2.4 Current Production Facilities

2.4.1 Foundry Shop

At present, cast steel, cast iron, and copper alloy products are manufactured in the foundry shop. The in-house manufacturing processes are composed of a line of facilities, starting with the fabrication of patterns, sand treatment, molding, melting, pouring, shake-out, fettling, heat treatment, and quality inspection.

Most of the facilities were found to be aged considerably, ranging between 35 and 40 years of service. However, the facilities were well maintained and used with the due care. The general arrangement of the foundry shop is shown in Figure 2.4.1-1.

While the major pieces of equipment are listed in Table 2.4.1-1–5, the results of the feasibility study, arranged in the sequence of casting processes are given below.

1) Pattern fabricating facilities

As to the facilities for the fabrication of patterns, the shop has been found to be sufficiently provided with proper types of equipment as listed below.

Band saw	2 sets
Circular saw	1 set
Hand feed planer	1 set
Planer	1 set
Wood working lathe	1 set
Common lathe	1 set
Pattern polisher, circular type	1 set
Pattern polisher, cylindrical type	1 set
Universal miling machine	1 set
Radial drilling machine	1 set
Bench type drilling machine	1 set
Duplex head grinder	1 set
Surface plate for inspection	1 set

It was determined that the types and quantities of equipment was adequate in carrying out the fabrication of patterns under normal conditions.

The sanitary standards are maintained in the shop in a satisfactory manner with the provision of a network of ducts to collect dust and fumes generated by each piece of equipment.

While the area of the workshop is approximately 460 m^2 (37.2×12.4 m), the number of equipment and work benches installed in the area makes the space very crowded. As a result, it is likely that limitations are imposed on the fabrication of medium- to large-sized patterns.

It was further noted that there is a shortage in the number of large-sized surface plates, which are required for the inspection of large-sized models. Accordingly, care must be exercised in this area when the Owner intends to increase the number of large-size patterns in the future.

2) Sand treatment facility

The sand treatment facility is situated adjacent to the hand molding line (used in combination with the speed slinger). The facility forms a shop, which is made up of a sand drier, mixer and silos for various types of sand. The facility is installed in an area of 1,146 m^2.

Mostly, green sand is used as molding sand. The facing and backing sands are blended and mixed by the mixer at a rate of 6 tons/hr and 24 tons/hr respectively. The present capacity of the mixer is considered to be more than sufficient, and moreover, there will still remain a surplus even with a 50 percent increase in production.

The existing sand treatment facility was constructed 10 years ago together with the addition of the hand molding line. Therefore, the facility can be regarded as relatively new. For the time being, there is no problem for molding with green sand, but when organic self-hardening molds (for example, furan casting sand) is intended to be used in hand mold castings, it is needless to mention that changes must be made in the equipment. Consequently, there is a need for making a thoroughgoing review as to what the plant should be in the future in the light of equipment investment.

3) Molding facility

The molding line is composed of a hand molding lines for small-sized castings, and medium- to large-sized castings, which are used together with a sand slinger (speed slinger), liner manufacturing line by molding machine, and a mechanical molding line for small castings.

The sand slinger capacity is 6 m^3/min, but the actual situation is such that there is surplus capacity since the operation rate is below the 50 percent mark.

The two Zimmerman type molding machines are used for the manufacture of liners, one is seldom used. The molding machines are comparatively new. They were installed six years ago.

Idle times in the handling for molding, mold setting, and transportation by crane are seen in the shop. The molding efficiency can be raised by improving the flow of process and timely crane utilization.

As to the line made up of Badische molding machines for small-sized castings, the mold setting after molding is not systemized. Therefore, efficiency can be raised by modifying the line together with the installation of conveyor lines.

The existing SPO molding machine in the small-sized casting area is of the jolting type. However, since the machine must be manually rammed, it should be updated to a jolt screw type.

There is a sand blowing machine for the core making machine, but it is better to use the cold box sand, which is being used to some extent at present than the CO_2 sand. Furthermore, it is desirable to provide a small capacity speed mixer for the sand.

4) Melting facility

Three Heroult type electric furnaces (10 ton, 3 ton and 3 ton capacities), one induction furnace (1.5 ton capacity), and a special furnace (for nonferrous metal and white iron castings) are used in the melting process.

The 10 ton furnace was installed last year and it is in the process of entering into full-scale operation. Since one of the furnaces (3T-furnace) does not have a sliding roof, considerably long period of time is required in charging the raw materials. Furthermore, since the melting materials and scrap storage yard is located some distance away from the furnaces, time loss due to the hauling of materials to and charging them into the furnace is conspicuous.

As to the electric furnace in particular, idle time is generated by two cranes used for the mold setting, pouring, charging of melting materials, handling of ladle filled with molten metal. Besides, the aged cranes breakdown frequently, and restricts the Foundry works to a considerable extent.

5) Finishing facility

The finishing process has been targeted as one of the most important processes in the feasibility study. The process consists of a shot blasting equipment, riser cut-off device, grinder, heat treatment furnaces, cranes and other handling equipment, dust collector, and jigs.

Detailed explanations of the layout of the facility, capacity and operations of major equipment are given below.

(1) Layout

The area of the finishing shop is about 1,500 m^2, which is located adjacent to the medium-sized molding shop, four heat treatment furnaces, which is away from the finishing shop, and an outdoor intermediate process product storage area.

The finishing shop is divided into a shot blasting area, riser cut-off area (two places), rough grinding shop, small-sized castings and final grinding shop, and an inspection area. The layout is shown in Figure 2.4.1-2.

As mentioned in the section covering the general outline of equipment, the layout was not constructed all at once. Instead, the layout was expanded by one are at a time, a feature which could not be avoided as history indicates.

However, from the viewpoint of elevating productivity, there are several areas which require improvements. While the improvements are explained below, an in-depth study must be made before plans are drawn up to modify the workshop buildings and relocating major pieces of equipment since implementation of such a plan will entail a vast amount of capital expenditure, and cause adverse effects on the production processes under operation.

a) Arrangement of heat treatment furnaces

As can be seen from the layout drawing, there are four heat treatment furnaces, three in the foundry shop and one in the scrap yard, but they are considerably far away from the finishing shop.

Most of the castings are heat treated after they processed through the shot blasting and riser cut-off operations and are returned to the shot blasting process.

As a consequence, the castings are loaded on transfer cars, making round trips between the finishing shop and heat treatment furnaces. Since the crane hooking and handling work is not considered as a value added operation, and since an increase in the number of steps required for the operation results in loss of time by waiting for the crane availability, the layout of the furnaces must be reviewed in such a manner that the handling work is reduced to the minimum.

b) Layout of shot blasting facility

The shot blasting facility is situated in the center of the finishing shop and adjacent to the grinding shops located in the back of the shop.

After the shot blasting process, all of the castings other than the high chrome cast iron products are delivered to riser cutoff and heat treatment process without the grinding process. For this reason, there is an inevitable increase in the handling of castings by transfer cars for shot blasting alone.

In other words, the present layout is such that there is interference in the entry and exit, and cranes which are used jointly by the grinding shops, adversely affecting the grinding process as well as lowering the efficiency in transporting castings to the shot blasting shops located in the back side.

Therefore the layout should be modified so that it will be compatible to the processes in the upstream and downstream, and product flow.

c) Building layout and handling method

As mentioned in the item concerned with the heat treatment furnaces and shot blasting, the materials transported between the processes in the finishing shop is mainly carried out by the use of transfer cars.

As can be seen from the layout, the finishing shop dominating an area of 1,500 m^2, appears to represent a single block, but the differing crane rail gauges divide the shop area into several sections by the range of overhead crane travel.

Furthermore, since the aisles between the buildings are very narrow, the transfer cars are forced to leave certain areas of the building and circle around to reach their destinations.

As compared to the overhead traveling cranes, the method of handling by the tractor type transfer cars requires several times of manhours when the number of steps are compared.

If possible, the crane rail gauges should be made uniform so that handling of products through the workshop can be covered by the overhead traveling cranes.

(2) Major equipment capacities and operating conditions

a) Shot blasting

The shot blasting facility is composed of rotating drum type equipment (1 set) for small castings, and a turntable type (1 set) for large-size castings. The rotating drum type is 1,067 mm ϕ (42" ϕ) and 1,220 mm (48") long. The equipment is capable of processing 600 kg at a time.

The turntable type is provided with a chamber having a frontage of 3,350 mm, 2,280 mm high, and 5,500 mm deep. The turntable is of a self-motive type, 3,200 mm in diameter with a loading capacity of five tons. The shot blasting equipment is also equipped with an exclusive shot particle separator.

While the two pieces of equipment are aged, the owner has maintained them in a very satisfactory manner, despite the fact that the shot blasting operation is carried out under a two-shift operation.

However, there are frequent breakdowns, and the records indicate that there were six instances of shutdowns extending over a period of more than one day for repairs in a year.

b) Riser cut-off device

There is a variety of methods available for the cutoff of riser and trough in accordance with the casting material. Some of the more common methods are cutting by oxy-acetylene gas, arc-air-gouging, grinding wheel, and powder.

However, the existing riser for cast iron products is cut off by a knock-off method using hammers (manual).

Of the methods mentioned above, the oxy-acetylene gas and arc-air-gouging methods are the ones which are widely used.

In the oxy-acetylene gas cutting, hoses are drawn from the bottles, and the cutting is accomplished manually by the use of cutting torches.

In the arc-air-gouging method, an exclusive power source (1 set) and plant air are used for cutting, which is also accomplished manually.

The capacity of power source equipment for the gouging operation is 1,500 amps, which is rated as strong. The maximum diameter of the carbon rods at its round cross section is 15.9 mm (5/8″).

The oxy-acetylene gas cutting operation is carried out under a two shift setup (one man each), while the arc-air-gouging is performed on a one shift basis (one man).

c) Grinders

The grinding shops are provided with six large-size swing grinders, four medium-size swing grinders, four duplex head grinders, and several air and high frequency hand grinders. The large-size swing grinders assume the largest burden of the grinding operation.

In the rough grinding shop, there are five large- and one medium-size grinders taking care of the rough grinding requirements.

The large-size swing grinders are 2,500 mm long, 860 mm wide, weighing 368 kg, and driven by 15 HP motors. The grinder is suspended from a manually operated one ton chain block, which is attached to a swivelling arm that is installed on columns of the shop building.

The grinding wheel turns at a speed of 1,400 rpm, and the diameter of the grinding wheels used for rough grinder is 610 mm and the thickness is 76 mm. The grinding wheels are of the resinoid type. The grinders are very old. There are pieces of equipment which have been in service for more than 50 years.

According to old catalogs, the design of original equipment was simple and did not have belt covers. However, the Owner has effected many improvements on the machines since the installation, and one obtains an impression that they are also maintained in a satisfactory manner.

In the aspect of grinding efficiency, however, the peripheral speed of grinding wheels in the existing machines is 45 m/s, whereas the peripheral speeds of the modern machines ranges between 60 and 80 m/s. Furthermore, the revision in the source frequency from 60 to 50 Hz has caused the speed to drop to 35 m/s.

Since the change in the frequency directly lowers the productivity of the grinding operation, it is desirable to replace the existing equipment with the latest types as soon as possible, especially since the processes are being carried out at capacity under two shifts.

The medium-size swing grinders were introduced five years ago. The machines were found to be of latest design, and provided with grinding wheels with a peripheral speed of 80 m/s.

On the other hand, the duplex head and hand grinders were found to be those with relatively low rate of operation. Most of them are of the old type. Such being the situation, it is desirable that the Owner take immediate steps to replace the existing grinders with the latest type with fixed peripheral speed, and small and lightweight high frequency grinders.

Suction type of dust collecting system is provided for the swing grinders, but the effect of suction is lost due to improper positioning of the suction port. Therefore, the situation should be improved at the earliest possible date.

d) Heat treatment furnace

There are four large- and small-size oil fired furnace under a three shift operation.

(a) The No.1 furnace is of a transfer car type 10 ton furnace, 3,000 mm wide, 1,400 mm high, and 4,500 mm deep, the maximum working temperature is 1,093°C, and a water tank 4,700 mm wide, 3,700 mm long and 1,600 mm deep is located next to the furnace for water toughening.
The furnace was installed about 15 years ago. A one point thermocouple is used for the control of temperature, and the burners are manually controlled.

(b) The No.2 furnace was an electric furnace, but it does not exist at present.

(c) The No.3 furnace is of a four ton transfer car type, 1,500 mm wide, 1,100 mm high, and 1,900 mm deep. The maximum working temperature is 1,065°C, and the furnace is provided with one burner. The furnace is very old and constructed by the Owner approximately 40 years ago.

(d) The No.4 furnace is of a 40 ton top charging round type, 3,800 mm in diameter and 2,500 mm high. The maximum working temperature is 970°C.

The furnace is used for the annealing and tempering of ladles, mill covers and other large-sized castings.

This is a new furnace, which was also constructed by the Owner three years ago.

(e) The No.5 furnace is of a 30 ton, transfer car type, 3,300 mm wide, 3,200 mm high, and 4,700 mm deep. The maximum working temperature 1,205°C. The tempering facility is composed of air cooling fans, and a water tank, 5,000 mm wide, 5,000 mm long, and 3,700 mm deep, which is situated adjacent to the furnace.

This furnace was constructed four years ago, and it is considered to be the one which is most modernized. "Kao Wool" (fire resistant glass wool) is used in the walls and doors.

The burners are installed along the edges in three places so as to circulate the combustion gas within the furnace. The furnace is automatically controlled by means of six thermocouples and program settings.

e) Handling facilities

The handling facilities are composed of various types of cranes, transfer cars, and fork lifts. The finishing shop is provided with the following pieces of equipment.

1 of 10 ton max. overhead and floor operated cranes covering the rough grinding shop and turntable type shot blasting shop.

3 each of 5 ton and 1 ton overhead and floor operated cranes.

1 set of monorail transporting equipment with 1 each of 3 and 1 ton chain blocks.

Most of the transfer cars are equipped with rubber tires. Others travel on rails. All of the cars are towed by tractors and fork lifts.

The rubber tired cars are 1,500 mm wide, 2,600 mm long, and 710 mm high with a loading capacity of five tons. Additionally, there are each two cars with 15 ton and 10 ton loading capacity.

6) Testing and inspecting facilities

The testing and inspecting facilities are under the control of the Quality Control Department. The facilities consist of sand testing equipment for castings, and equipment for mechanical properties of materials, testing equipment for chemical analysis and dimensional inspection.

- Universal sand strength machine, permeability tester, moisture tester, and sand grain tester, etc. are made available for measuring the sand properties.

- Leco carbon meter, Leco sulfur measuring instrument, atomic absorption analyzer, emission spectrum absorption analyzer and instruments for the wet method chemical analysis are made available for the analysis of components.

- 30 ton universal tensile tester, microscope, Rockwell and Brinnell hardness testers are made available for mechanical tests.

- Ultrasonic flaw detector, magnetic particle detector, α-ray exposure equipment, and X-ray equipment are made available for nondestructive inspection.

As to equipment used for quality control, the facility is provided with the required number of quality instruments and equipment. As long as each piece of equipment and instruments are fully utilized, there should be no problem.

List of Major Equipment for Casting Processes

Table 2.4.1-1 Equipment for Pattern Manufacturing Processes

	Equipment	Q'ty	Specifications, Others	Remarks
1	Wood working lathe	1		
2	Common lathe	1		
3	Universal milling machine	1		
4	Hand feed planer	1		
5	Planer	1		
6	Band saw	2		
7	Circular saw	1		
8	Wood working polisher (cylindrical type)	1		
9	Wood working polisher (disk type)	1		
10	Bench drill	1		
11	Radial bolling machine	1		
12	Duplex head grinder	1		
13	Marking press	3		
14	Inspection surface plate	1		
15	Monorail	1 set	1 ton, 4 ton	
16	Fork lift	1		
17	Hydraulically operated transfer car	1		
18	Manually operated transfer car	1		
19	Dust collector	1 set		
20	Hand tools			
21	Inspection tools			

Table 2.4.1-2 Equipment for Molding Process

	Equipment	Q'ty	Specifications, Others	Remarks
1	Shakeout machine	1	25 ton, stationary type	
2	Shakeout machine	1	5 ton, motive type	
3	Shakeout machine	1	5 ton, motive type	
4	Belt conveyor for sand feed	1 set	32t to 25t/H	
5	Sand silo	5	45 m^3 each	
6	Sand mixer	1	24 ton/H	
7	Drying furnace	3		
8	Mixer for mold wash	3		
9	Core molding machine	2		
10	Molding machine (SPO)	1		
11	Molding machine (Badisch)	2		
12	Molding machine (Zimmerman)	2		
13	Speed slinger	1	6 m^3/min.	
14	Portable mold drier	5	Electric type, 70 kw - 3 each, 140 kw - 2 each	
15	Welder	1	600A	
16	Bender	1		
17	Molding pit	2		
18	Divices related to sand treatment	1 set		
19				
20				

Table 2.4.1-3 Equipment for Melting Process (1/2)

	Equipment	Q'ty	Specifications, Others	Remarks
1	Heroult type electric furnace	1	3T (Rectromelt)	
2	Heroult type electric furnace	1	3T (Rectromelt)	
3	Heroult type electric furnace	1	10T	
4	Introduction furnace	1	Intermediate frequency	
5	Special furnace	1	For nonferrous metals (Bladen copper)	
6	Special furnace	1	For white iron (Bladen copper)	
7	Ladle	18	800 kg to 13 ton	
8	Preheating burner for ladle	3	Heavy oil burning type	
9	Brick cutter	1		
10	Crane	1	10/30 ton	
11	Crane	1	7.5/15 ton	
12	Crane	1	5/10 ton	
13	Crane	1	5/10 ton	
14	Tractor	1		
15	Gasoline car	1		
16	Transfer car	2	15 ton	
17	Car truck	1	11 ton	
18	Crane (Scrap yard)	1	5/10 ton	
19	Lifting magnet (Scrap yard)	1	4 ton	
20	Shearing machine (Scrap yard)	1	760 W x 50 t	
21	Gouging machine (Scrap yard)	1	1,250 Awp	

Table 2.4.1-3 Equipment for Melting Process (2/2)

	Equipment	Q'ty	Specifications, Others	Remarks
22	Platform weighing machine (Scrap yard)	1	20 ton	
23	Weighing machine (Scrap yard)	7	5 kg to 30 ton	
24	Ventilator	11	27,000 ft/m^3 x 3 HP	

Table 2.4.1-4 Equipment for Finishing Process

	Equipment	Q'ty	Specifications, Others	Remarks
1	Drum blast	1	48" x 42"	
2	Table type blast	1	5 ton car truck	
3	Swing grinder	6	24" x 12" x 3" (Large)	
4	Chain block	6	1 ton	
5	Swing grinder	4	(Medium size) Peripheral speed - 80 m/min	
6	Chain block	4		
7	Duplex head grinder	4		
8	Welder (wire feeder)	3		
9	Semiautomatic welder	3		
10	Gouging	1		
11	High frequency converter	3		
12	Platform balancer	1	1.5 to 2 ton	
13	Transfer tractor	4	15 ton - 2 each, 10 ton - 2 each	
14	Crane	5	3 ton - 2 each, 5 ton - 2 each, 10 ton - 1 each	
15	Monorail	1 set	1 ton, 3 ton	
16	Wall crane	1	2 ton	
17	Heat treatment furnace	1	10 ton (No.1)	
18	Heat treatment furnace	1	4 ton (No.3)	
19	Heat treatment furnace	1	40 ton (No.4)	
20	Heat treatment furnace	1	30 ton (No.5)	
21	Roof ventilator	4	27,200 ft^3 - 2 16,750 ft^3 - 2	
22	Dust collector	3	4.02 m^3	

Table 2.4.1-5 Equipment for Quality Control

	Equipment	Q'ty	Specifications, Others	Remarks
1	Leco carbon meter	1		
2	Leco sulfur measuring instrument	1		
3	Photo electric photometer	1		
4	Atomic absorption analyzer	1		
5	Electroanalyzer	1		
6	Emission spectrum absorption analyzer	1	16 element/2 minutes	
7	Universal tensile tester	1	30 ton	
8	Microscope	2		
9	Rockwell hardness tester	2		
10	Brinell hardness tester	1		
11	Ultrasonic hardness tester	1		
12	Micro Vickers hardness tester	1		
13	Purity meter	1		
14	Cross-section micro comparator	1		
15	Sand testing equipment	1 set		
16	α-ray exposure device	2		
17	X-ray equipment	2		
18	Ultrasonic detector	3		
19	Thickness measuring instrument	1		
20	Magnetic particle flow detector	1	2,000 Awp	
21	Penetrant, fluorescent magnetic particle	1		

No.	Name of Shop
1	No.1 Heat Treatment Furnace
2	No.3 Heat Treatment Furnace
3	No.4 Heat Treatment Furnace
4	No.5 Heat Treatment Furnace
5	Arc Cutting Shop
6	Oxygen Gas Cutting Shop
7	Finish Grinding and Inspection Shop
8	Samll Casting Shot Blasting Shop
9	Rough Grinding and Shot Blasting Shop for Large Castings

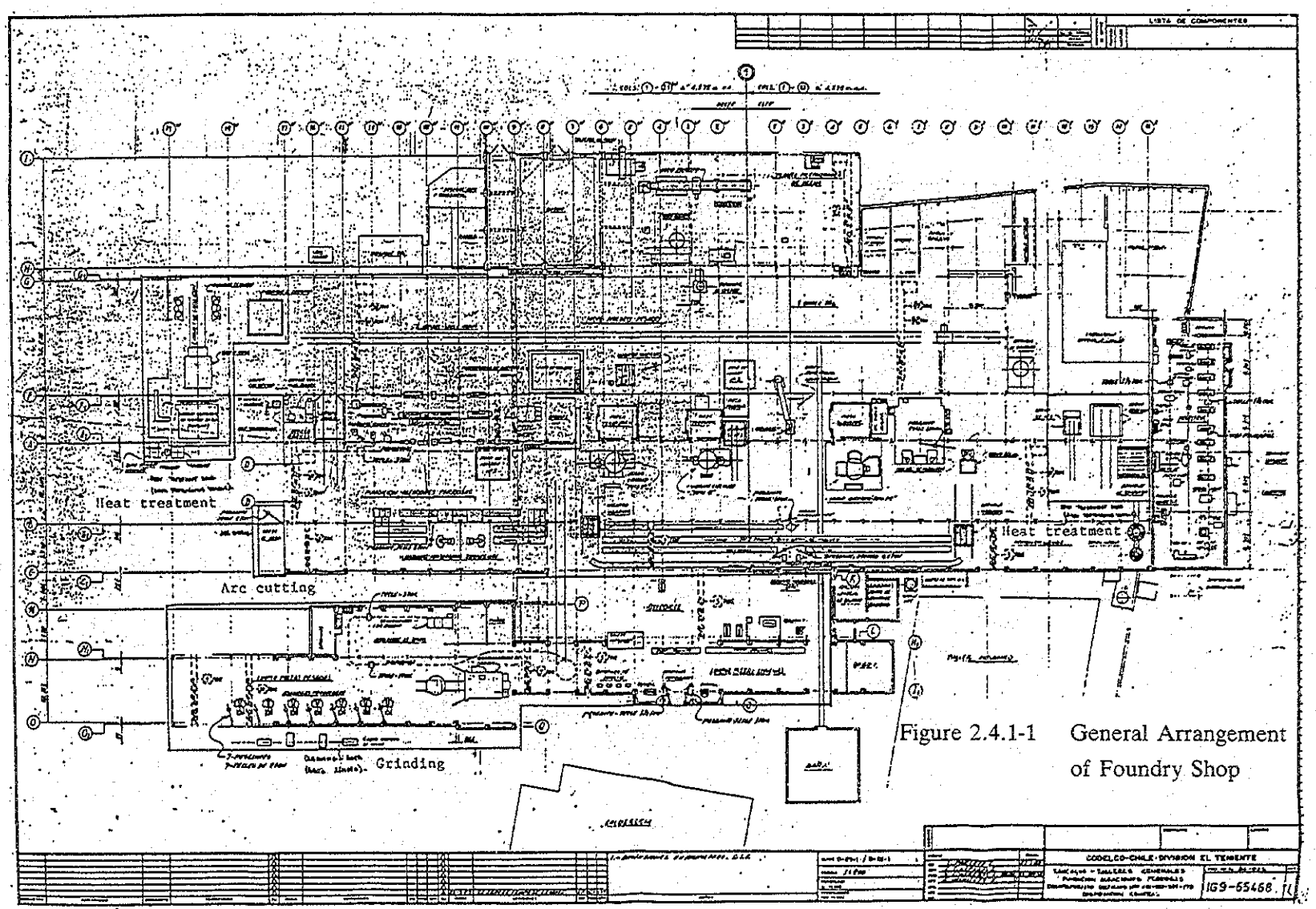


Figure 2.4.1-1 General Arrangement of Foundry Shop

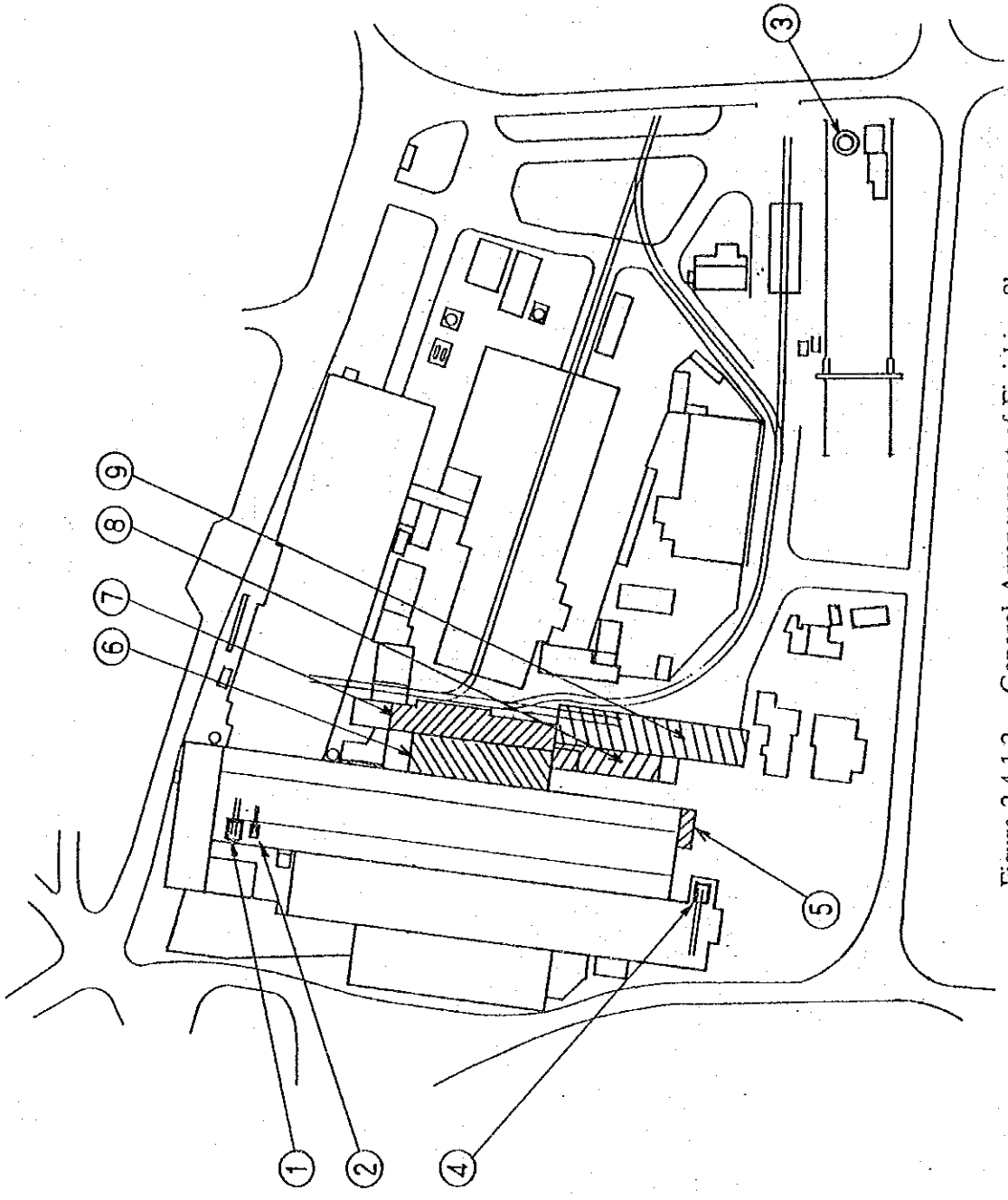


Figure 2.4.1-2 General Arrangement of Finishing Shop

2.4.2 Plate Shop

The plate shop undertakes the manufacture of a variety of products, involving the cutting, shearing, bending, and welding of steel sheets and plates, shapes and round as required by the captive mines, ore floatation and refining plants, and workshops in the casting shop.

The plate shop also carries out the over-lay welding of worn parts, repair welding of castings, manufacture of screens for ore screening equipment, and forged components such as mining bits and liner retaining bolts.

Accordingly, the plate shop is provided with various types of equipment which are capable of handling the manufacture or repair of products. Since the layout has been expanded from time to time, it is characterized by a typical service shop with many different types of equipment, but without a unified line of products.

Each piece of equipment together with the building have been found to be very old. Except for a part of the welding equipment, most of the equipment have been in service for 30 to 40 years. However, the owner has maintained the equipment in a very satisfactory manner.

The layout is shown in Figure 2.4.2-1 and -2, and major pieces of equipments are shown in Table 2.4.2-1 to -4. The survey results relating to the general arrangement and processes are given below.

1) General arrangement

As can be seen from Figure 2.4.2-1, the plate shop is composed of the main shop, 30 m wide and 90 m long, mechanical round bar cutting shop, shot blasting shop, paint shop, and an outdoor material and semi-finished goods storage yard.

The center of the plate shop is broadly divided into screen fabricating shop, forging shop, welding shop and other plate workshop. While the plate shop runs lengthwise from north to south, a large space is provided on the south side as the storage yard for materials and semi-finished goods. The machine shop is located on the east side, casting shop on the north side, and an electric shop on the west side. Consequently, there is no passageway wide enough to allow transportation of large products. For this reason, delivery of materials and shipment of large products are restricted to the access in the south side, causing a U-turn in the flow.

As shown in Figure 2.4.2-2, processes in the sequence of cutting, bending, assembling and welding are located near the entrance on the south side. However, since a large bending roller with a low operating efficiency is located near the center of the plate shop, the arrangement cannot be considered satisfactory due to the equipment tending to isolate the assembly shop.

Over-lay welding of crushers, ladles, and other large-sized castings are undertaken in the welding shop located in the rear of the plate shop, but there is no continuity with the processes in the downstream and upstream. Therefore, it is desirable that the welding shop be relocated in a area near the entrance of the shop to facilitate the transportation of products to the heating treating furnaces or provide an exclusive area for the build-up welding shop.

No.	Designation
①	Plate Shop
②	Angles of Sections Shearing Shop
③	Sand Blasting Shop
④	Paint Shop
⑤	Outdoor Material Storage Yard

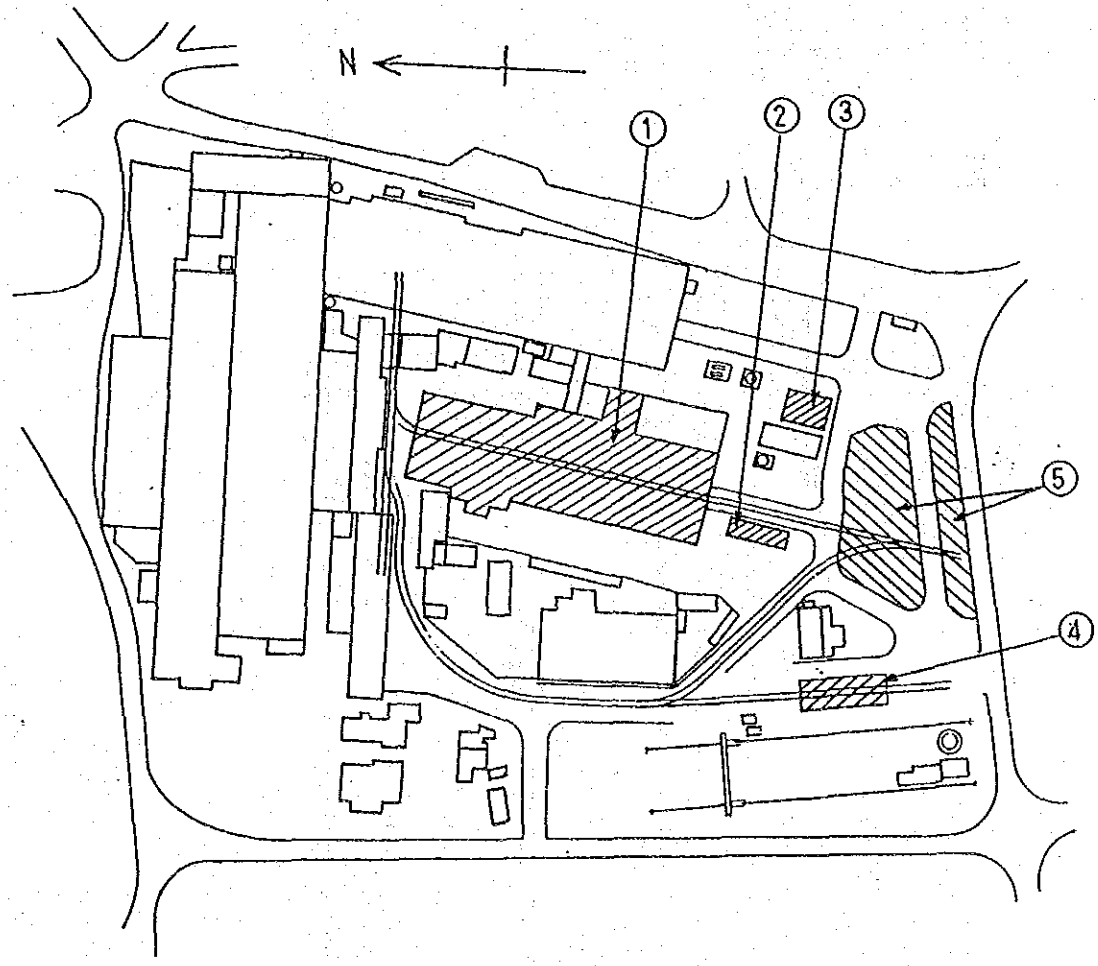


Figure 2.4.2-1 General Arrangement of Plate Shop

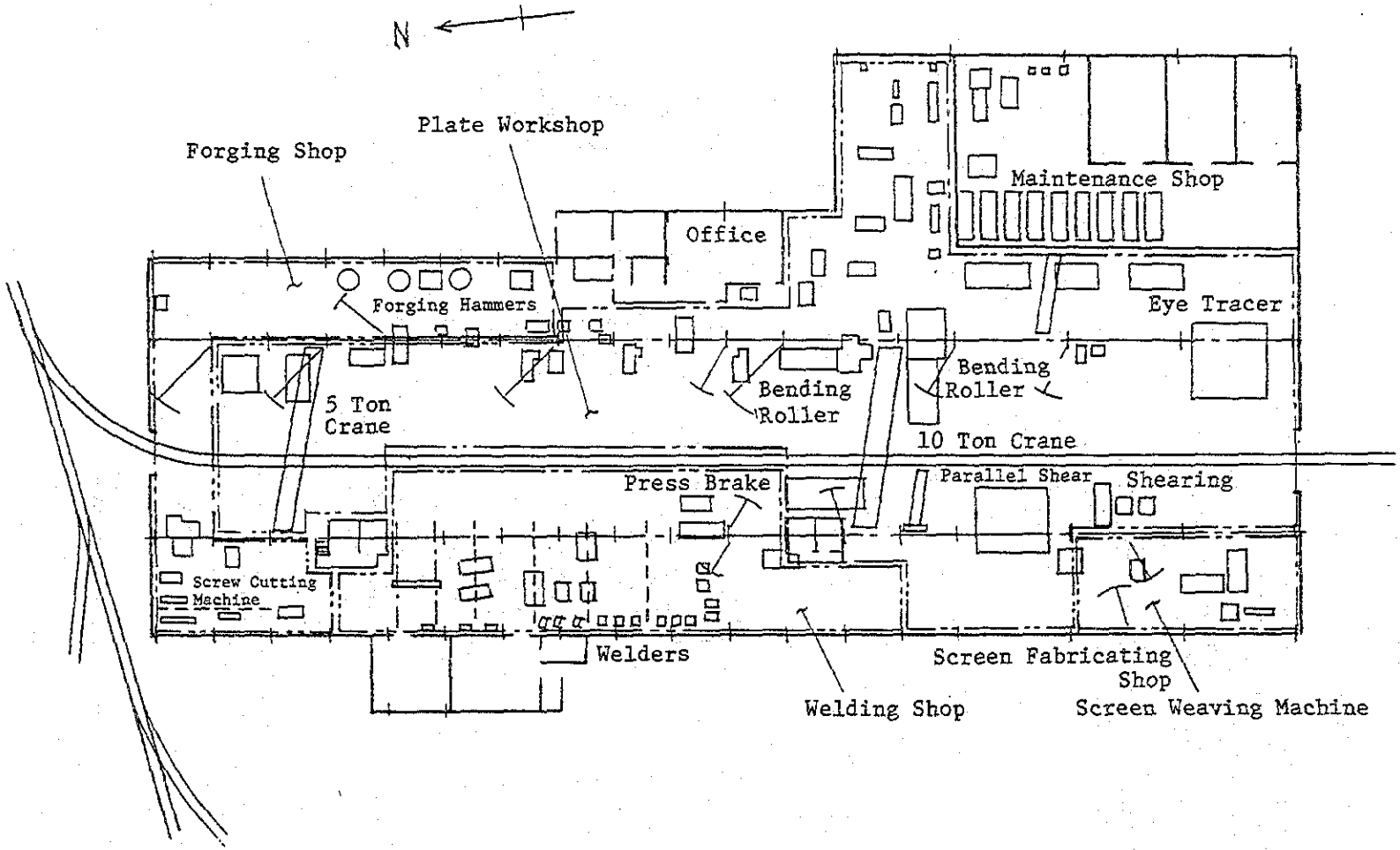


Figure 2.4.2-2 General Arrangement of Workshops in Plate Shop

All equipment including those of small capacities cannot be moved readily since they are anchored to the floor. However, when considering the plate shop which is characterized by the handling of a variety of products, it is desirable to make changes in the arrangement of equipment so as to facilitate better handling when there are changes in the types of products.

While it is needless to mention that equipment with large-sized foundations cannot be relocated simply, providing common beds fabricated of heavy gauge steel plates for small-sized equipment such as bending rollers, shearing machines, radial drill presses, and stress relieving presses is an ideal method for relocating the equipment simply by means of cranes.

2) Screen manufacturing equipment

The equipment for manufacturing screens if located in a space, 7.5 m wide and 15 m long, which is a lean-to constructed on the south side of the plate shop. The screens are woven by drawing the wires externally from the building, and the process is isolated from the other processes.

The screen manufacturing shop consists of one wavy bending machine installed before the weaving process, one weaving machine, one screen cutter, and two swing wall cranes (with an one ton chain block). Screens in sizes of about 1×2 m using wires in diameters ranging from 2 to 10 mm are manufactured by the equipment.

3) Equipment for manufacturing forgings

The process of manufacturing forgings dominates a space of about 300 m^2 under a lean-to which is constructed on the north side of the plate shop. The major work carried out in this shop consists of forgings of liner retaining bolts to thread cutting, mining bits, welding of pattern pipes, and casting of bushing metal for bearings used in casted wheels. Majority of the products manufactured in this shop are small-sized, that is, those which can be held in one's hands.

The forging shop equipment is composed of the following equipment.

- 7 small furnaces composed of heavy oil fired furnaces, gas fired furnaces, and coke fired furnaces
- 2 hammers

- One bolt forging machine
- 4 thread cutting machines
- 3 duplex head grinders

Each piece of equipment is very old. Of the oldest, the hammers were manufactured in 1972.

4) Plate shop equipment

The plate work process consists of marking of steel sheets and plates, shape steel, and rounds, cutting and shearing, bending and assembly. This is the main process of the plate shop dominating about 2/3 of the overall area.

As to the manufacturing capacity of the plate shop, the surveyors were told that it has a record of manufacturing a cylindrical welded structure using steel plates 37 mm thick, 4,000 mm in diameter, and an overall length of 17,000 mm, and weighing 80 tons. However, this is considered to be a special case. On basis of the present equipment capacities, the plate shop can be regarded as medium-sized for manufacturing of products using steel plates of thickness up to 35 mm thick and maximum bending weight of 15 tons.

The major equipment capacities and operating conditions are explained below.

(1) Shears

The shears are made up of 2 eye tracers, 4 small-sized automatic gas cutters, and 1 wide shearing machine. Additionally, there are 1 saw for cutting rounds, 1 hydraulic shearing machine for sections steel, 1 nibbler for steel sheets, and 1 vertical band saw.

One of the eye tracers was purchased from Linde Co. of the United States this year. The installation has been completed and the equipment was under trial runs. The eye tracer is of the latest design, equipped with an NC system. The equipment is provided with 5 oxy-acetylene torches and 1 plasma torch. The tracer is also capable of cutting complicated configurations. The table is capable of handling steel plates 200 and 65 mm (stainless steel) thick, 3,500 mm wide and 3,000 mm long. The other is of an old type, and the capacity is about the same. At present, 5 oxy-acetlylene torches are used to carry out parallel cutting.

The small-sized automatic cutter is of the conventional type consisting of light-weight rails, 200 mm wide and 3,000 mm long with a self-propelled car for the oxy-acetylene torch. The cutter is used for straightaway cutting.

It so happened that cutting was being carried out with many notches during the survey. According to the person in charge, the notches are caused by frequent voltage fluctuations resulting from the recent floods. Therefore, the cutting accuracy was much lower than allowable tolerance.

The wide shearing machine is a mechanical shear, capable of handling steel plates up to a maximum thickness of 9.5 mm and 3,000 mm wide. While the shear is also old, the equipment did not show any problem in the shearing operation.

(2) Bending equipment

In proportion to the scope of the plate shop, the number of bending equipment was found to be more than sufficient. However, a 4-column type plate press, which is normally installed in a plate shop, was not found. Without such a press, a plate shop is regarded as a "cripple" since the important processes of bending of heavy gauge plates, bending of the ends before charging into the bending rollers, stress relieving, and straightening of bends cannot be accomplished.

The following equipment are used for the bending processes.

- 4 Bending rollers
- 1 Press brake
- 1 Angle bender
- 1 Transverse-feed press for stress relieving
- 1 Rail straightening machine
- 1 Bending machine for steel sheets

a) There are four large and small bending rollers, but they are also very old. Since processing of steel plates through a set of rolls is originally considered to be an efficient method, the problem of accuracy in the existing equipment can be eliminated and the operating efficient can be raised as long as the parallel of the rolls and screwdown control can be maintained properly. In other words, aging of equipment is not that significant.

Other than the small-sized pyramid type, the others are of the initial pinch type. This is one of the reasons why the abovementioned 4-column type plate press is not installed.

Without the plate press, the ends of heavy gauge plates cannot be properly bent with small sized rollers. Therefore, additional length must be taken to obtain the necessary bend cut off the extra length. The largest press can handle steel plates with a thickness of 25.4 mm and 4,267 mm wide.

Since there is no handling equipment before and after the bending equipment, the plates are supported by means of cranes. Furthermore, since the bending rollers are located in the center of the plate shop, they divide the space into two. The surveyors were advised that the rollers are used only two to three times a year. If that is the case, the equipment should be moved to one side.

As to other rollers, there are manually turned bending rollers for the handling of steel plates 16 mm thick and 3,658 mm wide, and 10 mm thick and 1,830 mm wide. Since the roll diameters and pitch are smaller, the bending rollers are used according to the product sizes.

b) The press brake is provided with a brake pressure of 150 tons and a standard capacity of handling steel plates 8 mm thick and 3,050 mm wide. The press brake is the only equipment in the shop that is serving as a general purpose bending machine. The press brake is used for the bending of a variety of small and large size products.

During the survey, the press brake was used for the bending of reinforcing killed steel for head ways (about 25 mm in diameter) and bending of steel plates 35 mm thick and 500 mm wide with a small radius. The operation was being carried out at full capacity under two shifts.

However, since the press brake is originally designed for the processing of light gauge metal. The machine is characterized with a very narrow head width. For this reason, the press brake is used for narrow steel plates of narrow width, and when bending the metal with a small radius, the form tends to bite the product.

The study team were informed that importance is not attached to the appearance of products since they are consumed internally. However, it was noted that the bending operation showed signs of instability, indicating problems from a safety standpoint. In the midst of the survey, cracks developed in the metal. The development can be regarded as a natural consequence

since edge preparation of base material is not undertaken. Accordingly, it is recommended that a review is made on the bending techniques together with the equipment.

c) The angle bender is of a 3-roll type, and it is capable of bending angle steel up to 125 mm.

d) The transverse-feeding press for stress relieving is a of small type with a braking force of 630 kg. The press is used for the stress relieving of light gauge welded steel structures, 300 mm wide.

e) The bending machine is of the manually operated type for the processing of 2 to 3 mm light gauge sheets.

(3) Other equipment

While the plate working processes are mainly composed of cutting, shearing and bending equipment, other types of equipment consist of the following.

1 Radial drill press
1 Duplex head grinder
Several hand air brinders

The radial drill press is of a swing arm type, and it is capable of drilling holes up to 30 mm in diameter.

5) Welding equipment

The welding process is another process which particular importance is attached to the survey. As mentioned in detail in Item 2.2.1 relating to production, welding of ore carrier bogies, ore floatation equipment, and other general steel structures, and over-lay welding of crushers, ladles and other types of castings are carried out in the welding shop.

However, such welding work is not carried out constantly. At the time of the survey, over-lay welding was carried out on 4 large ladles and crushers, and welding of 1 bucket for shovel cars, several structural steel members, and two heavy gauge gusset plates. There was a stack of completed arches in the semi-finished storage yard.

The welding shops cover an area of approximately 480 m^2, 15 m wide and 32 m long which includes a lean-to. The area is located in the plate shop about 50 m from the entrance on the south side. However, since the space is extremely crowded, and since there is only a 2 ton chain block provided in the lean-to, it is impossible to maintain all of the pieces under the roof. Therefore, they are carried into various parts of the plate shop and even as far as the machine and repair shops located in adjacent buildings to carry out the welding work.

Since the ladles in particular, weigh 15 tons, it is impossible to haul them into the plate shop. Therefore, the welding work is carried out in the machine shop using the 20 ton crane. Accordingly, it can be said that the shortage in overhead travelling crane capacity and space are posing a serious problem in the handling of ever larger size products.

The welding shop is equipped with the following pieces of equipment.

- 15 Manual AC welders
- 5 Semiautomatic welders
- 1 Revolving positioner
- 2 Turning rolls
- 1 Manipulator
- 1 Dust collector

The welding work is carried out at full capacity under a 3-shift system.

a) There is a total of 20 welding machines. Five of them are of a semiautomatic open arc type. The capacity of most of the welders is 600 amp, followed by 400 and 300 amps. The welding machines are relatively new, which the majority were purchased within the past 10 year period, other than six AC manual welding machines, which were purchased 30 years ago. There is also one submerged arc welding machine, but it is not in use at present.

b) As auxiliary welding equipment, the shop is equipped with one each 8 ton positioner, 10 and 60 ton turning rollers, and an in-house manufactured manipulator. The welding shop is also equipped with a fume and dust collecting system. The system is composed of a total of 18 flexible hoses so located that they are fully capable of drawing fumes and dust generated in areas where arcs are produced, a sign indicating that the Owner has given due consideration to sanitation aspects.

The line-up of welding equipment provided in the welding shop indicates that the operation is centered on manual welding. Furthermore, most of the auxiliary equipment are not used. Therefore, increased use of semiautomatic and automatic equipment is desirable from a standpoint of raising productivity.

6) Crane

One 10 ton/5 ton crane, and one 5 ton overhead travelling crane with an operator's pulpit are provided in the main plate shop building with a 15 m span in addition to one wall crane, and one 2 ton overhead travelling crane in the lean-to. Manually operated 2 and 5 ton chain blocks are installed on the columns of workshops or attached to swinging arms and monorails.

One serious problem is in the recent increase in the size of products for manufacture or repair, which exceed the existing crane capacities. The actual condition is such that the work is being carried out by overloading the handling equipment.

Another big problem is in the existence of many manually operated chain blocks, which is the main cause of low working efficiency. It is recommended that the inefficient chain blocks be replaced with electrically driven hoists.

Table 2.4.2-1 Screen Manufacturing Equipment

	Equipment	Quantity	Specifications, Others	Remarks
1	Wire bending machine	1	ϕ4, 5, 8, 10 mm	
2	Wire weaving machine	1	ϕ2 ~ 10 mm	
3	Nibbler	1	For screen cutting	
4	Wall crane	2	Manually operated 1 ton chain block	

Table 2.4.2-2 Equipment for Manufacture of Forgings

	Equipment	Quantity	Specifications, Others	Remarks
1	Coke furnace	4	400 mm x 400 mm	
2	Gas furnace	1	Propane, 1250°C	
3	Heavy oil furnace	1	1,250°C	
4	Heavy oil furnace for bolts	1	For liner retaining bolts	
5	Hammer	2	125 kg, 178 mm x 178 mm	
6	Bolt forging machine	1	Exclusive machine	
7	Thread cutting machine	4	Exclusive machine	
8	Duples head grider	3	508 mm x 50 mm x 25 mm	
9	Wall crane	3	Manually operated 1.5 ton chain block	

Table 2.4.2-3 Equipment for Plate Shop

	Equipment	Quantity	Specification, Others	Remarks
1	NC eye tracer	1	Table, 3 m x 3.5 m with plasma torch	
2	Eye torch	1	Table, 2 m x 6 m	
3	Automatic gas cutter	4	4-wheeled	
4	Mechanical shear	1	9.5 mm x 3,000 mm	
5	Hydraulically operated shear	1	MAX 50 mm	
6	Nibbler	1	MAX 3 mm	
7	Vertical band saw	1	MAX 25 mm	
8	Saw	1	MAX ϕ300 mm	
9	Bending roller	1	25.4 mm x 4,287 mm	
10	Bending roller	1	16 mm x 3,658 mm	
11	Bending roller	1	10 mm x 1,830 mm	
12	Bending roller	1	Manual-rolling	
13	Press brake	1	150 ton, 8 mm x 3,050 mm	
14	Angle bender	1	MAX 125 mm	
15	Transverse-feed press	1	630 kg	
16	Rail straightener	1		
17	Bending machine	1	Manually operated	
18	Radial dripp press	1	MAX ϕ30 mm	
19	Duplex head grinder	1	250 mm x 25.4 mm x 22 mm	
20	10 ton/5 ton overhead travelling crane	1	15 m span	
21	5 ton overhead travelling crane	1	15 m span	
22	Wall crane	1	1 ton	
23	2 ton overhead travelling crane	1	7.5 m span, floor operated	
24	Wall crane	9	0.5 ton, 1 ton, 1.5 ton	

Table 2.4.2-4 Welding Shop Equipment

	Equipment	Quantity	Specification, Others	Remarks
1	Semiautomatic welders	5	Open arc type 600Amp	
2	Manual AC welders	15	600Amp, 400Amp, 300Amp	
3	Revolving positioner	1	8 ton	
4	60 ton turning rolles	1	60 ton	
5	10 ton turning rolles	1	10 ton	
6	Manipulator	1	Swing arm type	
7	Dust collector	1 set	20 HP	
8	Monorail	5	Manually operated 1.5 ton chain block	
9	Overhead travelling crane	1	Manually operated 2 ton chain block	

2.5 Current Technical Engineering

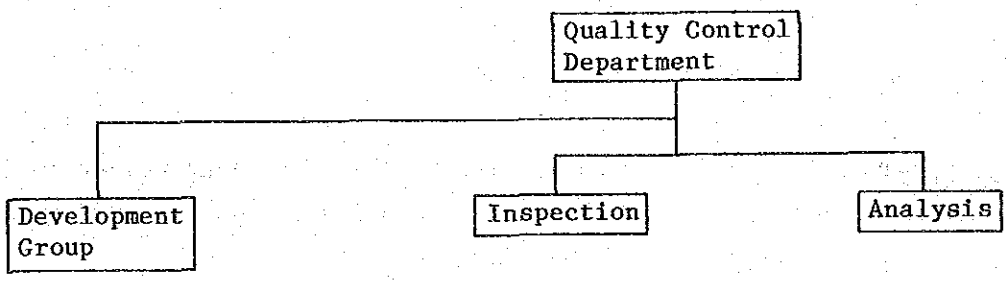
2.5.1 Engineering Management

1) Foundry shop

The improvement of product quality, development and trial manufacture of new products is undertaken by the Quality Control Department.

(1) Organization

A Development Group is established in the Quality Control Department. The organizational chart is shown below.



Engineer : 2
Technician: 1

Two engineers (university graduates) and one technician (technical high school graduate) are assigned to the Development Group. Their duties include technical reviews, preparation and issuance of instructions, and drawings.

(2) Development of prototypes

The orders for new castings are issued to the foundry shop by the Engineering Department (other than the Workshops Department), which is located in the E1 Teniente area. The orders are routed to the Quality Control Department through the Production Control Department.

The orders contain pertinent instructions relating to drawings and materials. A meeting is called together by the Manager, Quality Control Department, attended by members of the Development Group and other personnel concerned to make a review of the new parts specified in the orders.

As soon as the methods for the casting of prototypes are determined, instructions are issued to each of the processes in the foundry shop. In addition to casting plan drawing, the instructions are prepared in a form referred to as the "Method of Manufacturing Castings". The form contains the necessary instructions such as patterns molding, melting, and finishing.

As soon as the prototype is completed, the results are checked by the Quality Control Department. The Development Group also participates in the checking work as a matter of course.

(3) Improvement of defectives

The Development Group is also responsible for developing measures to be taken on defectives generating in the course of manufacture. Nonconformity control sheets are issued by Quality Control Department.

When the problem is critical, a review is made together with the Development Group to investigate the cause of failures and measures are developed to improve the situation. However, the Development Group does not assume the leadership in finding the points in the workshop for improvement and implementation.

(4) Research, review, and development of new technologies and equipment for introduction

Studies relating to new equipment for the foundry shop and manufacturing methods are not carried out by the Foundry Shop. The surveyors have failed to find the department responsible for making unified studies and drawing up proper recommendations and conclusions. It appeared that the individual sections were carrying on with their own type of studies. The results are submitted whenever questions are raised by the plant management. The decisions are made by a management group, which includes the Plant Manager.

Accordingly, it seems that there is no definite group assigned with the responsibility of investigating and researching equipment and manufacturing technologies in a long-term as well as short-term perspective.

2) Plate shop

The Engineering Department of Div. E1 Teniente, responsible staff of future planning directly under the Plant Manager, Production Control Section of Production Planning Department, Quality Control Department, and Production Sections are responsible for the control of manufacturing technologies in the plate shop.

(1) Establishment and maintenance of work standards

So long as the scope of the plant operation is small, the maintenance and improvement of production facilities can be handled by the skills made available by the workers, and passing on the necessary skills to newly employed workers can be conveyed through OJT programs.

However, as the scope of the plant operation grows together with an increase in the number of workers and products, it is necessary, first of all, to collect the basic skills from the skilled workers, and put them in writing for use as training and educational materials. In other words, the plate shop is considered to be in such a state at present.

There is no work standards whatsoever at present. The standards must specify the proper work methods, precautionary measures, knack and feel, and safety measures.

In the course of preparing the standards, the best of the skills possessed by the skilled workers at the respective stages are collected, and by combining technical capabilities of the individual skilled worker, skills at the highest level, which are available at that time, are concentrated. As a result, the level of skills is unified, irrespective of individual differences in technical capabilities. Furthermore, conformance to work standards determines whether the work is carried correctly.

While it is needless to mention that the work standards serve as the most important tool in training and educating the workers, it does not mean that all is taken care of, once the work standards are prepared.

As progress is made in the manufacturing technologies, the work standards must be revised accordingly. In doing so, the transmission of technologies are recorded and maintained in a tangible form as a valued treasure of the plant.

Examples of typical work standards are listed below.

a. Marking standards
b. Gas cutting standards
c. Eye tracer cutting standards
d. Shape steel and flange bending standards
e. Manual welding standards
f. MIG welding standards

The work standards are prepared by the production sections taking the leading role.

(2) Feedback system and improvement of manufacturing methods

Of the ore carriage bogie under manufacture at the plate shop, 11, which were of the same shape, were completed, and the 12th and 13th in the process of manufacture. The case appeared to the surveyors as extraordinary for a plate shop fabricating various types of welded structures to be manufacturing wagons each time orders are received from the Division. The surveyors were fortunate in having the opportunity of observing the manufacture of large-sized structures, all having the same shape, in large quantities.

Since there are many cases of producing comparatively the same type of products in large quantities in the foundry shop, a system has been established, whereby mass production is entered into after the prototypes have been prepared and reviewed by the Production Engineering Section of Quality Control Department.

However, since most of the production in the plate shop is based on "single items", there still occurred many problems in manufacturing the 11th wagon, despite it being manufactured on a quantity production basis. Some of the problems are listed below.

- Although exaggerated, the welded joints had many large gaps through which one can pass his fingers through.

- The base material was automatically cut and the faces were finished comparatively smoothly. However, when assembling, the pieces with same configurations could not be mated at 24 places. Therefore, the plates were manually cut in the vertical position. As a consequence, the edges were ziggagged, causing the quality of weld and work efficiency to drop drastically.
- Since the wagon is 3,000 mm wide, 10,496 mm long and 3,734 mm high, proper type of scaffolding is required in a sufficient amount, but the workers were performing the work by using makeshift type of scaffolds.

Most of these problems can be readily solved at the engineering stage prior to manufacture and when discovered in the course of manufacture by making an immediate feedback to the Design Department and upstream processes.

Since the QC Circle has been introduced in the plant, the activity should be utilized to its fullest extent to unearth the problems that are buried in the workshops, and using the suggestion program (feedback system), marked improvements can be expected in technical levels and productivity within a short period of time through implementation of improvements. Accordingly, the QC circle should be adopted on a plant-wide basis.

(3) Welding methods and procedures

Since various welding techniques play the leading role in the welding processes of a plate shop, there remains much room for the intervention of welding engineers. That is, there is a need for making the following selections.

- The grade and thickness of steel materials to be welded.
- Positioning of applicable welding joints, shape of welded structures and working environment.
- Welding positions and groove shapes.
- Welding method (such as manual or MIG).
- Type of welding rods, diameters and length.
- Welding current, voltage and speed.
- Welding sequence and method of feeding welding rods.
- Preheating and postheating.
- Nondestructive inspection and method.

In making the selection, welding tests are carried out as necessary, welding methods are determined, and welding procedures are issued as welding work standards for the welders. It is also necessary to take steps so that the welders are familiarized with the publications.

When the foregoing procedures are applied to the plate shop, the procedures for weld repairing of crusher parts are the only ones in existence. However, the procedures are considerably aged, and revisions have not been made in accordance with the technological progress. Furthermore, since the procedures are established primarily for the engineers of managerial and shop foreman class, there is a need for preparing a set of easy-to-understand procedures for the welders who are actually performing the job.

(4) Improvement of technical skill of welders

From the standpoint of importance attached to the welding operation in a plate shop, the level of skill of the welders can be considered as a gauge for measuring the technical level of the shop.

In fabricating a flotation tank in June, this year, performance tests for welders carried out by the quality Control Department is considered to be an epoch-making event. Therefore, it is recommended that the tests be carried out every year.

Differing from other types of occupation, it is easy to objectively determine to the performance level of welders. The results are directly linked to the improvement of morale of the individual.

Ultimately, the welding work is mostly dependent on the morale of the welder. That is, once the welding work is completed, one cannot detect the condition of the groove, quality of electrodes, current and voltage used for the welding.

While the welding work must be performed under established conditions, it is impractical to have someone observing the work from start to finish. Therefore, the work is dependent on the morale of the welder. Consequently, it is necessary to assign welders with proper qualifications to important welding jobs. The welder must be wear a badge, tag or indications affixed on safety helmets to identify the qualification that the holds.

2.5.2 Process Control

1) Foundry shop

The production of foundry shop is first planned by the production control division, according to which the work schedule is distributed to proceed the work.

(1) Production plan

The annual production plan is established in November based on the demand mainly for Div. E1 Teniente. This is further broken into the plans based on the quarterly workload classification, giving a margin to the production capacity likely to break it to the full workload for the first month, two-thirds for the second and one-third for the third month. This is attributable to the planning to allow any interrupting job to be taken in the due course of work execution. Table 2.5.2-1 below gives an example of this plan.

This work schedule is input into a computer to newly issue the monthly schedule. As an example of this actual schedule.

a) The production output list of pouring, and finishing sections is given in Table 2.5.2-2 below, showing the order No., molding job classification, part name and drawing No., and describing the following per part.

- Ordered and received quantities
- Remaining quantity
- Quantity casted up to the end of previous month
- Quantity casted in the previous month
- Quantity to be finished this month
- Quantity finished up to the end of previous month
- Quantity finished in the previous month
- Term of delivery

For casting, the actual lists are prepared on the cast completed and in-process items per part, name & job classification, and per material, describing the following data items.

b) Lists of cast completed and in-process items

(a) List per part name and per casting job classification (quantity and weight).

- Unit weight of casting item (kg)
- Ordered and received quantities
- Remaining quantity
- Quantity casted in the previous month
- Weight of remaining work (kg)
- Weight of items casted in the previous month
- Term of delivery

(b) List of materials

- Remaining work in this month (kg)
- Weight of items casted in the previous month (kg)

For the finishing, the lists are also prepared on the finishing completed and in-process items per part, name & molding clasification, and per material.

c) Lists of finishing completed and in-process items

(a) List per part name and per molding job classification (quantity and weight)

- Unit weight of casting item (kg)
- Remaining quantity
- Quantity finished in this month
- Quantity finished in the previous month
- Weight to be finished in this month (kg)
- Weight finished in the previous month (kg)

(b) List per material

- Weight of finishing in process (kg)
- Weight finished up to the previous month (kg)

A planned production schedule (Table 2.5.2-1) is made according to the list of performance mentioned above.

(2) Process control

a) Pattern shop

The production control department first issues the orders in accordance with the work instruction and process schedule, showing the drawing No., work No., quantity, weight, part name and standard manhour.

The serial reception number of these work orders shall first be entered in the log book, according to which the wooden pattern stocks shall then be checked. For the drawings, the review numbers are very important to be confirmed firmly. The production control department requests in advance to the pattern shop an estimate of manhours and materials for pattern prior to two weeks to a month.

The pattern shop reports to the production control department on the manhours and applied materials after completion of the pattern manufacture.

b) Foundaty shop

Since the 3-month production schedule (computer list) issued from the production control department is distributed to all concerns, the total workload and how much workload to be completed can be clarified to all concerns. This classifies all jobs into the large items, machine moulding items and others, which are listed separately. These lists are issued monthly.

The work order cards are used for job instruction. This card is made of 3-copy type for molding section, i.e. the first sheet is to be sent to the pattern shop to collect the pattern information the second sheet is to be used for molding and the third to the core shop. This card shows the part name, quantity and scheduled manhours, but the quantity only needs to be reported, requiring no actual manhour spent per individual part.

A sample of this card is given in Table 2.5.2-3 below. The report is made on the casted items only, whose format is called "Production de la Colada." Further, there is a larger 3-copy card consisting of a white sheet and two yellow sheets, of which the molding record is entered in a sheet of yellow card to be filled in the foundry shop. Other white and yellow sheets are sent to the finishing process, of which the yellow card is returned to the foundry shop and then to the production control department. The remained white card is used for shipping.

The cards come to the finishing process after casting the products, which are the carbon copies on the white base. The casted items, even if any is clear to be rejected of due to leakage, etc., are all sent to the finishing process is casted items. For the items casted in he previous day, the cards are sent to the finishing process at 07:00 hours of the following morning. These cards bear such information as part name, weight (Casted weight = Calculated weight), order No., drawing No., divided No. of lot, molder name, etc.

The casted items shall receive the inspection to be conducted by the quality control inpectors after finishing them, who prepare and distribute the documents on the items to be disposed of, to the molding process, finishing process, production control department, etc.

For the finished items, the following shall be entered in the cards.

Right Column
- Order No.
- Order quantity
- Actual quantity
- Weight
- Material
- Part name
- Drawing No.
- X mark (machining)

Left Column
- Quantity in inspection (X-ray, etc.)
- Weight in inspection
- Quantity to be rejected of (to be determined by QC)
- Quantity of accepted items
- Weight of accepted items

For reporting the weight, no individual item may normally be weighed. The weight established based on the past experience is filled in. For the completely new items, the weight is measured. For the items having been produced conventionally, almost no item is measured and checked it any time.

Above description is the out line of process control, no manhour is measured at any of the molding, and finishing process. Although the scheduled manhours are filled in the cards for molding process. The scheduled manhours filled in the cards seem also to have not so much reliability. They seem to collect no manhour spent, eventually, because of difficulties in grasping the exact manhours per part. Rather, the importance is placed on how many quantity has been produced vs. the planned monthly quantity. This may also be acceptable for merely seeing the production per manhour, but the manhours per product or lot must be collected to improve the productivity.

Unless the systems are established to allow these data to be collected and always checked for what improvement has reduced what portion of manhours are so far as the lump sum accounting remains like in the present way, where is a problem cannot be grasped. For the weight of casted items, although the prototypes are fairly (exactly made with exact patterns, the weight varies fairly) depending upon the gradual drop of pattern accuracy or rough modeling work, so that the weight should be tried out to be measured periodically, because a fair amount of weight of castings could be sold free of charge without knowing.

Table 2.5.2-1 Planned Production Schedule

ME	ALEAC	ORD TRABAJO	DESCRIPCION	PLANO	SV	P/UNIT	C/PRO	P/TOTAL	U	MODELERIA	MOLDEO	TERMINACION
07	P	M-13	574508-301	MANTO INFERIOR	GE-2278-A	03	2640	2	5280	3		
07	P	M-13	574432-201	CORAZA	IG-20977-A	02	3000	2	6000	2		
07	P	M-13	574433-201	MANTO	IG-20978-A	03	2750	2	5500	2		
07	P	M-13	574776	ANILLO DESGASTE	GE-4153-A	01	330	2	660	3		
07	P	M-13	578245-403	MANDIBULA FIJA	IG-25795-A	01	1000	2	2000	9		
07	P	M-13	793147-201	CORAZA	SK-3622-287	02	4000	3	12000	0		
07	P	M-13	793148-901	MANTO INFERIOR	SK-3622-283	03	2700	2	5400	0		
07	P	M-13	793149-801	CORAZA-TUERCA	SK-3622-284	04	3300	3	9900	0		
07	P	M-13	999990	**********	TOTAL				300			
07	P	TD-650	793150-405	CORAZA	SK-3620-540+400		439	1	439	0		
07	P	TD-650	793150-406	CORAZA	SK-3620-540+500		480	1	480	0		
07	P	TD-650	793150-407	CORAZA	SK-3620-540+600		430	1	430	0		
07	P	TD-650	999990	**********	TOTAL				900			
07	P	ZZZZ	999999	**********	TOTAL MES				900			
08	P	A-45	574123-402	SECCION TRASERA	GE-16165-A	05	2150	1	2150	5		
08	P	A-45	574123-403	SECCION LATERAL	GE-16165-C	05	550	1	550	5		
08	P	A-45	574123-404	SECCION LATERAL	GE-16165-D	05	550	1	550	5		
08	P	A-45	574123-405	SECCION DELANT	IG-24507-A	02	1650	1	1650	5		
08	P	A-45	574421-401	CAMARA INYECT	IG-47000-A	00	1000	1	1000	2		
08	P	A-45	577805-301	OLLA	IG-38530-A	02	8000	1	8000	5		
08	P	A-45	999990	**********	TOTAL				900			
08	P	E-80	574514-601	TUERCA SEGURO	IG-21828-A	04	750	2	1500	3		
08	P	E-80	999990	**********	TOTAL				900			
08	P	L-425	574481-501	LAINA PROT HOR	IG-58107-A	01	4520	4	18080	3		
08	P	L-425	574482-601	LAINA PROT HOR	IG-58495-A	00	4100	5	20500	3		
08	P	L-425	999990	**********	TOTAL				900			
08	P	M-13	574014-701	MANTO	GE-2357-A	04	2420	5	12100	3	29-11-85	
08	P	M-13	574014-702	CAMPANA	GE-2372-A	05	2570	5	12850	3	29-11-85	
08	P	M-13	574304-201	CAMPANA	GE-2275-A	05	4082	2	8164			
08	P	M-13	574432-201	CORAZA	IG-20977-A	02	3000	3	9000	2		
08	P	M-13	574433-201	MANTO	IG-20978-A	03	2750	3	8250	2		
08	P	M-13	578245-305	CORAZA INFERIOR	IG-26158-A	01	560	1	560	9		
08	P	M-13	578245-306	CORAZA	IG-26161-A	01	700	1	700	9		
08	P	M-13	578245-503	MANDIBULA FIJA	IG-25795-A	01	1000	2	2000	9		
08	P	M-13	578245-504	MANDIBULA MOVIL	IG-25796-A	01	1000	2	2000	9		
08	P	M-13	793147-401	CORAZA	SK-3622-287	02	4000	4	16000	0		
08	P	M-13	793148-901	MANTO INFERIOR	SK-3622-283	03	2700	3	8100	0		
08	P	M-13	793149-901	CORAZA-TUERCA	SK-3622-284	04	3300	3	9900	0		
08	P	M-13	999990	**********	TOTAL				990			
0	P	ZZZZ	999999									

Table 2.5.2-2 Actual Production List of Pouring and Finishing Processes

PAG= 11

LOC02-3 SITUACION DE ORDENES DE TRABAJO EN FUSION Y LIMPIA DEPTO:TALLERES

MES: JUNIO 86

ORDEN	TRAB	ALEACION	DESCRIPCION	PLANO	CANT SOLI	FUSION PEND	FUSION ACUM	FUSION MENS	LIMPIA LIMP	LIMPIA ACUM	LIMPIA MENS	O/T REPROC	OBSERVACIONES FUSION	OBSERVACIONES LIMPIA
574098	101	L FG-19	RETEN LABERINTO	GE-0458-A	5	5	0	0	0	0	0		915/59	
574098	201	L FG-19	RETEN LABERINTO	GE-0458-A	7	7	0	0	0	0	0		917/59	
574100	101	A A-45	DEDO VOLCADOR	GE-0925-A	63	63	0	0	0	0	0		5163/99	
574100	201	A A-45	DEDO VOLCADOR	GE-0925-A	63	63	0	0	0	0	0		5163/99	
574100	301	A A-45	DEDO VOLCADOR	GE-0925-A	62	62	0	0	0	0	0		5162/99	
574100	401	A A-45	DEDO VOLCADOR	GE-0925-A	62	62	0	0	0	0	0		5162/99	
574101	102	A FG-19	MACHON ACOPLAM	GE-1197-A	2	2	0	0	0	0	0		512/99	
574101	103	A FG-19	MACHON ACOPLAM	GE-1197-B	2	2	0	0	0	0	0		512/99	
574109	301	A TF-19	ZAPATA UNIVERSAL	TA-T-0132-A	200	0	200	0	37	163	0		13	
574113	0	P FG-28	POLEA	GE-7839-H	4	4	0	0	0	0	0		314/99	
574117	601	P I-13	CAJA BOMBA	GE-14401-A	10	0	10	0	2	8	0		31	
574117	701	P I-13	CAJA BOMBA	GE-14401-A	10	10	0	0	0	0	0		3110/99	
574117	801	P I-13	CAJA BOMBA	GE-14401-A	10	10	0	0	0	0	0		3110/99	
574117	901	P I-13	CAJA BOMBA	GE-14401-A	10	10	0	0	0	0	0		3110/99	
574117	910	P I-13	CAJA BOMBA	GE-14401-A	10	10	0	0	0	0	0		3110/99	
574118	101	S I-12	CAPACHO	GE-15236-A	200		200	0	0	200	74		31	
574118	201	S I-12	CAPACHO	GE-15236-A	200	0	200	30	139	61	61		31	
574118	301	S I-12	CAPACHO	GE-15236-A	200	122	78	78	78	0	0		31112/99	
574118	401	S I-12	CAPACHO	GE-15236-A	250	250	0	0	0	0	0		31250/99	
574120	101	A BR-62	BOCINA PARTIDA	GE-16092-A	12	12	0	0	0	0	0		3112/99	
574120	201	A BR-62	BOCINA PARTIDA	GE-16092-A	12	12	0	0	0	0	0		3112/99	
574121	101	L BR-62	BOCINA PARTIDA	GE-16092-B	13	13	0	0	0	0	0		3113/99	
574121	201	L BR-62	BOCINA PARTIDA	GE-16092-B	13	13	0	0	0	0	0		3113/99	
574122	0	L BR-62	BOCINA PARTIDA	GE-16092-C	14	14	0	0	0	0	0		3114/99	
574123	303	P A-45	SECCION LATERAL	GE-16105-C	1		1	1	0	1	1		51	
574123	304	P A-45	SECCION LATERAL	GE-16105-D	1		1	1	0	1	1		51	
574123	402	P A-45	SECCION TRASERA	GE-16105-A	1		1	1	0	1	1		51	
574123	403	P A-45	SECCION LATERAL	GE-16105-C	1		1	1	0	1	1		51	
574123	404	P A-45	SECCION LATERAL	GE-16105-D	1		1	1	0	1	1		51	
574123	405	P A-45	SECCION DELANTE	GE-24507-A	1	0	1	1	1	0	0		51	
574123	502	P A-45	SECCION TRASERA	GE-16105-A	1	1	0	0	0	0	0		511/09	
574123	503	P A-45	SECCION LATERAL	GE-16105-C	1	1	0	0	0	0	0		511/09	
574123	504	P A-45	SECCION LATERAL	GE-16105-D	1	1	0	0	0	0	0		511/09	
574123	505	P A-45	SECCION DELANTE	GE-24507-A	1	1	0	0	0	0	0		511/09	
574123	602	P A-45	SECCION TRASERA	GE-16105-A	1	1	0	0	0	0	0		511/11	
574123	603	P A-45	SECCION LATERAL	GE-16105-C	1	1	0	0	0	0	0		511/11	

Table 2.5.2-3 Process Card (Molding)

8	10054		24	3	ORDEN DE TRABAJO 1	573047 301	
					2		
CANTIDAD	FECHA		CANT. TOTAL	Nº DE PARC.	3	NUMERO DE ORDEN	
DESCR.	MUELA DELANTERA				UTILIZADO PARA	LIMPIADOR DE VIAS	PLANO 10.24442-A
MAT. PRIMA	DENOM. Acero Cromo Ni. Mo.	MEDID.			ESPEC. Y TOL.	E-30	CANT. 38,00 Kgs. 190
CROQUIS					INSTRUCCIONES ESPECIALES		
					N 8 - Mandril y Plantilla en Pañol M 11 - Templar a la llama zona de rodadura		

Ref As: 686 421800 - 401 000

TALL.	OPER. Nº	DESCRIPCION DE LAS OPERACIONES	CENTRO TRABAJ	TARJETA INSTRUC	TIEMPO POR UNIDAD	PREP. MAQUIN	TRABAJO REALIZADO FECHA	TRABAJO REALIZADO FIRMA	REGISTRADO FIRMA
F	1	Moldear	MA		0.10				
F	2	Hacer Alma	AA		2.00				
F	3	Fundir	FS		0.01				
F	4	Limpiar	LM		1.50				
F	5	Tratamiento Térmico	TT		-				
F	6	Revisar	RF		-				
M	7	Tornear	RB		0.70	3.0			
M	8	Tornear Completar	TK		1.50	2.0			
M	9	Trazar	HA		0.30	0.3			
M	10	Perforar a Hilo	DA		0.20	0.5			
M	11	Tratamiento Térmico	HG		-	-			
M	12	Revisar	RM		-	-			

FORM. TA 33 - F 18 MIRA

2) Plate shop

The process control means the control activities subject to control each production process for the purpose to manufacture the ordered products by the specified term of delivery and economically. The plate shop as viewed from the process control aspect involves mostly in the jobs
as required from the mining, mineral processing and refining departments, if which 70% is the new products pursuant to welding, while 30% is repairing each part of crushers. While the annual repair manhours can be estimated for repair parts representing 30%, the welding structures occupying 70% represent the orders received in at least three months before starting the production. Therefore, this shop exists in an environment under which a long-term production schedule can hardly be established.

(1) Organization

The process control is carried out by centering at the production control division of production planning department. The staff having a plenty experience in the field work are assigned to the production control division to issue up to the job instruction schedule which is to be used actually in the work fields, as well as the manufacture orders.

(2) Kinds of schedules

For the work schedules of plate and machine shops, the IBM scheduling system (Capacity Planning and Operation Sequencing System-Extended (CPOSSE)) is used from the manpower planning to allocating the manhours per job classification.

Various schedules shall be discussed hereinafter, centering at the welding process in this system.

a) Annual production planning

Even reviewing the annual welding workload (an actual example in Table 2.5.2-4 below) results in finding 100% or more workload for the latest one month, and 80% for the following three months, but almost near to nil henceafter, indicating that the orders may be received from now on. Therefore, no annual manufacturing schedule exists. The shop has planned nothing but an approximate

production plan only based on the divisional production plan established in about last November.

Further, the annual workload schedule per job classification summarizes the capable manhours, required manhours and idling manhours in unit of 6-day (weekly) for the first month and in unit of 24-day (monthly) for the second month and afterward to output the annual production. This is used for a long-term supervisor manpower planning.

b) 10-week schedule per job classification (actual 60-day work)

This is a schedule per job number, consisting on such contents as job receiving data from the previous process, time for spending in it's own process, time for sending to the following process required manhours, manhours for preparation, capable manpower, night-shift or not, and daily workhours. An actual example of this schedule is given in Table 2.5.2-5 below.

c) 2-week schedule per job classification (actual 2-day work)

Except for the daily capable, required and idling manhours, this bears the information for 2-week workload as same as in the 10-week schedule. Further, this schedule contains a 2-week plan in 2-week later in the same form, i.e. this form is designed to allow you to know of 4-week schedule. An actual example of this schedule is given in Table 2.5.2-6 below.

d) 2-week schedule of plate shop (actual 12-day work)

This schedule indicates each job number, product name, quantity, scheduled manhours per process (marking, gas cutting, bending, boring, roughening, welding, painting and inspection), scheduled manhours for preparation, and completion date, so that the manufacturing flow of articles can be known. An actual example of this schedule is given in Table 2.5.2-7 below.

e) Work instruction schedule

The minimum unit drawings of products (in unit of single sub assembly) are bagged together with a work instruction schedule as exampled in Table 2.5.2-8 below, which are then sent to the plate shop from the production control division. This bears such information as subassembly name, drawing No., bill of component materials, material quality, weight, quantity, scheduled manhour per process, and scheduled manhour for preparation. These data are daily input into a computer, which are then fed back into the schedule to be issued in the following week, as well as the actual performance being output.

(3) Actual status of process control

Although the schedule control system applied in this shop is almost complete, observing the actual status of production lines what completed assembling were left from welding nearly for about one month and that there were some welding joint gaps exceeding 10 mm allow us to assumed that there is a considerable amount of dispersion, even if the ratio satisfying the schedules in the past two years is said 84%. Further in the future, it is necessary to analyze and collect the current status data of capability for the purpose to improve the exactness of standard manhours per job.

(4) Format of schedule

The schedule applied in the plate shop is designed of process instructions in terms of numerical indications, so that it can hardly be said to be of process schedule available to be understood at a glance. The process schedule is preferably made to allow all workers to see it at any time, to grasp the process at this momemnt by themselves and to recognize the role of each worker himself or herself.

Table 2.5.2-4 Annual Workload Schedule Per Job Classification (Welding)

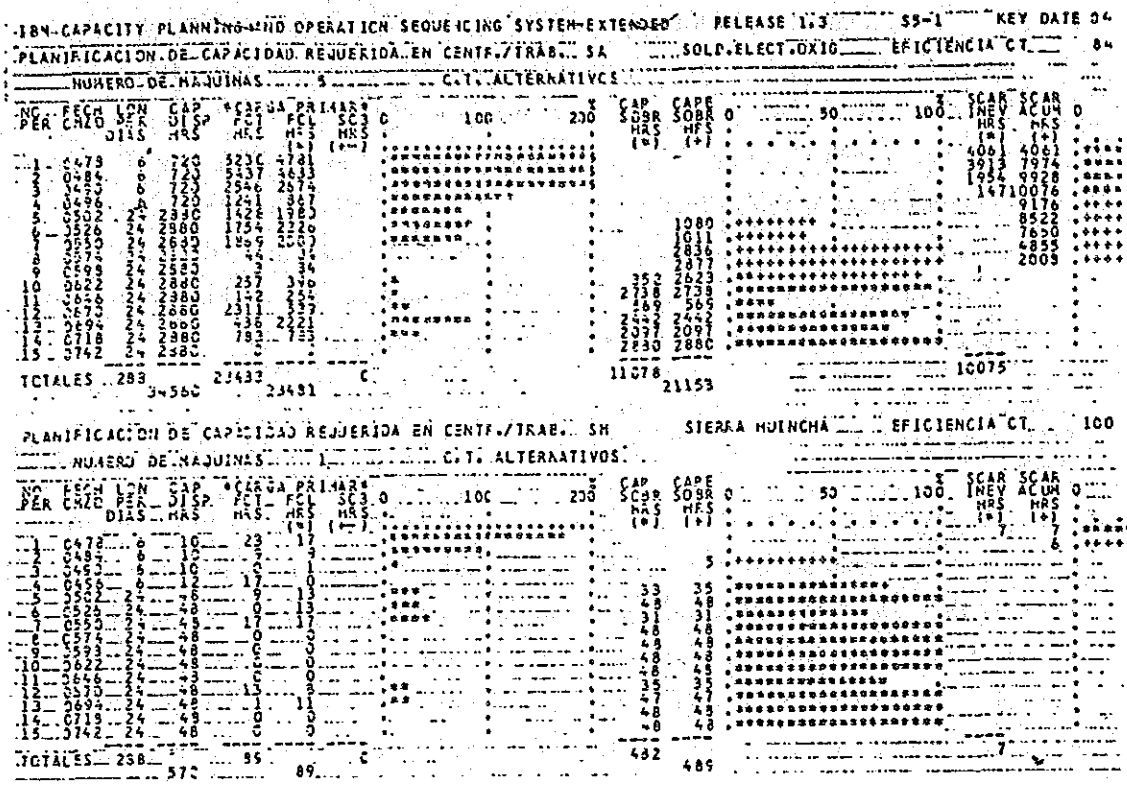


Table 2.5.2-5 10-Week Schedule Per Job Classification (Welding)

IBM CAPACITY PLANNING AND OPSRATION SEQUENCING SYSTEM-EXTENDED RELEASE 1.3 06-3 KEY DATE 04

LISTADO DE OPERACIONES PROGRAMADAS POR CT SA SOLD.ELECT.OXIG NO. DE MAQS 5

CENT. TRAB: NO. DE MQS NO. TURNOS CAP.BASIC.TURNO

SA 5 3 3.0

NO PROY	NO ORD	P L	O/T CONTAB	NO OP	OP ALT	DESCRIPCION	PROGRAMA FCC	PROGRAMA FTC	M G	CANT	TPO OPER	TPO PREP	DESDE CT	DESDE FTC	HACIA CT	HACIA FCC	CT PLAN	EN PR
	7144		5781167	001		REC.CAB. C/EJE	490	490	1	1	4.76	1.1			SA	499		
	7031		5781115	001		RECUP TAZA CH.	490	502	2	1	292.62	5.9			VB	510		
	7033		5781119	001		RECUP CAB SEC	495	503	3	1	297.62	9.5			VB	523		
	7026		5781131	001		RECUP MARCO P	495	505	4	1	357.14	4.7			CO	515		
	6928		5782234	001		REC/CAB.	490	494	5		3.24	1.1			VB	497		
	7146		5781183	001		RECUP. TAZA CH	495	500	5	1	238.10	5.9			VB	526		
	8564		6508857-134	005		POSTE	490	490	1	2	5.71	2.3	FO	490	RM	490		
	0197		5782206	003		MODIF.TOLVA M.	490	490	1	1	5.71	2.3	CO	490	MB	490		
	6929		5782232	005		VORTEX	490	490	1	1	2.66	2.3	GR	490	PI	495		
	6494		5756779	002		REP CAB SEC 13	490	499	1	1	202.38	31.9	AR	490	VB	503		
	8551		6508857-128	005		PERNO ANCLAJE	499	499	1	1	1.48	2.3	AR	491	RM	499		
	6697		1304243-196	005		PASADOR	499	499	1	14	1.67	2.3	FO	491	RM	499		
	8545		6508857-132	005		PERNO ANCLAJE	499	499	1	6	1.71	2.3	AR	491	RM	499		
	8552		6508857-137	005		PERNO ANCLAJE	499	499	1	8	1.95	2.3	AR	492	RM	499		
	7144		5781167	001		REC.CAB. C/EJE	499	499	1	1	297.62	7.1	SA	490	TB	512		
	6708		5781151	001		REC. CAJA SDMB	500	503	2	1	76.19	7.1	TB	490	TB	515		
	8559		6508857-129	005		TOBERA	500	503	3	16	1.52	2.3	AR	491	RM	523		
	8548		6508857-105	005		PERNO ANCLAJE	503	503	3	16	1.90	2.3	AR	492	RM	523		
	8547		6508857-104	005		PERNO ANCLAJE	503	503	3	16	2.14	2.3	AR	495	RM	523		
	8546		6508857-103	005		PERNO ANCLAJE	503	503	3	16	1.67	2.3	AR	495	RM	523		
	0087		5782286-101	005		PLACA DE SEGUR	503	503	2	8	2.86	2.3	MO	500	MO	526		
	0197		5782206	002		MODIF.TOLVA M.	503	503	3	1	9.52	2.3	AR	492	AR	523		
	6927		1303263-101	005		CONJ PLATAFORM	503	503	3	1	9.52	2.3	AR	501	BR	504		
	0014		5745185	009		ALMA DEF	503	504	5	10	7.14	2.3	AR	497	PI	504		
	4494		1133001-302	005		SET DE PROTEC	503	505	5	25	29.76	2.3	AR	500				
	4495		1133001-402	006		SET DE PROTEC	503	505	5	25	29.76	2.3	AR	500				
	8549		6508857-106	005		PERNO ANCLAJE	504	504	5	128	15.24	2.3	AR	501	RM	504		
	0332		5746127	005		BARRET	504	505	5	95	11.31	2.3	FO	499				
	4493		1133001-301	005		PROTECCIO	505	507	3	50	59.52	2.3	AR	504				
	8165		5781146	001		RECUP TAZA #5	505	517	5	1	297.62	4.7			AR	529		
	8257		2521867	001		RECUP TAZA # 6	505	517	5	1	297.62	5.9			RM	517		
	8256		2521537	001		RECUP OLLA # 1	505	520	4	1	357.14	4.7			RM	520		
	5526		1300651-101	007		CONJ DEF	507	509	3	15	35.71	2.3	MO	507	PI	509		
	7076		5780531	003		RECUP. MARCO P	509	509	3	1	2.38	2.6	CO	505	AR	509		
	8271		5795805	007		OLLA	509	513	3	1	114.29	2.3	LP	490	PI	514		
	7076		5780531	005		RECUP MARCO P	512	513	1	1	23.81	2.3	AR	509	BA	523		
	7249		5782225	002		REC/CAJA	513	514	3	4	19.05	1.1	TG	500	TG	529		
	7077		5781172	003		RECT. PERF. TAZA	513	514	1	1	3.57	1.1	MA	508	MA	652		
	6494		5756779	005		REP CAB SEC 13	513	513	1	1	1.76	1.1	MA	511	RM	513		
	8526		6508857-103	005		PLACA LATERAL	513	513	1	1	15.58	1.1	LP	490				
	7247		5781193	001		REC.TAZA	514	514		2	3.24	2.9			VB	546		
	7027		5780772	001		RECUP TUERCA S	514	524		1	238.10	7.1			AR	535		
	7143		5781162	001		REC.TUERCA SEC	514	524		1	238.10	7.1			AR	535		
	7131		5781157	001		RECUP.TUERCA S	514	529		1	357.14	5.9			YC	557		
	8509		6508814-201	002		TAMBOR MODIFIC	514	538		1	595.24	5.9			TJ	551		
	8276		5733522	002		TAMBOR MODIFIC	525	550		1	595.24	7.1			TJ	566		
	8285		5798004-201	005		TAZA 325 PIES	526	540		1	357.14	1.1	LP	490	PI	567		
	8286		5798004-301	005		TAZA 325 PIES	526	540		1	357.14	1.1	LP	490	PI	561		
	8287		5798004-401	005		TAZA 325 PIES	526	540		1	357.14	1.1	LP	490	PI	561		
	8288		5798004-501	005		TAZA 325 PIES	526	540		1	357.14	1.1	LP	490	PI	561		
	8282		2523228	002		MODIFIC.TAMBOR	526	541		2	385.95	2.3	TJ	491	TJ	557		
	7533		5781118	005		RECUP CAB SEC	531	531		1	1.41	2.1	VB	520				
	7146		5781167	005		REC.CAB. C/EJE	543	544		1	7.14	1.1	AR	532	RM	544		
	8289		5798004-601	005		TAZA 325 PIES	545	560		1	357.14	1.1	LP	490	PI	581		
4441	360		6107C6-660	003		VARILLA	550	550		2	2.24	2.3	FO	499	MT	550		
4441	361		6107C6-661	003		VARILLA	550	550		2	2.24	2.3	FO	499	MT	550		
2977	0101			012		S7 CAMARA INYE	550	550		1	3.60	2.3	AR	527	XX	550		
2977	0201			012		S7 CAMARA INYE	550	550		1	3.60	2.3	AR	527	XX	550		
8437	301		6508857-115	005		CONJ CUCHARA R	550	550		1	1.71	2.3	AR	492				
4441	007		6107C6-607	004		SOPORT L/TOLVA	550	550		4	1.19	2.3	AR	503				
4441	008		6107C6-608	004		SOPORT L/TOLVA	550	550		4	1.19	2.3	AR	503				
4441	010		6107C6-610	005		SOPORTE L/CHAS	550	550		4	2.38	2.3	AR	503	MA	577		
4441	033		6107C6-633	004		MANILLA	550	550		32	3.81	2.3	CF	507	FO	580		
4441	372		6107C6-670	004		BIZAGRA MOSTR.	550	550		4	4.76	2.3	AR	499	MA	577		
4441	072		6107C6-672	004		BIZAGRA OPUEST	550	550		4	4.76	2.3	AR	508	MA	577		

Table 2.5.2-6 2-Week Schedule Per Job Classification (Welding)

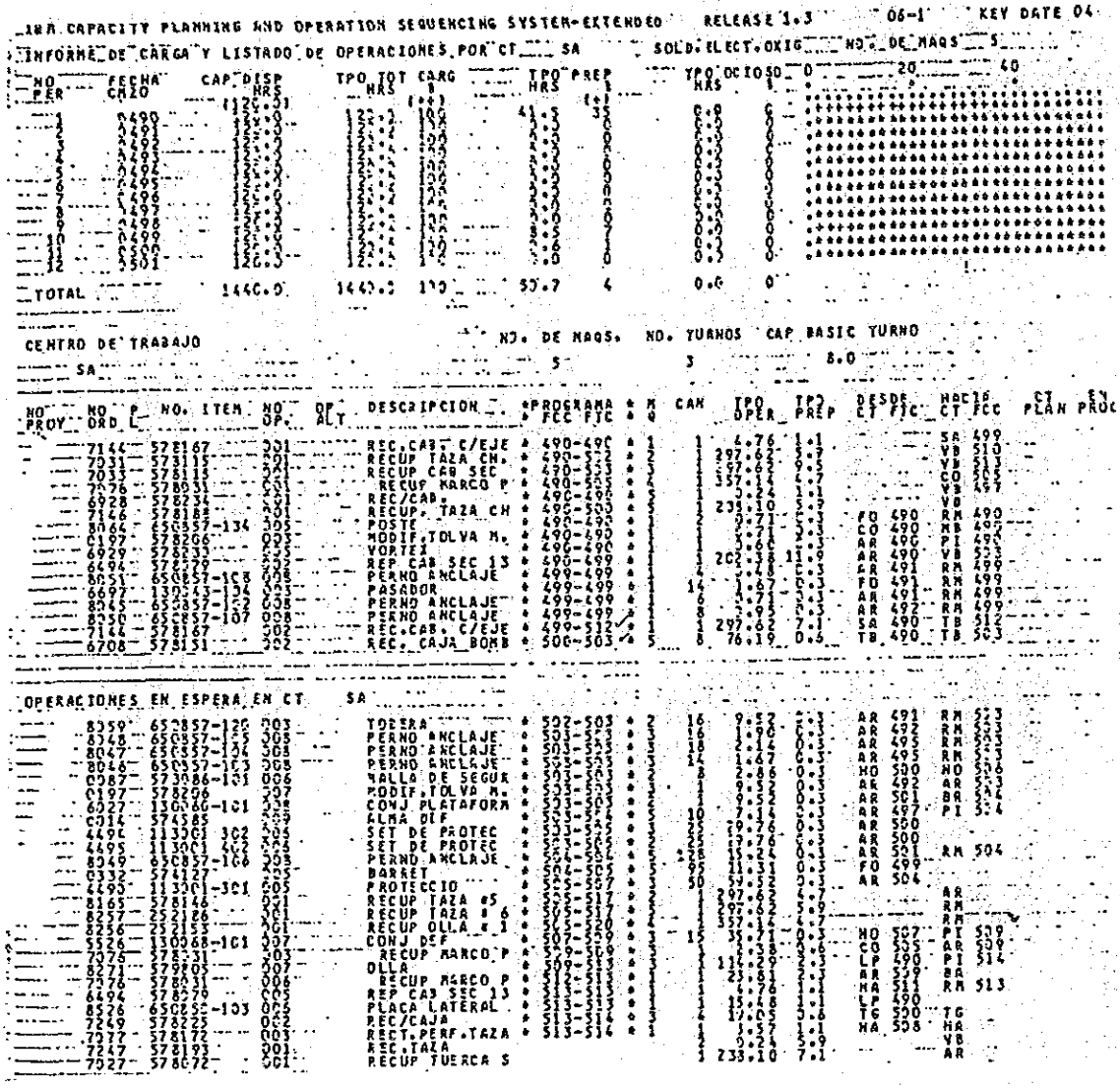


Table 2.5.2-7 2-Week Schedule of Plate Shop

IBM CAPACITY PLANNING AND OPERATION SEQUENCING SYSTEM-EXTENDED RELEASE 1.3 PS-1 KEY DATE 0
CAPOSS-E DEPTO.TALLERES PROGRAMACION DE ORDENES

NO. PROY.	NO. ORD.	P	NO. ITEM NO. OP.	DESCRIPCION	CT	CANT	TPO. OPER HRS	TPO. PREP HRS	*PROGRAMADA* * FCC	FTC *	FCT	FCL	P T	I R	RED I-O
	6569		573449-101	PLANCHA DESGASTE	DUE=262	QTY=	30	PRI=2(EXT) =14(ORD)							
			001	PLANCHA DESGAS	TR	30	11.05	0.3			491	491			44
			002	PLANCHA DESGAS	CO	30	8.15	0.3			491	491			44
			004	PLANCHA DESGAS	HA	30	15.00	0.2			492	492			46
			005	PLANCHA DESGAS	DA	30	31.58	0.5			494	494			46
			007	PLANCHA DESGAS	AR	30	3.75	0.6			496	496			46
			008	PLANCHA DESGAS	AR	30	18.75	0.3			497	497			46
			009	PLANCHA DESGAS	SA	30	35.71	0.3			498	498			46
			010	PLANCHA DESGAS	PI	30	3.75	0.3			500	500			46
			011	PLANCHA DESGAS	RM	30	0.30	0.1			500	500			46
	6570	*	573449-201	PL. DESGASTE	DUE=444	QTY=	30	PRI=2(EXT) =16(ORD)							
			001	PLANCHA DESGAS	TR	30	11.05	0.3			491	491			42
			002	PLANCHA DESGAS	CO	30	8.15	0.3			491	491			42
			004	PLANCHA DESGAS	HA	30	15.00	0.2			492	492			42
			005	PLANCHA DESGAS	DA	30	31.58	0.5			494	494			42
			007	PLANCHA DESGAS	AR	30	3.75	0.6			496	496			42
			008	PLANCHA DESGAS	AR	30	18.75	0.3			497	497			42
			009	PLANCHA DESGAS	SA	30	35.71	0.3			498	498			42
			010	PLANCHA DESGAS	PI	30	3.75	0.3			500	500			42
			011	PLANCHA DESGAS	RM	30	0.30	0.1			500	500			42
	6573	*	573504-102	BARRAS ACERO	DUE=698	QTY=	10	PRI=4(EXT) = 6(ORD)							
			001	BARRAS ACERO	MV	10	0.11	0.1			497	697			
			003	BARRAS ACERO	RA	10	1.50	2.5			498	698			
	6577	*	573574	BOCINA PARTIDA	DUE=237	QTY=	5	PRI=4(EXT) =18(ORD)							
			006	BOCINA PARTIDA	RA	5	11.23	4.5	* 491-492	* 490	490				40
			007	BOCINA PARTIDA	HA	5	2.50	0.2	* 492-492	* 491	491				42
			008	BOCINA PARTIDA	DA	5	2.41	0.5	* 493-493	* 492	492				42
			009	BOCINA PARTIDA	FA	5	9.69	1.4	* 495-496	* 493	493				42
			010	BOCINA PARTIDA	HA	5	3.13	0.3	* 496-497	* 494	494				40
			011	BOCINA PARTIDA	RM	5	0.05	0.1	* 497-497	* 495	495				40
	6578	*	573575	BOCINA PARTIDA	DUE=237	QTY=	6	PRI=4(EXT) =18(ORD)							
			006	BOCINA PARTIDA	RA	6	10.62	4.5	* 490-491	* 490	490				42
			007	BOCINA PARTIDA	HA	6	3.75	0.2	* 491-492	* 491	491				42
			008	BOCINA PARTIDA	FA	6	6.00	1.4	* 494-495	* 492	492				42
			009	BOCINA PARTIDA	FA	6	12.86	1.4	* 496-496	* 493	493				42
			010	BOCINA PARTIDA	DA	6	1.69	0.5	* 497-497	* 494	494				42
			011	BOCINA PARTIDA	HA	6	6.75	0.3	* 497-498	* 495	495				42
			012	BOCINA PARTIDA	RM	6	0.06	0.1	* 499-499	* 496	496				42
	6585	*	573586	EJE	DUE=496	QTY=	3	PRI=2(EXT) = 2(ORD)							
			001	EJE	TR	3	0.11	0.1			492	492			
			002	EJE	CO	3	0.83	0.3			492	492			
			004	EJE	HA	3	1.50	0.2			493	493			
			005	EJE	DA	3	3.16	0.5			494	494			
			007	EJE	AR	3	0.38	0.6			495	495			
			008	EJE	AR	3	1.88	0.3			495	495			
			009	EJE	SA	3	3.21	0.3			495	495			
			010	EJE	PI	3	0.38	0.3			495	495			
			011	EJE	RM	3	0.03	0.1			495	495			
	6588	*	573632	CODO 45 GRADOS X 6"	DUE=496	QTY=	20	PRI=2(EXT) = 6(ORD)							
			004	CODO 45 GR.X 6	LP	20	0.25	0.1	* 490-490	* 490	490				13
			005	CODO 45 GR.X 6	RA	20	26.25	1.2	* 492-492	* 490	491				13
			006	CODO 45 GR.X 6	DN	20	7.25	1.8	* 509-515	* 493	493				13
			007	CODO 45 GR.X 6	HA	20	2.50	0.2			494	495			13
			009	CODO 45 GR.X 6	RM	20	0.20	0.1			495	495			13
	6592	*	573655	CAJA CONTRAEJ	DUE=341	QTY=	1	PRI=2(EXT) =18(ORD)							
			007	CAJA D/CONTRAE	MA	1	5.00	0.6	* 490-490	* 490	490				40
			008	CAJA D/CONTRAE	BA	1	75.00	2.5	* 491-495	* 491	491				43

Table 2.5.2-8 Work Instruction Schedule (Welding)

TRANSPORTAR EL MATERIAL ES-
PECIFICADO MAS ABAJO, SEGUN
MARCAS.

CANTIDAD	FECHA	REQUISIC. DE TRABAJO	NUMERO DE ORDEN

Nom.	FIJADOR	Utilizado Para	CARRO METALERO 100 — 10-53782-1
Mat. Prima / Norma	Instruco. Especiales / Mod.	Espec. y Tol.	A37-24ES/A42-23 — Cant. 2,36 kg. — 120

CROQUIS

1 PL. 8 x 75 x 410 (1)
2 Barras Acero p/pernos 13ø x 60
2 Tuercas Hex. Std. 1/2"-13 UNC
2 Golillas Presión Std. 1/2"

MyA: 001 000392 401 000

INSTRUCCIONES ESPECIALES

Taller	Oper. Nº	DESCRIPCION DE LAS OPERACIONES	Centro Trabajo	Tarjeta Instruc.	Tiempo por Unidad	Prep. Maquin.	Pues Nº	TRANSPORTES 1	2	3	4	5
	1	Cortar en Hidráulica	CH	(2)	0,03	0,3	1					
P	2	Trazar	TR	(1)	0,08	0,3	1					
P	3	Perforar	MT	(1)	0,10	0,3	1					
P	4	Puntear	BR	(1)	0,05	0,3	1					
P	5	Terrajar	BR	(1)	0,10	0,3	1					
P	6	Armar Apuntalar c/t.y Col.	AR	(2)	0,10	0,3	1					
P	7	Soldar	SA	(1)	0,10	0,3	1					
P	8	Pintar	PI	(1)	0,05	0,3						
P	9	Revisar	RP		-	-						
		Enviar a J. Arcas										
		CANTIDAD 105 Unidades										

17 1986

MUA

Form. TA 33 - F 31 Imp. Inostroza

HOJA DE TRANSPORTES

2.5.3 Quality Control

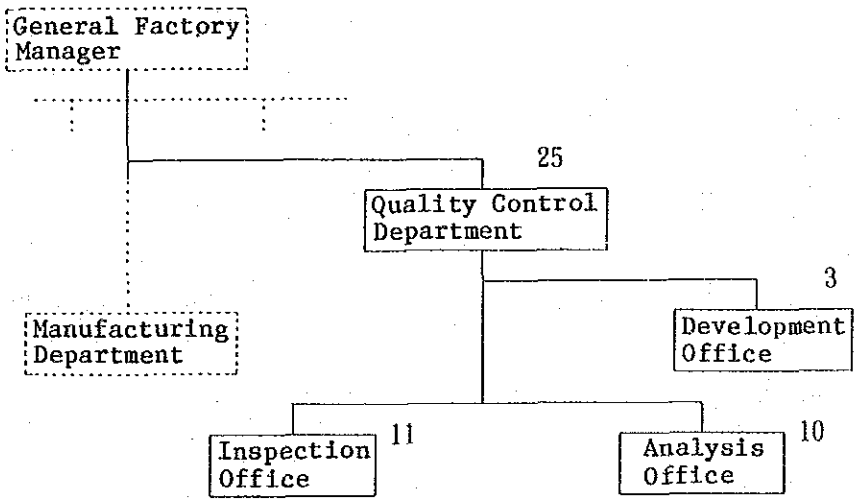
General

The quality control department is generally orgainzed as a staff element of this Workshops Department, and stipulated to execute the control on all quality. This department also develops new materials, and examines the manufacturing methods of new products.

1) Present conditions

(1) Organization

The quality control department is organized as follows.



The quality control department consists of such three groups as inspection office to inspect the products, etc., analysis office substantiated to the chemical analysis of materials and development office to develop new products, etc. as illustrated above. 25 personnels in total are assigned to this department.

(2) Functions

a) Inspection office

The business in the inspection office are divided into a group to check dimensions, etc. and another group to conduct the nondestructive inspection, consisting of 10 personnels in total, except for chief. Each group is assigned with five persons.

b) Analysis office

The analysis office is divided into such two sections as one related with the chemical analysis and the other related with metals, consisting of nine personnels, except for chief.

The chemical analysis section is assigned with two analytical specialists and two assistants, while the metal section with two inspection specialists, two engineers and one assistant.

c) Development office

The development office assumes the development of new materials and appropriate manufacturing processes, the improvement of defectives, etc., consisting of two manufacturing engineers and one technician.

2) Educational background and qualification

(1) Educational background

The quality control department is assigned with 25 people in total.

Looking at their educational background results in finding 15 university graduates (including the graduates from colleges), 3 technical high school graduates, 6 ordinary high school graduates and others. The experience of engineers and technician class people is mostly more than 9 years. Engineers engage in the control activities to analyze and judge data. Five persons are now assigned as technicians to directly operate the machines.

The ordinary high school graduates engage in the general jobs called "Musterello," but are given oppotunities to be promoted to technicians upon passing through the intra-company promotional tests in the future. For the reference purpose only, the educational system in the Republic of Chile is as follows.

- Civil engineering ..... 6-year course after graduation from a high school
- Engineer ..... 5-year course after graduation from a high school
- Engineer, effection/kimico ..... 4-year course after graduation from a high school
- Technico technician ..... 3-year course after graduation from a high school
- High school ..... 3-year after graduation from a primary school (8-year course)

(2) Qualification

The Republic of Chile has an INN (Institute National de Normarization) as a bureau to administer the national regulations, whereby establishing various qualifications.

For this quality control department, a lincense is required in the Republic of Chile for nondestructive inspection associates, expecially for the isotope handling qualification.

Six (6) persons are now qualified in this department, consisting of two license persons of university graduates and four of high school graduates.

An IDIEM qualification is given to the nondestructive inspection, which represents a qualification recognized internationally. This seems in conformance to the American Society of Nondestructive Tests (SNT-TC-IA) and the qualification by classifying into the following three levels is given.

Level I = Operator
Level II = Evaluation
Level III = Procedure approval

3) Equipment

The equipment applied to the quality control can broadly be classified into the material analysis equipments, mechanical property test equipments such as hardness and strength of materials, nondestructive apparatus for internal inspection of materials and the dimension measuring equipments.

These existing equipments can sufficiently assume the functions as those to perform the quality control activities. The principal equipments
and functions are as follows.

(1) Equipment related with the chemical analysis

The principal work related with the chemical analysis consists of analysis of raw materials (e.g., scraps, alloy iron, etc.), components before and after casting, and finished products. The equipment provided for this purpose are as follows.

- Leco carbon meter (1 unit) (Model 572-100)
- Leco sulfur measuring instrument (1 unit) (Model 532-000)
- Photoelectric photometer (1 unit) (Si, Ni, Mo, Ti and Fe) (Spectronic 20, Bauch and Lomb)
- Atomic absorption analyzer (1 unit) (Mg, Mn, Cr, Sn and Zn) (PENTINELMER 303)
- Electro analyzer (1 unit) (for Bronze: Cu, Pb, Zn) (EBERBACH)
- Emission spectrum absorption analyzer (1 unit)
- Available to measure 16 elements of steel, cast iron, bronze, white pig iron, etc. Analysis for about 2 minutes (DV2 BAIZD CORPORATION)

Among all others as above, the emission spectrum absorption analyzer is often used.

(2) Equipment related with metallurgy and physical measurement

The activities to be performed herein concern the casting process (e.g., casting sand test, etc.) in the foundry shop at Rancagua, control of processes in the plate shop control on the mechanical and metallurgical characteristics of products, tests on the mechanical properties (e.g., tensile strength, compression strength, elongation (%),

bending, hardness, etc.), metallurgical, metallographic and fracture plane inspection, production inspection and development.

The equipment provided for these activities are as follows.

- Universal tensile test equipment (1 unit) (up to 30,000 kg; Model TA-60 RIEHLE)
- Hardness testers (Rockwell hardness tester×2 units; Brinell hardness tester×1 unit; Ultrasonic hardness tester×1 unit; and Microvickers hardness tester×1 unit)
- Metallurgical microscope (2 units) (Metallux II)
- Specimen grinding associated equipment (3 units)
- Cross-section microcomparator (for bolts, gears, etc.) (1 unit)
- Impact tester (Charpy tester) (1 unit)
- A complete set of sand testing equipment.

(3) Equipment related with nondestructive inspection

The activities to be performed herein concern the radiographic tests for castings as specified in the ASTM and the steel sheets up to 12-inch in thickness.

Other nondestructive test equipment include the ultrasonic flaw detector, magnetic particle flaw detector, etc., and the inspection with a liquid penetrant a surface test. The following equipments are provided for these nondestructive examinations.

- Gamma-ray test equipment (2 units) (with a Cobalt 60 exposure room and a special room)
- X-ray test equipment (2 units) (6-200/S and 6-30 made by Philips)
- A complete set of ultrasonic flaw detector (3 sets)
- A complete set of magnetic particle flaw detector (1 unit; 2,000 Amp)
- Thickness measuring instrument (1 unit) (1.2 to 300 mm in thickness, made by Krautkramer)
- A complete set of liquid penetrant

(4) Equipment for dimensional inspection

These equipments check the dimensions of in-process and finished products. The principal equipments are as follows.

- Vernier caliper (5 units) (8-inch and 12-inch)
- External micrometer (15 units) (up to 16-inch)
- Internal micrometer (15 units) (up to 200 mm)
- Scale with a level (4 units) (12-inch)
- Width measuring instrument (3 units)
- Pitch measuring instrument (for bolts, screws, etc.) (3 units)
- R (radius) measuring instrument (2 units)
- Various scales (a complete set)
- Surface roughness tester (Surf-test B) (1 unit) (up to 3,000 micro-inch, made by Mitsutoyo)

2) Foundry shop

(1) Quality control standards

As shown above, the quality control equipment and functions were fairly sufficient, but the quality control standards could not be said sufficient upon the study of survey term.

First, for examples, no quality assurance system was established. Of course, no quality assurance system manual was prepared. The quality control standard seemed to be prepared to a certain extent, but no QC process chart of foundry work was prepared.

The basis of quality control starts with the preparation of standards, which are then to have workers observe and to be managed. It is necessary to examine what level, under what control systems and to check under what measuring methods in each process of the foundary or how to treat an emergency. From such viewpoints, it would be necessary to complete the standards.

(2) Quality control activities on castings

a) Preparation of quality records on castings

For inspecting castings, the competent quality control inspecting castings, the competent quality control inspectors check the products after shakeout and finishing the castings and at the final inspection.

For the actions corresponding to when a defective nappens, the defect card is issued. When an item is rejected, the return notice card is issued and then circulated to the production control department and manufacture associated sections. Looking at such an example results in finding no clear indication of what kind of defect appears under what situation and at what portion of the products. The defective part is said illustrated at required, but it seems for us to be practiced not so much. These factors are very important for examining the quality. Sketches should necessarily be attached.

b) Meeting related with quality

For the problems which can easily be solved, no meeting is held, but for the large defects and critical nonconformanace, all concerns gather to discuss. Therefore, no regular quality meeting is held.

The big problems are discussed in the key personnel meeting (general factory manager and other eight persons) to be held weekly. Such a meeting may be favorable to be held by gathering the key personnel only, but it ought to miss essence of problems via filtration.

It would be necessary for the quality control to act more positively so as department to recognize the actual situation to solicit the personnel at the foreman and team leader classes in the manufacuring department to participate in the meeting, to determine the causes and to take appropriate countermeasure actions.

c) Preparation of statistic data related with quality

A monthly report on the qulity status is prepared and submitted to the general factory manager, but no meeting is held to discuss the quality immediately upon submitting this report. Such a meeting may also be held upon the instruction from the general factory manager, as required. No data is collected for defectives of shipments outside the factory, i.g. no statistics is collected, because of very little occurrence of defectives, for example, only one claim occurs within a few months after the delivery of four thousands pieces.

d) Quality status of castings

(a) The statistic data of defectives over the past 3-year period are given in Table 2.5.3-1 below.

Table 2.5.3-1

Material	1983			1984			1985		
	Cast (kg)	Defective (kg)	Percent Defective (%)	Cast	Defective (kg)	Percent Defective (%)	Cast	Defective (kg)	Percent Defective (%)
Cast steel	3,222,990	131,794	4.09	3,336,631	160,793	4.82	2,555,961	138,975	5.44
Cast iron	1,423,499	196,624	13.81	1,526,499	116,144	7.61	2,540,696	314,321	12.37
Copper alloy	103,585	2,474	2.39	86,195	3,395	3.94	150,254	12,148	8.08
Total	4,750,074	330,892	6.79	4,949,325	280,332	5.66	5,246,911	465,444	8.87

For these defectives, approximately 80% of the cast steels in rejected and the rest 20% is saved by welding repair, etc. The defective cast irons and copper alloy castings quoted herein represent the disposals. Looking at the trend over the past 3-year period results in finding that the percent defective of cast steel increased to 4.09%, 4.82% and 5.44% consecutively; that the same of casted irons to 131%, 7.51%, 12.37%, indicating a fluctuation, but still remaining at a high level; and that the same of copper alloys to 2.39%, 3.94% and 3.28%, an uptrend.

(b) Percent defective per phenomenon

① Percent defectives of cast steels phenomenon

The percent defectives of cast steels are given in Table 2.5.3-2 below.

Table 2.5.3-2

Defect Phenomenon	1984		1985	
	Rejection (kg)	%	Rejection (kg)	%
1. Porosity (shrinkage) and blowhole	51,484	32.02	49,726	35.78
2. Hot tear and cracks	43,009	26.75	24,010	17.28
3. Damage and incomplete shape	24,241	15.08	36,546	26.30
4. Missing at finishing	15,950	9.92	-	-
5. Gas inclusion in the molten metal	10,216	6.35	-	-
6. Dimensional defectives, such as shape, hole position, deformed shape, etc.	8,437	5.25	24,39	17.55
7. Metal penetration	5,396	3.36	-	-
8. Shape different from the drawing	2,060	1.27	1,320	0.95
9. Heat treatment defective, etc.	-	-	2,148	1.54
Total	160,793	100%	138,975	100%

There is a difference in the percent defectives of cast steels per phenomenon annually, but the top three of defective phenomenon are same for all years, main defects are principally the porosity (shrinkage), crack (hot tear) and damage (incomplete shape), total of those three defects show more than 70% every year. These pareto diagrams were drawn, resulting in an example of 1985 as shown in Figure 2.5.3-1 below.

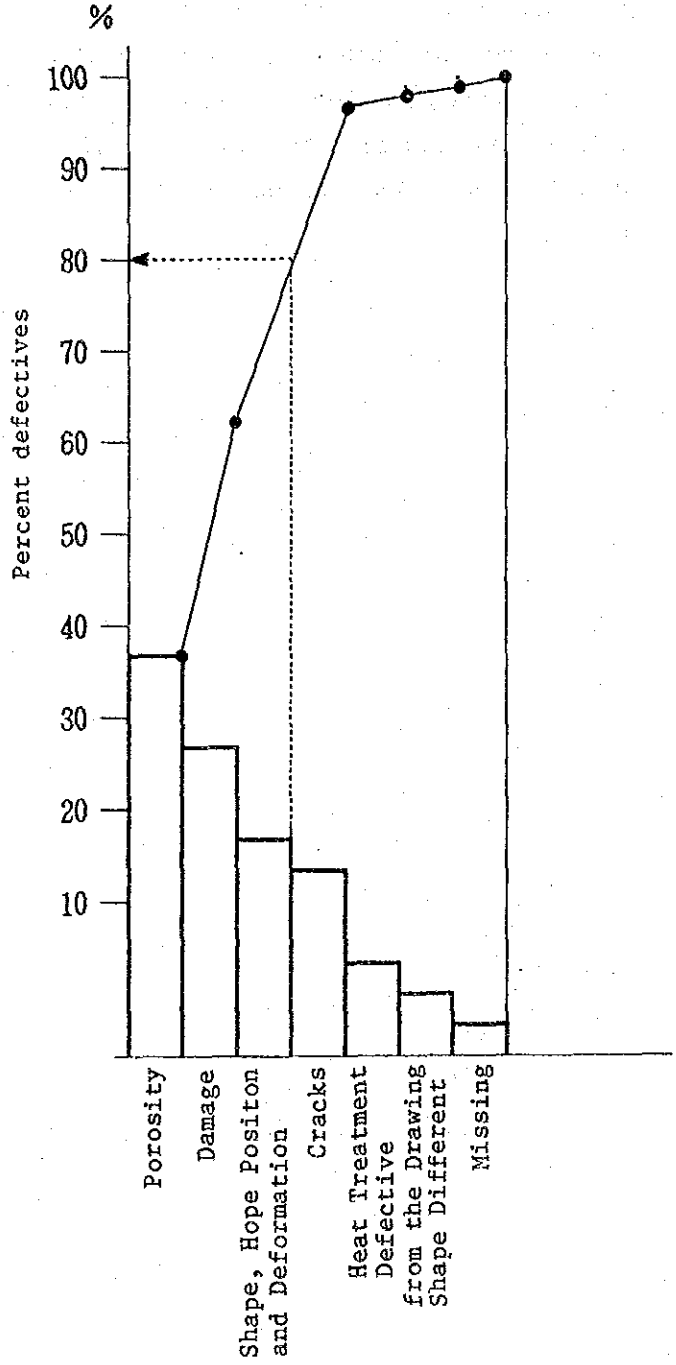


Figure 2.5.3-1 Pareto Diagram of 1985 Percent Defectives of Cast Steels per Phenomenon

As shown in Figure 2.5.3-1 above, the top three of defective phenomena occupied nearly 80% in 1985.

② Percent defectives of cast irons per phenomenon

The percent defectives of cast iron per phenomenon are given in Table 2.5.3-3 below.

Table 2.5.3-3

Defect Phenomenon	1984		1985	
	Rejection (kg)	%	Rejection (kg)	%
1. Porosity (shrinkage) and blowhole	48,575	41.82	80,758	25.69
2. Hot tear and cracks	35,705	30.74	92630	29.47
3. Different hole position, sand burning around holes and deformation	16,531	14.23	92,630	29.40
4. Damage and incomplete shape	10,303	8.87	13,881	4.42
5. Gas inclusion in the molten metal	2,420	2.08	-	-
6. Mold shift	1,654	1.42	4,424	1.41
7. Missing at finishing	956	0.84	87	0.03
8. Sand inclusion	-	-	21,350	6.74
9. Different from the drawing	-	-	8,783	2.97
Total	116,144	100%	314,321	100%

Similarly as for the cast steels, the top three of defective phenomena of cast irons are same for 1984 and 1985, occupying 80% or more. An example of 1985 pareto diagram per defective phenomenon is given in Figure 2.5.3-2 below.

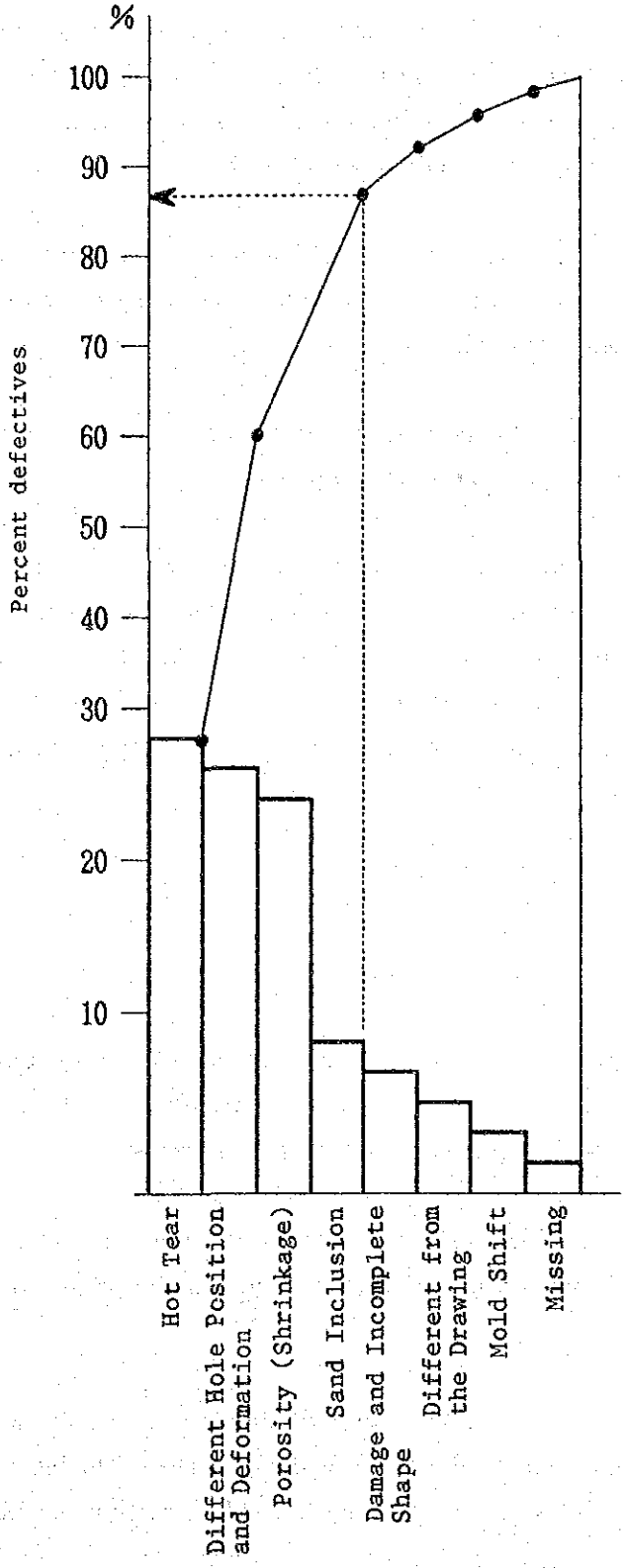


Figure 2.5.3-2 Pareto Diagram of 1985 Percent Defectives of Cast Irons Per Phenomenon

The top three of defective phenomena of cast irons occupies nearly 85% in 1985. The quality status of foregoing cast irons cannot be said good. Since the defective phenomena are likely same every year, it cannot be denied that the quality control is not thoroughly pursued, because these defectives are not reduced.

Excellent staff are gathered in the quality control department, which would rather be too luxurious. Fully having their capability demonstrate could contribute to a fair reduction of these defectives.

For this purpose, the staff need to observe each job of the work fields in the shops at all times.

For the quality control, it is necessary not only to check the products and to take actions after any defective happens, but also to put a further force to how to prevent any defective from happening beforehand. The quality control department should make a further effort of measures for improving the product quality by taking a powerful leadership.

3) Plate shop

(1) Activities of inspection division

The responsibility of inspection division is the scope of final inspection and non-destructive examination (mainly the X-ray penetration test) of the products manufactured in the shop and of receiving inspection of purchases.

The in-process inspection, control of raw materials and submaterials (mainly the welding materials), measuring instrument test, etc. are left in the voluntary hand of the plate shop.

For inspection, there is no inspection standard especially, so that whether the products are good or not is determined by the inspectors. The big problems are solved through the discussions among the engineers of inspection section and work shops department.

An actual example of inspection results is given in Table 2.5.3-4 below. This inspection sheet consists of the left half for inspection application from the plate shop and the right half for inspection results. For the flow of this inspection sheet, it is first filled in the left half by the plate shop, which is then sent to the inspection section. The inspection section enters the inspection results in the right half on the same sheet, which is then sent back to the plate shop.

For the nondestructive examination (generally the X-ray penetration test), the films of items determined as rejection are immediately brought to the plate shop, whereby repairing them. Therefore, the inspection results are not remained in a form. Nothing is statistically processed to figure out the percent defectives, etc.

The inspection section manager assumed that the X-ray percent defective is 1.5 to 2.0%. This percentage can be judged more than a level for shops manufacturing the general welded structures.

(2) Quality control activities in the plate shop

The in-process inspection is left in the voluntary hand or workers in the plate shop.

Observing the actual status of the plate shop resulted in finding no trace of conducting the voluntary in-process inspection.

The nonconformed quality is listed as follows.

- The gas cut surface is very rough, where is welded as many notches remain.
- Many pushed scratches are generated due to improper bending molds in the bending work.
- Many gaps exceeding 10 mm are seen at the welded joints. For correction, a welding electrode is inserted into the gaps or applied in place of a backup metal.
- The defective part of castings is dug by the are air gauging, into which a welding electrode is inserted and on the top of which is covered by welding.
- Many lengthes are dispersed.
- The welding electrodes are scattered around in the plate shop. No welding electrodes of low hydrogen type is also dried.

- Storing the mild steels and high tensile steels at a same place as they remain mixed results in the possibility of mistakingly using the steel materials.

Viewing these actual examples, this is attributable to the easy-going that there own products for domestic use only are being manufactured and to the fact that the technical skills are yet insufficiently followed, although it is coming to manufacture the products of high quality is the production increases. Because of applications to their own mines, it is surely necessary to improve the product value. Nevertheless, the foregoing examples depict a question in the strength, and it is necessary to take immediate actions, viewing from the meaning of improving the productivity.

Before fabricating a floatation tank, checking the welder skills was one of the great progresses. In the future, the great technical improvement can be hoped by salving the foregoing problems one by one.

(3) Quality standards

To carry out the activities as above, it is necessary to establish the standards which become the basis of judgement on what level or quality must be achieved in each process and up to what can be allowed.

Table 2.5.3-1 Inspection Sheet

Pág. ____ de ____

Fecha ____

(Verduzco. Zaldarte 167

O/T.	DESCRIPCION	N.° Plano	Material	Piezas presentadas	Peso unitario	OBSERVACIONES	Rechazados Pzas.	Rechazados Kilos	Acepte Pzas.
610306	[illegible]	IA-20373	8	8	164,50				8
610306	[illegible]	IA-20373		8	164,50				8
610306	[illegible]	IA-20373		8	164,50				8
610706	TUBO	IA-00553		4	2,61				4
610706	TUBO	IA-00553		4	3,61				4
610306	TUBO	IA-00553		4	3,61				4
						TOTALES			36

Responsabilidad de la Supervisión de Maestranzas

MAESTRANZA N.° 2 ☐

MAESTRANZA N.° 3 ☒

SUPERVISION MAESTRANZAS

Responsabilidad de Control de Calidad y Procesos

SUPERVISION CONTROL DE CALIDAD Y PROCESO

2.5.4 Transportation Control

The transportation activities of this workshop factory can be classified into such three activities as the transportation to and from outside, which is to be charged by the transportation department belonging to Div. El Teniente, the road transportation in the premises, which is to be charged by the transportation section belonging to the maintenance shop of the Workshops department, and the transportation in each shop, which is to be charged by each manufacturing shop.

- Activities of Transportation Department in Div. El Teniente

This transporatation department is in charge of not only the transportation to and from the workshops, but also the transportation activities of entire Div. El Teniente. Viewing on the workshops only, this department is in charge of the transportation of spare and repair parts to the mining, mineral processing and refining places from this factory, and the receiving of raw materials. For the transportation means, trucks and trailers are used. For the transportation routes to and from the foregoing places, the paved exclusive high way is completed.

- Activities of Transportation Section in the Maintenance Shop

This transportation section is in charge of receiving the materials in the workshops, loading the shipments, transporting the articles on the road in the factory, and mobile crane work. Although this transportation section charges a wide range, such as for foundry shop, plate shop, machine shop and assembling shop in this factory, only six people assigned. Because of this little number of people are assigned, the nuclei of transportation activities in the manufacturing processes are left in the hand of manufacturing shops.

Figure 2.5.4-1 below gives the functional orgainzation and personnel assignment chart of this transportation section.

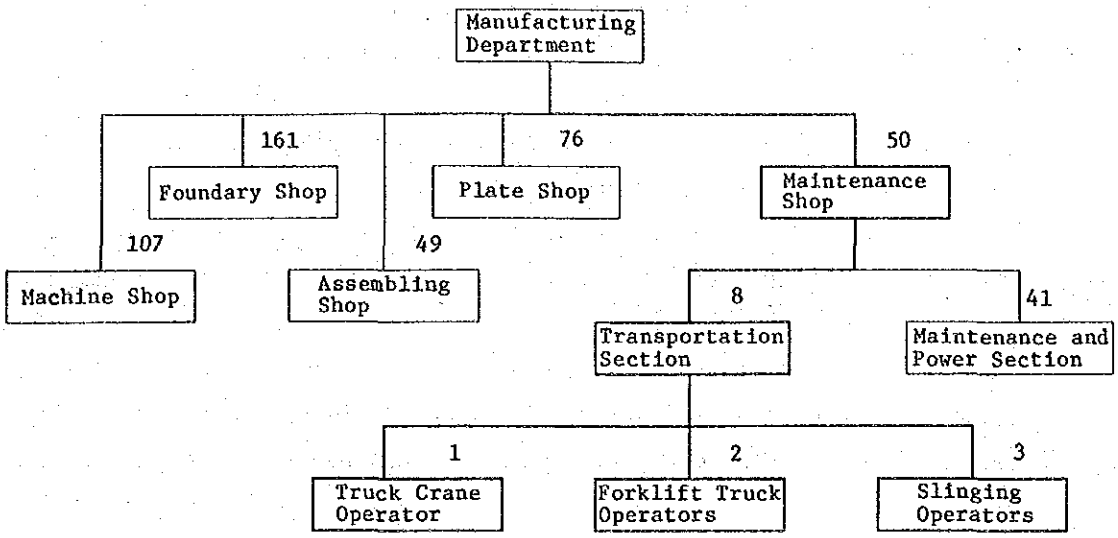


Figure 2.5.4-1 Functional Organization and Personnel Assignment Chart of Transportation Section

- Transportation Activities in Each Manufacturing Shop

Each manufacturing shop is naturally in charge of various transportation activities pursuant to the manufacturing processes in the shops, i.e. in charge of majority of the transportation controls.

The transportation means between the processes vary depending upon the nature of each shop. There is a modern shop totally adopting a belt conveyor system like sand processing shop, but others adopt almost no automatic conveyance-like, for which the overhead cranes and tractive bogies become the main means.

Since this study is subjected to the survey of foundry and plate shops in this factory, the transportation in these two shops is discussed as follows.

1) Foundry shop

The transportation in the foundry shop adopts broadly the following three means.

- Transporation by mens of such automatic conveying systems as belt, bucket and roller conveyors
- Transportation by means of overhead cranes and a monorail
- Vehicle transportation by means of tractive bogies and forklift trucks

(1) The conveyors are used for conveying sand to the sand processing plant and molding shop in the sand shop constructed relatively recently, consisting of various sizes of belt and bucket conveyors which are reasonably arranged by well using the cubic space and which are very good. The conveyor lines, although they are not automated, are also arranged before and after the small and medium-mold making shop. For transferring the casting molds onto these conveyors from the moding machines, however, they are lifted up one by one by the electrically-operated hoist installed to the turning arm to transfer them onto the conveyors, thus resulting in no continuous flow work. This conveyor line is partly used, because of low operating rate of the modling machines, thus resulting in a stock yard where the wooden molds and empty casting flask are stacked up.

The surrounding space is also very narrow with insufficient aisle space for work. This situation needs to be reconsidered. No other conveyor than these is used.

(2) The transportation by means of cranes becomes a nucleus in this shop, installing many of large and small overhead travel cranes, monorail and wall cranes with a high operating rate as well. The crane and slinging operators are specifically assigned as an indirect worker. For the transportation by these cranes, such lifting tools meeting the shapes of transporting articles are used as shackle hackers, hooks, lifting balances, etc., in addition to the wires and chains which are used generally.

While, however, no lifting lug like liners is provided for casting. Unstable slinging work was seen, such as lifting by chaining of single winding, directly chaining the feeder head, etc. For these methods, it is desired to make the suitable casting design, taking the safety handling method into consideration. Such problems are also arising as over workload due to a short capacity of ceiling cranes, pursuant to recently enlarging the products, frequent occurrence of troubles due to the obsolescent cranes, etc.

(3) The vehicle transportation by means of forklift trucks and tractive bogies is carried out between the work fields, as well as between the shop buildings, via the roads in the premises. For transportation between the shop buildings, the bogie transportation on the rails is mainly used, which causes no special problem as a transportation means of heavy items.

There is, however, a problem in the transportation means of rubber tire type tractive bogies between the work fields via the roads in the premises. This is especially many in the cast finishing process. As already mentioned in para. "Manufacturing Equipment," this is arising out of the question of equipment layout. The transportation by means of tractive bogies cannot avoid loading, moving unloading and idling time before and after these actions, so that it is a very inefficient way, because of accompanying an occupation of place for a long time as well.

The problems in respect to the transportation control of entire foundry shop are:

- that there are many in-process items which are seen scattered around on the floor of work fields and in-process item stack yard in the shop;
- that the manual transport (slinging work) is frequent;
- that the roads in the premises are not paved, especially the passages for work around the shop, leaving the convexes, concaves, water ponds, muddy places, etc.; and
- that there are many locations with sand stacks on the work fields and ailses for work in the shop, so that the stepping base is bad;

The foregoing were noticed by us. For these, the following improments are required.

- The in-process items should be placed on the pallets, bogies, conveyors, etc., instead of scattering around on the floors. Useless slinging work should be omitted to give a reasonability to the transportation.
- It should be recognized that the movement itself of articles is a useless work without any added value, and the layout should be reviewed so as to minimize this loss.
- The work passages in the premises should be paved. The work fields should always be kept clean to improve the safety and workability.

2) Plate shop

The transportation in the plate shop is carried out by such two means as cranes in the shop and bogies to and from outside the shop. A rail is provided to pass through the center in the plate shop, but this is not used now for transportation. Since the plate shop manufactures a variety of small lot items more than the foundry shop, the automatic conveyance system like conveyors can hardly be introduced, so that the current way of doing can be assumed unavoidable. While, however, the variation of product machining processes means the variation of transporting routes. To plan the locations and layout in meeting the processes becomes the basis of transportation control. In this regard, the ways of fixing the work fields and equipment layout need to be reconsidered. As already mentioned in para. 2.4.1.1 "Layout of Manufacturing Equipment." it is desired for the small equipment to be changed freely for layout to correspond to the manufacturing processes. This shop also uses 21 units in total of 0.5 to 2.0 tons manual chain blocks for cranes of turning arm and monorail types to transport the small items. Replacing them with the electrically-operated type can improve the transport work efficiency.

Another problem on the transportation control in the plate shop is, similarly in the foundry shop, that many inprocess items are disorderly placed on inside and outside the shop. It is necessary for this shop to consider the use of pallets and the exact use of sleeping lumbers so that the following transportation work can smoothly and safely be carried out, as well as to make the effective use of space through putting everything in order.

2.5.5 Maintenance

The maintenance is required to increase the productivity, as well as to maintain the equipment so that the equipment functions can always be demonstrated to a maximum extent, through the diagnosis, daily inspection, repair and improvement of shop equipment. In this regard, the Workshops Dept. is situated under circumstances that a majority of equipment is very old of three to four decades ago and that they have to be modified to achieve a further higher performance, corresponding to the increasing production and product enlargement, as well as to the wear and deterioration. This importance can be said especially great.

1) Maintenance organization

The maintenance activities to the equipment in the workshops can be classified into those to be charged by the maintenance department belonging to Div. El Teniente and the others to be charged by the maintenance and power section belonging to the production department.

(1) Maintenance department in Div. El Teniente

The departments belonging directly to Div. El Teniente include the construction maintenance department and the electric power maintenance department, assuming the following activities.

(a) Building maintenance

(b) Electric power supply, electric equipment maintenance and electric work

(c) Water supply and its piping maintenance

(2) Maintenance and power section of production department

This section belongs to the maintenance shop of production department, assuming the following activities.

(a) Regular inspection and lubrication of complicate machines and equipment

(b) Machine repairs and parts replacement, except for the electric work

(c) Improvements and modifications of machines and equipment, except for electricity

The electric associates and instrumentation controls in the machines and equipment are, therefore, assumed by the electric division in Div. El Teniente. The ordinary machines/equipment inspection, lubrication and cleaning are performed by the operators in each manufacturing shop.

(a) Organization and personnel assignment of maintenance and power section

The organization and personnel assignment chart of maintenance and power section is as shown in Figure 2.5.5-1 below, consisting of 40 people to include the manager with the following breakdown.

(i) Manager	1
(ii) Foreman	2 (2-shift)
(iii) Staff	2
(iv) Mechanical	16
(v) Mechanical assistant	14
(vi) Lubricator	2
(vii) Welder	1
(viii) Warehouse man	2

The average age of personnel in this section is a little less than 40 years old, and the average service length is about 20 years. The mechanical personnel forming a nucleus in this section are of excellent technicians especially with abundant experience, including those transferred from the production department. This group is formed with members of well knowing the equipment in the shops.

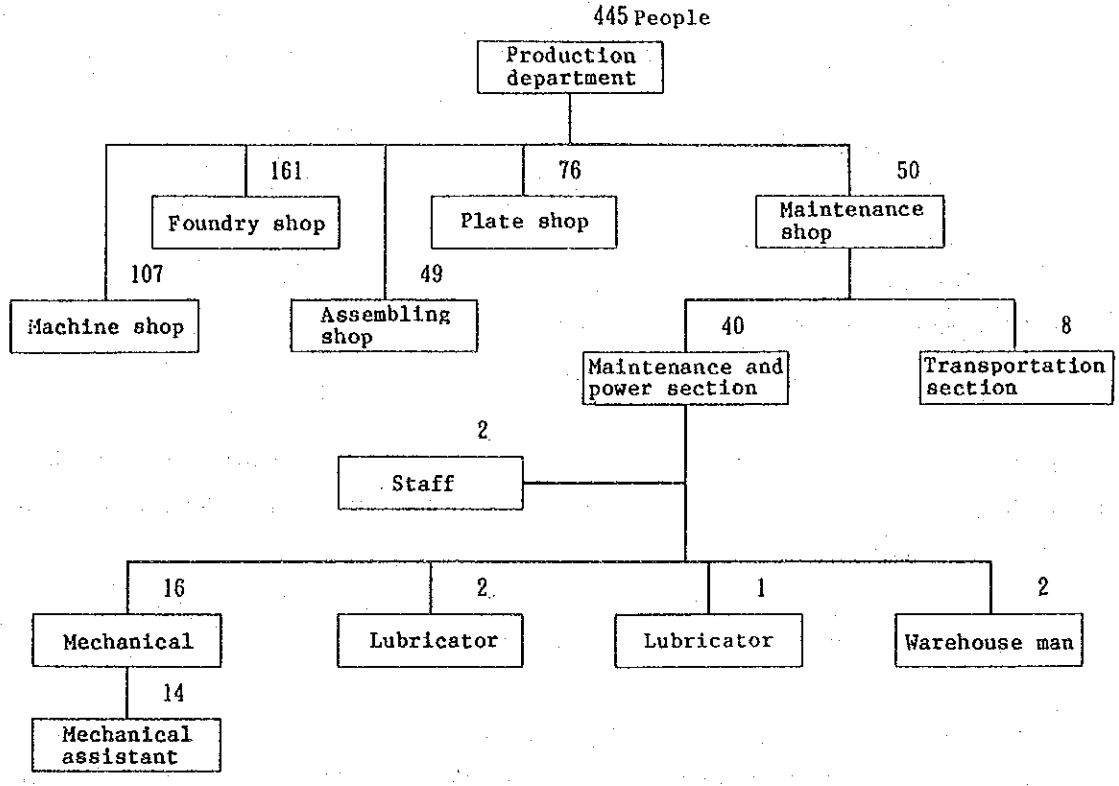


Figure 2.5.5-1 Organization Chart of Maintenance and Power Section

(b) Activity particulars of maintenance and power section

The activity particulars of maintenance and power section are as shown in Table 2.5.5-1 below. This section is in charge of maintaining the compressors, operating the boilers, and maintaining the fuel oil, gas and air piping lines, as well as maintaining the equipment.

2) Maintenance equipment

The principal equipment for working the maintenance are as follows.

- Lathe turning machine 1 unit
- Shaper 1 unit
- Milling machine 1 unit
- Bench drilling machine 2 units
- Welding equipment 1 unit
- Double-head grinder 1 unit

Further, the maintenance shop has a 15×27 m shop, whereby repairing and machining the small items. The maintenance is, in most cases, worked out at where the machines and equipment are located.

3) Completing the standards concerning the maintenance

The standards concerning the maintenance are very well completed. An example of inspection manual for lathe turning machine is given in Table 2.5.5-2 below, concretely specifying the inspection procedure per type of equipment and instructing the name and quantity of applicable tools, parts and lubrication oils. The daily, weekly, monthly and annual inspection items per equipment are specified as a maintenance manual.

Table 2.5.5-1 Activity Particulars of Maintenance and Power Section

No.	Name of Person in Charge	Contents
1	Foreman and staff	. Preparation of preventive maintenance program . Preparation of maintenance program for following month . Provision of maintenance parts . Instructing the diagnosis of sudden incidents and the repairing methods
2	Mechanical	. Check, parts replacement, repair and modification in accordance with the maintenance programs . Manufacture of parts necessary for maintenance . Operation of compressors and boilers . Utility maintenance, except for electricity and water
3	Lubricator	. Lubricating the machines and oil change in accordance with the maintenance programs
4	Welder	. Welding the repair parts
5	Warehouse man	. Control and issuance of maintenance tools and parts

Table 2.5.5-2 Inspection Manual for Lathe Turning Machine

MEA10-1 . CEPIC. TALLERES PAG: 1
28MAY06

PAUTA/INTERV: TORNC REVCLVER CODIGO: TORNH143M
H-H: 16,0 HRS. DET.: 0,0 OTM : L-81111

* * * * I N S T R U C T I V O S * * * *

* * * * O P E R A C I O N E S * * * *

	SEC	MODIF	D E S C R I P C I O N
0001730000	1	(-)	******** CONJUNTO MAQUINA ********
9201731999	2	(-)	DESCONECTAR CONJUNTO EQUIPO
5271731380	3	(-)	LIMPIAR CONJUNTO EQUIPO EXTERIOR(ES)
9999999999	4	(-)	
0004905000	5	(-)	******** SIST.FLUIDO CORTANTE ********
8172090850	6	(-)	SACAR EMULSION TODO(S)
8062090800	7	(-)	REVISAR/CAMBIAR EMULSION SOLO SI CORRESPONDE
5271310999	8	(-)	LIMPIAR BANDEJA
4523775608	9	(-)	INSP.P/FUNCIONAM LINEAS DISTRIBUICION POR FILTRACIONES
4521365000	10	(-)	INSP.P/FUNCIONAM BOMBA ********
8062270800	11	(-)	REVISAR/CAMBIAR FILTRO(S) DE AGUA SOLO SI CORRESPONDE
9999999999	12	(-)	
0004895000	13	(-)	******** SIST.TRANSMISION ********
80 770999	14	(-)	REVISAR/AJUSTAR CORREAS (JUEGO)
46..668600	15	(-)	INSP.VISUAL CLARO INFERIOR CANAL POLEA MOTRIZ
9999999999	16	(-)	
00/ 514000	17	(-)	******** CARRO TRANSVERSAL ********
000.612000	18	(-)	******** CARRO LONGUITUDINAL ********
4521697850	19	(-)	INSP.P/FUNCIONAM COMPONENTES TODO(S)
0271920130	20	(-)	AJUSTAR DESLIZAMIENTO DEL CARRO(S)
5271697999	21	(-)	LIMPIAR COMPONENTES
5331725999	22	(-)	LUBRICAR CONJUNTO DEL
9999999999	23	(-)	
0005145000	24	(-)	******** TORRE PORTA HERRAMIENTA ********
4521731000	25	(-)	INSP.P/FUNCIONAM CONJUNTO EQUIPO ********
4611780607	26	(-)	INSP.VISUAL CREMALLERA POR EROSION/DESGASTE
5334223855	27	(-)	LUBRICAR PISTA DE RODADO TORRETA AUTOMATICA
9999999999	28	(-)	
0001054000	29	(-)	******** ALIMENTADOR DE BARRAS ********
4521697000	30	(-)	INSP.P/FUNCIONAM COMPONENTES ********
4611085850	31	(-)	INSP.VISUAL ARTICULACIONES TODO(S)
9999999999	32	(-)	
0004275000	33	(-)	******** PLATO UNIVERSAL ********
1942759999	34	(-)	DESMONTAR PLATO UNIVERSAL
1981697999	35	(-)	DESARMAR COMPONENTES
1181697999	36	(-)	LAVAR COMPONENTES
0571725999	37	(-)	ARMAR CONJUNTO DEL
6042759999	38	(-)	MONTAR PLATO UNIVERSAL
35 25225	39	(-)	PROBAR FUNCIONAMIENTO DE CONJUNTO(S)
99.999999	40	(-)	
100 31000	41	(-)	******** CONJUNTO EQUIPO ********
03 45610	42	(-)	REVISAR CAJA REDUCTORA POR LUBRICACION
6520999999	43	(-)	CONECTAR EQUIPO
742100038	44	(-)	ENTREGAR EQUIPO PROBADO AL SUPERVISOR

* * * M A T E R I A L E S Y H E R R A M I E N T A S * * * *

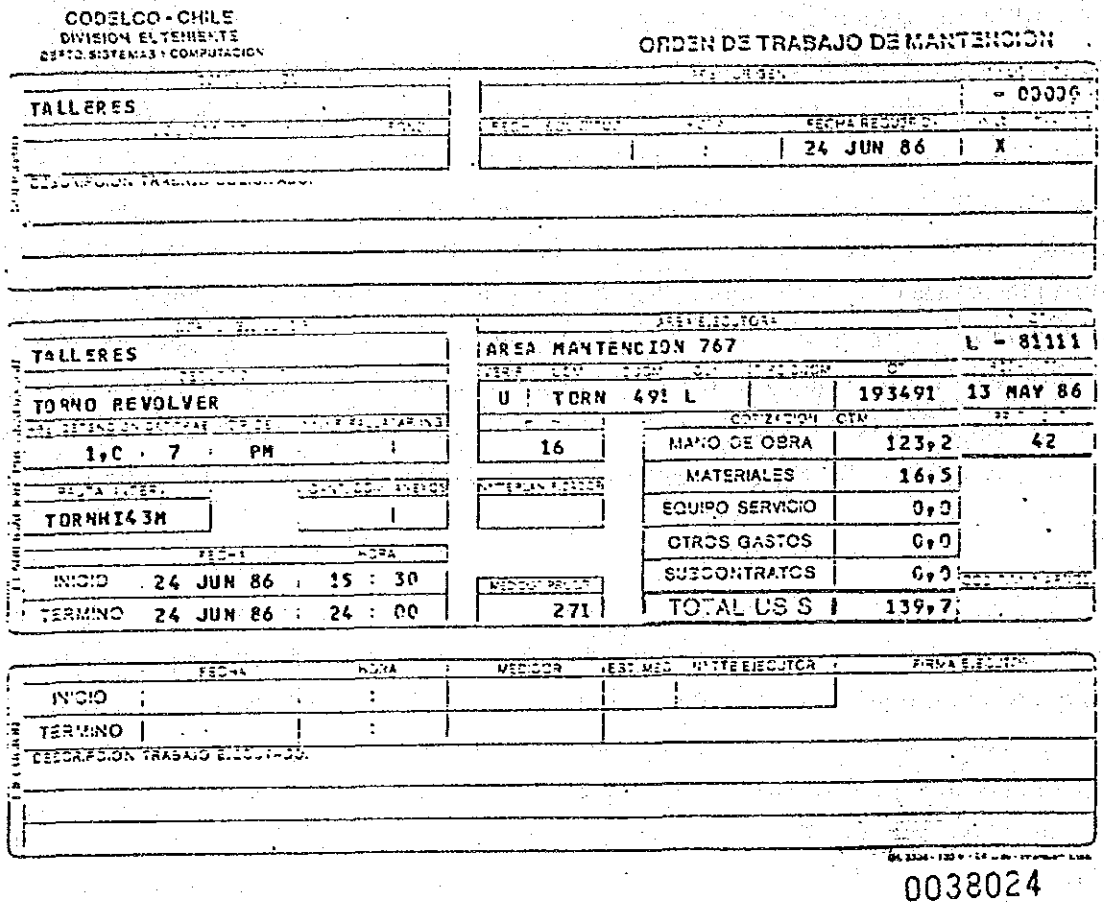
SEC	CP	M Y A	CANT	D E S C R I P C I O N
1	7	19332733	10	ACEITE PTA-1056 O SU EQUIVALEN
2	8	23146004	2	OSNABURGO
3	14	00000000	1	NO EXISTE DESCRIPCION
4	21	19634518	2	KEROSENE
5	22	19394105	1	NO EXISTE DESCRIPCION
6	27	19394105	1	NO EXISTE DESCRIPCION
7	36	19634518	2	KEROSENE
8	42	19351410	3	ACEITE DTE HEAVY MEDIUM O SU E

4) Maintenance execution plan

For the maintenance planning, the maintenance programs for following month are prepared by the staff based on the annual maintenance plan per equipment, past maintenance records and modification requests from the production department, and the provision of necessary parts is simultaneously arrange from the warehouse. Any sudden incident, if it happens, is reported to the foreman who in turn investigates it to instruct to the staff how to repair it, as well as to ask the competent electricians in Div. El Teniente for repairing the electric associates. The staff upon instruction prepare the work instruction which is handed over to the workers by the foreman. These programs are controlled by a computer to print out the repair starting date and time, scheduled man-hours, replacing part name and quantity, etc. in the work instruction. After completion of the repair, the actual repair performance are recorded and reported to the staff who in turn input such information into the computer. Table 2.5.5-3 below gives an example of work instruction for lathe turning machine.

The maintenance workload is equalized. The occurrence frequency of sudden incidents in this factory is so often that it occupies 60% of the total maintenance manhours, as mentioned later. For the corresponding measures, although the 2-shift system is established, they are not especially concentrated at night or on holiday when the production is suspended. The replaceable parts are purchased from the equipment manufacturers (mainly from the European and American manufacturers). For a reduction of expenses, however, ships are used for delivery, and stocks for 8 to 12 months are held. Simple parts are also manufactured in their own shops.

Table 2.5.5.3 Maintenance Work Instruction for Lathe Turning Machine



CODELCO - CHILE
DIVISION EL TENIENTE
DEPTO. SISTEMAS Y COMPUTACION

ORDEN DE TRABAJO DE MANTENCION

TALLERES			- 00009
		24 JUN 86	X

DESCRIPCION TRABAJO EJECUTADO

TALLERES	AREA MANTENCION 767				L - 81111
TORNO REVOLVER	U	TORN	49! L	193491	13 MAY 86
1,C : 7 : PM	16		COTIZACION CTM		
TORNHI43M			MANO DE OBRA	123,2	42
			MATERIALES	16,5	
			EQUIPO SERVICIO	0,0	
			OTROS GASTOS	0,0	
			SUBCONTRATOS	0,0	
INICIO 24 JUN 86 : 15 : 30			TOTAL US $	139,7	
TERMINO 24 JUN 86 : 24 : 00	271				

	FECHA	HORA	MEDIDOR	TEST MED	JEFE EJECUTOR	FIRMA EJECUTOR
INICIO		:				
TERMINO		:				

DESCRIPCION TRABAJO EJECUTADO

0038024

5) Maintenance execution status

The served unit number and manhours per shop over the past 3-year period are as shown in Table 2.5.5-4 "Actual Maintenance Work" below. This maintenance manhour represents those spent by the maintenance department only, but not including any manhour spent by the production department. This total manhour consists of about 60% for repair due to sudden incidents and the rest 40% for regular inspection, improvements and modifications. As seen from this table, the maintenance manhours spent are yearly increasing greatly for both of the foundry and plate shops. Comparing this with the trend of 3-year production as mentioned in para. 2.2 above, the production is leveled in the foundry shop, while the maintenance manhours spent increased by about 32%; and the production increased by about 25% in the plate shop, while the maintenance manhours spent by about 45%, thus resulting in a great increase more than the production increase.

The trouble status to shut down the principal equipment for more than a day last year is given in Table 2.5.5-5 below, finding that the equipment are mostly very old of three to four decades ago.

Considering these actual performance together with the current favorable status of maintenance systems, it may probably be judged that the old equipment in this factory now come to a time of renewal.

For renewing the equipment, not only because of merely increasing the troubles, but also because of inversely affecting such wide ranges as production decrease, increasing the waiting time of workers and the resources consumption, safety reduction, etc., in addition to the repair cost increase, through the deterioration and loss of the equipment, as shown in Table 2.5.5-6 below, it is necessary to make sure the feasibility of new equipment introduction (investment), as well as to sufficiently ensure the current status through analyzing the foregoing factors. Since both the foundry and plate shops plan to increase the production in the future, these analysis and study should soon be conducted in cooperation with the production department.

Table 2.5.5-4 Actual Maintenance Work

Shop	Item	1983	1984	1985
Foundry	Total maintenance manhours spent (H)	26,211 (100)	29,534 (112.7)	34,548 (131.8)
	Total number of units completed for annual maintenance	208	215	235
	Total number of equipment maintained	283	283	283
Plate	Total maintenance manhours spent	4,002 (100)	4,795 (119.8)	5,789 (144.7)
	Total number of units completed for annual maintenance	42	38	37
	Total number of equipment maintained	74	74	74

Note: Figures in parentheses represent the ratio to 100 of maintenance manhours spent in 1983.

Table 2.5.5-5 Trouble Status of Principal Equipment (1985)

Shop	Equipment Name	No. of Equipment	No. of Equipment shutdown for a day or more
Foundry	Overhead crane	5	2
	Electric furnace	3	3
	Heat treatment furnace	4	3
	Shot blast machine	2	6
	Ladle	18	1
	Shakeout machine	5	5
	Sieving machine	3	3
	Carrier	40	4
	Sand conveying bucket	4	4
	Sand mixer	2	2
	Pneumatic conveyor	1	3
	Dust collector	3	3
	Core dryer	1	2
	Swing grinder	10	1
Plate	Overhead crane	2	1
	Wire netting machine	2	2
	Shearing machine	1	2
	Sawing machine	1	2
	Radial drilling machine	1	1
	Eye tracer	1	1
	Casting machine	3	1
	Hammer	2	1

Table 2.5.5-6 Equipment Deterioration and Loss

No.	Item	Description
1	Repair cost	Expenses of labor and replacing part costs required for repair
2	Production decrease	Loss arising out of the production decrease during a period of suspending the production
3	Waiting time of workers	Loss arising out of the waiting time of workers during a period of suspending the production and in relation with the suspended processes
4	Product defective	Loss arising out of the disposal or repair cost due to an occurrence of defectives
5	Increase of resources consumption	Increase of labor, raw material and power costs due to a performance reduction
6	Quality reduction	Loss arising out of the price drop and lost credibility
7	Safety reduction	Loss arising out of the incidents
8	Worsening of environmental conditions	Reduction of workers' motivation

2.5.6 Instruction and training

Instruction and training at the El Teniente Division is entrusted to the initiative of the department charged with Personnel Capability Development, with the Projects and Programs Coordinator—reporting directly to the Workshop Superintendent—undertaking coordination of all programs covering personnel capability development, work safety and similar activities.

The items of instruction/training comprise:

(A) Technical instruction within the Workshops
(B) Instruction in management and control
(C) Instruction in computerized processing of business and information data
(D) Instruction and training abroad
(E) Activities aimed at preventing peril in work.

At the Workshops, 2,671 hours were spent in instruction/training during 1985, representing 0.3% of the total volume worked in the course of the same year.

Also, when new equipment is introduced, whether in Foundry or in Plate Shop, selected employees are sent to the equipment manufacturer for special instruction on equipment manipulation, and the skills thus acquired are then imparted to the other operators on shop floor in on-the-job training.

An example of schedule for training programs is reproduced in Tables 2.5.6-1 and -2.

1) Foundry shop

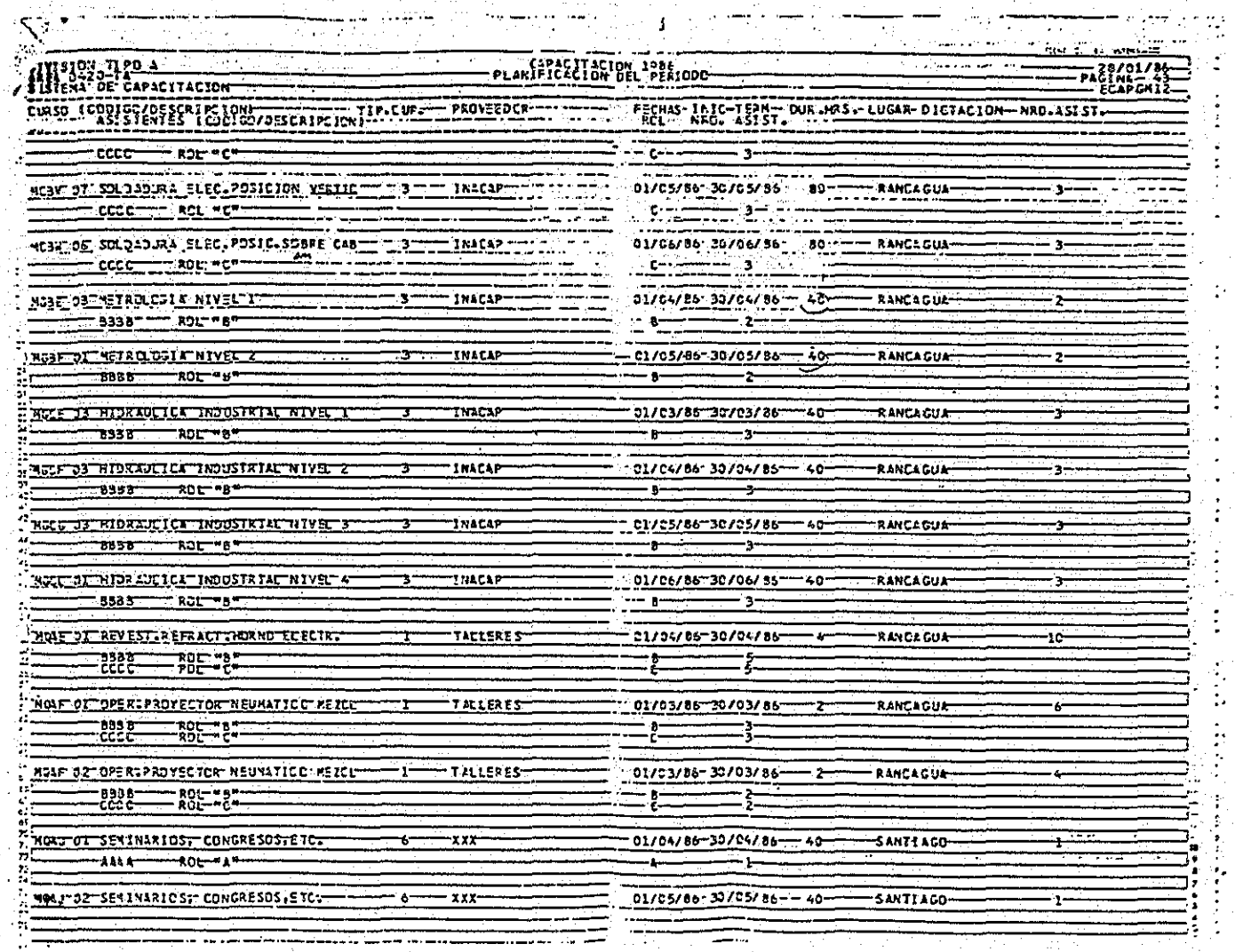
Apart from general orientation courses administered to newly recruited employees, and courses on basic notions of health and safety, systematic training courses in foundry skills held outside the premises are hardly ever attended by the foundrymen, who gain their experience and skills exclusively through on-the-job training.

2) Plate shop

Instruction/training is centered around the welders: Basic courses given at INACAP are attended by newly recruited welders, who go through 320 hours of training—80 hours each in flat, horizontal, vertical and overhead positions. For new welding methods to be mastered, the requisite number of welders are initiated into the relevant techniques on each occasion: For MIG welding, as example, welders undergo 45 hours of training at INDURA (Welding rod manufacturer) before being permitted to practice on shop floor.

Otherwise, acquisition of experience and skill depends largely on on-the-job training, although some special instruction courses are given for instance in marking and in plasma cutting.

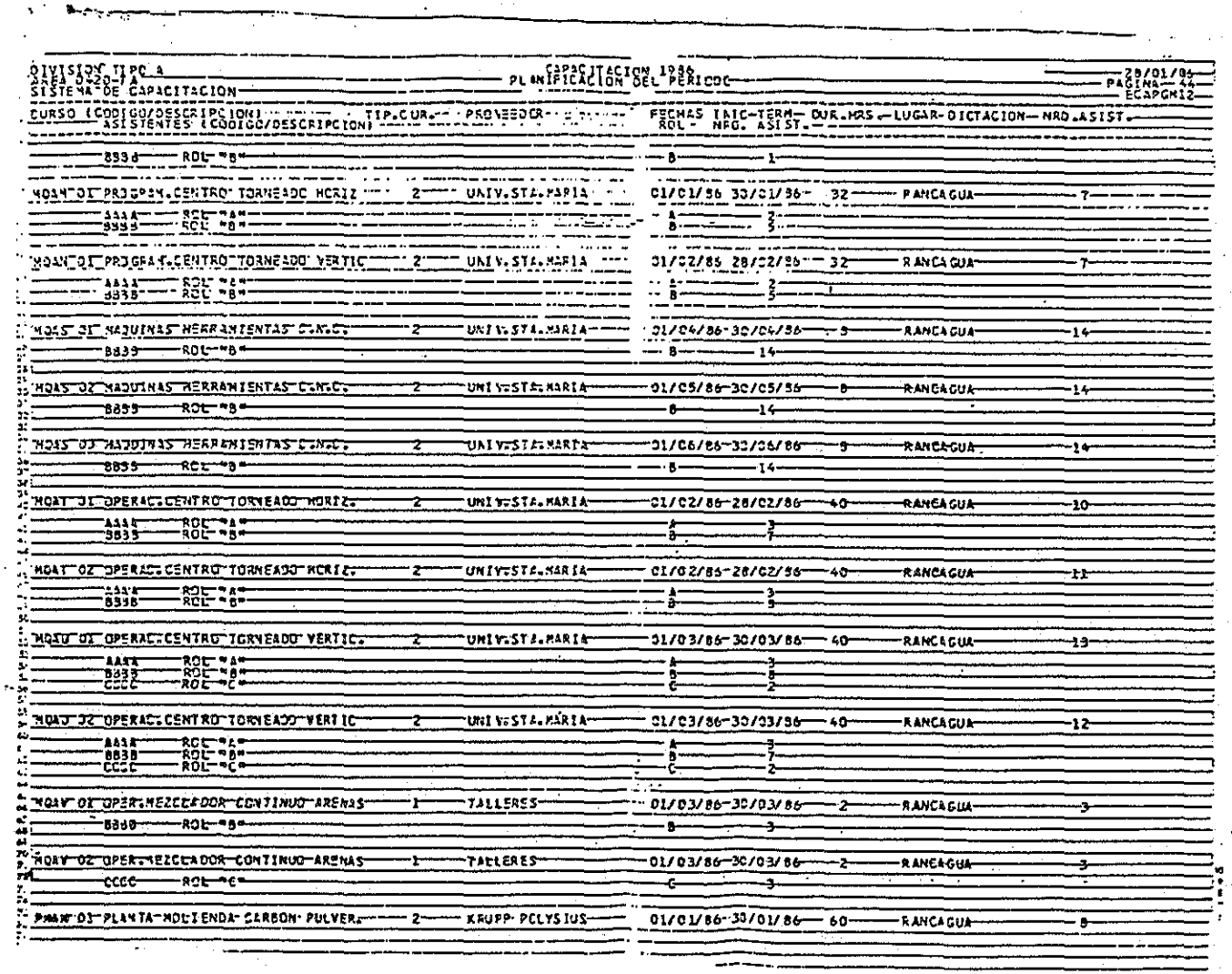
Table 2.5.6.1 Example of Training Program



CAPACITACION 1986
PLANIFICACION DEL PERIODO

CURSO (CODIGO/DESCRIPCION) / ASISTENTES (CODIGO/DESCRIPCION)	TIP.	CUF.	PROVEEDOR	FECHAS INIC-TERM / ROL	DUR. HRS. / NRO. ASIST.	LUGAR DICTACION	NRO. ASIST.
CCCC ROL "C"				C	3		
MC3F 01 SOLDADURA ELEC. POSICION VERTIC	3		INACAP	01/05/86-30/05/86	80	RANCAGUA	3
CCCC ROL "C"				C	3		
MC3F 06 SOLDADURA ELEC. POSIC. SOBRE CAB	3		INACAP	01/06/86-30/06/86	80	RANCAGUA	3
CCCC ROL "C"				C	3		
MG3F 03 METROLOGIA NIVEL 1	3		INACAP	01/04/86-30/04/86	40	RANCAGUA	2
BBBB ROL "B"				B	2		
MG3F 01 METROLOGIA NIVEL 2	3		INACAP	01/05/86-30/05/86	40	RANCAGUA	2
BBBB ROL "B"				B	2		
MG3F 04 HIDRAULICA INDUSTRIAL NIVEL 1	3		INACAP	01/03/86-30/03/86	40	RANCAGUA	3
BBBB ROL "B"				B	3		
MG3F 03 HIDRAULICA INDUSTRIAL NIVEL 2	3		INACAP	01/04/86-30/04/85	40	RANCAGUA	3
BBBB ROL "B"				B	3		
MG3F 05 HIDRAULICA INDUSTRIAL NIVEL 3	3		INACAP	01/05/86-30/05/86	40	RANCAGUA	3
BBBB ROL "B"				B	3		
MG3F 01 HIDRAULICA INDUSTRIAL NIVEL 4	3		INACAP	01/06/86-30/06/85	40	RANCAGUA	3
BBBB ROL "B"				B	3		
MG4F 01 REVEST. REFRACT. HORNO ELECTR.	1		TALLERES	01/04/86-30/04/86	4	RANCAGUA	10
BBBB ROL "B"				B	5		
CCCC ROL "C"				C	5		
MG4F 01 OPER. PROYECTOR NEUMATICO MEZCL	1		TALLERES	01/03/86-30/03/86	2	RANCAGUA	6
BBBB ROL "B"				B	3		
CCCC ROL "C"				C	3		
MG4F 02 OPER. PROYECTOR NEUMATICO MEZCL	1		TALLERES	01/03/86-30/03/86	2	RANCAGUA	4
BBBB ROL "B"				B	2		
CCCC ROL "C"				C	2		
MGAJ 01 SEMINARIOS, CONGRESOS, ETC.	6		XXX	01/04/86-30/04/86	40	SANTIAGO	1
AAAA ROL "A"				A	1		
MGAJ 02 SEMINARIOS, CONGRESOS, ETC.	6		XXX	01/05/86-30/05/86	40	SANTIAGO	1

Table 2.5.6.2 Example of Training Program



DIVISION TIPO A — CAPACITACION 1986 — 29/01/86
AREA 0120-1 A — PLANIFICACION DEL PERIODO — PAGINA 44
SISTEMA DE CAPACITACION — ECAPGM12

CURSO (CODIGO/DESCRIPCION) / ASISTENTES (CODIGO/DESCRIPCION)	TIP.CUR.	PROVEEDOR	FECHAS ROL	TAIC-TERM NRO. ASIST.	DUR.HRS	LUGAR-DICTACION	NRO.ASIST.
8886 ROL "B"			B	1			
MOAM 01 PROGRAM.CENTRO TORNEADO HORIZ	2	UNIV.STA.MARIA	01/01/86	30/01/86	32	RANCAGUA	7
AAAA ROL "A"			A	2			
8888 ROL "B"			B	5			
MOAM 01 PROGRAM.CENTRO TORNEADO VERTIC	2	UNIV.STA.MARIA	01/02/86	28/02/86	32	RANCAGUA	7
AAAA ROL "A"			A	2			
8888 ROL "B"			B	5			
MOAS 01 MAQUINAS HERRAMIENTAS C.N.C.	2	UNIV.STA.MARIA	01/04/86	30/04/86	8	RANCAGUA	14
8889 ROL "B"			B	14			
MOAS 02 MAQUINAS HERRAMIENTAS C.N.C.	2	UNIV.STA.MARIA	01/05/86	30/05/86	8	RANCAGUA	14
8889 ROL "B"			B	14			
MOAS 03 MAQUINAS HERRAMIENTAS C.N.C.	2	UNIV.STA.MARIA	01/06/86	30/06/86	8	RANCAGUA	14
8889 ROL "B"			B	14			
MOAT 01 OPERAC.CENTRO TORNEADO HORIZ.	2	UNIV.STA.MARIA	01/02/86	28/02/86	40	RANCAGUA	10
AAAA ROL "A"			A	3			
8888 ROL "B"			B	7			
MOAT 02 OPERAC.CENTRO TORNEADO HORIZ.	2	UNIV.STA.MARIA	01/02/86	28/02/86	40	RANCAGUA	11
AAAA ROL "A"			A	3			
8888 ROL "B"			B	8			
MOAU 01 OPERAC.CENTRO TORNEADO VERTIC.	2	UNIV.STA.MARIA	01/03/86	30/03/86	40	RANCAGUA	13
AAAA ROL "A"			A	3			
8888 ROL "B"			B	8			
CCCC ROL "C"			C	2			
MOAU 02 OPERAC.CENTRO TORNEADO VERTIC	2	UNIV.STA.MARIA	01/03/86	30/03/86	40	RANCAGUA	12
AAAA ROL "A"			A	3			
8888 ROL "B"			B	7			
CCCC ROL "C"			C	2			
MOAV 01 OPER.MEZCLADOR CONTINUO ARENAS	1	TALLERES	01/03/86	30/03/86	2	RANCAGUA	3
8880 ROL "B"			B	3			
MOAV 02 OPER.MEZCLADOR CONTINUO ARENAS	1	TALLERES	01/03/86	30/03/86	2	RANCAGUA	3
CCCC ROL "C"			C	3			
PMAM 01 PLANTA MOLIENDA CARBON PULVER.	2	KRUPP POLYSIUS	01/01/86	30/01/86	60	RANCAGUA	8

2.5.7 Cost control

1) Organization for cost control

The unit in the Workshops Department charged with cost control is—as indicated in Fig. 2.5.7-1—the Cost Control Group comprising 2 members, in the Programming and Control Section, performing their work with close collaboration provided by the General Accounting Section in the El Teniente Division as shown in Fig. 2.5.7-2.

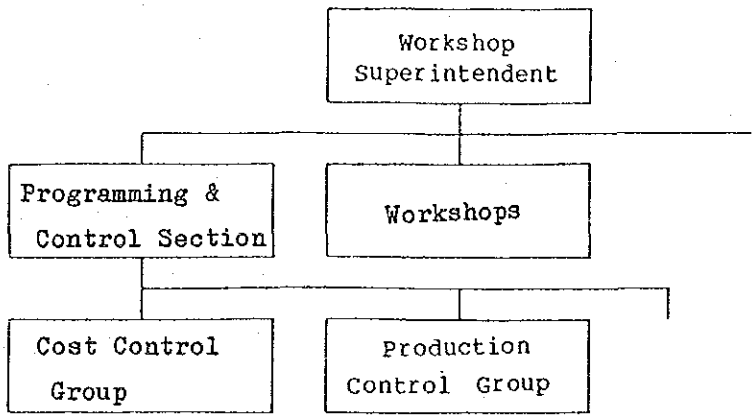


Fig. 2.5.7-1 Position of Cost Control Group in Workshops Division

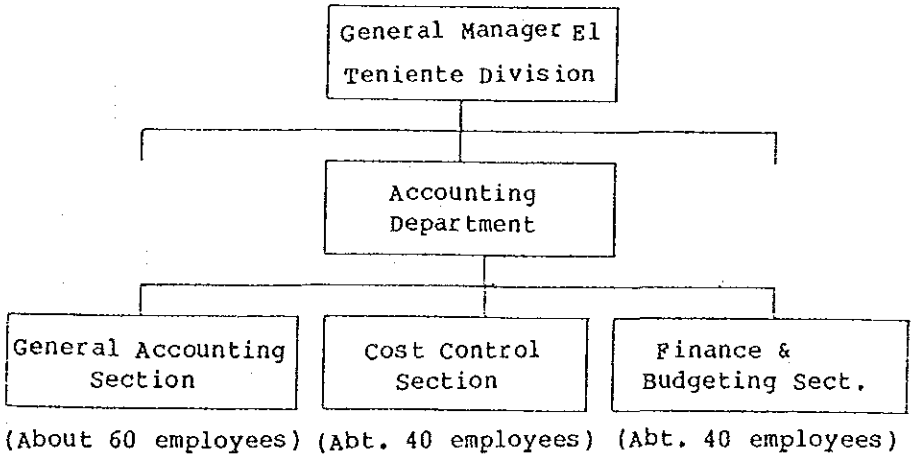


Fig. 2.5.7-2 Position of Accounting Groups at El Teniente Division

2) Generation of actually incurred cost data for individual cost factors

Work Orders issued by the El Teniente Division are received at the Workshop by the Production Control Section, where the data contained in each Order are inputted into computer, and the progress of each work is followed by the same Section.

Raw materials are managed separately for those held in stock at Workshop and those requiring to be purchased on spot. For both categories of material, purchase requisitions or stock control programs are drawn up at the Workshops Department, while the procedures of purchasing, acceptance and issue from stock are under the charge of the El Teniente Division Purchasing and Stores Departments.

Expenditures on materials are accounted for by the Cost Control Section. Manhours and equipment utilization are estimated for each work by the Production Control Section, and followed up by comparison with the number of hours actually spent for the Work.

Labor cost is controlled by the Cost Control Section, based on the flow of data shown in Fig. 2.5.7-3.

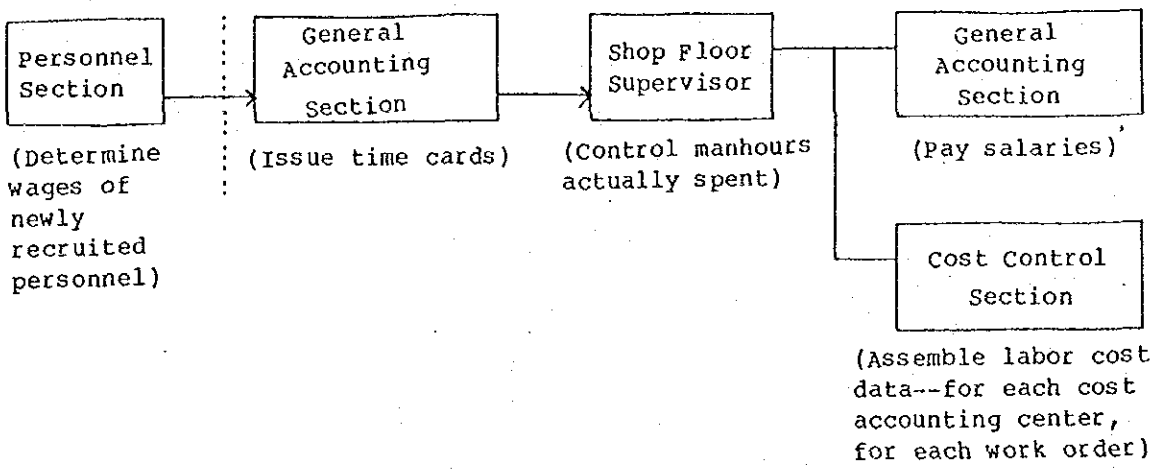


Fig. 2.5.7-3 Flow of Labor Cost Data

Other expenditures generated at the individual cost accounting centers are disbursed by the General Accounting Section, and relevant data are assembled by the Cost Control Section.

3) Principal control data

The system of cost accounting adopted at the Workshops Department is what is known as the Cost per Work Order System, with the Cost per Process System adopted instead in part of the Foundry Shop. A modernized procedure of cost accounting is established, and computerized cost control techniques introduced.

The cost control data generated in the Cost Control Group, Production Control Group and Accounting Department comprise:—

- Balance sheet (General Accounting Section)
- Profit and loss statement (Ditto)
- Estimated and actually incurred expenditure comparison (Cost Control Section)
- Standard unit production cost table (Production Control Group)
- Unit production cost record (Cost Control Group).

Follow up of budgeted production costs by comparison with actually incurred expenditures is performed monthly on computer outputs giving comparisons for each department or section (see Table 2.5.7-1) generating the expenditure and for each cost accounting element (see Table 2.5.7-2). Notable discrepancies found between budgeted and actually incurred expenditures are made subject of inquiry from the Cost Control Section to the Workshop Superintendent. Within the Workshops Department, the Cost Control Group keeps check on expenditures by comparisons with budgeted figures and analyses based on data obtained from the Cost Control Section.

The standard unit production cost for each product is derived from standard unit manhours and materials established for each cost center and for each kind of job, in turn derived from flow charts drawn up for each process from actual production records.

Apart from the foregoing principal control data, other indexes utilized for production control include:—

- Productivity—kg/manhour
- Reject rate—% pieces or % kg rejected
- Fulfillment of production aims.

All in all, the current system of production cost accounting at the Workshops Department is considered well equipped, with active use made of computer, and based on well-established cost accounting procedures.

Table 2.5.7-1 Cost Centers of Workshops Department

COST CENTER No.	COST CENTER DESIGNATION ENGLISH	SPANISH
650	Workshop Superintendent	Superintendencia Talleres
651	Quality Control & Product Development	Control de Calidad y Desarollo Productos
652	Production Control	Control de Produccion
655	Control & Programming	Control y Programacion
660	Foundry Shop - General	Fundicion General
662	Patternmaking	Modeleria
664	Sand Preparation	Preparacion de Arenas
666	Coremaking	Confeccion de Almas
668	Furnace Charge Preparation	Preparacion de Cargas Hornos
670	Melting	Fusion
672	Molding & Shaking Out	Moldeo y Desmoldeo
674	Heat Treatment - Foundry	Tratamientos Termicos - Fundicion
678	Finishing	Limpia
680	Workshops - General	Maestranza General
683	Workshop No. 1 - Repairs	Maestranza # 1 - Reparaciones
684	Workshop No. 2 - Rancagua	Maestranza # 2 - Rancagua
686	Workshop No. 3 - Plate Shop	Maestranza # 3 - Caldereria
687	Heat Treatment - Fabrication Shop	Tratamientos Termicos - Mecanicos
688	Jig/Tool Preparation	Preparacion Herramientas
689	Maintenance Service	Servicios Mantencion
699	Calcination Plant	Planta de Calcinacion

Table 2.5.7-2 Cost Elements of Workshops Department

	ENGLISH	SPANISH
1.	Labor	Mano de Obra
	Base wages/salaries	Sueldo/Salario Base
	Overtime	Sobretiempo
	Triennial allowance	Trianos
	Special assignments/bonus	Asignaciones y Bonos
	Production incentive	Bono de Produccion
	Retirement premium etc.	Proviciones-Indemnizacion, *Aguinaldos etc.*
	Social security contribution	Leyes Sociales
2.	Materials	Materiales
	Primary materials	Materials primas
	Fuel	Combustibles
	Spare parts	Repuestos
	Other materials	Otros Materiales
3.	Other expenses	Otros Gastox
	Subcontracted services	Servicios por Terceros
	Telecommunications	*Comunicaciones - Telefono y Telex*
	Printing, reproduction	Publicacione y Impresos
	Welfare	Otros Beneficios al Personal
	Miscellaneous expenses	Gastos Varios
4.	Indirect expenses	
	Maintenance/repair of buildings/equipment	Mantencion y Reparacion - Maquineria , Edificios
	Service personnel	Equipo de Servicio
	Electric power	Energia Electrica

2.6 Organization and Personnel Management

2.6.1 Overall Organizations and their Functions

1) Organization

The workshops belonging to the service department of Div. E1 Tenlente, having 515 employees, which are equivalent to approx. 6% of total employees of the entire division, performs important duties of manufacturing and repairing of mine facilities. Total 31 engineers specialized in machinery and metal engineering are assigned to the workshops, 24 persons out of these employees are college-graduated engineers and the remaining 80% are technical school graduated specialists, forming a think tank of the workshops.

The workshops comprise Production Planning, Quality Control, and Production Departments, and Calcification Shop. Design, Personnel, Procurement, Financial and Engineering Departments are centrally controlled as the operation division to provide services to the workshops as necessary.

The detailed organization chart of Workshops Department is shown in Figure 2.6.1-1 and number of persons by department in Table 2.6.1-1.

2) Functions

Duties of respective departments are as shown below.

(1) Superintendent

Under the direction of the assistant general manager of the service department of Div. E1 Teniente, controls Workshops Department with the sole responsibility for manufacturing and repairing casted products and steel plate products demanded by the production department of the division. Also, has the sole responsibility to Div. E1 Teniente and other mines for supply of line.

a) Staff Attached to Superintendent (In Charge of Future Program)

Is in charge of development project accompanying investment, training program and safety program for the purpose of partially relieving burdens imposed on the line and smoothing the entire shop operation.

b) Staff Attached to Superintendent (In Charge of Delivery Control)

Services as the window for orders from CODELCO and other divisions, and performs sales promotion of shop products. Also, serves as the engineer to grasp needs of various divisions and to perform the follow-up of using state (evaluasion) of products.

(2) Production planning department

This department directly supports the shop operations and provides information to Superintendent and the manager of Production Department. This department consists of the following sections:

a) Production control section

Based on orders from Div. El Teniente and other divisions, issues production orders to Production Department.

: Grasps daily production state of all shop sections through the computer system.
: Issues standard costs, budget, etc.

b) Computer section

: Manages the computer system used in shops.
: Manages raw materials, materials, spare parts and fixed assets.

c) Accounting section

: Manages the shop accounting system.
: Decides original units for cost calculation and prepares their tariff.
: Prepares annual budget, checks and analyzes monthly state of budgetary consumption.

(3) Quality control department

This department performs not only quality control of each stage of production process but also management of raw materials and purchased products. This department consists of the following sections:

a) Inspection section

Performs inspection of production processes in the foundry shop and process shop. This section not only inspect completed products but also performs in-process inspection during production processes.

b) Analysis section

(a) Chemical analysis

: Chemical analysis of raw materials
: Initial and final chemical analyses of molten metal
: Chemical analysis of products

(b) Metallic analysis

: Analysis of mechanical and metallic characteristics (tension, compression, bending, hardness, etc.) of products

(c) Non-destructive inspection

: X-ray transmission test of products in thickness up to 12″.
: Ultrasonic test
: Magnetic-particle test
: Liquid penetrant test

c) Production engineering section

This section examines optimum materials, design and production method for castings to be newly produced, and then, manufactures them on an experimental base to find out the optimum method for mass production.

(4) Production department

This department is responsible for execution of production programs and controls machining, assembling, facilities maintenance and carrying of products in addition to the foundry and plate shops which are the subjects of the moderninzation program.

a) Foundry and plate shops

Described in detail in 2.6.2.

b) Repair shop

This shop is in charge of assembly of repaired machines and repair of mining machines. This shop is adjacent to the workshop site.

c) Machine shop

This shop performs the machining of parts manufactured and repaired by the production and repair shops. This shop is now under modernization with a Machining Center introduced.

d) Maintenance section

This section has two functions; one is to perform maintenance and inspection of machines and control power plants in respective shops, nd the other is to perform transportation, materials receiving and unloading, and loading of final products for shipment in Div. E1 Teniente. However, management of electricity and buildings is under the control of Div. E1 Teniente.

(5) Lime calcination shop

This shop is a branch shop situated at a location 10 km south of Rancagua and is producing 75,000 ton of 75% CaO. The shop is operated in three shifts a day for 320 days per year.

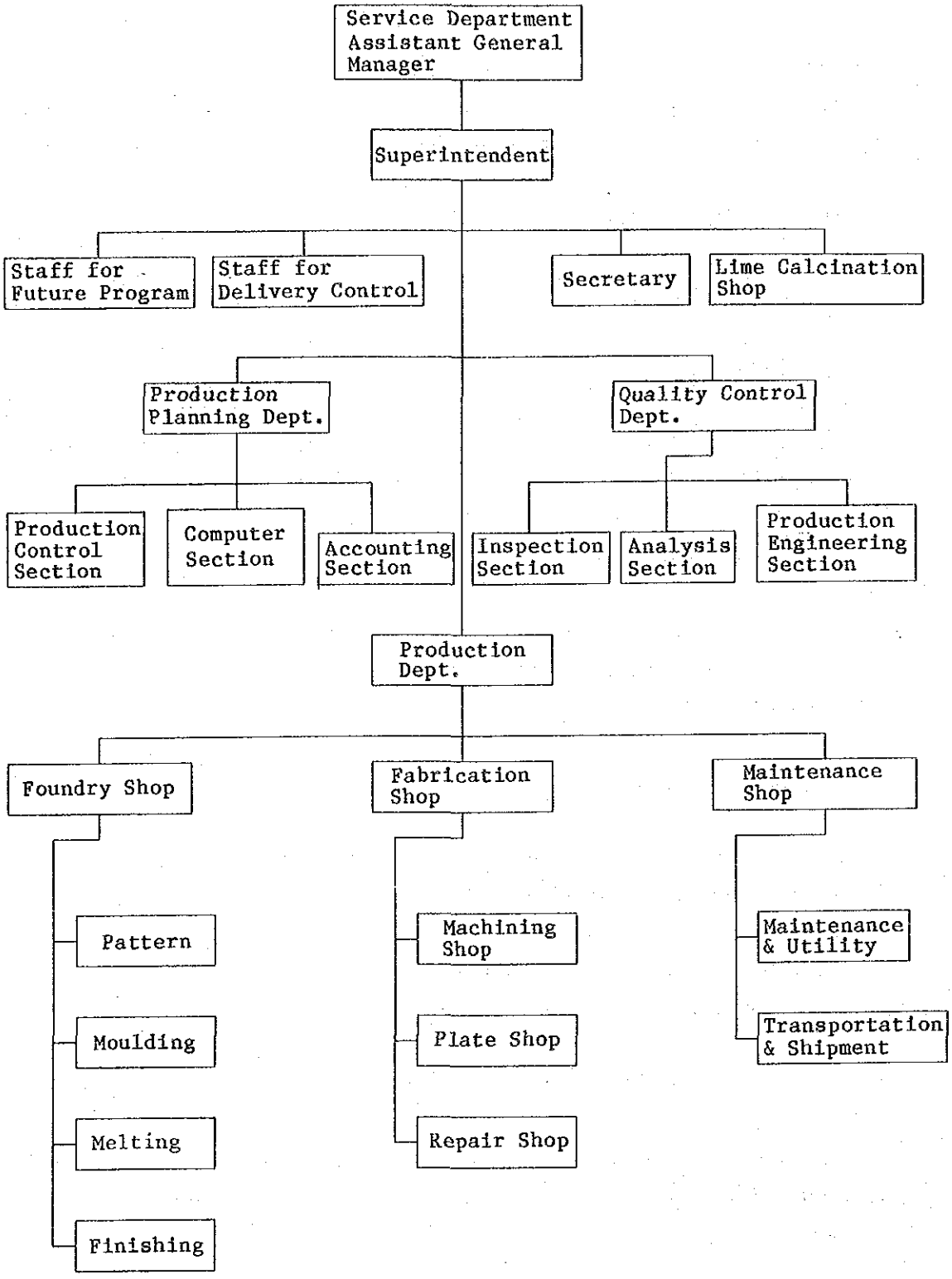


Figure 2.6.1-1 Workshops Department's Detailed Organization Chart

Table 2.6.1-1 Workshops Department's Manning Table

	Manager Engineer	Clerk Specialist	Worker	Total
Superintendent & Staff	3	2	0	5
Calcination Shop	2	9	7	18
Production Planning Dept.	4	15	0	19
Quality Control Dept.	5	14	4	23
Production Dept.	1	1	0	2
Foundry Shop	6	55	102	163
Fabrication Shop	8	140	86	234
Maintenance Shop	2	28	21	51
Total	31	264	220	515

2.6.2 Organization Charts & Personnel Deployment

1) Foundry shop

The functional organization and staffing of Foundry Shop of Production Department are as shown in Figure 2.6.2-1. Further, the manning table by occupation is shown in Table 2.6.2-1. As to their functions, the pattern shop performs planning of the pattern manufacturing design cnsidering a moulding system to be applied based on drawings, drafting, pattern manufacturing, pattern inspection and storage of patterns.

The moulding shop is divided into the manual moulding and mechanical moulding. Mulling of mounding sands is also under the control of this shop. This shop performs moulding and pouring, and turns castings over to the finishing shop.

The melting shop supplies molten metals in quality demanded chiefly by electric furnaces. This shop also performs repair of refractory materials of ladles and melting furnaces in addition to melting and supply of molten metal.

The finishing shop performs such works as shaking-out, cutting of riser, sprue, etc., cleaning of castings by shot blasting, finishing with a grinder, heat treatment, etc. and finishes castings as final products.

The casting department is consisting of 3 basic departments; moulding, melting and finishing, and the pattern manufacturing shop is added. The moulding, melting and finishing departments are staffed with 142 employees and when employees assigned to the pattern department are added, the total staffing is 161 employees.

At present, the operation is performed partially in three shifts at the melting shop and finishing shop, and partially in two shifts at the moulding (mechanical moulding) and finishing shops. The pattern manufacturing shop is operated in a single shift.

When the current staffing and output (380 ton/month) are considered, it seems that this shop still has a sufficient production capacity on the whole.

Productivity of the moulding shop is not so high. At present, the moulding machines are not fully operated. One of the causes will be that a pertinent production model and production quantity have not been timely programmed.

The melting operation is performed in three shifts and therefore, even when output is loss, minimum number of workers is required but production efficiency should be raised by increasing output.

The finishing shop is considered to be able to sufficiently digest workload with current staffing. However, deteriornation as well as low efficiency of currently equipped machinery and facilities and considerably
large manpower requirement for conveyer lines are problems to be solved.

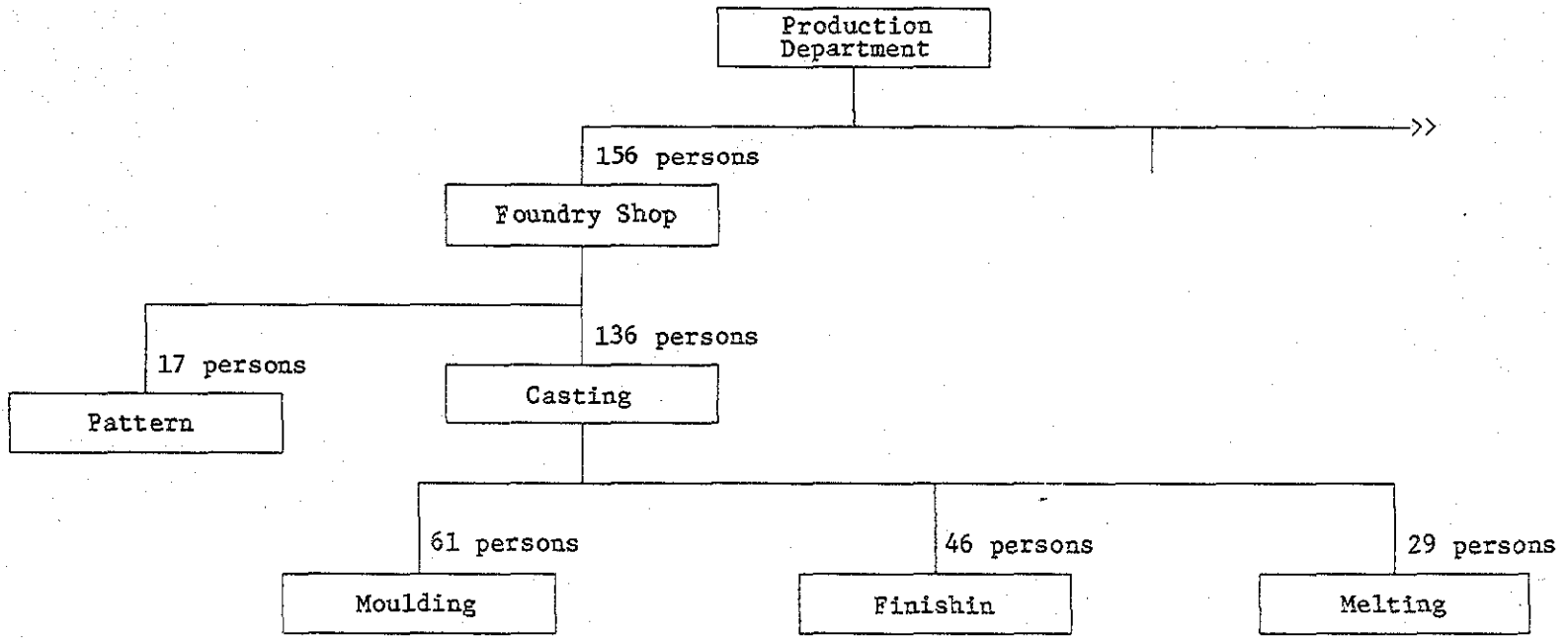


Figure 2.6.2-1 Foundry Shop's Organization Chart

Any engineering groups as the foundry shop or production department are not seen in the organizational structure. It is considered advisable to establish the engineering groups for engineering management at production sites separately from the quality control or development department in the future and provide the function to allow flexible and speedy handling of various matters in connection directly with job sites by incorporating job site engineering groups directly under the production lines.

Table 2.6.2-1 (1/2) Foundry Shop's Manning Table by Occupation

Unit: Number of Persons

		Indirect			Direct
		Engineer Technician	General Clerical	Worker	Worker
Common	Section Chief	1			
	Assistant Section Chief	1			
	Secretary		1		
	Subtotal 3	2	1	0	0
Pattern Manufac-turing Shop	Unit Chief	1			
	Foreman			1	
	Pattern Maker: Maestro				8
	Pattern Maker: Modelista				1
	Pattern Maker: Carpintero				4
	Warehouseman			1	
	Oddman			1	
	Subtotal 17	1	0	3	13
Moulding Shop	Unit Chief (Engineer)	2			
	Foreman			2	
	Moulder: Maestro A				2
	Moulder: Maestro B				5
	Moulder:				6
	Moulder: Moldeador				14
	Moulder: Apprentice				12
	Core Moulder				6
	Sand Process Worker			2	
	Core Sand Process Worker			1	
	Sand Slinger Operator				1
	Moulding Machine Operator				4
	Core Moulding Machine Operator				1
	Welder			1	
	Mould Drying Furnace Operator			1	
	Process Expediter			1	
	Subtotal 61	2	0	8	51

Table 2.6.2-1 (2/2) Foundry Shop's Manning Table by Occupation

Unit: Number of Persons

		Indirect			Direct
		Engineer Technician	General Clerical	Worker	Worker
Melting Shop	Unit Chief	2			
	Foreman (tecnico)	1			
	Melting Worker (Electric Furnace Worker)				5
	Melting Worker				5
	Ladle Preparing Worker				2
	Material Preparing Worker				2
	Oddman (Materials Preparation)				2
	Tractor Operator			1	
	Crane Operator			9	
	Subtotal 29	3	0	10	16
Finishing Shop	Unit Chief	1			
	Foreman (Tecnico)	4			
	Shake-out Worker				2
	Cutting Worker				3
	Welder				4
	Grinding Worker				17
	Shot Blasting Worker				6
	Heat Treatment Worker				4
	Process Expediter			2	
	Hoist Operator			3	
	Subtotal 46	5	0	5	36
	Total 156	13	1	26	116

2) Plate shop

The functional organization chart with staffing of the plate shop is shown in Figure 2.6.2-2 and the manning table by occupation in Table 2.6.2-3.

The plate shop is staffed with total 92 persons consisting of total 76 persons including one section chief and 2 unit chiefs with 16 external welders. Two unit chiefs take night duty alternately as the night work is partially performed.

The plate unit is divided into 3 groups of forging, mounting and welding works according to products to be produced and by occupation.

- The forging group is staffed with 6 workers and produces wire nets, reinforcing bolts and liner fixing bolts.
- The fitters group is responsible for marking of iron sheets, gas cutting, mechanical cutting, bending, mounting in partially two shifts with total 43 workers (newly purchased Eye Tracer work only). The group is further divided into small groups each of which consists of one skilled plate worker or general plate worker and one apprentice, total 2 workers. The gas cutting work is one of the basic works for accuracy maintenance and requires special technique when compared with the general fitting work. Though its workload is less for assigning specialized workers, anyone should not be allowed to perform the gas cutting, but certain persons should be appointed for this work.
- Next, the welding work, which is the prime target of this modernization program, is currently under the full operation with 19 regular workers and 16 external workers, total 35 workers in three shifts. Almost all of these 16 external workers have poor skill, which is one of factors for production impediment. From this sense it is also necessary to modernize welding process to improve productivity, thus realizing the working environment requiring no subcontract workers.

In addition to the above, 2 crane workers, 2 worehousemen and one clerk for general affairs are performing control of drawings, checking of workload, etc. as the staff serving commonly to these 3 groups.

Three foremen of these 3 groups are all college-graduated engineers and when the section chief and unit chiefs are included, college- graduated engineers are total 6 persons. It may be generally said to be luxurious for such a plate shop as this shop to have 6 college-graduated engineers (technical positions). However, there are certain conditions found on some products in process at this shop as if there is no engineer assigned. (Refer to 2.5 for definite examples.) Strictly speaking, it cann't but think that 6 engineers including Section Chief are employed only as head of production lines. It is strongly advisable to use capacity and capability of these engineers more efficiently aiming at improvement of the workshop.

Further, there is no job classification for handling current drawings in this shop but it is included in the duty for a person in charge of design in the engineering department of the division.

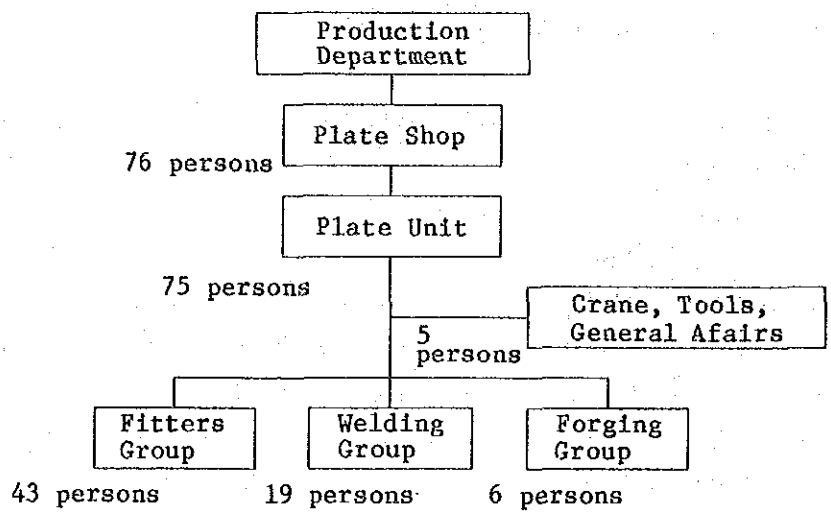


Figure 2.6.2-2 Plate Shop's Functional Organization Chart and Staffing

Table 2.6.2-3 Manning Table by Occupation

		Indirect			Direct
		Engineer Technician	General Clerical	Worker	Worker
Section Chief		1			
Unit Chief		2			
Foreman		3			
General Affair Clerk			1		
Warehouseman				2	
Crane Worker				2	
Mechanic					8
Forging Worker					3
Fitters	Skilled				6
	Ordinary				9
	Apprentice				19
Welder	Skilled				12
	Ordinary				6
Printer					2
Total		6	1	4	65

Grand Total: 76

2.6.3 Working conditions

Data on working conditions are assembled in Table 2.6.3-1.

The Patternmaking and Finishing Processes operate on 2 shifts; Melting and Heat Treating Processes on 3 shifts. An average of 266 days are worked in a year, and 200 hours in a month. The average age of employees is 42 in the Workshops, the rate of absence 17.6%, including leave, sickness, accident, and absence for personal reasons. The age limit is 65.

Table 2.6.3-1 Working Conditions at Workshops

1. Number of peronnel by work time zone

WORK TIME ZONE	DAYS	NUMBER OF PERSONNEL
23.00 - 7.00	Mon. - Sat.	10
7.00 - 15.30	Mon. - Fri.	and
7.00 - 12.30	Saturday	134
15.30 - 24.00	Mon. - Fri.	and
12.30 - 18.00	Saturday	117
7.00 - 16.36	Mon. - Fri.	199
8.00 - 17.36	Mon. - Fri.	4

2. Average hours worked per month; days worked per year

Average hours worked per month : 200 hours/month
Average number of days worked per year: 266 days/year

3. Average overtime worked per month

WORKSHOP	OVERTIME WORKED (h/pers.)	AVER.O.T./EMPLOYEE
Foundry	408	2.7
Plate	1,001	11.4
Machine	329	3.7
Maintenance service	244	7.0
Total	3,066	6.6

4. Average employee age, absence from work

SHOP	NUMBER OF EMPLOYEES	AVERAGE AGE	TOTAL NUMBER OF HOURS ABSENTED	ABSENCE RATE
Foundry	150	46	59,466	18.6
Plate	89	44	41,578	19.0
Machine	88	42	27,452	14.9
Maintenance service	35	42	15,258	16.3
Total	466	42	188,598	17.6

5. Age limit : 65.

Source: Workshops Department