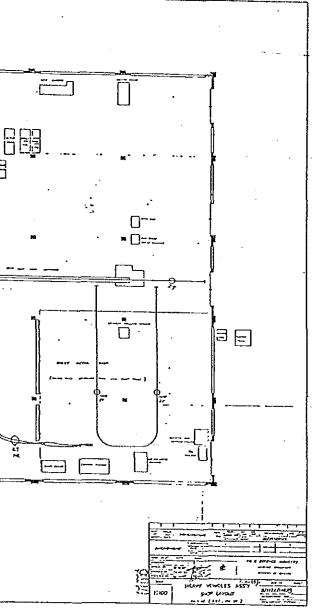
 TE and BM represent other models.
 The present capacity was established in 1982 due to change of working days (Saturday was set as off day).

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Figure AI-4-1-1 LAYOUT OF HEAVY VEHICLE ASSEMBLY SHOP





Al-4-12

		Figur	e Al-4-1-2 LAYOUT	OF HTAUKKYANT BUS S	нор	
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59. NO.	MONENGLATURE	
22	AIR COMPRESSOR	
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22 21 20	AR EDWORESSOR DUER NEAD CRANE DUER NEAD CRANE	
22 21 20 15	AIR EDWORESSOR DUER NEAD CRANE DIER NEAD CRANE WATER PLAN	
22 21 20 15 18	AIR EDWARESSOR DUER NEAD CRAME DUER NEAD CRAME WATER PLANP AIR EDWARESSOR	
22 21 20 18 18 17	AIR EDWARESSOR DER NEAD CRANE DER NEAD CRANE WATER PLAN MI COMPRESSOR AR COMPRESSOR	
22 21 20 18 18 17 16	AIR EDWARESSOR DER NEAD CRANE DER KEAD CRANE WATER PIMP NR COMPACESSOR AIR COMPACESSOR PORTABLE AN COMPACESSOR	
22 21 20 18 18 18 17 16 15	AIR EDAPRESSOR DUER NEAD CRANE DUER KEAD CRANE WATER PLANP NAR CONFRESSOR AIR CONFRESSOR PORTABLE AN COMPRESSOR PORTABLE AN COMPRESSOR	
22 21 20 15 18 17 56 15 14	AR COMPRESSOR DER NEAD CRANE DER KEAD CRANE WATER PIMP NR COMPRESSOR AR COMPRESSOR PORTABLE AR COMPRESSOR PORTABLE AR COMPRESSOR PORTABLE AR COMPRESSOR COMPETOR MOTOR	
22 21 20 15 18 17 16 15 14 13	ALR COMPRESSOR DUER NEAD CRANE DUER NEAD CRANE WATER PEMP AR COMPRESSOR PORTACLE AN COMPRESSOR PORTACLE AN COMPRESSOR PORTACLE AN COMPRESSOR COVERING MOTOR RUSHER CONTEXOR	
22 21 20 13 18 17 16 15 14 13 12	ALR COMPRESSOR DUER NEAD CRANE DUER NEAD CRANE WITTER PLAN WITTER PLAN WITTER PLAN AR COMPRESSOR PORTABLE AND COMPRESSOR	
22 21 20 15 18 17 18 17 16 15 14 15 14 13 12 11	ALR EDWARESSOR DER NEAD CRANE DER NEAD CRANE WITTER PLAVE WITTER PLAVE MR COMPRESSOR AR COMPRESSOR PORTABLE AUR COMPRESSOR PORTABLE AUR COMPRESSOR COVER TOR MOTOR ENTER COME YOR BRANE FLUD BLELOER PORTABLE WILLOWS TRANSCORMER	
22 21 70 18 18 17 56 15 14 13 12 11 10	AIR EDUPRESSOR DER NEAD CRANE DER NEAD CRANE WATER PLAP AM CONFRESSOR AR CONFRESSOR PORTABLE AIR CONFRESSOR PORTABLE AIR CONFRESSOR PORTABLE AIR CONFRESSOR COVERTOR MOTOR HISNER COVERTOR BRANE FLUD BELLEVER PORTABLE WELLOWS TRANSCORMER MORAVER GENERATOR	
22 21 20 19 18 18 17 18 15 15 14 13 12 11 10 9	AR COMPRESSOR DER NEAD CRANE DER NEAD CRANE WATER PINN MATCOMPRESSOR AR COMPRESSOR PORTABLE AR COMPRESSOR PORTABLE AR COMPRESSOR COMEYOR MOTOR RUSSER COMEYOR BRAKE FLUD BLEDOR PORTABLE WELDOWS TRANSSORMER MODALIKE GENERATOR THE WELATION EDUP:	
22 21 20 19 18 17 56 15 16 15 14 13 12 11 10 9 6	AR COMPRESSOR DUER NEAD CRANE DUER NEAD CRANE WATER PLANE WATER PLANE WATER PLANE WATER PLANE WATER DUPRESSOR PORTABLE AND COMPRESSOR PORTABLE AND COMPRESSOR PORTABLE AND COMPRESSOR PORTABLE WILLOWS TRANSCORMER MUDRAULK GENERATOR THE WILLIOWS COUPS: ELECT: BENCH GAUGER	
22 21 20 18 18 17 16 15 14 13 12 11 11 10 9 8 7	ALR EDWARESSOR DUER NEAD CRANE DUER NEAD CRANE WATER PLAN AR COMPRESSOR AR COMPRESSOR PORTABLE AND COMPRESSOR PORTABLE AND COMPRESSOR PORTABLE AND COMPRESSOR PORTABLE AND COMPRESSOR PORTABLE WILLOWS TRANSFORMER MUDANAKE GENERATOR THE WILLION GULDOS ELECT: BENCK GAUGER WOOD BAND SAMAS AJE	
22 21 20 19 18 17 56 15 16 15 14 13 12 11 10 9 6	ALR COMPRESSOR DUER NEAD CRANE DUER NEAD CRANE WATER PLAN AR COMPRESSOR PORTABLE AN COMPRESSOR PORTABLE AN COMPRESSOR PORTABLE AND COMPRESSOR PORTABLE NOTOR COVER TR MOTOR RUSHER CONTEXAR PORTABLE WILLOWS TRANSFORMER MIDDAUGK GENERATOR TIME WILLATION COUP: ELECT: BENCH GRUNDER WIDDO BAND SANNAS M/C MICH SPEED CHICULARSAW	
22 31 70 19 16 17 16 15 16 17 16 15 14 13 12 11 10 9 6 8 7 6	ALR COMPRESSOR DUER NEAD CRANE DUER NEAD CRANE WITTER PLANE WITTER PLANE WITTER PLANE WITTER PLANE WITTER PLANE WITTER PLANE AR COMPRESSOR ROMTABLE AND COMPRESSOR PORTABLE AND COMPRESSOR PORTABLE AND COMPRESSOR PORTABLE WILLOWS TRANSFORMER MODANULS GENERATOR TRAE WILLOWS TRANSFORMER MODANULS GENERATOR TRAE WILLOWS TRANSFORMER MODANULS GENERATOR TRAE WILLOWS TRANSFORMER MODANULS GENERATOR TRAE WILLOWS TRANSFORMER WIDDO BAND SAMING N/C MIGH SPEED CRECULARSAW BLOCK M/C	
22 31 70 18 18 17 16 15 16 17 16 13 12 11 10 9 8 7 7 5	AR COMPRESSOR DER NEAD CRANE WATER PENN WATER PENN MAR COMPRESSOR AR COMPRESSOR PORTABLE AR COMPRESSOR PORTABLE AR COMPRESSOR PORTABLE AR COMPRESSOR PORTABLE MELOWERSON BRANE FLUD BLEEDER PORTABLE WELDWE TRANSFORMER MODAUKE GENERATOR THE INFLATION EQUP: ELECT: BENCH GRINDER WIDOD BAND SANNE A/C MICH SPEED CHICULARSAW BENCH A/C ELECTRIC BENCH ORKL	
22 21 20 19 18 17 16 15 15 14 13 12 11 10 9 8 7 6 5 4	AR COMPRESSOR DER NEAD CRANE DER NEAD CRANE WATER PLAN WATER PLAN MA COMPRESSOR AR COMPRESSOR PORTABLE AR COMPRESSOR PORTABLE AR COMPRESSOR PORTABLE AR COMPRESSOR PORTABLE AR COMPRESSOR PORTABLE MELDOWS TRANSCORMER MEANING GENERATOR THE WILLOWS TRANSCORMER MEDAUKE GENERATOR THE WILLOWS TRANSCORMER MEDAUKE GENERATOR THE WILLOWS TRANSCORMER MEDAUKE GENERATOR THE WILLOWS TRANSCORMER MEDAUKE GENERATOR THE SPEED CHICKLARSAW ELECT: BENCH GRUCER MEN SPEED CHICKLARSAW ELECTRIC BENCH DRULL STATION SPOT WELDER	
22 21 70 19 18 17 15 15 14 13 12 11 10 9 8 7 6 5 4 3	AR COMPRESSOR DER NEAD CRANE DER NEAD CRANE WATER DEMP NAR COMPRESSOR AR COMPRESSOR PORTABLE AN COMPRESSOR PORTABLE AN COMPRESSOR PORTABLE AN COMPRESSOR COMEYOR MOTOR RESARE COMEYOR BRANE FLOD RULLOER FORTABLE WELDOWS TRANSSORMER MODALINE GENERATOR THE WELATON EOLO: ELECT: BENCH GRUNDER WIDOD BAND SANNAS N/C NICH SPEED CHECULARSAW BENCH N/C ELECTRIC BENCH DRULL STATION SPOT WELDER WIND SHEAR N/C	
22 21 20 19 18 17 16 15 15 14 13 12 11 10 9 8 7 6 5 4	AR COMPRESSOR DER NEAD CRANE DER NEAD CRANE WATER PLAN WATER PLAN MA COMPRESSOR AR COMPRESSOR PORTABLE AR COMPRESSOR PORTABLE AR COMPRESSOR PORTABLE AR COMPRESSOR PORTABLE AR COMPRESSOR PORTABLE MELDOWS TRANSCORMER MEANING GENERATOR THE WILLOWS TRANSCORMER MEDAUKE GENERATOR THE WILLOWS TRANSCORMER MEDAUKE GENERATOR THE WILLOWS TRANSCORMER MEDAUKE GENERATOR THE WILLOWS TRANSCORMER MEDAUKE GENERATOR THE SPEED CHICKLARSAW ELECT: BENCH GRUCER MEN SPEED CHICKLARSAW ELECTRIC BENCH DRULL STATION SPOT WELDER	

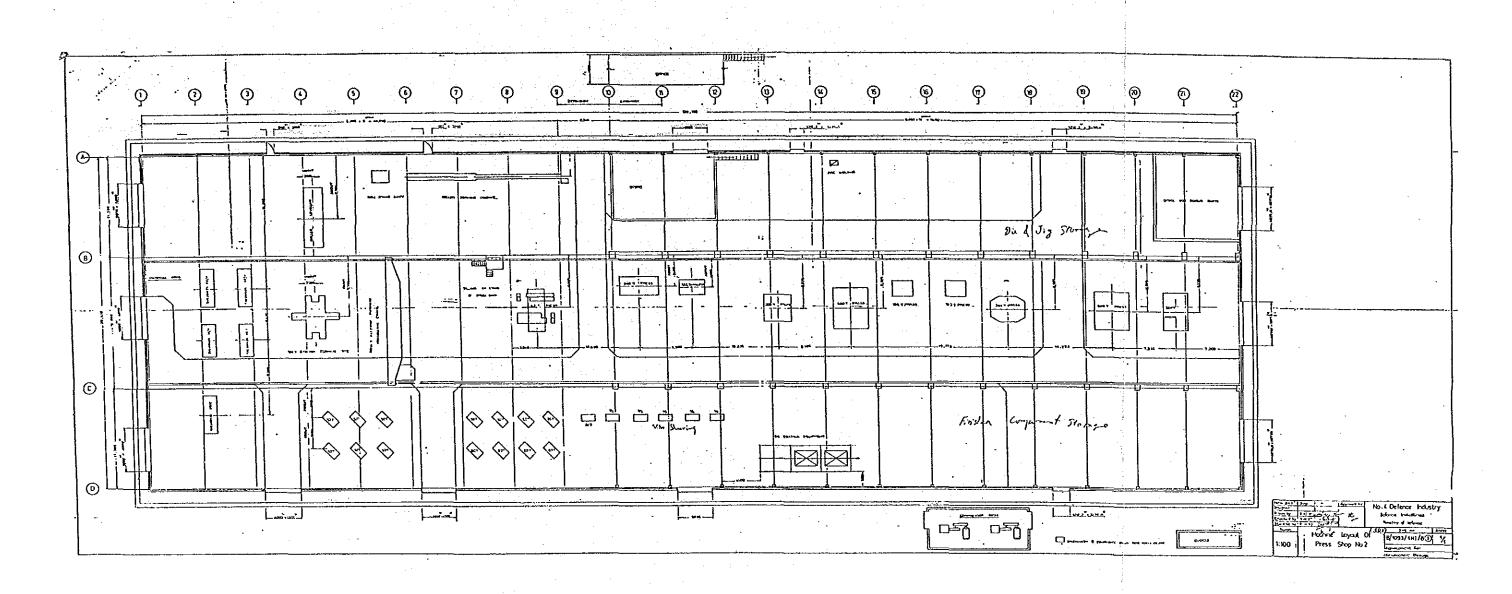


Figure AI-4-1-3 LAYOUT OF PRESS SHOP NO.2

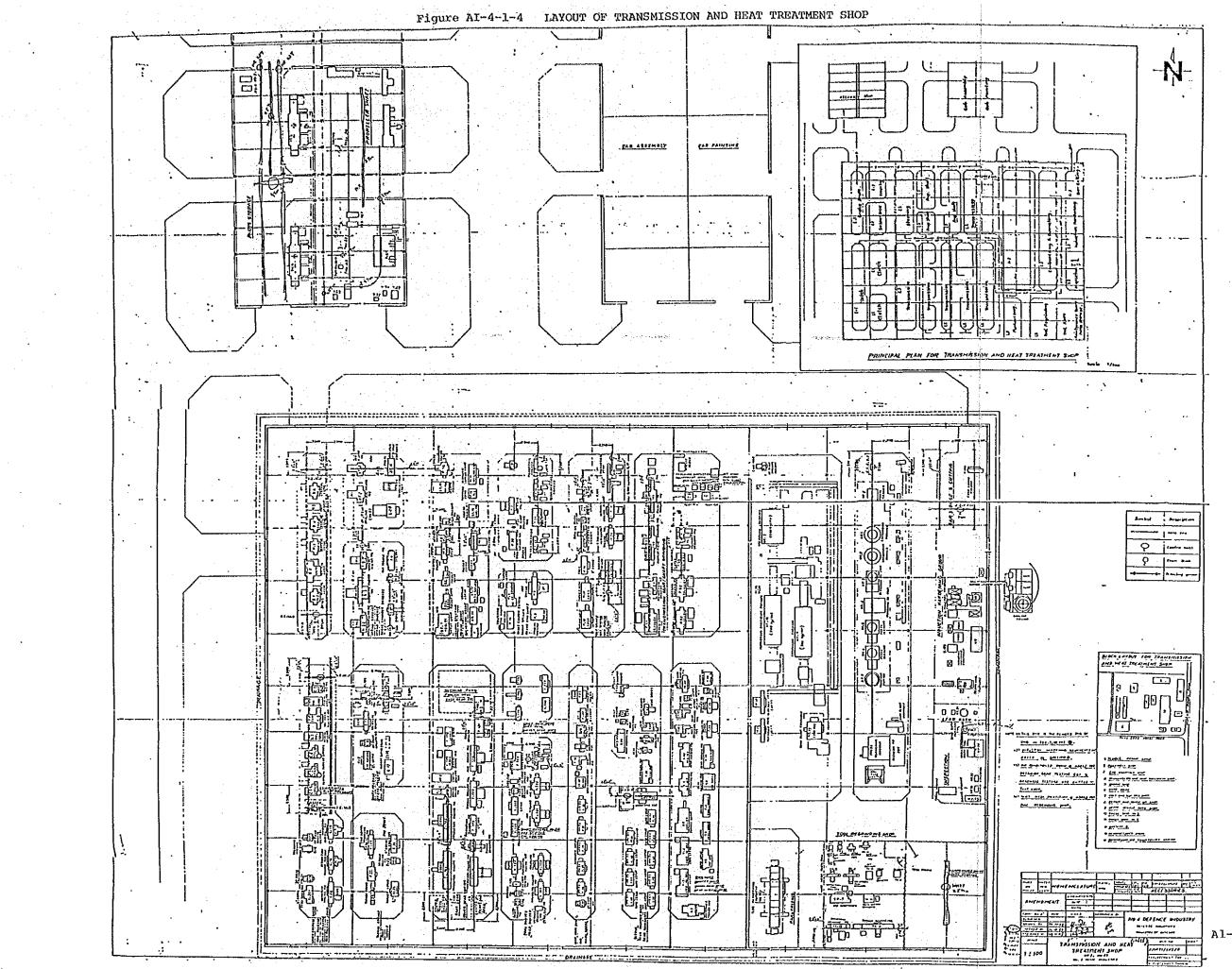
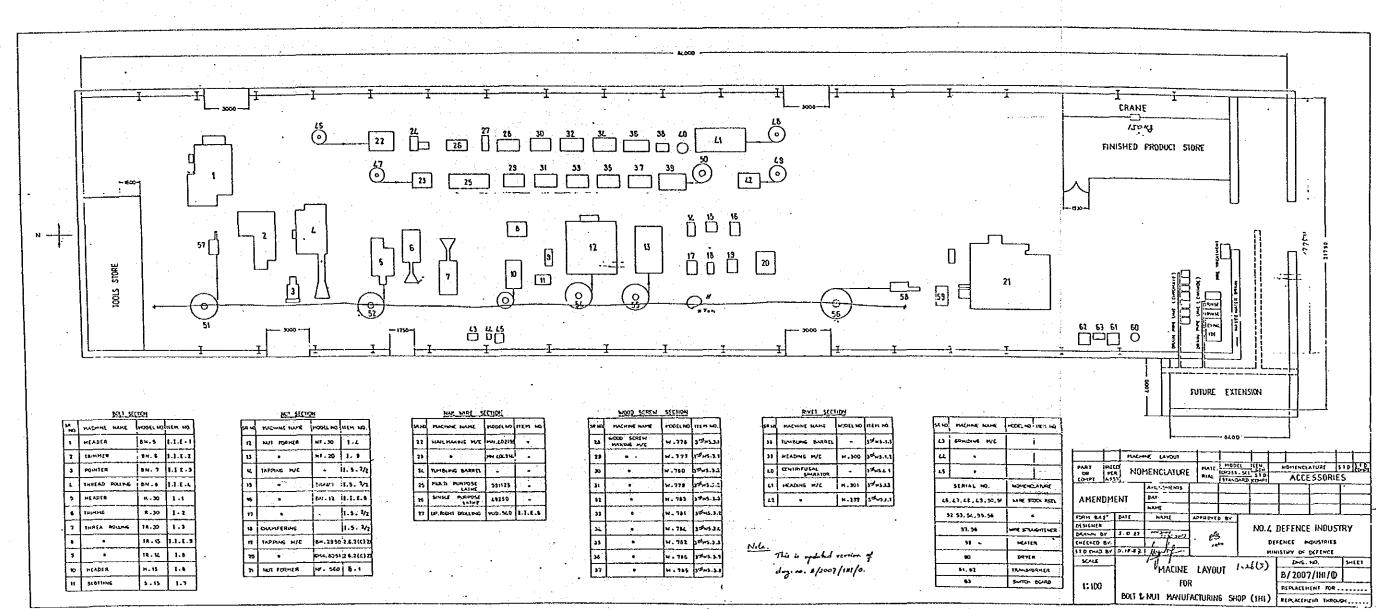
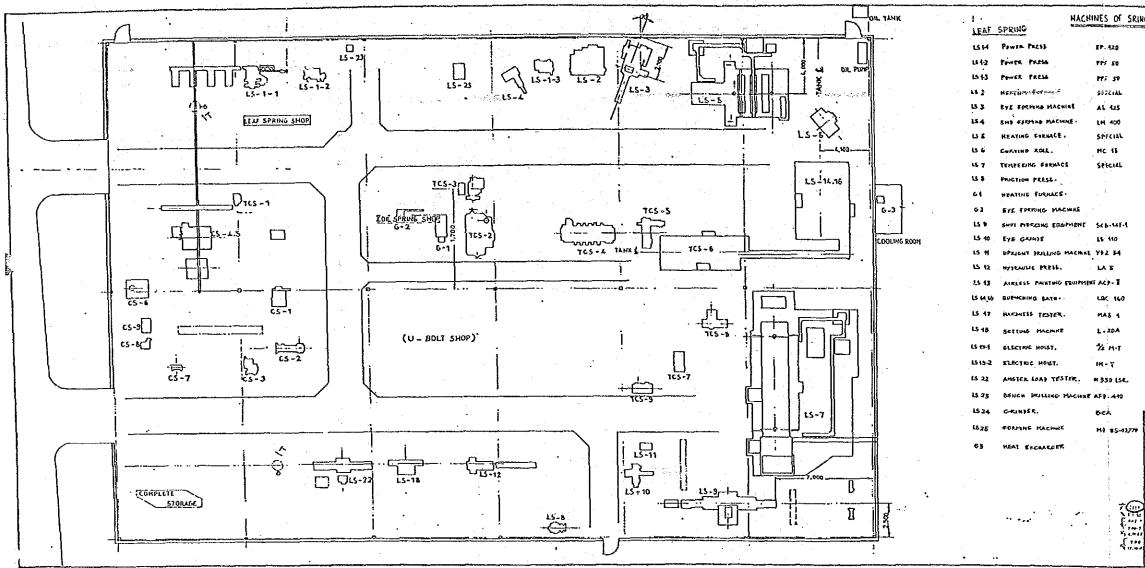


Figure AI-4-1-5 LAYOUT OF BOLT & NUT MANUFACTURING SHOP



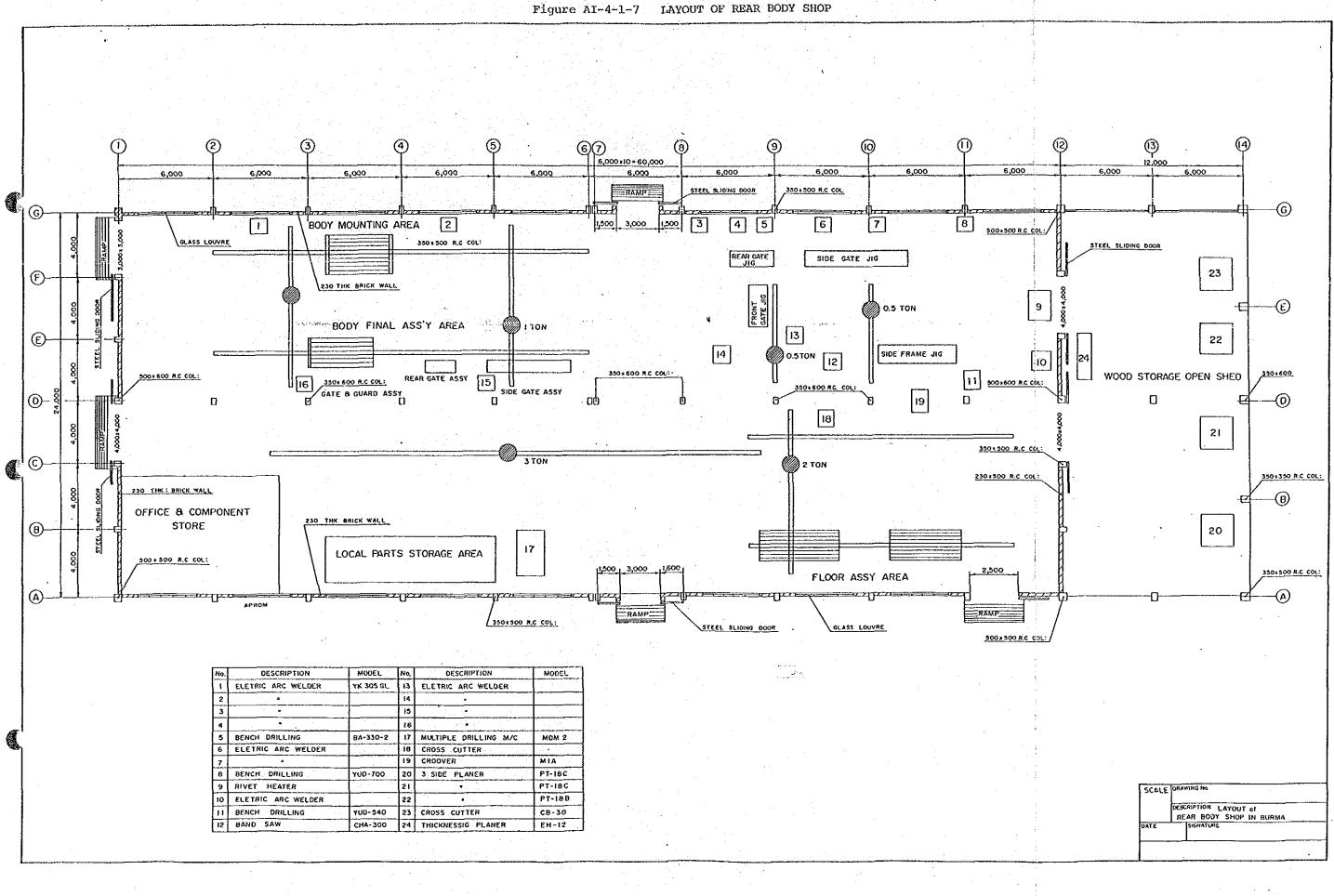
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Figure AI-4-1-6 LAYOUT OF SPRING SHOP



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