Chapter 3

LIGHT VEHICLES MANUFACTURING FACILITY

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3-1 Painting and Light Vehicles Assembly Shop

3-1-1 Outline of Processes

(1) Equipment and its layout: shown in Fig.AI-3-1-1.

(2) Organization and personnel

Organization is indicated on Fig.AI-3-1-2.

Total personnel number is 172.

(3) Raw materials and parts and their supply performance

The supply performance for raw materials and parts up to December, 1988 is shown in Table AI-3-1-1.

(4) Production performance and production capacity

Recent production performance is shown in Table AI-3-1-2.

Production capacity for the painting line is estimated at 14.5 vehicles per day or 319 vehicles per month

Period for one machine in the drying oven is 35 minutes drying time and four vehicles can be accommodated in the oven at one time.

1) Preconditions for calculating productive capacity

Working time : 22 days per month

Actual working hours: 7.5 hours per day

Operating rate : 85%

2) Calculation of productive capacity

35 minutes divided by 4 vehicles = 8.75 minutes per vehicle

8.75 minutes x 3 times = 26 minutes

26 minutes divided by 85% = 30.5 minutes

7.5 hrs/d divided by 30.5 minutes = 14.8 vehicles a day

Light vehicles line slat conveyer set interval for automatic timer:

30 minutes tact (1 section move each 30 minutes)

Productive capacity: 15 vehicles a day or 330 vehicles a month

3-1-2 Analysis of Production Process

(1) Outline of analysis of production processes

1) Painting Shop

The painting processes are the same in the painting shop for B-600, T-2000, the cab complete X-2000, and body complete.

The painting process for the B-600 cabin complete is shown in Fig.AI-3-1-3.

2) Vehicles assembly shop

The flow chart and diagram outline of process chains is shown in Fig.AI-3-1-4.

(2) Flow chart

The flow chart for the painting shop is indicated on Fig.AI-3-1-5.

The processing flow chart for the light vehicles assembly shop is indicated on Fig.AI-3-1-6.

(3) Problems and improvement of operational procedures and production flow of main finished products and parts

1) Vibration coating room (shared with black coating of main frame)

This follows the surface processing stage. As it is separated from the surface treatment area by about 100 meters this hinders production. Consideration of all of the equipment in the painting area and its layout is necessary. A dipping tank especially for the black painting of the frame as shown in the original layout can be used to shorten the distance.

2) Painting method for sheet metal parts

Parts brought into the light vehicles shop are placed on the floor. Parts are placed on the truck and the top and underneath are painted, and these placed on the floor after drying. Rust easily develops because of this placing directly on the floor. Painting involves wasteful operations such as piling and unloading a part on the truck and moving the part totaling to 4 times. This entails a considerable lowering of productivity. It is necessary to consider the introduction of new equipment such as accommodation boxes, pallet, hand lifts, etc. and to use the boxes instead of placing the parts on the floor. It is necessary to consider the methods and layout of painting of small parts.

3) Painting process from surface treatment to inspection

When B-600, X-2000, and T-2000 are painted, as there are 2 drying ovens repeated movements center around these. In addition to the need for man power in each process carrying distances are great as shown in the following table and this lowers productivity. Consideration of the layout of the painting process is needed. For example use of a putty painting, wet sanding method and vibration coating room, and the increase of drying oven equipment and use of unused minibus equipment needs considering.

Outline of Movement Distances	
surface treatment to vibration coat	85 meters
vibration coat to wet sanding	75 meters
wet sanding to first coat	75 meters
first coat to wet sanding	65 meters
wet sanding to second coat	75 meters
second coat to wet sanding	65 meters
wet sanding to final coat	75 meters
final coat to inspection	10 meters
Total	approx. 525 meters

However, the above figures do not include the transfer distances inside the drying oven.

4) Engine sub assembly section

The pool for the engine carried in and its sub assembly of the engine when carried in was removed. Rust and lowering of quality is to be feared for the part of the engine in direct contact with the floor. Operations performed sitting and half sitting have less workable and operational efficiency is reduced. Return to the original layout needs considering.

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

1) Light vehicles assembly shop

Sub Assembly Section A
B-600 rear axle assembly

For B-600, Section A attaches the differential carrier complete received from the engine, transmission and axle assembly lines and other parts received from various other shops to the rear axle housing and then supplies the final processes with the rear axle complete.

In the case of the X-2000, attachment of the differential carrier complete and other parts to the rear axle housing takes place on the engine, transmission and axle assembly lines and the axle completes is supplied to the final processes of vehicle assembly shop.

As similar operations are carried out for the B-600 and X-2000 in the two shops it is not possible to undertake the common use of similar

assembling tools or the rationalization of personnel.

In the case of the X-2000 it is necessary to consider the transfer of the engine, transmission and axle assembly lines of the above operations from their present location to the vehicle assembly shop which has room to spare.

(5) Problems and improvement of layout and material handling

1) Painting line

The in-shop entrance routes for the cab, box and body complete.

Due to the installation of the domestic parts sub-store transportation into the shop along the paths indicated in the original layout is no longer possible. As this transportation distances are long, involving curves and intersection points, a general reduction in safety and material handling efficiency takes place.

It is necessary to re-consider the entire layout of the shop and either do away with or change the position of the domestic parts sub-store.

2) Assembly shop

a) Sub assembly section A : Rear axle assembly shop

The movement of axle completes in the case of the B-600 rear axle between the complete pool area and the conveyer No.0 section is done with manpower. Moreover, the trucks for transportation of the engine block the pathways.

Distance of transportation of rear axle cpt : approx. 15M
No. of workers for rear axle cpt transportation: 2

The carrying of heavy objects by manpower and the blockage of routes by the trucks is extremely dangerous. Assembly operations are interrupted by transportation procedures and this means a lowering of productivity. The gantry and monorail located at the Conveyer No.0 Section needs to be extended by approximately 15 m and changeover from manpower transportation to hoist transportation

needs considering.

b) Sub assembly sections No.1, 2 and A (excluding rear axle completes)

The distances between the sub assembly sections No.1, 2 and A and the destination point for parts supplies and to the final assembly lines are too great (for close points some 40 m and for the furthest points up to 78 meters). Further supply of each particular part by the various operators takes place. Supply of lots in amounts of one day's or a half day's quantity is not possible at present because of the lack of transportation carts.

Walking distances and time involved in the delivery of each completed item individually is great and causes a drop in productivity. Further working operations are often interrupted and there is a lack of concentration on the operations which is a cause of the high frequency of operational misses.

Reconsideration of layout in order to move the sub assembly section close to the final assembly line conveyer needs considering and introduction of transportation boxes and carts to allow the supply at one time of a full days parts is necessary.

c) Assembly shop for the cab, box and seat

At present, there is a pathway of four meters width between the assembly shop for the cab, box and seat and the supply destination of these parts at the conveyer line. Conveyance is thus lengthened by this distance. Further, this path is only used by carts and the operators and hardly any vehicles use it.

As the conveyers and the cab, box and seat assembly shops are distanced material handling efficiency is poor.

As the seat assembly shop and coating room of the painting shop are next to each other smells of paint and thinner are strong and this affects the environment of the seat assembly shop badly.

In order to bring the cab, box and seat assembly area closer to the conveyer it is necessary to examine layout in order to move the route of four meters width to the area between the dividing wall

for the painting shop and the assembly line (Refer to Fig.AI-3-1-7).

(6) Problems and improvements of working equipment

1) Painting line

a) Phosphate treatment devices

Of the 6 machines existing at present only one is in operation because the other 5 were stopped due to breakdown of the burner, and nozzle. The treatment capacity of one machine is shown in Table AI-3-1-3.

Deterioration of the remaining machine in operation is advanced and it is difficult to predict the time when it will breakdown completely. If the remaining set were to breakdown this would result in a situation of production stoppage in the vehicle assembly shop. The treatment capacity of one machine is for 4 vehicles per day only and at present expansion in excess of the present production can not be hoped for. It is necessary to undertake repair evaluation through replacement of all of the phosphate treatment equipment and introduction of repair parts.

b) Coating and drying room for the minibus

The coating and drying rooms are idle because of the ceasing of production for the minibus, and these are used as storerooms. The drying oven burner has been removed and is in use elsewhere. The longer the idle period the more performance suffers, and as parts are used for repairs of other equipment there is a danger that it will be impossible to recommence production. It is necessary to examine the installation of a new drying oven burner and the total layout of the coating shop needs consideration. In particular its adaptation to use for drying and painting of the B-600, X-2000 and T-2000 needs to be considered.

c) Vibration coating room

Coating takes place with the air intake and exhaust device in a state of deterioration and the control panel out of order. Due to

the reduction in the performance of the air intake and exhaust ducts the fumes of paint and thinner are trapped in the coating room and creates an unsanitary and poor working environment.

It is necessary to undertake replacement of the air intake and exhaust devices and control panel.

d) Vibration coating equipment

Due to deterioration of the mixing tank, pump and spray gun coating capacity is reduced. As the spreading of paint material is not even, areas with thin, thick coating and uncoated areas result and the sound-proofing of the vibration coat is reduced. Coating takes too much time, and productivity is poor.

It is necessary to replace the tank, pump and spray gun equipment.

e) Carts for exclusive use of cab, box and body

There are a large number of special use carts which are out of use because of deterioration or breakdown (Refer to Table AI-3-1-4). Deterioration of twenty six carts in operation is advanced, with the wheel rubber deformed and worn, and the bearing of the supporting shaft worn. Wheel deformation and wear on the supporting shaft (steering axle) leads to a lowering of carriage efficiency. Repair and re-use of all operating and damaged carts is necessary.

f) Hot blast drying oven

Damage due to deterioration of the drying oven duct and rusting of the outer panels of the oven has occurred. In the event of a breakdown of the drying oven production in the entire vehicles assembly shop will completely cease. Therefore prompt replacement of the duct and panel is needed.

2) Vehicles assembly shop

a) Conveyer No.0 section

0.5 ton hoist: 1 set

Deterioration is advanced and the magnetic starter often breaks down. Repairs take 2 to 3 months when this happens and the B-600, X-2000, and T-2000 axle completes and main frame completes are carried using manpower during that period. As the materials are heavy 2 to 3 workers are required and regular work is suspended for this, resulting in reduction of productivity. The carriage area is on the conveyer, which has poor foothold and is dangerous. Replacement and provision of repair parts for the present hoist are needed.

b) Conveyer lines No.2, 4 and 8 sections

0.5 ton hoist: 3 sets

Deterioration is advanced with the single line wiring cut, twisted, and hooks worn because of lack of oil. This can lead to human accidents. When breakdown occurs there is no replacement and repairs require time. Reliance on manpower is inevitable and this would lower productivity.

c) Tire assembly area

Wheel balancing machine:

No wheel balancing machine is used after the assembly of the wheel and tire to test and adjust the wheel balance. There is therefore a danger that wobbling motion will arise at high driving speeds, and this is both dangerous and leads to reduction of finished product quality. It is necessary to stipulate the replacement of the wheel balancing M/C and the use of the balancing machine.

d) Testing lines

1. The headlamp tester

Because of breakdown of the condenser adjustment device of the headlight tester this can not be used.

In driving during night time, the focal points of the right and left headlights do not meet and the model image suffers because

of inconvenience caused to oncoming drivers.

2. brake tester

The brake testing indicator is out of use because of its functional defect and deterioration. There are discrepancies between the indicator's reading for each time the brake is used. The driving tests are dangerous because they are carried out without checking of defective braking and with unexplained oil leakage. Replacement of the brake testing indicator is necessary.

3. Speedometer tester

The air lift of the speedometer does not completely work and this is not used. The air lift does not rise after the finish of the vehicle speedometer test and so cannot be extracted from the tester. For this reason it is unused and testing of the speedometer performance cannot be done. The overhaul or replacement of the air lift is necessary.

e) Shower tester

Shower tester cannot be used because of breakdown of the water pump and motor. Lowering of finished product quality is expected as the vehicles are completed without confirmation of rain leakage into the cab area. Replacement of the water pump and motor is needed.

f) Paint touch-up area

1. Spraying booth

The wall surface of the coating room is idle with filters for upper surface unattached. As coating takes place outside of the coating room this leads to a worsening of environment thereabout, and may cause lowering of quality of other completed vehicles nearby through paint flying or spreading. Introduction of roll filters and their use in the spraying booth is needed.

2. Infrared drying device

The bulbs of the 4 group infrared drying device are burned out and the device's drying capacity reduced because of deterioration. Drying is time consuming because of drop in drying temperature. Thorough counter measures to reduce the reject rate to zero are needed but for the time being in order to strengthen the drying capacity the introduction of one additional infrared red drying device should be considered.

g) Two ton hoist and gantry crane of the minibus assembly plant

Because production of the minibus has stopped the hoist, gantry and pit are idle. Use of parts for other hoists and long disuse lead to decrease in performance. Re-examination of the general layout of the vehicle assembly together with activation plans are needed.

h) Sheet assembly work area

Sewing machine:

Of the 8 machines in stock 3 are idle because of breakdown. Provision of repair parts is difficult because the model is old. The present production output (including the X-2000 hood for dispatch purposes) can be handled with overtime working. However, production capacity will not permit increase of output. Replacement of the 3 broken machines is needed.

i) Tools and measuring devices for assembly and retouching operations

Because of deterioration of clamping tools such as impact wrenches, sockets, spanners, screwdrivers, etc., worn tools are used. Wear on the interior of the impact wrench results in inadequacies of the clamping torque. Wear of spanners and screwdrivers results in lowering of both quality and production with damage occurring to bolts, hexagon nuts, and screw heads. Replacements and supplements of these tools and measuring devices are needed.

Tools indicated for use in assembling parts are not used. For example use of a rubber (plastic) hammer for the insertion of the transmission shaft is indicated but a metal one is used. This

means retouching of damaged shaft ends is needed and quality and productivity suffer. Use of specified tools must be emphasized and supplements provided.

Breaks in the air hose and damage to junctions result in air leakages in several places. This leads to insufficient clamping of the torque because of lowering of air pressure, burden on the compressor, and increased electric consumption. Replacements and supplements are needed.

Deteriorated and inaccurate torque wrenches, engine tachometers, and timing lights, etc. are used. As the measuring accuracy is not guaranteed measurements have little reliability and quality suffers. Replacements and supplements are needed.

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

1) Vehicles assembly shop

a) Testing lines

Adjustments of B-600 toe-in, camber angle and caster are difficult compared to those for the X-2000 or T-2000 because the support system for the front axle of this is of an independent hanging frame type and this means that adjustments require considerable time. B-600 models which have instabilities in handling during the test run and require re-measuring or re-testing are returned once again to the testing line.

Time for Measurement, Adjustment and Retouching the Toe-in, Camber and Caster

	Measuring and Ajusting Time	Retouching Time
B-600	30 min.	30 min.
X-2000	20 min.	-
T-2000	20 min.	-

Almost no retouching is involved with X-2000 and T-2000.

The test line, where adjustments of the toe-in, camber and caster of vehicles coming off the conveyer should take place in principle,

is often disturbed by the retouching operations for the B-600.

In order to have re-adjust the toe-in, camber and caster take place off the line and to avoid having cars re-enter to the test line the introduction of the following supplementary gauges should be considered:

- toe-in gauge
- a portable turning radius gauge
- magnetic camber and caster gauges

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

1) Press parts from the No.1 HI press shop

There is no attention given to the occurrence of damage or wastage rates during assembly of the small parts received from the same shop, which are sent in quantity 10% above the production schedule quantity. Since adjustment of orders to the press shop on the basis of stock inventory and remaining stock in the assembly shop does not take place the increased 10% quantity of parts piles up and the number in store augments. In order to store them, a LP sub-store has been set up inside the shop.

Unusable Rusted and soiled parts were evident because of the long storage. Considerable loss of press processing, storage management, space, and finances are involved. The following improvements should be considered:

- stopping the 10% over production
- implementation of a monthly stock inventory system
- inspection of parts stored in the LP sub-store and discovery and disposal of parts rusted, obsolete, or defective
- construction of the press shop near to the No.4 HI vehicles frame shop.

(9) Problems and improvements of product dispatch

None in particular.

3-1-3 Analysis of Products Quality

(1) Occurrence of rejects

1) Coating shop

The cabs, boxes and body completes brought from the vehicles frame shop all have rusted. So before surface treatment sand paper or barb is used to remove rust. An increase in frequency of removing rust leads to a reduction of productivity and a worsening of quality in coating.

Possible improvement measures for this state of affairs may be as follows:

a. undertake a policy of first in first out for materials in the press shop

b. practice storage maintenance of materials

c. avoid using rusted materials in the molding processes.

d. ensure sufficient rust prevention in the press shop

e. ensure that delivery from Rangoon to No. 4 HI in the rainy season is carried out with sufficient water proofing.

f. avoid direct placing on the ground.

g. undertake training of workforce to increase awareness of the importance of finished product quality

2) Vehicles assembly shop

The reject rate for vehicles coming off the conveyer is 100%. All of the vehicles come off the conveyer with inadequacies of assembling or incomplete fixing of parts. So the time involved in processes for re-

touching or fixing of missing parts is far greater than processes of assembly as can be seen from Table AI-3-1-5.

The missing parts situation for B-600 and X-2000 is shown in Table AI-3-1-6.

(2) Problems and improvement of product quality standards and inspection methods

1) Coating shop

Painting inspection area and lighting device

The existing four lighting devices have fluorescent tubes removed and are idle. Inspections take place using only the ordinary shop lighting. The inspection area is not bright even in daytime. In rainy conditions lighting conditions are worse, so that without lighting devices inspection of the paint coating is difficult. Such an inspection system without proper lighting results in an increase of the reject rate of vehicles coming off the conveyer and is a factor causing the lowering of product quality.

Renovation and use of the existing lighting devices is necessary.

2) Vehicles assembly shop

a) Clamp torque maintenance

Checks of the clamping torque are only occasionally conducted, but since no records are kept the actual situation is unclear.

Further at present there is no inspection system to maintain and guarantee the precision of the torque wrenches. Even if temporary torque checks are occasionally carried out, torque wrenches of inferior precision are used then maintenance and improvement of product quality is impossible. It is necessary to repair the tore wrenches and other measuring devices, set up the inspection and measuring system, and train engineers for repair and inspection.

b) Quality of B-600 finished vehicle

As this model was introduced some 24 years ago it is inferior to recent models in appearance, engine performance, operatability, comfort, and product quality. As a general use car it does not satisfy the needs of the Burmese consumers. Particularly when driving at full throttle the engine is very noisy because of lack of power and this gives a bad impression. The seating space is cramped and gives the user an uncomfortable and claustrophobic feeling. The dissatisfaction of users is seen in the growing tendency to buy second hand cars from abroad. It is necessary to consider a model change by using existing production equipment to full limits in order to widen the body and extend the wheel base. Changeover to a water cooled substitution engine, which has more engine power and makes less noise, and also change of materials for the seat cushion rubber to those having standard specification thickness and elasticity must be considered.

3-1-4 Maintenance of Production Equipment

The Electric and Service Department of HIC Main Office is stationed at No.4 HI and is responsible for the maintenance of each of the shops. The sphere of the department's activities is limited to maintenance of electrical areas. Present organization and equipment is limited and repairs of equipment are time consuming. So it is necessary to consider having maintenance personnel sent from the department stationed in each shop and installation of necessary equipment.

3-1-5 Products Design

The Path Finder is a remodeled X-2000 with an extended wheel base by 500mm length and with body independently developed by HIC. Between 1986 and 1987, nineteen cars were produced and dispatched. However, there are quality inferiorities of body parts, interiors, vibration and squeezing in running, compared to common cars. As the main frame extension and, body extension parts are hand worked improvements in quality and productivity is difficult. It is considered necessary to set up a shop capable of producing its own press jigs for converting hand work to press work, and welding machine tools for improving workability of welding, and undertake the training of engineers and create a general production system.

Table AI-3-1-1 RM AND CP PROCURED (VEHICLE ASS'Y SHOP)
- Apr., 1987 to Jan., 1988 -

Model	M.C.Store(II)	Engine·T/M, Axle Ass'y Shop			Body Ass'y Shop			
	Imported CP*	Engine CP	Differential Gear/Carrier	Axle CP	Cab Ass'y	Body Ass'y	Box Ass'y	Frame CP
B600	310	350	350	-	390	-	359	382
X2000	201	226	-	226	-	187	-	194
T2000	142	109	-	-	-	-	110	-

Note: * Up to Dec., 1987.

Table AI-3-1-2 ACTUAL PRODUCTION

Apr., 1986 to Mar., 1987

Model	1986									1987			Total
	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	
B600 Series	56	50	6	70	36	55	55	40	20	35	41	38	502
X2000 Series	2	14	8	41	21	13	26	14	16	32	20	17	224
T2000 Series	4	17	23	56	20	47	12	29	62	7	6	25	308
	62	81	37	167	77	115	93	83	98	74	67	80	1,034

Apr., 1987 to Dec., 1987

Model	1987									Total
	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	
B600 Series	15	33	27	29	41	39	28	42	56	310
X2000 Series	12	22	28	9	29	32	29	26	14	201
T2000 Series	12	9	29	15	31	27	10	2	7	142
	39	64	84	53	101	98	67	70	77	653

Table AI-3-1-3 TREATMENT CAPACITY FOR A SINGLE PHOSPHATE COATING DEVICE

Tank	Liquid Type	Injection Qty/1 time	Treatment Capacity
Tank Blue	Phosteam #88L	2000cc	4 B600 Cabs/Day
	Phosteam Solvent #88	800cc	or
	Ridosol	70cc	4 B600 Boxes/Day
	Water	150ℓ	or
			2.5 X2000 Bodies/Day
Tank Yellow	Deoxylite Solution	195cc	or
	Water	150ℓ	3.5 T2000 Boxes/Day

Table AI-3-1-4 ACTUAL STATE OF CARTS IN STOCK

For Use	Cart Size (mm)	Number Operating	Damaged/ Idle
B600 Cab, Box	2,050 x 900	5	3
X2000 Body	3,150 x 900	21	7

Table AI-3-1-5 WORKING TIME BY PROCESS

(Unit: Hour)

Model	Painting	Assembly	Touch-up
B600	8.25	4.30	22.0
X2000	8.25	4.30	18.0

Table A1-3-1-6 LIST OF PARTS IN SHORTAGE

B600

Part No.	Part	Q'ty (in No. of Vehicle)	Mfrg. Shop	Shortage (in No. of Vehicle)	Reason of Shortage
3360 42 020	Oil Tank Ass'y	1	Body Shop	23	Delay of Press Parts
3300 42 430	Cap Ass'y/-Filler	1	Press Shop	33	
3360 58 110	Sash-Door	1	Body Shop	33	Delay of Press Parts
3360 59 110	Sash-Door	1	Body Shop	33	Delay of Press Parts.
0111 69 211	Inner Box	1	Press Shop	32	

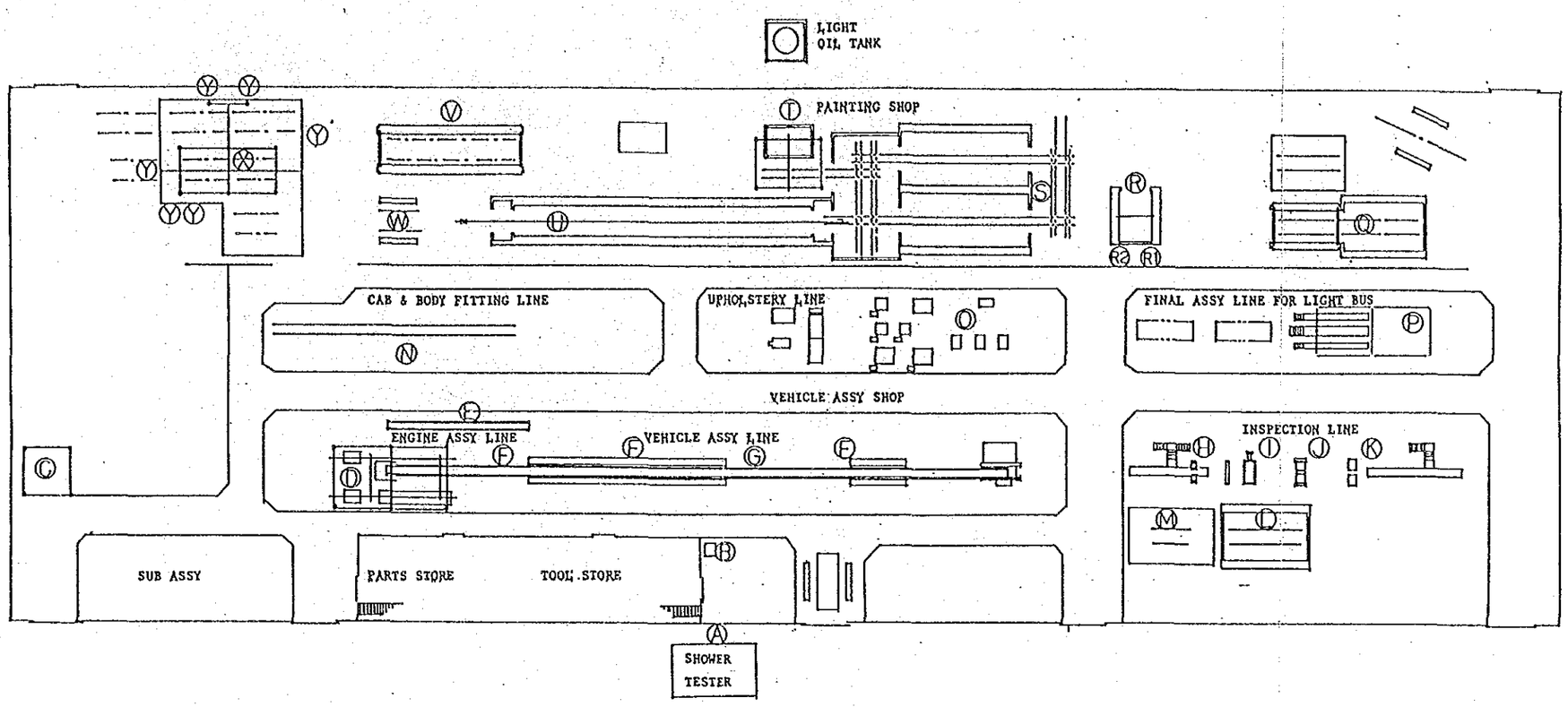
X2000

Part No.	Part	Q'ty (in No. of Vehicle)	Mfrg. Shop	Shortage (in No. of Vehicle)	Reason of Shortage
3341 57 250	Sub Seat-Back	1	Body Shop	35	Delay of Press Parts
3341 57 600	Sub Seat-Cushion	1	Body Shop	35	Delay of Press Parts
0647 58 560	Lock Hook-R	1	Body Shop	40	Delay of Press Parts
0647 59 560	Lock Hook-L	1	Body Shop	40	Delay of Press Parts
0647 65 860	Shatter Holder	1	Body Shop	25	Delay of Press Parts

T2000

	Shortage (in No. of Vehicle)
- Waiting for CPs failured in assembly works in assembly shops of engine, transmission and axle.	13
- Under retouching.	5

Figure AI-3-1-1 LAYOUT OF PAINTING & VEHICLE ASSEMBLY SHOP



Code	Equipment	Qty	Condition: Deterioration	Condition: Failure	Condition: Idle	Remarks
Ⓐ	Shower Tester	1		X		Water pump damaged and removed.
Ⓑ	Wheel Balancer OWB-4500	1			X	Accuracy is not known.
Ⓒ	1 Ton Hoist & Gantry	1	X			Wire rope wires are broken.
Ⓓ	0.5 Ton Hoist & Gantry	1	X			Magnet starter is repaired temporarily, with broken wire cover or without wire cover.
Ⓔ	Roller for Engine Complete Assy	1			X	Removed.
Ⓕ	0.5 Ton Hoist & JIB Crane	3	X			Wire ropes are with broken wires or twisted.
Ⓖ	Slat Conveyer	1				No Lubrication on chain, Driving gear, etc.
Ⓗ	Head Lamp Tester	1		X		Condenser of light lay can not be adjusted.
Ⓘ	Slide Slip Tester	1				
Ⓙ	Brake Tester	1		X		Indication of meter is not consistant.
Ⓚ	Speed Meter Tester	1		X		Free roller lift is malfunctioning so that removal of vehicle is difficult.
Ⓛ	Spraying Booth	1		X	X	Filter on the wall is missing.
Ⓜ	Infrared Lay Dryer	4				Two each bulbs are off.
Ⓝ	Roller Conveyer for Cab & Body Complete	1				
Ⓞ	Sewing Machine	8		X(3)		Three sets are failed from deterioration but no spare part is available.
Ⓟ	2 Ton Hoist & Gantry	1			X	For micro bus.
Ⓠ	Spraying Room & Drying Oven	1		X	X	Drying oven burner is removed and missing.
Ⓡ	0.5 Ton Hoist Vibration Paint Booth	1	X			Booth wall around filter is damaged.
Ⓡ1	Paint Mixer & Pump	1	X			Vibration painting machine capacity decreased.
Ⓡ2	Control Panel	1		X		Damaged.
Ⓢ	Painting Booths	1				Water circulation pump in preparation area is out of service.
Ⓣ	Dipping Tank & 0.5 Ton Hoist	1			X	Out of service. "R" is being used for black painting of frame.
Ⓤ	Drying Oven	1	X			Wall partially damaged, rust and holes on duct, fan belt is missing.
Ⓥ	Ditto	1				
Ⓦ	Illumination	4			X	Fluorescent lamps are removed. Structure is idle.
Ⓧ	1 Ton Hoist & Gantry Surface Treatment Area	1			X	Filter on the wall is removed.
Ⓨ	Phosphaping Treatment	6		X(5)		Burner, nozzle, etc. are failed and removed.
	Hand Truck for B600 Box, 2050X900	8		X(3)		Wheel and axle are failed.
	Ditto for X2000 BODY 3150X900	28		X(7)		Wheel and axle are failed.

Figure AI-3-1-2 VEHICLE & PAINTING SHOP ORGANIZATION

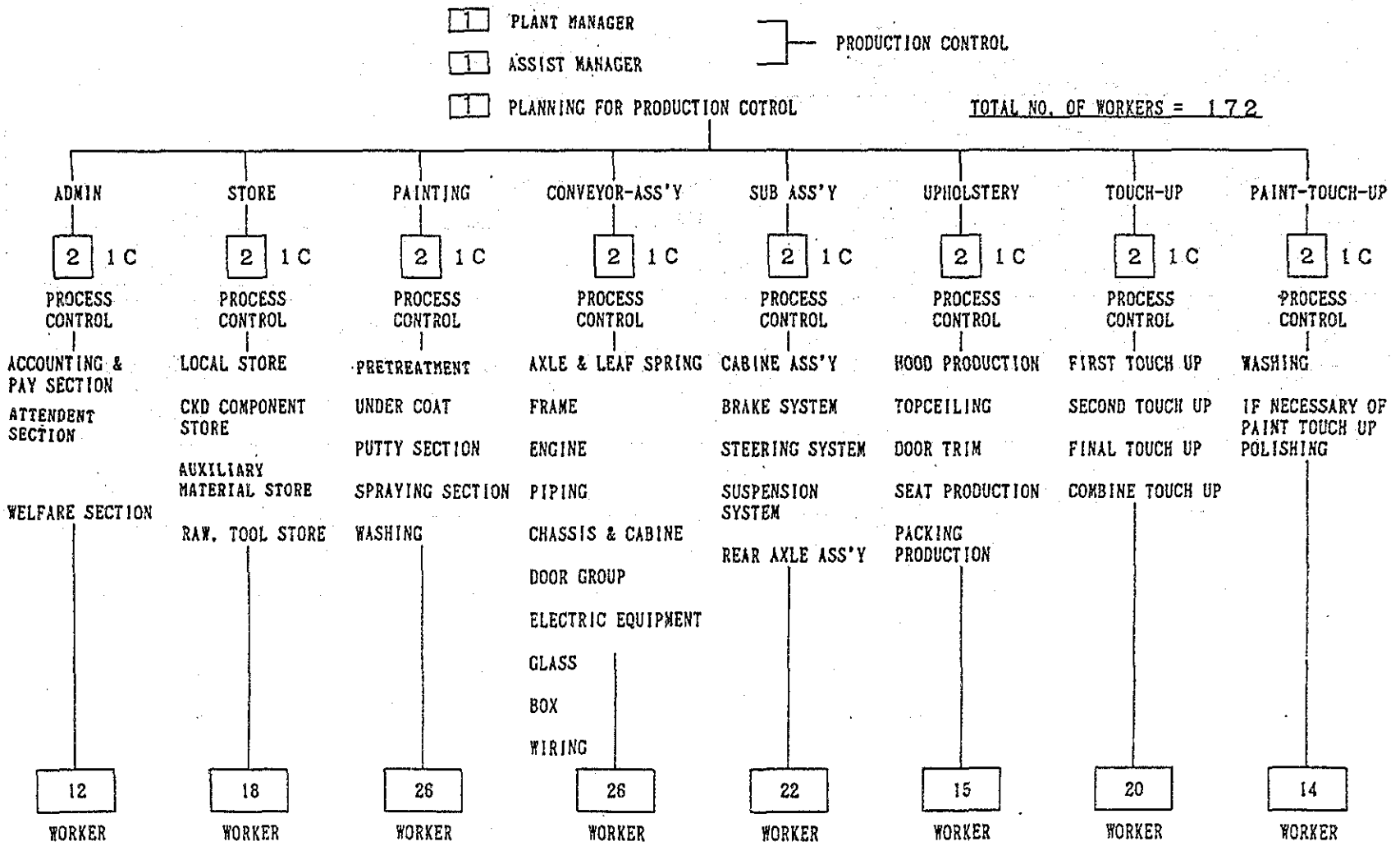


Figure A1-3-1-3 PAINTING SHOP

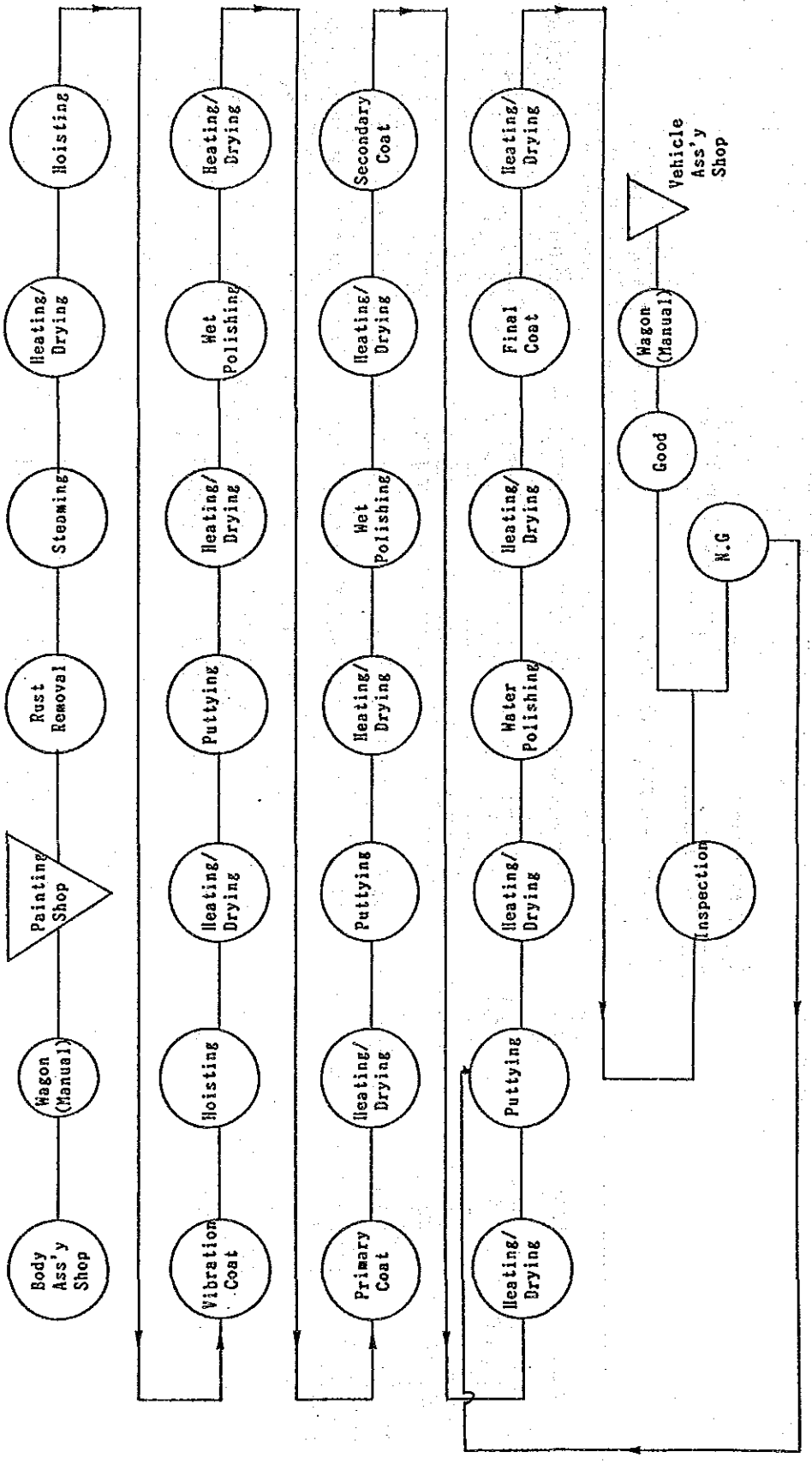
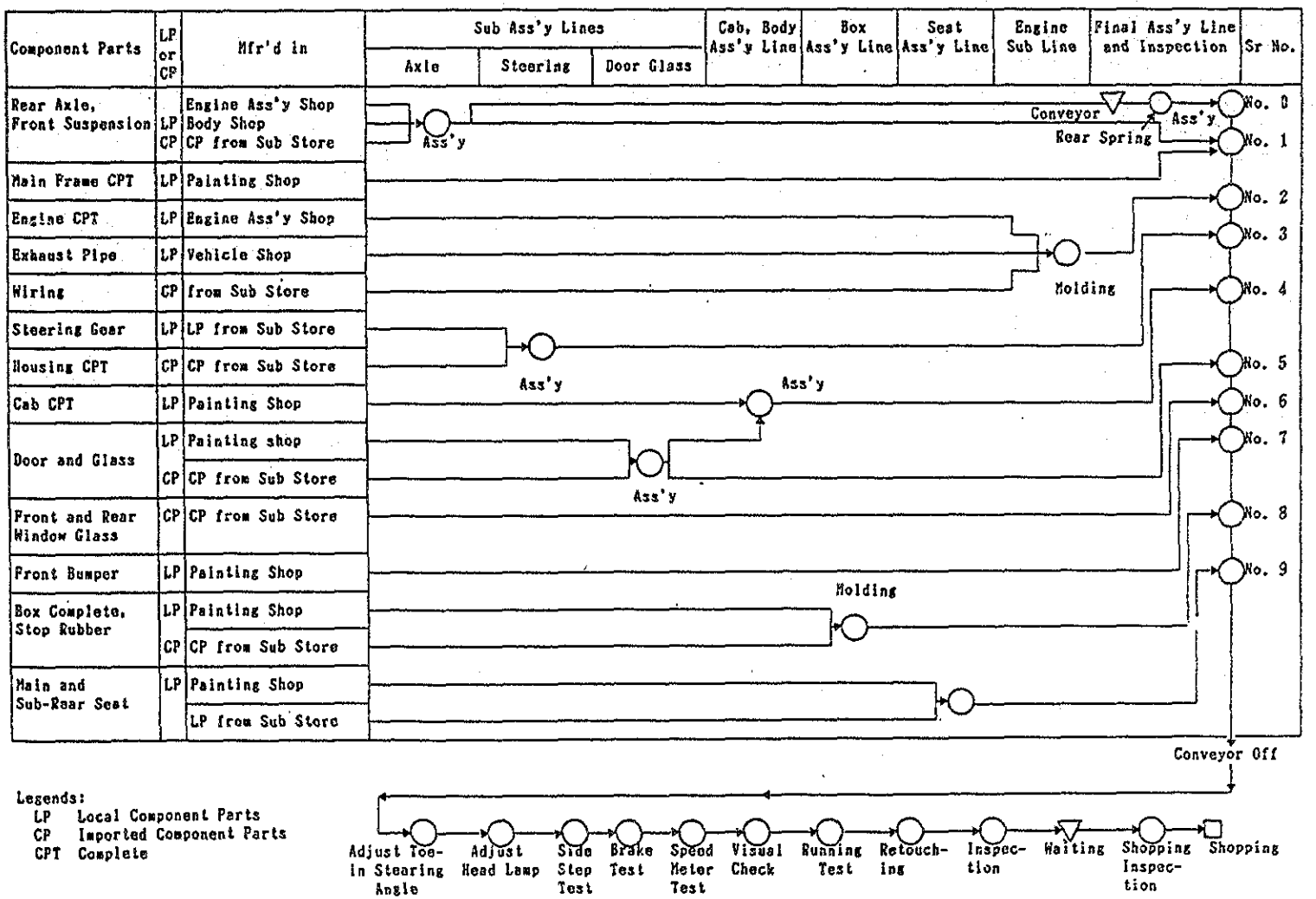


Figure AI-3-1-4 VEHICLE ASSEMBLY SHOP

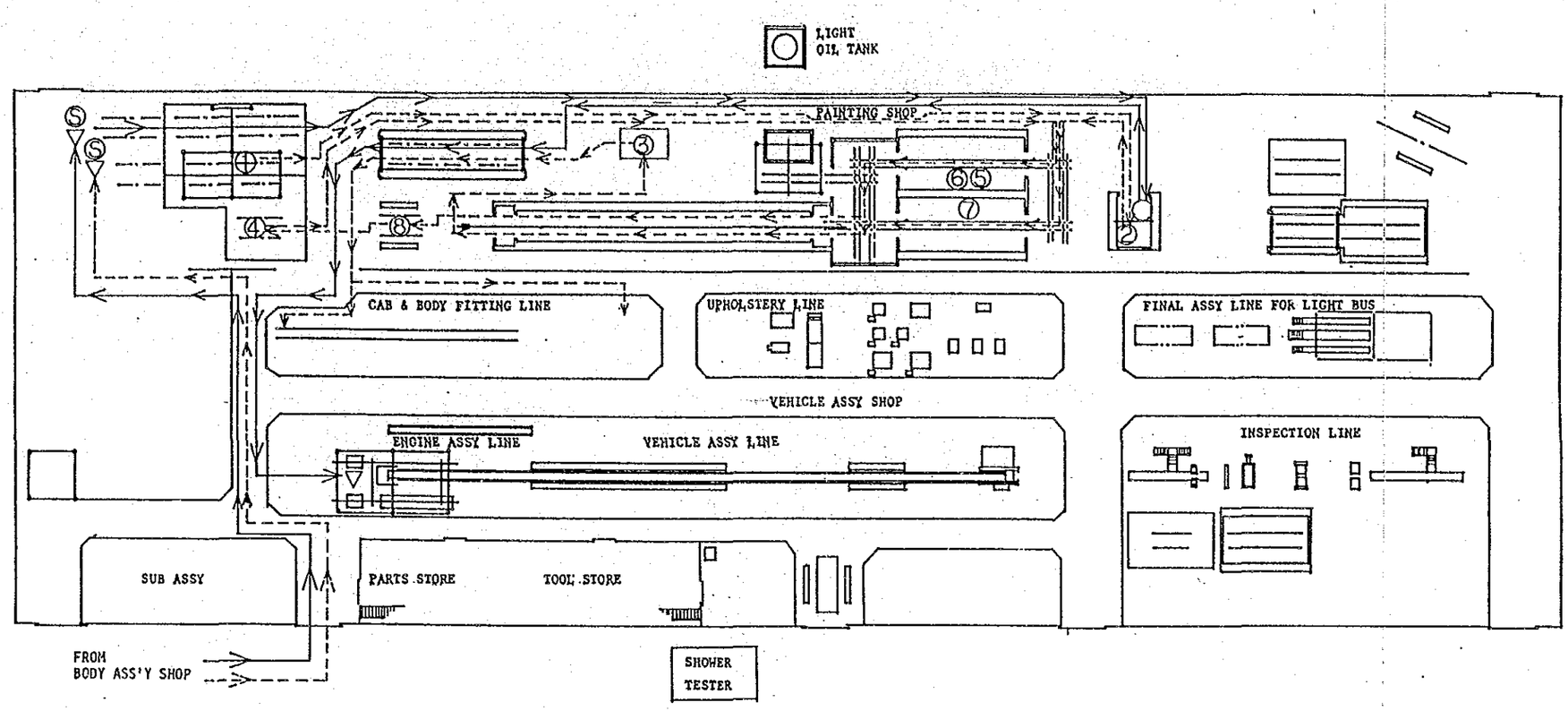
Component Parts	LP or CP	Mfr'd in
Rear Axle, Front Suspension	LP	Engine Ass'y Shop
	LP	Body Shop
	CP	CP from Sub Store
Main Frame CPT	LP	Painting Shop
Engine CPT	LP	Engine Ass'y Shop
Exhaust Pipe	LP	Vehicle Shop
Wiring	CP	from Sub Store
Steering Gear	LP	LP from Sub Store
Housing CPT	CP	CP from Sub Store
Cab CPT	LP	Painting Shop
Door and Glass	LP	Painting shop
	CP	CP from Sub Store
Front and Rear Window Glass	CP	CP from Sub Store
Front Bumper	LP	Painting Shop
Box Complete, Stop Rubber	LP	Painting Shop
	CP	CP from Sub Store
Main and Sub-Rear Seat	LP	Painting Shop
		LP from Sub Store



Legends:
- LP Local Component Parts
- CP Imported Component Parts
- CPT Complete

Note: The assembly lines of B600, X2000 and T2000 in the shop are similar to each other. Therefore, the flow chart show in this figure refers to that of B600 and represents those three processes.

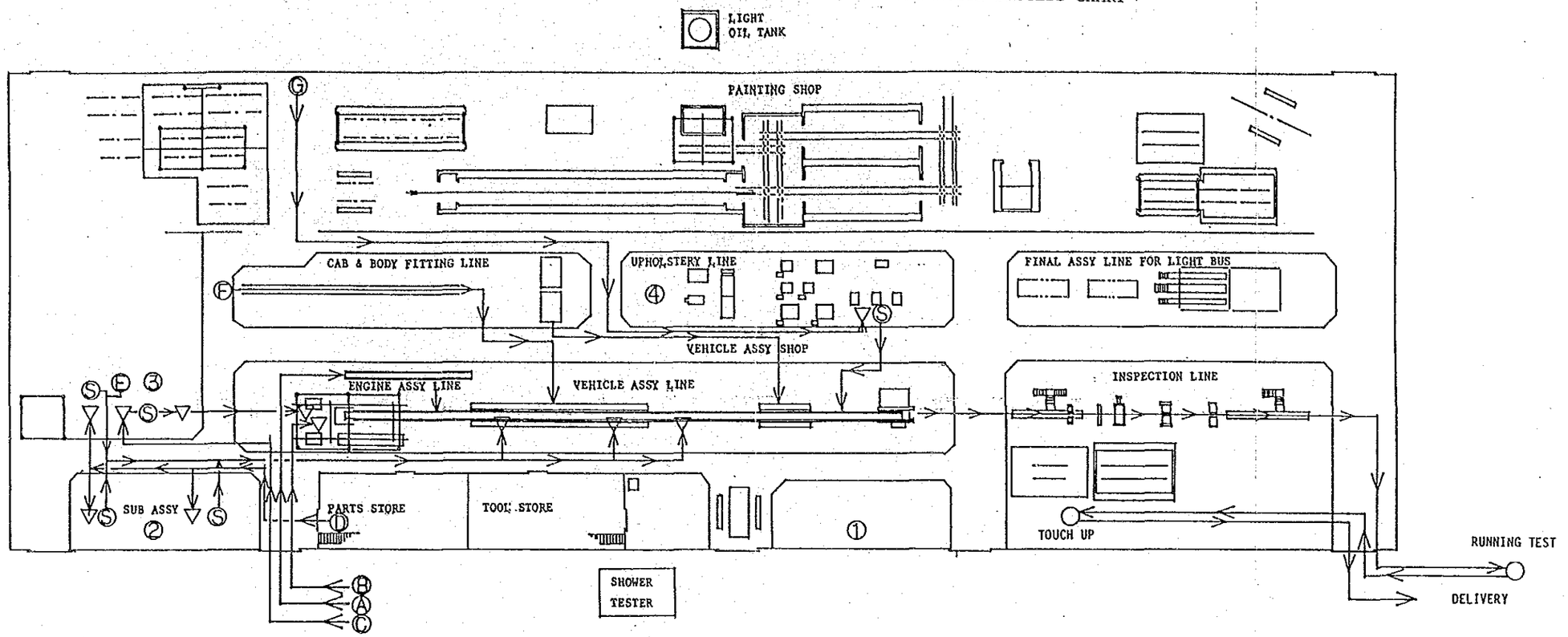
Figure AI-3-1-5 FLOW CHART OF PAINTING SHOP



Legends

1. Continuous line B600 and X200 Frames
2. Dotted line B600 Cab Box
3. Marks
   - ⑤: Rust removal of cab, body and box
   - ①: Surface treatment-- **steam cleaning
   - ②: Vibration spray painting back of cab, body and floor
   - ③: Puttying surface of cab, body and box
   - ④: Surface rubbing with water and emery paper
   - ⑤: Painting of the first coat
   - ⑥: Painting of the second coat
   - ⑦: Painting of the final coat
   - ⑧: (If passed the inspection)-- to cab & box assy line
     (If rejected)-- to return to a step ③ to ⑦
4. Transferring from Body Assy Shop: One unit is put on each hand truck and moved by 2 to 3 workers.
5. Quantity transferred from Body Assy Shop: Determined on the production schedule assigned to Painting and Vehicle Assembly Shop
6. Timing of Transferring from Body Assy Shop: In the evening 2 days before or morning 1 day before the day the assembly work is scheduled.

Figure AI-3-1-6 NO.4 HEAVY INDUSTRY VEHICLE ASSEMBLY SHOP OPERATION PROCESS CHART



WORK FLOW CHART OF ENGINE, AXLE DIFFERENTIAL GEAR CARRIER COMPLETES

LINE Ⓐ: FLOW Of B600 , X2000 and T2000 engine completes
LINE Ⓑ: Flow of X2000 axle complete
LINE Ⓒ: Flow of B600 differential gear carrier complete
LINE Ⓓ: Flow of domestic products of small-sized component parts of vehicles from substore to sub-assy line
LINE Ⓔ: Flow of domestic products of small-sized component parts of vehicles from sub-assy line to the final assy line
LINE Ⓕ: Flow of cab, body and box completes of vehicles to the final line
LINE Ⓖ: Flow of painted seat frame

Ⓢ: Sub-assy of small-sized component parts
①: B600, X2000 and T2000 tire and wheel assy line
②: Sub-assy area

Major component parts:

B600	X2000
Idle & pitman arm	Acceralator pedal
Steering housing	Hand brake lever
Center link	Transmission cover
Propeller shaft	Master cylinder & bracket
Axle and brake pedal	Steering gear
Door sash & glasses	Front door sash & glass

③: Sub-assy area

Major component parts:

B600
Rear axle complete
Front suspension complete

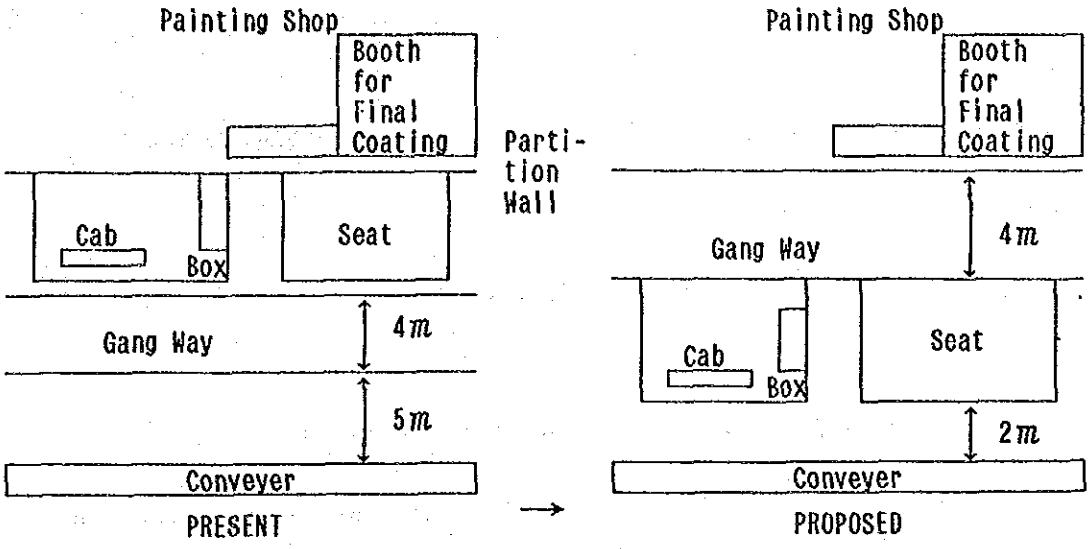
④: Seat assy area

Major component parts

B600
Front and main subseat
Back seat

X2000
Front seat
Back seat
Road carrying platform hood

Figure AI-3-1-7 PRESENT AND PROPOSED LAYOUT OF PAINTING SHOP



3-2 Body Assembly Shop

3-2-1 Outline of Processing

(1) Working equipment and its layout

The working equipment and its layout is shown in Fig.AI-3-2-1.

(2) Organization and personnel

Organization is shown in Fig.AI-3-2-2
The total personnel is 181.

(3) Raw materials, parts and their supply performance

Table AI-3-2-1 shows the supply performance for raw materials and parts for the period from April 1987 to January 1988.

(4) Production performance and production capacity

Table AI-3-2-2 shows the production performance from April, 1987 to January, 1988.

As there are no machines or devices which form the productive base for production capacity in this factory, the human factor is decisive in determining productive capacity. The original productive capacity of the factory was planned for a level indicated in Table AI-3-2-3. Table AI-3-2-3 productive capacity (HIC estimate row) gives estimated figures for the reduction of efficiency rates due to deterioration or breakdown of the portable spot welder, welding machine, AC welder, drilling machine, etc. However, the origin of these estimates is not clear.

3-2-2 Analysis of Production Processing

(1) Outline analysis of processing

The Table analyzing the processes for the X-2000 Body complete is shown in Fig.AI-3-2-3.

The Table analyzing the processes for the X-2000 main frame complete

is shown in Fig.AI-3-2-4.

(2) Flow charts

The flow chart for the B-600 and X-2000 main frame complete refer to Fig.AI-3-2-5.

The flow chart for the B-600 cab and X-2000 body complete refer to Fig.AI-3-2-6.

(3) Problems and improvements of the manufacturing methods and processing chains for the main finished products and parts

1) Temporary anti-rust coating area for the B-600 and X-2000.

A temporary anti-rust coating area is installed at the side of the LP sub-store in the shop, and anti-rust treatment for the B-600 and X-2000 takes place here. ORGA TO 758 GREY (Nippon Paint) is used as coating material and this is dried naturally. Distance from the sub assembly shop for the above parts to the temporary anti-rust area, and from the anti-rust area to the B Section jig assembly is 150 meters and transportation is by manpower with carts.

Natural drying of the ORGA anti-rust paint, which requires artificial drying, results in pin holes and cracking because of the dust which sticks on at drying or oil soiling during assembly, and this reduces quality severely. Urgent attention to the above is needed.

Putting an end to coating with the ORGA TO 758 GREY should be considered.

There are a number of factors such as press processing with rusty materials, methods of anti-rust treatment (oil coating in the press shop), transportation distances, number of supply lots, timing of supply, importation of raw materials, timing of imports, and maintenance after import, which cause rusting. It is necessary to resolve all of these problems. In particular the effect of press processing with rusted materials, anti-rust treatment, transportation, and supply quantities are significant and thorough consideration of counter measures to these problems is required.

2) Main frame welding shop: F and G sections

As the frame welding jig and distortion adjusting jig for B-600 and X-2000 are installed through the F and G sections gangway. The moving between the jigs takes place with carts or manpower, and distance is long. Safety of the heavy objects transportation route, as well as increase of process stages decreases the productivity. It is necessary to reduce the space for the local component parts sub-store inside the shop and change the layout so that the welding and distortion adjusting jigs are next to each other. However use of a gantry hoist for transportation to the jigs should be considered.

3) Temporary maintenance of the received parts and sub assembly parts

Most of the parts supplied by the local component parts sub store are placed on the floor near to operating benches. Parts which have been assembled by welding are also placed on the floor and are loaded into carts at dispatch time. This is a cause of rust and leads to a reduction in quality. Also the placing of parts near the operating benches is dangerous. Introduction of a supply boxes, pallet truck, palette, hand lifts, finder and special carts, etc. Temporary shelving instead of placing on the floor, and change of transportation methods need to be considered. Also layout needs to be changed to allow a shortening of transportation distances.

4) Grinding of the spot welder chip nose

Grinding of the chip nose is not regular but takes place according to amount of welding or when the nose is not usable. Defective lots and rejects are difficult to follow up. Measures to increase quality are difficult. A system making regular grinding of each welder and the records of this compulsory is needed.

(4) Operational procedures and division of labor: problems and improvements

1) Section G: X-2000 main frame for Path Finder

After cutting, the side members of the frame for the X-2000 which are conveyed from the press shop are joined by 500mm and then welded using a jig, drilled processed with a special assembly jig, and then

processed by the distortion rectifying jig. After completion of these jig processes the product is completed. Cutting, joining, and welding are time consuming and productivity poor. The joining and welding of parts is poor and looks inferior.

The four sets of the Path Finder have been exported and more orders received. The installation of press jigs for large type pressing and frames is needed in order to expand the number of exports.

2) B-600 and X-2000 press parts

As pierced press jigs are not provided drilling operations in the frame are frequent. These drilling operations for small press parts are largely done with an upright drill YUD-60 machine of G section. There are 48 parts for the B-600, and 122 parts for the X-2000 which require drilling. Processing of drilling operation with a drilling machine has a lower productivity when compared to press processing. As the drilling of small parts is concentrated on the YUD-60 machine bottlenecks occur and productivity is lowered. Installation of extra drilling machines is considered advisable with the given output.

(5) Problems and improvement of layout and material handling

1) Inside the shop: material handling for each section

The carts for transportation between sections are superannuated and there are not enough because of damaged wheels, etc. The shortage due to deterioration and required quantity of wheels for maintenance are as indicated in the following table:

Type of Cart	Size	Qty. out of order	Wheel Req'd	
			Free	Fixed
Standard H-1	1200 X 800	3	-	-
Standard H-2	900 X 598	4	-	-
Cart	1539 X 1120	39	78	78

Manpower transportation results in limiting of transport loads, increase in number of loads, and detriment to operating efficiency and material handling rates.

Along with the increase in number of loads is stoppage of operations and hindrance to concentration on operations which has the danger of increasing the reject rate.

Purchase of spare cart wheels and repair and re-use of carts together with the re-consideration of the layout to realize more efficient material handling is a necessity.

2) Materials handling from the car body shop to the vehicles assembly shop.

Cabs, Boxes, and Body Completes are loaded onto the special carts some two days before the assembly shop's scheduled assembly day in requested amounts and pushed to their destination by 2 or 3 workers. Conveyance distance is 500 m x 2. There are 18 carts in stock for exclusive use. Of these 10 are operating and 8 are idle in the LP sub-store, and four of these latter are without wheels. Productivity is impaired because of stoppages due to transportation (for one cart 30 min. x 3 workers = 1.5 hrs lost). Material handling is bad because done with manpower. Transportation time is particularly affected by rainy conditions. Spare parts must be introduced, and effective re use of the four idle carts undertaken. Use of fork lift to draw carts should be considered.

(6) Problems and improvement of the equipment

1) B-600: welding jigs for the main frame

The great height of the welding jig and the fact that it is not rotational makes operating efficiency poor. The welding of the upper surface of the main frame and that for the lower surface is done with different jigs so that the preparations involved in changing the welding devices ar time consuming. Conversion of the present jigs to rotary type and modifications in the layout are necessary.

2) B Section: floorboard of B-600 and X-2000, welding jig

According to the daily production schedule jig changing preparations for the 2 jig carts for the B-600 and for the 4 welding jigs for the X-2000 are involved in welding assembly. The jig carts for these welding jigs are without brakes and movement of the carts is dangerous. Setting of the jigs is time consuming and time is lost. A re-consideration of the layout is necessary in order to arrange for securing of the welding jigs for the B-600 and X-2000 to the floor and replacement with wheels with braking devices should be considered.

3) 0.5 ton hoist in the cab complete pool

The 0.5 ton hoist is idle because of a defective magnetic starter. Conveyance of the cab, box and body completes is done with manpower using carts.

Movement of heavy materials with manpower is dangerous. As operations are halted for transportation this hinders productivity.

Replacement of the hoist is needed. The state of disrepair and defective parts of the similar model hoist in stock of No.4 HIC jigs should be evaluated and provision of spare parts considered.

4) AC arc welder

The noise of the AC Arc welder in present use is abnormally great. Its welding performance is poor. As welding time is long a decrease in product quality and productivity results.

Replacement of all the welders and provision of spare parts is needed.

5) Shearing machine of G Section (made by Tomita Iron Works)

The gap between cutting edges is adjusted to the thickness of materials being cut. However the gap changes during cutting operations and this results in defects to the cutting surface.

Re-touching operations result in a loss of productivity and waste of materials. Evaluation of the possibility of replacement or repair and stock taking of spare parts should be done.

2) Pipe bender of B section (TYPE 2A made by IHI)

It is difficult to form to the indicated bending dimensions and shape. Forming is time consuming. The bend is badly wrinkled and looks inferior to imported products.

Possibility of replacement and repair and stock taking of spare parts should be done.

7) Portable spot welder

Introduced 14 years ago deterioration is advanced and breakdowns frequent. There is one unit for the control panel, transformer and spot gun and the shaping of the gun is specially shaped to fit the part for welding, so use elsewhere is difficult. As the model is out dated supply of spare parts is nearly impossible.

Poor performance leads to time consuming welding and hinders productivity. Defective welding is a cause of inferior product quality. Replacement of the entire series should be considered.

8) Bending machine of B section (made by Fritz Werner)

Used for the loops and pillars of the specialist car which is the base of the X-2000. Using this bending machine 33 stiffeners are hand processed and manufactured.

As the allowable width dimension of the present bending machine is 1200m/m 20 of the 33 stiffeners cannot be handled. These are joined to 2 processed parts and welded and this lowers productivity and is undesirable for product quality.

Introduction of new bending forms for the intended parts needs consideration and replacement with a general use bending machine is considered advisable.

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

None in particular

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

1) Press parts from the No.1 HI press shop

Many parts are rusted. Moreover the parts precision is poor. Also small parts are supplied in quantities of half a year's quantity. So those of defective precision and rejects have to be re-touched in the present factory.

Productivity is hindered as rust removing operations are increased. Also re finishing operations are increased. Individual lots received are already large since each lot has an estimated 10% reject quantity in addition storage space required expands.

Immediate measures to be employed are as follows:

- cease the 10% increase over production figures
- reduce the number of production lots
- inspection of small parts according to the planning diagram, and attachment of inspection data to the press parts.
- a system making it compulsory for the man in charge of the press shop to confirm with the car frame shop directly when defective precision parts occur, issue a report containing measures for preventing the re occurrence should be set up inside the HIC.

(9) Problems and improvement of dispatch of finished products

None in particular

3-2-3 Analysis of Products Quality

(1) Occurrence of rejects

A survey of the assembled cab, box and body completes showed a reject rate of 100%. Causes were marks by spot welding, distortion of jointures, and rust. Further the re touching time for the individual finished products of 1 car was as follows:

Model	Cab Cpt	Box Cpt	Body Cpt
B-600	1.2 hrs	1.2 hrs	-
X-2000	-	-	1.6 hrs

(2) Problems and improvement of product quality standards and inspection methods

1) Cab, box and body inspections

The inspection is visual by 5 inspectors and the results are recorded on a Check sheet and shown to the re touching area.

Check sheets are drawn up but the check points are not listed. Collection of data on inadequacies and feedback to the shop does not occur. Also the shop showed no policy of tackling the inadequacies. Therefore these are left as they are and this hinders productivity.

It is preferable to have the inspection headings and points marked on the check sheet. Also energetic action to ensure the gathering of data on inadequacies, their recording, and consultations between the inspection department and the shops for improvements, as well as provision of feedback to the shops should take place.

3-2-4 Products Design

(1) Finished product development, design and performance (Increasing the level of domestic production)

It is necessary to reconsider the assembly on location of the T-2000 cab and frame in order to increase the ratio of parts which are domestically produced.

To proceed with the changeover to domestic production at first individual completed parts should be imported and car assembly only take place. Then methods for the press working of the individual completed parts should be examined.

The necessary designing capability needed for design of the jig

equipment and process planning to realize the above increase of domestic production is at present insufficient at the HIC design department.

Table AI-3-2-1 RM AND CP PROCURED (BODY ASS'Y SHOP)
- Apr., 1987 to Jan., 1988 -

Model	Warehouse 9B (No.1 Press Shop)				
	Press Parts for Main Frame	Press Parts for Cab	Press Parts for Box	Press Parts for Body	Small-Sized Press Parts
B600	541	541	541		595
X2000	471			535	588
T2000			200		220

Table AI-3-2-2 ACTUAL PRODUCTION - Apr., 1987 to Jan., 1988 -

Model		1987									1988	Total
		Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	
B600	Cabin	30	29	25	46	40	45	50	41	58	26	390
	Box	10	38		45	22	70	50	38	36	52	361
	Frame	3	24	51	45	64	26	38	60	34	37	382
X2000	Body	15	3	33	23	38	21	11	11	29	3	187
	Frame	8	4	40	48	3	33	19	1	28	10	194
T2000	Box	38	12		7	27	25				1	110

Table AI-3-2-3 PRODUCTION CAPACITY OF VEHICLE COMPONENTS

Model			Cab	Body	Box	Frame
B600	Pick-up Van	Used for Plant Design	700	900	700	1,600
	Pick-up	Estimated by HIC	600		600	600
X2000		Used for Plant Design		600		600
		Estimated by HIC		400		400
T2000		Used for Plant Design			400	
		Estimated by HIC			200	

Figure AI-3-2-2 ORGANIZATION CHART OF BODY ASSEMBLY SHOP NO.4 HI

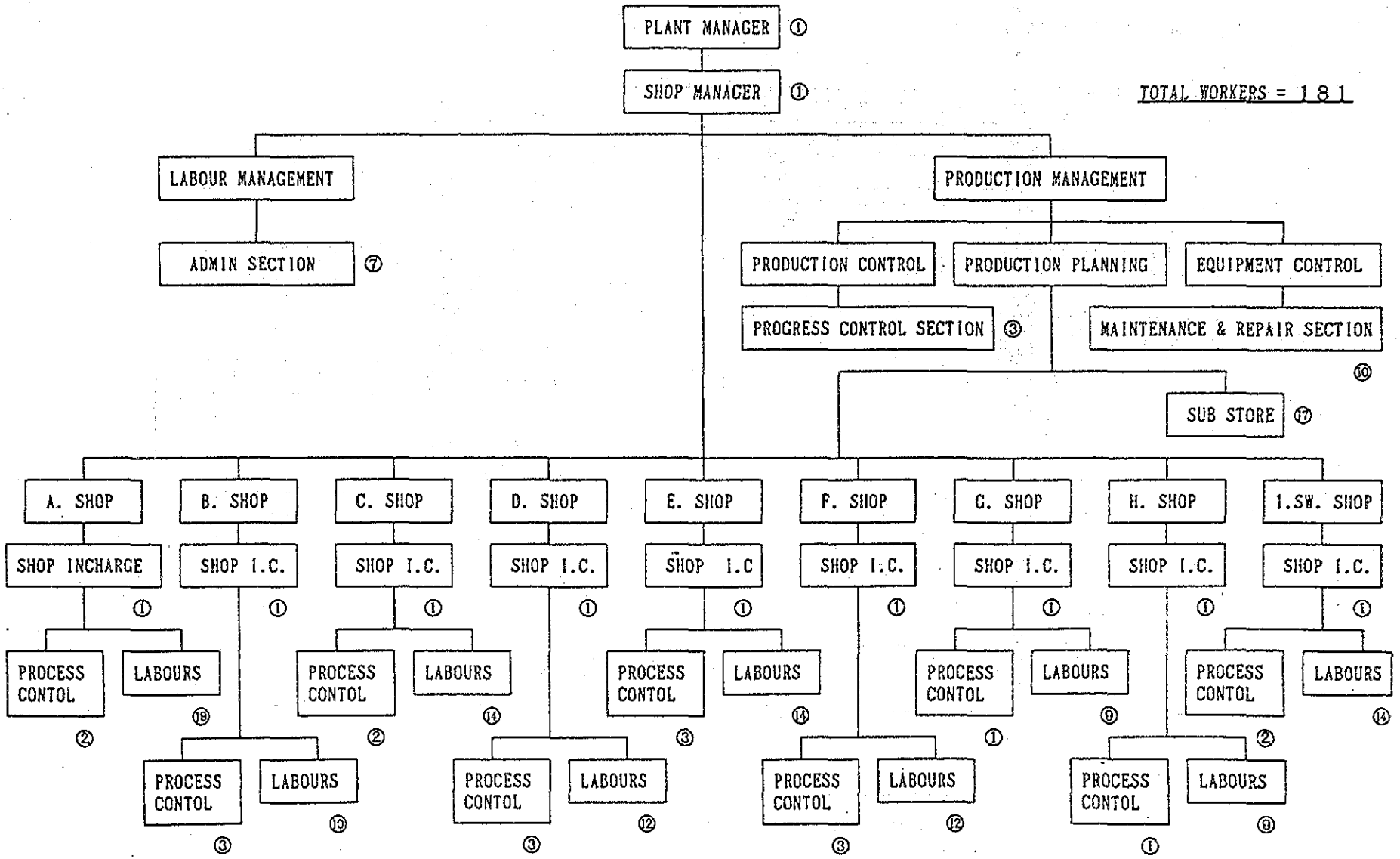


Figure A1-3-2-3 OUTLINE FLOW CHART (X2000 BODY B SECTION)

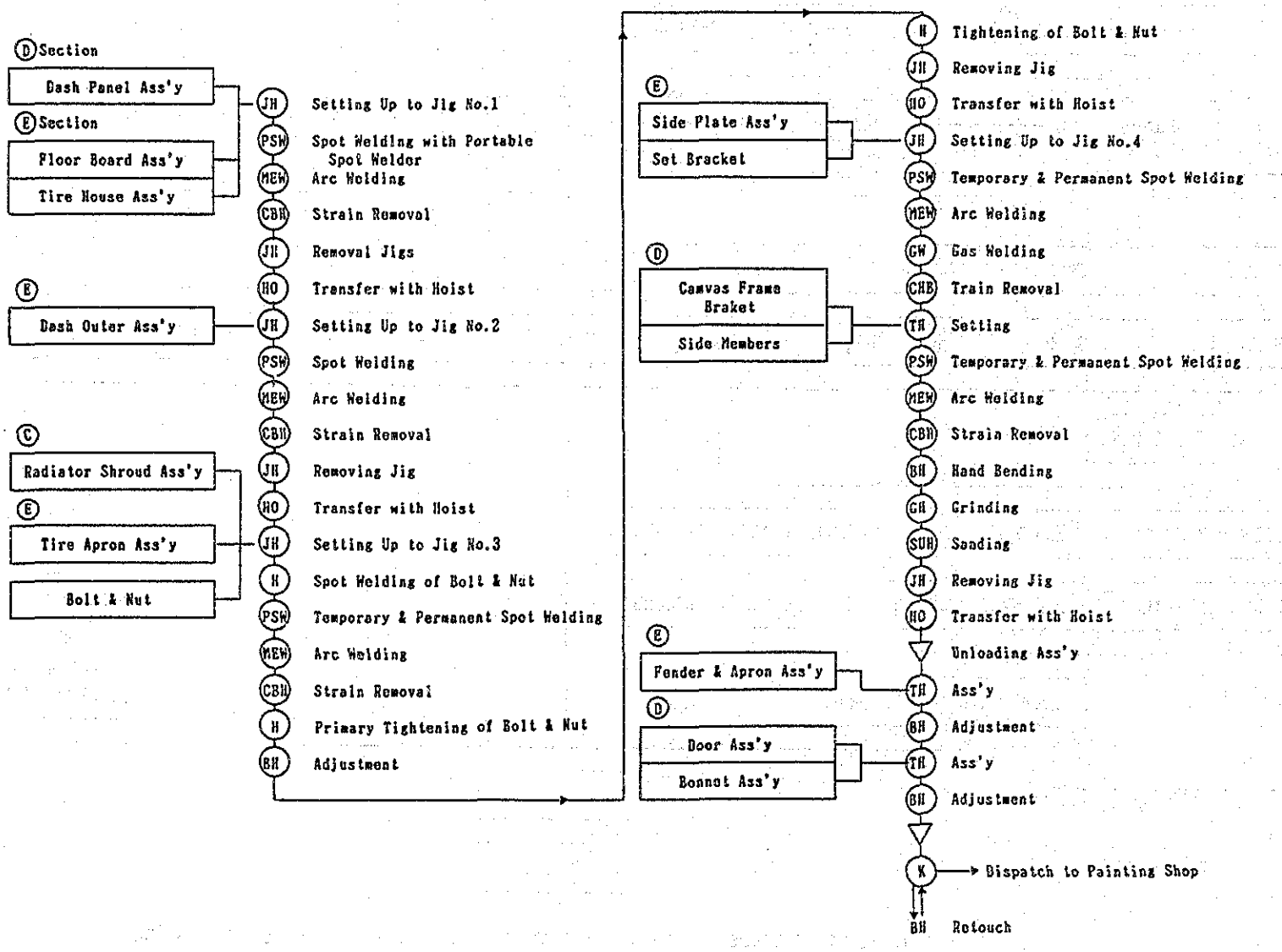


Figure AI-3-2-4 PRODUCTION PROCESS FLOW OF X2000 MAIN FRAME·COMPLETE

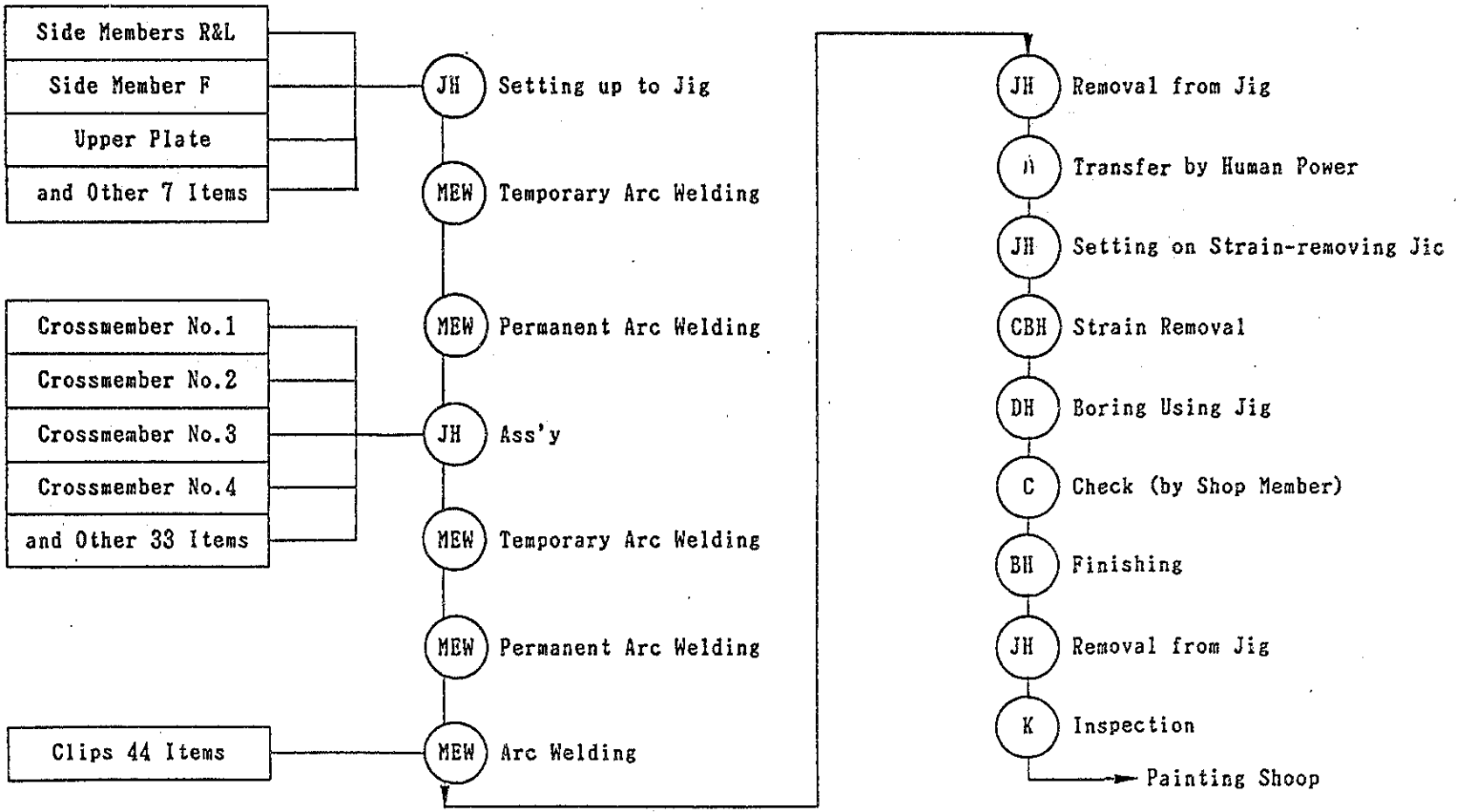
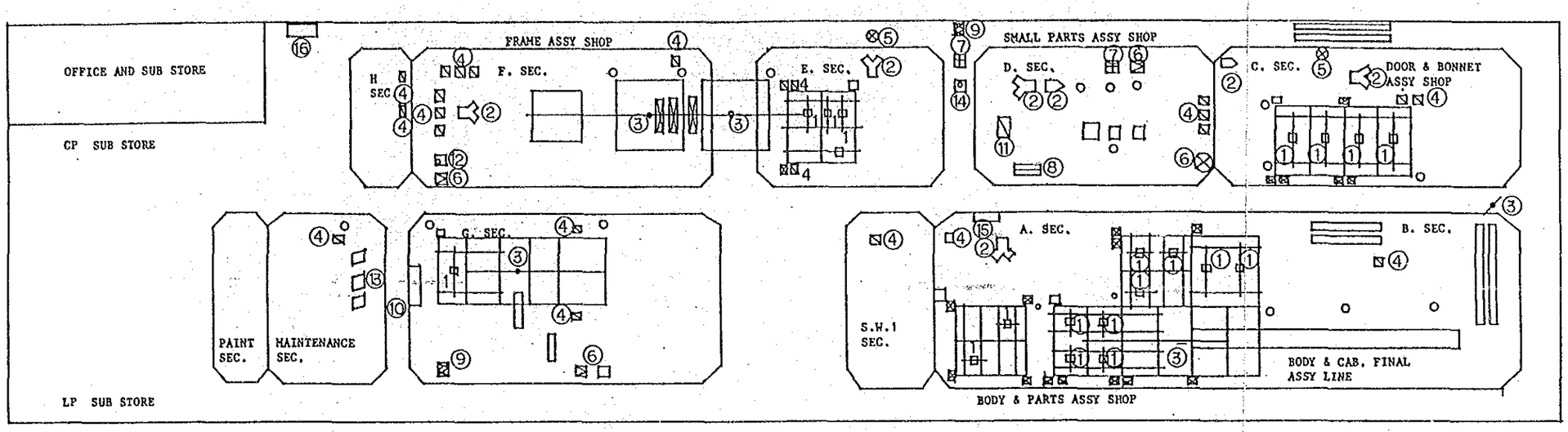


Figure AI-3-2-1 NO.4 HEAVY INDUSTRY BODY ASSEMBLY SHOP EQUIPMENT LAYOUT

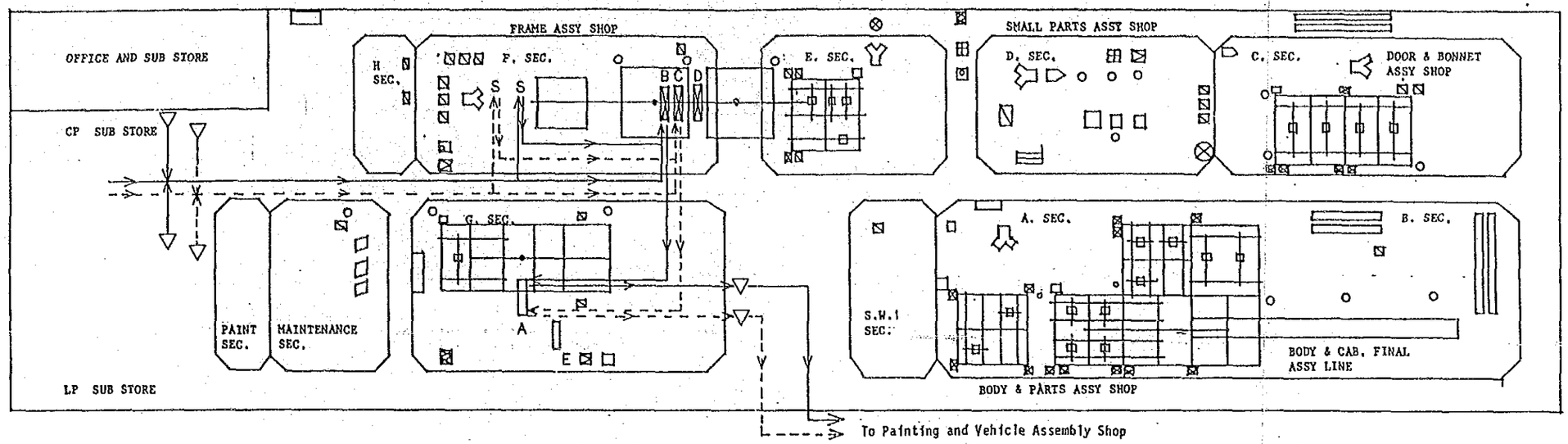


No.	Equipment	QTY	Condition: Deterioration	Condition: Failure	Condition: Idle	Remarks
①	Portable Spot Welder	20	x(20)			Spare parts for ignition control, printed circuit board and others are missing.
②	Stationary Spot Welder	6				
	Single	(2)		x(2)		
	Double	(4)				
③	Hoists	5		x(1)		Magnet switches of jig cranes in body complete pool are wrong.
	0.5 Ton	(4)				
	1 Ton	(1)				
④	ARC Welder	22	x(6)			Noise and drop of performance: 2 in Sec. A, 1 in Sec. C, 3 in Sec. F
⑤	Bench Drill	3	x(1)	x(1)		Burnt motor and drop of performance in Sec. D in Sec. D & F
⑥	Upright Drill	3	x(2)			
⑦	Grinding Machine	2				
⑧	Pipe Bending Machine	1	x(1)			Inferior profile of bent parts
⑨	High Speed Cut-Off Machine	2				
⑩	Shearing Machine	1	x(1)			Inferior Performance. Clearance between upper and lower blades enlarge in operation
⑪	Seam Welding Machine	1				
⑫	Hydraulic Press	1				Sec. F
⑬	80 Ton Crankless Press	3				
⑭	Vibroshear	1				
⑮	Bending Machine	1	x(1)			Insufficient bending capacity
⑯	Surface Plate, 2400 x 1200	1			x(1)	
	Transformer NH2-75-MB for portable spot welder(PSW)				x(6)	Cannot be combined with PSW as the model is obsolete

Symbols	Description
	Gantry with Rail
	Gantry for Monorail
	Movable Monorail
	Bench for Welder Attached to Gantry (for Single)
	Bench for Welder Attached to Gantry (for Double)
	Bench for Welder Attached to Gantry (for Installed)
	Bench for Arc Welder Type Single
	Bench for Arc Welder (for Double)
	Bench for Arc Welder (Installed)
	Universal Seam Welder
	Pipe Bending Machine
	Upright Drilling Machine
	Vibra. Shearing Machine
	Abrasive Grinding Machine
	High Speed Cut off Machine
	Hydraulic Pressure Machine

Symbols	Description
	Transformer for Portable Spot Welder
	Stationary Spot Welder (Double Head)
	Electric Hoist
	Shearing Machine
	Press Machine
	Roller Conveyor
	Gas Welder
	Energy Spot Welder
	Bench Type Drilling Machine
	Working Table
	Stationary Spot Welder (Single Head)

Figure AI-3-2-5 BODY ASSEMBLY SHOP B600 & X2000 FLOW CHART OF MAIN FRAME ASSEMBLY



Flow of B600 & X2000 Main Frame Assy

1. The highest monthly production achieved in 1987

Model	Month	Scheduled	Actual	Achievement, %
B600	July	53	45	84.9
X2000	July	50	48	96.0

2. Legends

Continuous Line : Flow of B600 Main Frame Assy
Dotted Line : Ditto
(Exclusive of Path Finder)

A : Frame Straightener for B600 and X2000
B : Frame Welder for B600
C : Ditto for X2000
D : Ditto for X2000 Path Finder
E : Upright Drill, for drilling of extended member of Path Finder
S : Sub-assembly, in Section F
1) Qty supplied from No. 1 HI Press Shop via substore:
approx. 70 items for B600

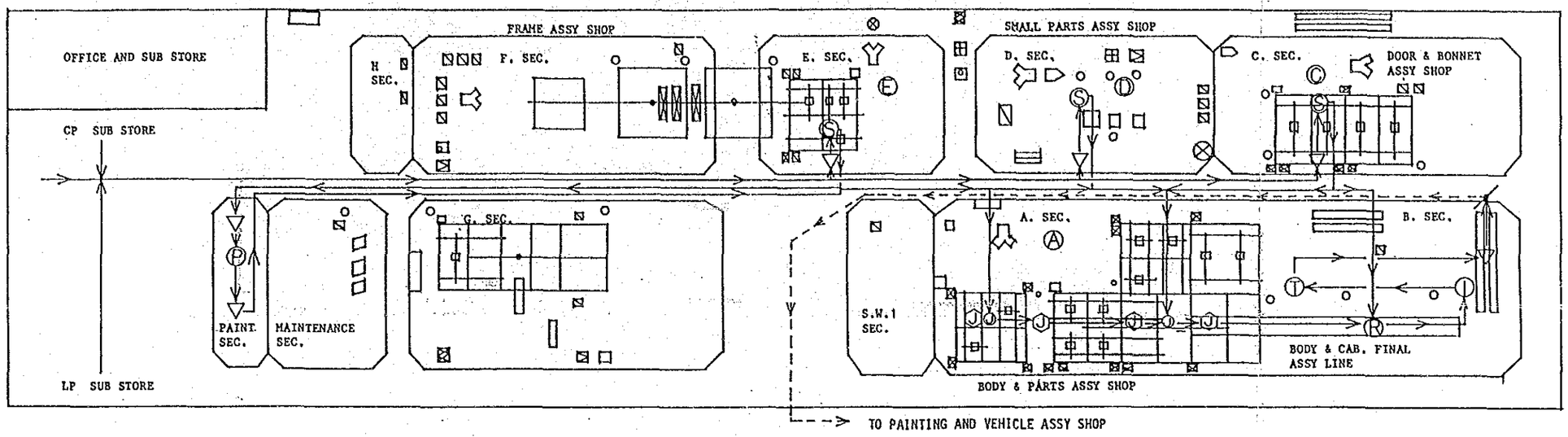
2) Qty assembled in Section F and supplied to welding Jig Line:
18 items for B600

3. Flow of materials in Shop
1) The weekly production schedule is indicated every Monday to assistant manager and foremen.
2) Upon the indication noted in 1) above the relevant substore delivers materials for 30 units vehicle to each section. The materials are transported by hand truck on the day of production or one day in advance.
3) Each set completed in Section F is supplied to Welding Jig Section at every completion , using hand truck.

Symbols	Description
	Gantry with Rail
	Gantry for Monorail
	Movable Monorail
	Bench for Welder Attached to Gantry (for Single)
	Bench for Welder Attached to Gantry (for Double)
	Bench for Welder Attached to Gantry (for Installed)
	Bench for Arc Welder Type Single
	Bench for Arc Welder (for Double)
	Bench for Arc Welder (Installed)
	Universal Seam Welder
	Pipe Bending Machine
	Upright Drilling Machine
	Vibra. Shearing Machine
	Abrasive Grinding Machine
	High Speed Cut off Machine
	Hydraulic Pressure Machine

Symbols	Description
	Transformer for Portable Spot Welder
	Stationary Spot Welder (Double Head)
	Electric Hoist
	Shearing Machine
	Press Machine
	Roller Conveyor
	Gas Welder
	Energy Spot Welder
	Bench Type Drilling Machine
	Working Table
	Stationary Spot Welder (Single Head)

Figure AI-3-2-6 NO.4 HEAVY INDUSTRY LV BODY ASSEMBLY SHOP WORK FLOW CHART OF B600 CAB COMPLETE & X2000 BODY COMPLETE



Flow of B600 Cab CPT & X2000 Body CPT

1. The highest monthly production achieved in 1987

Model	Month	Scheduled	Actual	Achievement %
B600 cab	Dec.	60	58	96.6
X2000 body cpt	Dec.	30	26	86.6

2. Legends

(Note)
Flows of both B600 cab and X2000 body cpt are essentially identical, as follows:

L.P. Substore---Subassembly section---Jig welding line---
--Roller assembly line---Inspection

Therefore, flows of the both are shown in one line in this figure.

Major points of difference are C.P. quantity in Subassembly Section and welding jig quantity.

Continuous Line : Flow of B600 cab & X2000 body cpt up to complete
Dotted Line : Flow of B600 cab & X2000 body cpt up to Shipment

Ⓐ Section A-Assy line using welding jig
Ⓒ Subassembly Section C
B600 : 7 items incl. of cab side frame head lamp set plate, and 4 items supplied to Painting Shop.
X2000 : 8 items incl. of front window dash outer, and 2 items supplied to Painting Shop

Ⓓ Subassembly Section D
B600 : 4 items incl. of battery carrier spare tire holder and 29 items supplied to painting Shop
X2000 : 6 items incl. of meter cover and 48 items supplied to Painting Shop

Ⓔ Subassembly Section E
B600 : 8 items incl. of dash panel, inside panel, and back plate
X2000 : 17 items incl. of tire apron, tire house floor board and 10 items supplied to *Painting Shop*

Ⓘ Inspection (check all items)
Ⓙ Ⓙ B600 Welding jig 2 items
Ⓙ X2000 Welding jig 4 items
Ⓢ Subassemble
Ⓟ Temporary Shop for spraying anti-corrosive paint
Paint : ORGA T10 758 GRAY, NIPPON PAINT
Parts : B600 25 items incl. of :
* *inside panel & dash panel* (Section E)
head lamp set plate (Section C)
: X2000 15 items incl. of:
tire apron, fender (Section E)
radiator shroud (Section C)

Ⓡ Roller Conveyer
Transfers parts for B600 and X2000 which are tightened with bolt, such as fender, door, bonnet, etc.

Ⓣ Retouching Line

Symbols	Description
	Gantry with Rail
	Gantry for Monorail
	Movable Monorail
	Bench for Welder Attached to Gantry (for Single)
	Bench for Welder Attached to Gantry (for Double)
	Bench for Welder Attached to Gantry (for Installed)
	Bench for Arc Welder Type Single
	Bench for Arc Welder (for Double)
	Bench for Arc Welder (Installed)
	Universal Seam Welder
	Pipe Bending Machine
	Upright Drilling Machine
	Vibra. Shearing Machine
	Abrasive Grinding Machine
	High Speed Cut off Machine
	Hydraulic Pressure Machine

Symbols	Description
	Transformer for Portable Spot Welder
	Stationary Spot Welder (Double Head)
	Electric Hoist
	Shearing Machine
	Press Machine
	Roller Conveyor
	Gas Welder
	Energy Spot Welder
	Bench Type Drilling Machine
	Working Table
	Stationary Spot Welder (Single Head)

3-3 Assembly Shop for the Engine, Transmission and Axle

3-3-1 Outline of Processes

(1) Working equipment and its layout

Is shown in Fig.AI-3-3-1.

(2) Organization and personnel

Organization is shown in Fig.AI-3-3-2
Personnel totals 40.

(3) Supply performance of raw materials and parts

The supply performance for raw materials and parts is shown in Table AI-3-3-1.

Note: As there is no record of the supply performance for raw materials and parts in this shop the supply performance shown in Table AI-3-3-1 was drawn up by referring to the production performance of the equipment shop and car frame shop. Further, outline of the supply methods of the shop is shown in Fig.AI-3-3-3 for reference.

(4) Production performance and production capacity

Production performance from 1987 to 1988 was shown in Table AI-3-3-2.

Notes: for vehicle assembly: engine and transmission.
for spare parts use : engine only.

Using the time employed at the engine firing test bench as a base for production capacity the estimated monthly production capacity is 330. Conditions for this calculation are as follows:

No. of working days per month	22	per month
No. of working hours per day	7.5	per day
Production output per day	15	per day

The main processes and time at the engine firing test bench are as follows:

Setting on and removal from firing test bench	30 minutes
Firing time for first test (1500 rpm)	10 minutes
Timing adjustment and adjustment of tappet	30 minutes
Firing time for second test (2000 rpm)	20 minutes
Total	1.5 hours

Number of engine firing test benches: 3 sets

3-3-2 Analysis of Production Processes

(1) Outline of table for analysis of production processes

B-600 differential carrier complete is shown in Fig.AI-3-3-4.
X-2000 Engine is shown in Fig.AI-3-3-5.
B-600 transmission is shown in Fig.AI-3-3-6.

(2) Flow chart

Flow charts for the engine and transmission completes of B-600 and X-2000 are shown in Fig.AI-3-3-7.

(3) Problems and improvement of operational methods and process chains of main products and parts

1) Assembly shop for engine parts

X-2000 cylinder block air leakage tester

A pressurized cylinder liner cylinder block is sent to the air leakage testing device at the side of the machine processing work area (cylinder processor) to undergo a leakage check. One way distance is approx. 33 m. Conveyance is by cart carrying loads of 4 pcs per trip.

The long distance of the transportation hinders increase of productivity.

productivity.

Addition of an air pressure testing device close to the cylinder liner assembly area should be carried out.

It is necessary to reconsider the layout of the engine and transmission work areas.

2) Transmission assembly area

Pressurizing of B-600 cylinder head bulb guide and pressurizing of the X-2000 transmission case bearing:

The press for use to pressure the B-600 cylinder head bulb guide is shared for pressuring the X-2000 transmission case bearing. After pressurizing the cylinder head bulb the distance for transportation to the next processing stage is approx. 25 m.

Productivity is hindered as waiting time is long. As the press is at present located in the transmission work area the transmission assembling process has effective material handling. However the material handling for the assembling process of the cylinder head is poor.

Separate presses for the exclusive use of the B-600 head bulb guide and the X-2000 transmission case bearing each are needed. A reconsideration of layout is needed.

3) Temporary storage of finished products and parts of the assembly shop

In every shop half processed parts and products being assembled were placed directly on the floor and near to transportation routes. As engines place on the floor were uncovered with covering sheets dirt, dust and spiders webs settle on these.

As parts clutter up the entire work area it is necessary to take detours around these to send parts on to the next process stage. This hinders increasing of productivity. Foreign bodies and dirt enter the engine through the carburetor opening or the oil injection and this could damage the engine performance.

The following measures should be examined:

- cease the system of 10% increase over the production output for domestic products (decreasing of products in progress)
- implement a monthly stock taking, and set up a system for setting supply orders on this basis
- stock taking of parts in each shop, and disposal of obsolete, rusty unusable parts
- implement order facilities of telephone and telex

4) Engine assembly area: transportation of the finished engine complete to the engine firing test room.

The complete of the docked engine and transmission of the engine assembly area Section No.6 is lifted with a jig crane and loaded onto the transportation carts and once taken to the firing room is set on the firing test bench using a traveling hoist. According to the planning layout the traveling hoist is indicated as moving the finished engine. But this does not happen.

As the jig crane, traveling hoist and cart are all used during transportation this hinders efficient material handling. Operations should take place as indicated with rails for the run of the engine assembly carts extended up close to the hoist.

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

1) Vehicle axle assembly area: B-600 and X-2000

Sub assembly of the universal joint to the propeller shaft

In the case of the B-600 after supply from the store room (originally coming from the machine shop) of front and rear propellers, and of yoke joint and flanges the joint bearing is added and assembly takes place. After this these are supplied to the vehicle assembly shops and sub assembly work areas. After the coupling attachment of the front and rear propellers in the sub assembly area this is supplied to conveyer No.3. In the case of X-2000 after reception of the propeller shaft, yoke joint, and flanges from the store room (which received these originally from the machine shop)the joint bearing is added and assembly takes place. After this these are supplied to conveyer No.3

of the vehicles assembly shop.

The frequent transportation of products between shops, work areas, and store rooms lowers efficiency of material handling. This not only hinders productivity but is detrimental to product quality.

The transfer of assembly operations after the machining shop stage for B-600 and X-2000 to the sub assembly area of the vehicles assembly shop needs to be considered.

(5) Problems and improvement of layout and material handling

1) Conveyance devices in the engine, transmission and axle assembly shops

As there is only one transportation cart in stock most of the movement of parts is done with manpower. Deterioration of the cart presently in use is advanced and the supporting pillar on the upper loading deck and the wheels are badly worn and loose.

As the loading capacity is small for transportation handling number of trips is increased and material handling is poor. As assembly workers are used for transporting this results in a reduction of productivity, and careless mistakes occur.

Conveyance distances should be shortened by re examining the layout. Also extra carts should be provided.

(6) Problems and improvement of working equipment

1) Axle parts: measuring instruments for shim adjustment in drive pinion mounting line

The dial gauge cover is broken and detached. The gauge needle comes into contact with other objects and there is a danger of decreased precision.

The replacement of damaged gauges and introduction of spare parts should be considered. It is necessary to consider inspection of measuring devices, creation of a checking system and training of inspecting and repair technicians. Setting up of a system of daily checks and regular precision checking must be considered.

2) Transmission assembly shop: B500 cylinder bulb guide pressure inserting jig

The same jig is used for bulb guide pressurizing and bulb spring assembly. There are a large number of removing and setting up operations involved. The increase in the cumulative total for the disassembly and setting up of the jig results in wear to the disassembly parts and damage to the fitting screws.

New jigs should be introduced so that each operation is done exclusively by one jig.

3) Washing tank for the engine parts assembly shop

The cleaning tank for parts is idle because of motor breakdown. As the volume capacity of the washing tank is small spilling of liquid easily occurs.

Machine processed parts are assembled without being washed. This results in early wearing and has an adverse effect on the engine performance.

Replacement of the motor is needed. By standardizing the parts to be washed the problem of capacity can be solved. If a motor can not be obtained then it will be necessary to consider replacement of one washing tank.

4) Washing devices for product parts and work area parts

Lack of detergents causes stopping of operations. Rust has formed inside the washing tank and boiler firebox.

All of the machine processed parts for the engine, transmission and axle are assembled without being washed. The efficiency and reliability of the finished parts is doubtful.

The operation of the washing devices for parts is needed to assure and maintain the quality of finished parts.

5) The engine firing test bench of the engine testing room

Three engine firing test benches are used for all of the engines of the B-600, S-2000, and T-2000. As the charging system of this device is broken another battery is used and engine ignition and driving done using this.

There is a loss of time involved in the battery charging arrangements. The handling capacity of the engine firing test is affected by the charging conditions of the battery used.

It is necessary to undertake repairs and pinpointing of reject areas as well as provision of spare parts. To facilitate inspection of the defective areas a manual must be made. An on site inspection in accordance with the manual should take place, focusing on problems of reject areas and spare parts.

6) Engine trial test room: engine performance testing bench

Engine performance tests are conducted of the B-600, X-2000 and T-2000 engines by sampling inspection. However due to breakdown of the testing bench testing has ceased and facilities are idle.

Except for electrified parts, the constituent parts of the engine such as the packing, gasket, oil seal, crank metal bearing, cam shaft gear (bakelite) are domestically produced. The level of precision of machine processing of these parts is insufficient. The engines assembled using these parts are just about up to the present planning target. However, it is possible that engines considerably below these design plans might be marketed with the present management of part precision. The present situation of disrepair of the testing bench is an obstacle to furthering of finished product export and hinders the realization of HIC's planning schedule.

Prompt repair is needed. Installation of an engine testing room and provision of an extra testing bench (including fuel expenses) which can check the performance of all the engines for assembly and dispatch and those independently developed by HIC itself is needed.

7) Transmission assembly shop

Transmission noise tester:

All of the transmissions of the X-2000 are tested for noise level using the noise tester made by No.4 HI, and then connected with the engines.

Problem points of the above tester are as follows:

- surrounding noise level is high
- though the number of test revolutions is the same engine stammer can not be measured though gear grating can be discerned.
- checking of the shift operating power and noise testing for each shift position can not take place.

The following improvements are needed:

- tests to take place in quiet areas
- devices with similar clutch mechanisms as to engine revolutions (including the noise meter)
- provision of a tester which can be used for the B-600, X-2000 and T-2000.

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

Nothing of note

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

1) Reception of parts from the machine shop

The assembly parts (engines, transmissions and axles) processed in the machine shop are not sent directly to the assembly shop in the same factory but are taken to the manufactured complete stores II and I. These parts are then supplied to the assembly shop in accordance with material planning for assembly parts.

As the material handling from the machine shop to store room to assembly shop is all by manpower the number of material handling operations increases and this is undesirable from productivity.

Direct supply to the assembly shop from the machine shop should be considered, particularly for large objects. Use of a color system to distinguish monthly production lots and records of supplies received should be systematized. Introduction of new storage boxes and palettes divided by type of parts to facilitate transportation should be considered.

(9) Problems and improvement of dispatch of finished products

1) Dispatch of engine completes to the vehicles assembly shop

There is no check of the engine dispatches. When engines are temporarily placed aside, dispatched the engine and in particular the openings are left uncovered. There are no transportation carts for exclusive use.

It seems that the inspectors are without a check list when conducting the firing test and rely on a personal external check. Therefore if the engine has no running problems major defects such as missing parts, mis-assembly, damage to parts after driving are left undiscovered and the product dispatched. Damage to the engines or engine performance may arise through entry of dust or foreign bodies into openings.

Checking at the pool area of lots should be done with a check list and results attached to the engine. It is necessary to produce covers for each engine, and covers and pipe covers for the intake opening of the carburetor.

Further it is necessary to add the operating processes of attaching and detaching these covers.

3-3-3 Analysis of Products Quality

(1) Occurrence of Rejects

There are no checks by inspectors in the assembly shop for engines, transmissions and axles. Quality of products is assured by operator checks. Therefore there is no documentation or records of rejects. Table AI-3-3-3 shows the state of engines which could not be assembled for want of parts.

The number of incompleted engines due to lack of parts as of Feb.16, 1988 is as follows:

B-600 : 80 units
X-2000: 139 units

(2) Relation to preceding and following processes

Nothing of note in particular

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

1) Inspection of finished parts

The engine, transmission and axle completes do not undergo inspection either in assembly processes nor in final processes. Main emphasis is on voluntary checks by the operators. There are no check lists or check point notebooks provided.

Firing tests and noise tests are conducted for the engine and transmission so that areas and parts related to these are checked. However, even if there are missing parts, damage or defective assembly in other parts there is a good chance that these will be dispatched to the vehicle assembly lines as they are. Moreover parts changing processes are more frequent with the completed vehicles than with the individual single components.

The following improvements are needed as counter measures to the above problems:

a) Implementation of inspections for the final processes and autonomous shop checks in accordance with a check list

b) Introduction of a check list for the autonomous checks which take place between processing operations.

2) Torque attachment and torque wrench

Records of these are not stored. The storage of the torque wrenches is rough and there are are large number with reduced precision.

Since there is no precision inspection for measuring devices and no system for precision inspection the reliability of the measuring devices is doubtful and this easily leads to a reduction in product quality.

The situation of the torque wrenches is as follows:

type (kg.cm)	work area	usage	error margin of indicator and zero point mark
0-1,200	axle assembly	tightning differential drive pinion flange	minus 100
0-1,200	axle assembly	tightning differential drive pinion flange	minus 50
0-3,200	axle assembly	tightning pitman arm nut	minus 10
0-600	axle assembly	clamping differential carrier complete and axle housing	plus 40
600-4,200	transmission assembly	tightning of output shaft flange	0
0-1,200	engine assembly	tightning of X-2000 fly wheel	minus 5
0-1,200	engine assembly	tightning of cylinder head bolt	plus 50

As improvement countermeasures against the above problems the following should be considered:

a) Make drawing up of record charts compulsory

b) renewal of necessary torque wrenches

c) set up inspection of measuring devices and an inspection system together with repair of measuring devices and training of inspection engineers.

(4) Maintenance of production equipment

Items relating to the maintenance of production equipment are the same as those mentioned in the following sections:

3-1: Report of the Painting and Light Vehicles Assembly Shop
3-2: Report of the Body Assembly Shop

(5) Product design

Nothing of note in particular.

Table AI-3-3-1 PROCUREMENT RESULT OF RM, AND CP

Model		Manufactured CP Store (II) 35B	Manufactured IP Store (I) 35C (Machine Shop)				Body Ass'y Shop
		Imported CP	Machined Engine Parts	Machined Mission Parts	Machined Axle Parts	Machined Diff. Gear Carrier Parts	Pressed Engine Parts
B600	Component Parts		400	400		400	400
	Spare Parts		352				352
X2000	Component Parts		187	187	187		187
	Spare Parts		226				226
T2000	-	109					

Table AI-3-3-2 ACTUAL PRODUCTION - Apr., 1987 to Jan., 1988 -

Model		1987									1988	Sub Total	Total
		Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.		
B600	Component Parts	10	40	30	50	40	45	45	45	45	50	400	
	Spare Parts	2	24	7	42	22	66	56	31	63	39	352	752
X2000	Component Parts	15	2	33	23	38	22	11	11	29	3	187	
	Spare Parts	19	37	6	25	36	31	19	15	8	28	224	411
T2000	Component Parts	35	15	20	30	8	2					110	
	Spare Parts	4		2		5						11	121

Table AI-3-3-3 LIST OF PARTS IN SHORTAGE

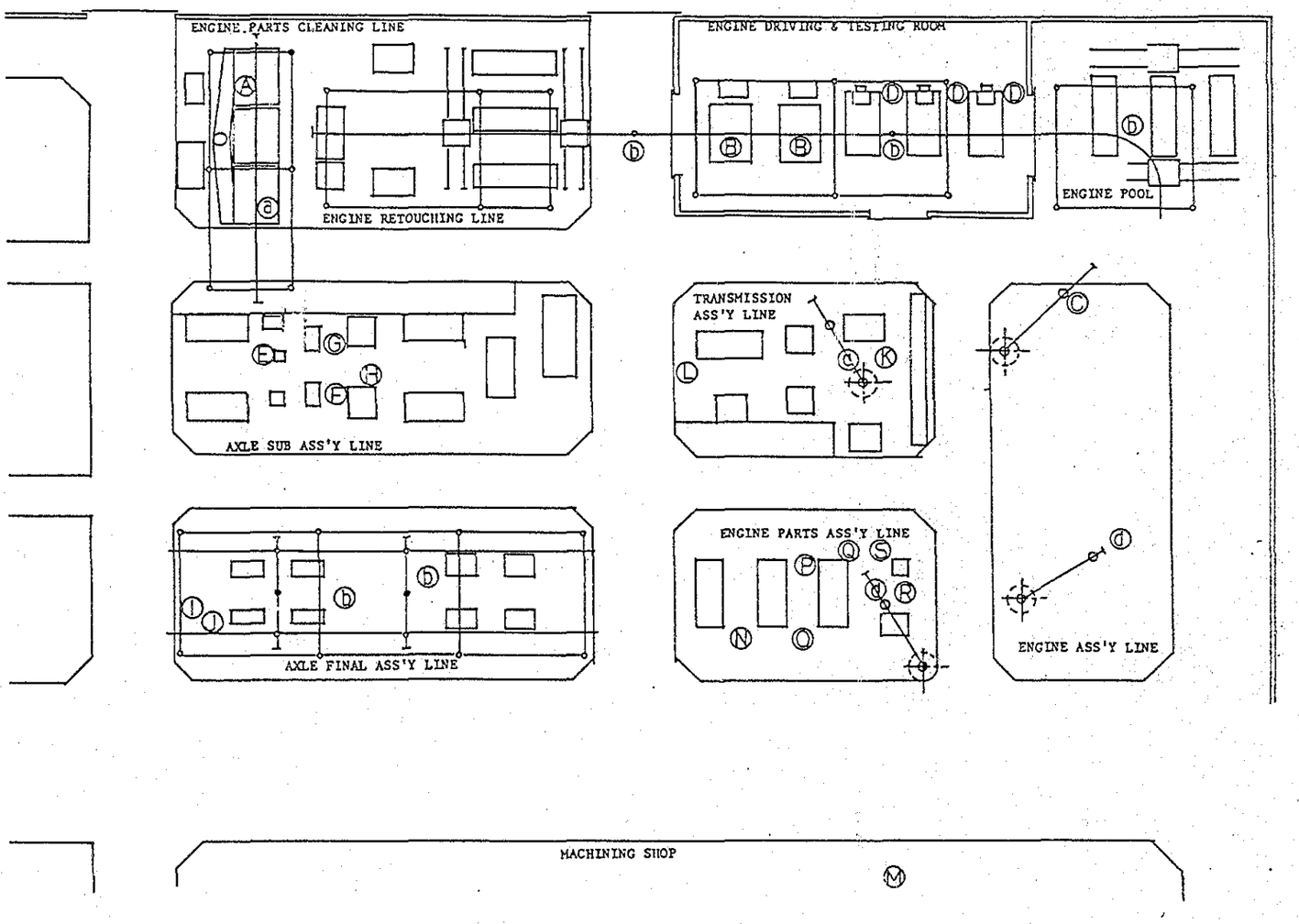
B600

	Part No.	Description	Q'ty (Vehicle)	Shortage	Reason of Shortage
1	2783 10 101	Cylinder Head RH	1	40	Delay of Machining (5RD)
2	2783 10 201	Cylinder Head LH	1	40	Delay of Machining (5RD)
3	0114 10 104	Valve Guide	4	120	Delay of Machining (4L)
4	2783 10 301	Crank Case	1	60	Delay of Machining (5RD)
5	0164 11 210	Connecting Rod	2	100	Delay of Forging (No.3 HI)
6	2783 17 271	Counter Shaft	1	50	Delay of Machining (Hobbing M/C)
7	0111 17 281	Reverse Gear	1	70	Delay of Machining (Hobbing M/C)

X2000

	Part No.	Part	Q'ty (Vehicle)	Shortage	Reason of Shortage
1	2675 10 220	Head Cover	1	139	Delay of Press Work (No.1 Press)
2	2587 10 301	Cylinder Block	1	99	Delay of Machining (5RD)
3	2473 10 480	Tappet Cover	1	139	2473 10 481 Delay of Press Work (No.1 Press)
4	0647 10 900	End Plate	1	139	Delay of Press Work (No.1 Press)
5	0647 17 271	Counter Shaft	1	139	Delay of Gear Machining (No.4 HI)
6	0647 17 661	Transfer Idle Gear	1	98	Delay of Gear Machining (No.4 HI)

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



EQUIPMENT LIST

No.	Line/Equipment	Qty. Unit	Condition: Partly Damaged	Condition: Out of Service	Remarks
1	Axle Sub-Assy Line	1			B600 differential gear carrier CPT & X2000 F&R axle
	Ⓔ TKK Hydraulic Press	1			Pressing bearing case in dif. gear carrier
	Ⓕ TKK Leak Tester	1			Testing leakage of wheel cylinder
	Ⓖ Adjusting Eqpmt for Drive Pinion Mount -ting Distance	1	x(gauge glass missing)		For X2000 dif. gear carrier
	Ⓗ Ditto	1	x(gauge glass damaged)		For B600 dif. gear carrier
2	Axle Final Assy Line				
	ⓑ Gantry & 1/2 Ton Hoist	2			
	Ⓘ Injection Press for Propeller Shaft Bearing	1	x(air leakage)		B600 2783 25 960
	Ⓙ TKK Hydraulic Press	1			For caukling
3	Transmission Assy Line				
	ⓓ Jig Hoist 1/4 Ton	1			Transferring transmmision to the next step
	Ⓚ Running-in Equipment	1			Manufactured by HIC
	Ⓛ TKK Hydr. Press	1			Injection of B600 valve guide and transmission hosing bearing
4	Engine Parts Assy Line				For B600, X2000 & T2000
	ⓓ Jig Hoist 1/4 Ton	1			Transfer of X2000 engine block
	Ⓜ X2000 Cylinder Liner Air Pressure Tester	1			Located next to Head Machining so causing a large transport loss
	Ⓝ Air Pressure Tester	1			For X2000 cylinder head
	Ⓞ Leak Tester	1			Service is disconnected since B600 inlet manifold ACP is imported
	Ⓟ Parts Cleaner	1			For cleaning of small-sized parts Motor is burnt and tank capacity is insufficient
	Ⓠ Jig for Valve Spirng	1			For X2000 cylinder head
	Ⓡ Piston Heater	1			For B600 & X2000
	Ⓢ Valve Seat Leak Tester	1			For X2000 cylinder head
5	Engine Assy Line				
	Ⓒ Jig Hoist 1/2 Ton	1			Engaging transmission to engine
	ⓓ Ditto 1/4 Ton	1			Setting cylinder block on engine assy truck
6	Engine Pool				
	ⓑ 1/2 Ton Hoist	1			
7	Engine Operating Test Room				
	Ⓑ Engine Test Bench CT-540	1	x(1)		Horsepower calculater damaged
	Ⓢ Ditto	1	x(1)		Ditto and damage of Eddic Dynamometer
	Ⓓ Engine Igniter Bench	3	x(3)		Damage of battery charger
	ⓑ Hoist 1/2 Ton	2			
8	Engine Retouching Line				
9	Engine Parts Cleaning Line				
	Ⓐ Parts Cleaning Equipment	1		x(1)	Service has been discontinued since the beginning of Project due to cleaning liquid shortage
	ⓐ Gantry and 1 Ton Hoist	1			

Figure AI-3-3-2 ORGANIZATION OF ENGINE, TRANSMISSION AND AXLE ASS'Y SHOP

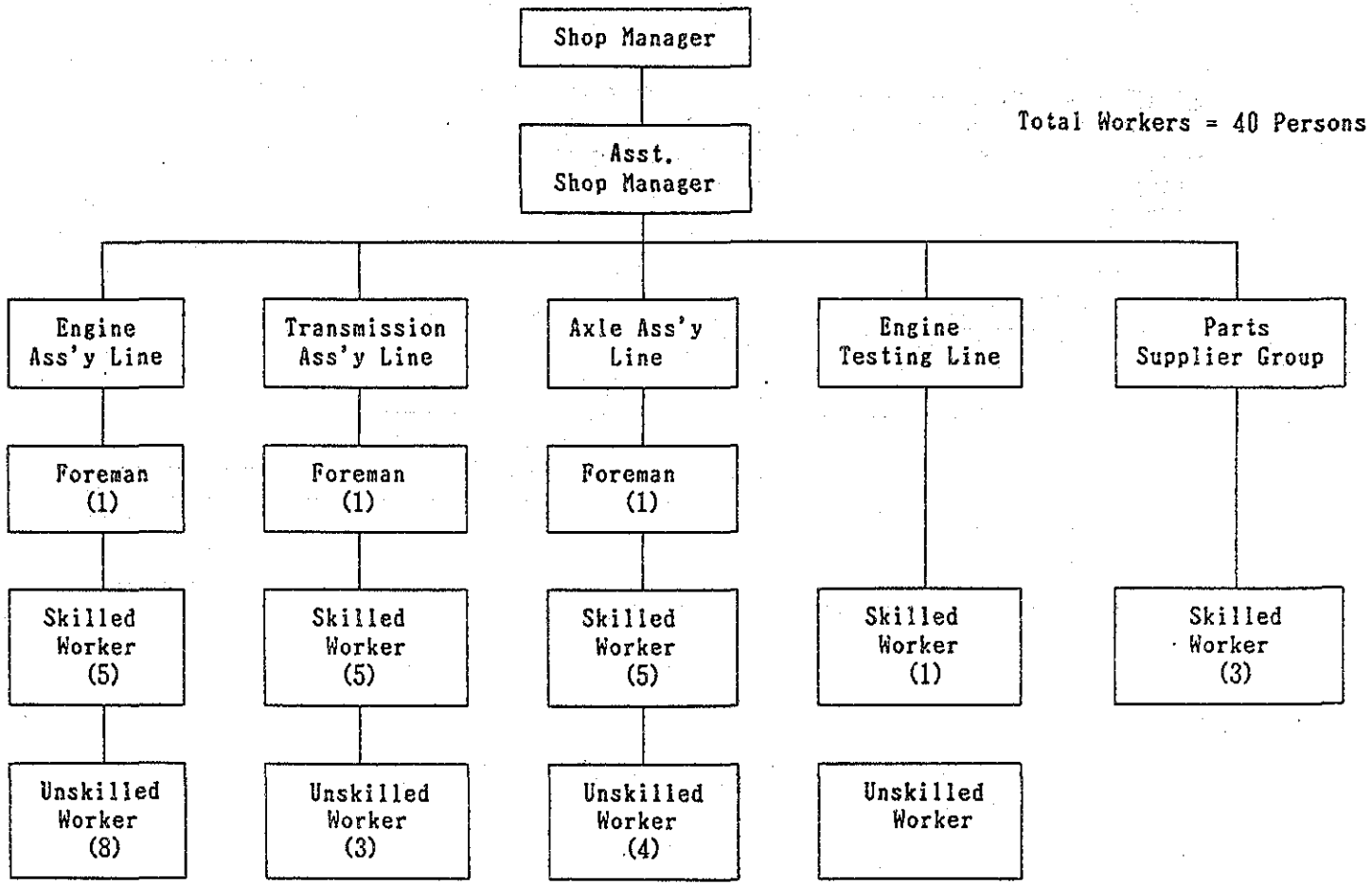


Figure AI-3-3-3 RECEIVING OF COMPONENT PARTS

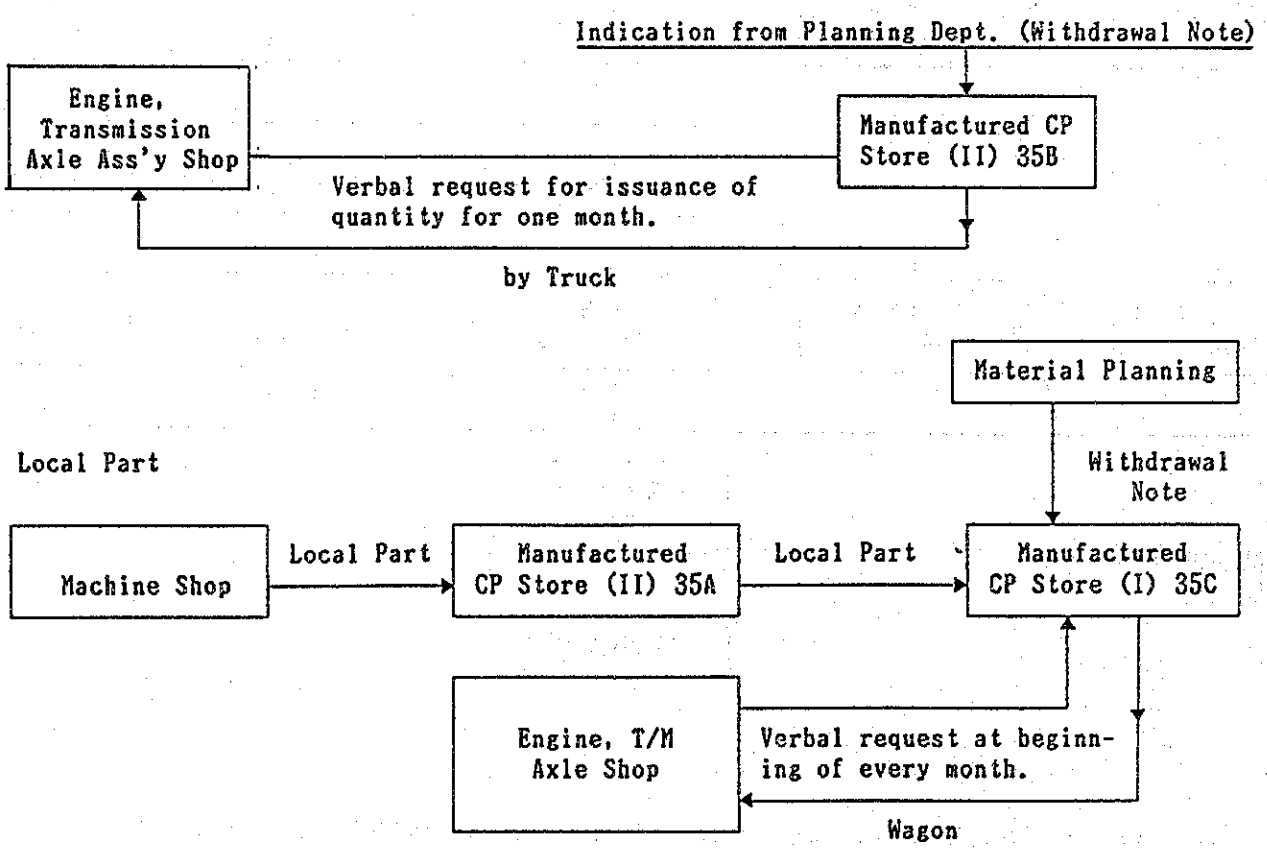


Figure AI-3-3-4 OUTLINE WORK FLOW - B600 DRIVING DIFFERENTIAL CARRIER COMPLETE -

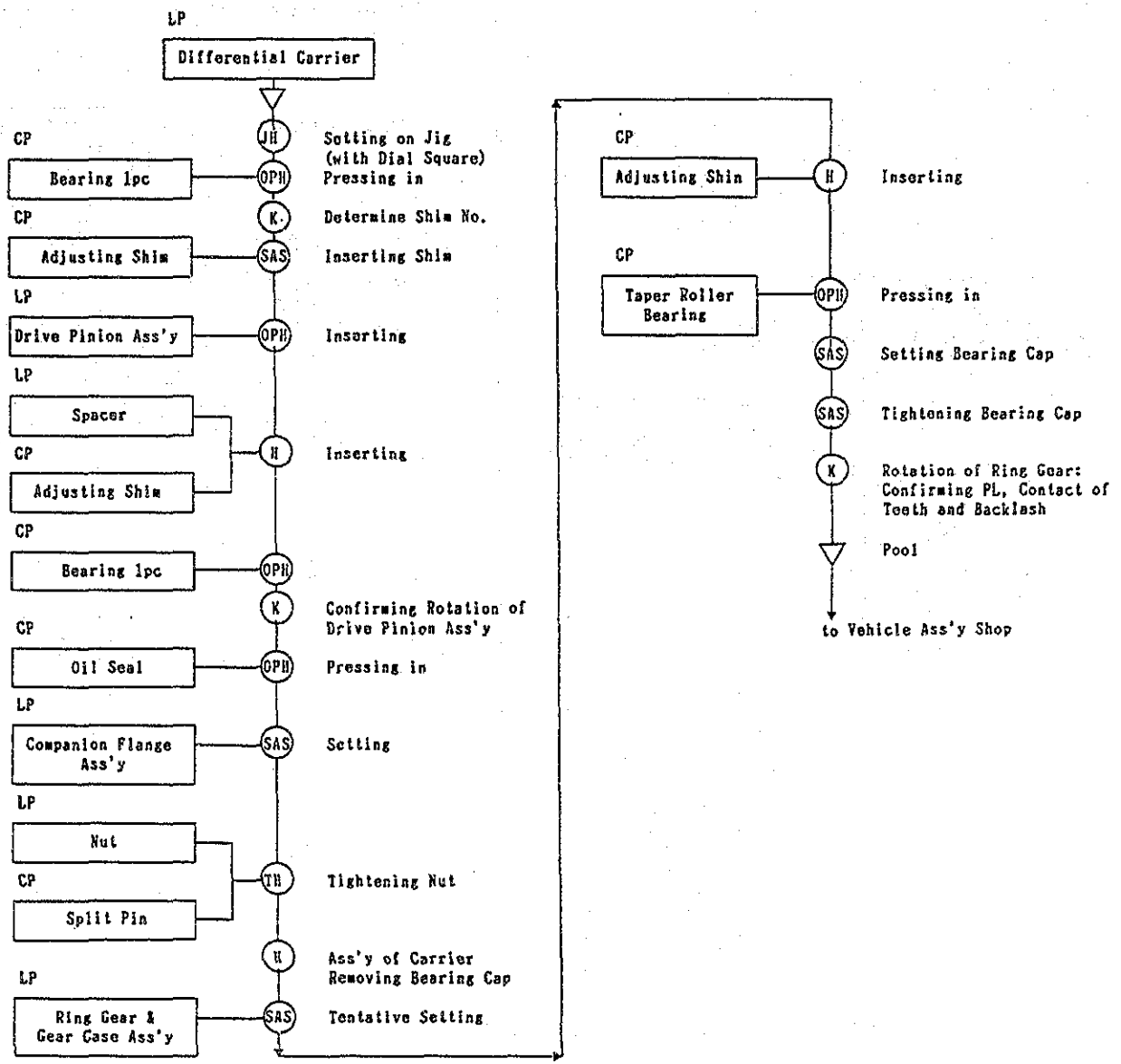


Figure A1-3-5 OUTLINE WORK FLOW - X2000 ENGINE COMPLETE (MAINLY FOR CYLINDER BLOCK)

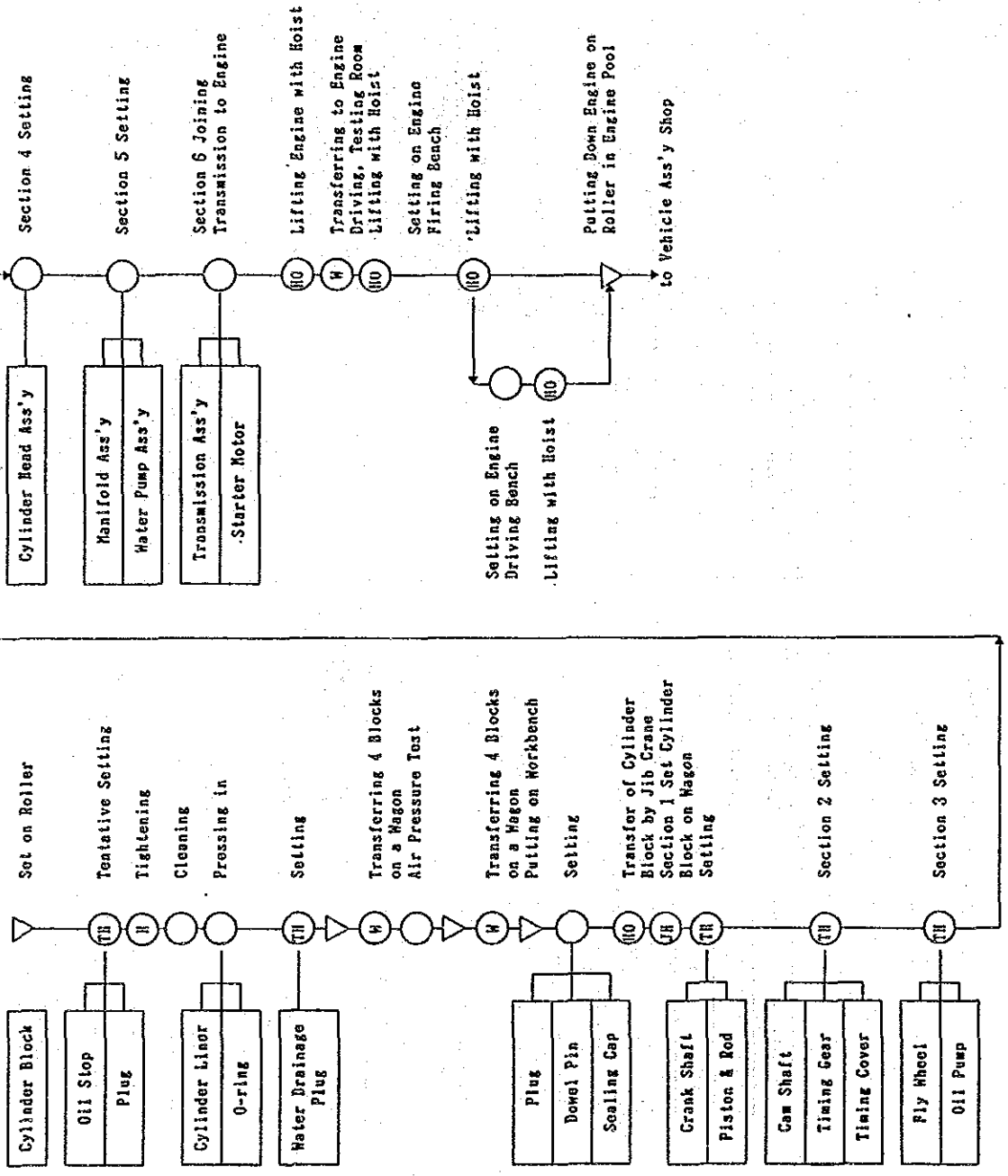


Figure A1-3-3-6 OUTLINE WORK FLOW - B600 TRANSMISSION COMPLETE (MAINLY FOR TRANSMISSION CASING)

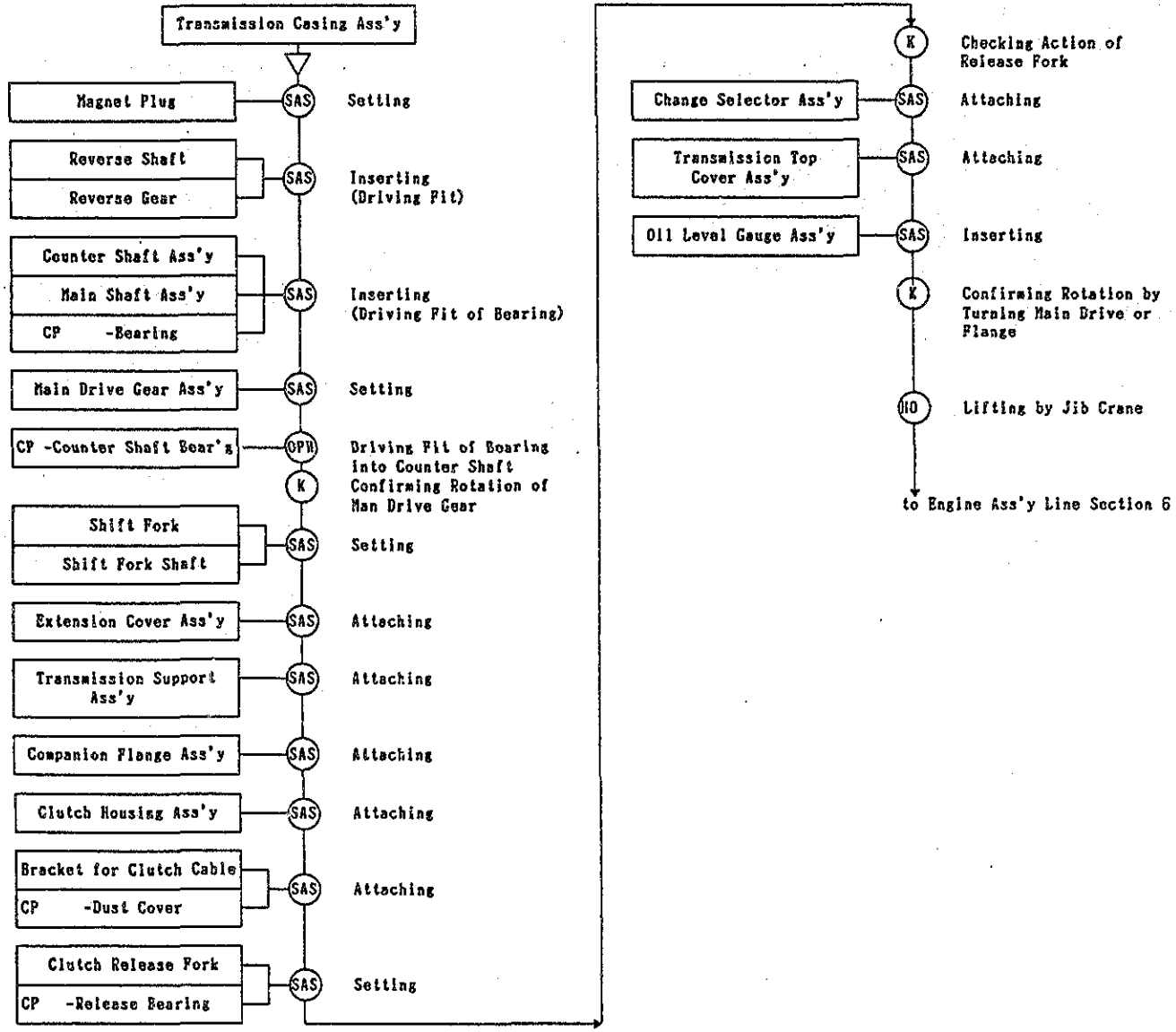
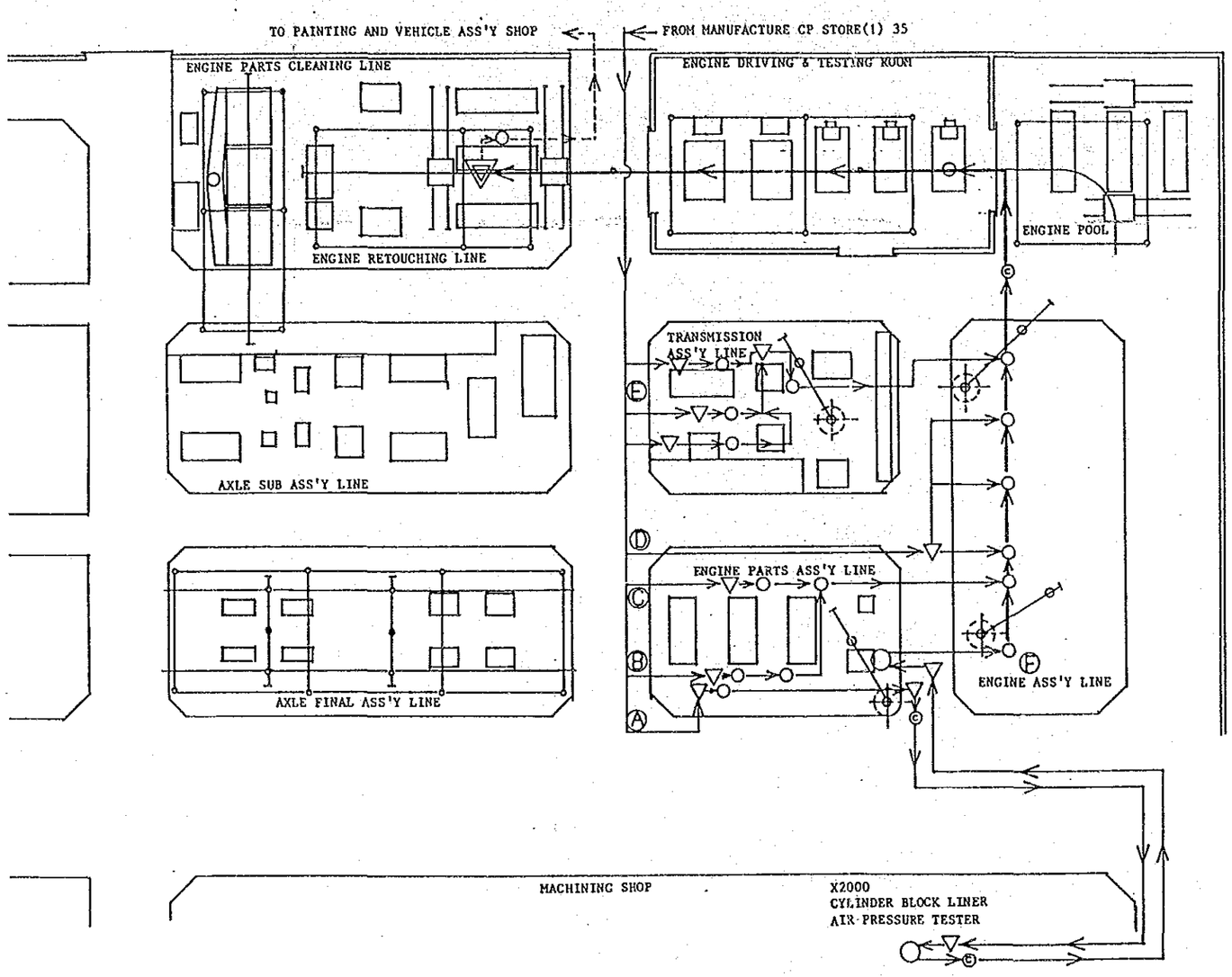


Figure AI-3-3-7 NO.4 HEAVY INDUSTRY LV WORK FLOW CHART OF X2000 ENGINE & TRANSMISSION COMPLETE



Flow of X2000 Engine CPT

Although locations of assy jigs and air pressure testers for X2000 are slightly different from those for B600, the flow of X2000 engine shown in this figure represents also that of B600. This is because the differences between the flows are insignificant and X2000 line contains subjects to be studied in its cylinder block line and transportation system.

Legends

Coutinuous Line: Flow of C.P. for engine and transmission from receipt from Manufactured CP Store to completion of assembly work

Dotted Line: Shipping of engine cpt from assy pool

Ⓐ : Flow of cylinder block
Ⓑ : Flow of cylinder head
Ⓒ : Flow of connecting rod, piston and crankshaft
Ⓓ : Flow of other engine parts
Ⓔ : Flow of transmission parts
Ⓕ : Final assembly line of engine

Total 6 sections and special use hand truck