FOREWORD

Accepting a request from the Government of the Republic of Korea, the Japanese Government decided to conduct a fundamental investigation and study for the improvement of railroad backshops for the Korean National Railroad as one segment of the railroad modernization project now being planned by the Government of the Republic of Korea, and entrusted this investigation to the Overseas Technical Cooperation Agency. The Agency formed a Study Team consisting of seven members with Mr. Takeji HAYASHI, Managing Director, Japanese National Railways, serving as the Team Leader and sent the group to the Republic of Korea from November 21 to December 12, 1966 to make the required study. This Report contains the results of the Study Team's trip.

This Report contains not only the team's proposals for the construction of railroad backshops, but long-range proposals for amalgamating and improving existing railroad backshops and for building a new workshop. Our forecast of the future traffic demands envisaged for the Korean National Railroad is based on the long-range forecast of development of the economy of the Republic of Korea, the estimated number of railway rolling stock required, and the necessity of maintenance and future modernization of rolling stock as well as the overall relation between the rolling stock base project and the railroad backshop construction plan. It will give us great pleasure if the present Report can serve to improve railroad backshops as well as aid the overall modernization of the railways of the Republic of Korea, and thus can contribute to further deepening the friendly relations existing between the two countries as well as accelerating trade relations.

Lastly, taking this opportunity, I should like to thank the members of the team entrusted with conducting this significant investigation and, at the same time, to express my heartfelt appreciation to those of the Government of the Republic of Korea, the Korean National Railroad and the Japanese Embassy in Korea, who have kindly extended cooperation and assistance to the Study Team in the Republic of Korea and to those of the Japanese

Ministry of Foreign Affairs, Ministry of Transportation and Japanese National Railways who cooperated in dispatching the team, as well as to the Japan Railway Technical Service which has aided us in preparing this Report.

March 1967

Shinichi SHIBUSAWA
Director General
Overseas Technical Cooperation Agency

CONTENTS

Abbreviations used in this Report

SL	.....	Steam locomotive
DL	.....	Diesel locomotive
DC	.....	Diesel railcar
PC	.....	Passenger car (pulled by locomotive)
FC	.....	Freight car (" " ")

INTRODUCTION

1. Purpose of the study

This Report contains our recommendations to the Government of the Republic of Korea prepared at the request of that Government, concerning suggestions for the improvement and construction of railroad backshops for the Korean National Railroad based on the results of the thorough investigation conducted by the Study Team dispatched to the Republic of Korea by the Overseas Technical Cooperation Agency.

2. Composition of the Study Team

The Study Team was composed of the following personnel:

Team Leader:	Mr. Takeji HAYASHI,	Managing Director, Japanese National Railways
Members:	Mr. Shigeru OMORI,	Superintendent, Omiya Workshop, JNR
:	Mr. Tsuneo SANO,	Deputy Director, Rolling Stock & Mechanical Engineering Dept., JNR
:	Mr. Akira HORIUCHI,	Asst. Chief, Building Section, Maintenance Dept., JNR
:	Mr. Katsutoshi NAKAMURA,	Asst. Chief, Administration Section, Rolling Stock & Mechanical Engineering Dept., JNR
:	Mr. Takashi NAGANO,	Asst. Chief, Foreign Dept., JNR
:	Mr. Tatsuo SHIMIZU,	Overseas Technical Cooperation Agency

3. Itinerary of the Study Team

The Study Team arrived in Seoul on November 21, 1966 and made the required investigations and studies in the Republic of Korea for 22 days until December 12. Mr. T. Hayashi, the Team Leader, however, returned home on November 29th after deciding the basic policies of the study for the Study Team.

The Study Team first heard from the related officials of the Korean National Railroad. They were briefed on the Second 5-year Economic Plan as well as the present status and furure plans of the Korean National Railroad, and received necessary data for the investigations and studies to be made. After that, the Study Team visited the existing Seoul, Yongdungpo, Pusan and Inchon railroad workshops, as well as various car bases such as the ones at Susaeg, Cheongryangri and Yongsan to inspect their present condition. The Study Team then went to the Taejon area, the construction site of the projected new railroad workshop, to inspect the area's topography, locational conditions, etc. After completing these field observations, the Study Team evaluated the results of the preceding investigation and prepared an intermediate report which was submitted to the Republic of Korea.

This is the final report prepared by the Overseas Technical Cooperation Agency based on the studies made by the team during their investigations.

CHAPTER I

GENERAL DESCRIPTION

CHAPTER I. GENERAL DESCRIPTION

The economy of the Republic of Korea has shown remarkable progress in recent years, the Gross National Product (GNP) registering an annual average increase of 5.9% in the last 12 years. In the last five years, gains have registered an average increase of 7.6%. Encouraging this economic expansion, the Government of the Republic of Korea has set up, following the first 5-year economic plan carried out during the period 1962-1966, a second 5-year economic plan for 1967-1971 aiming at an annual average expansion of 7%. The plan is well under way at present. In addition to the above, the Government is now preparing another long-range plan which will end in 1981 envisioning an increase in the GNP of about three times and a doubling of the total national per capita income over the present level. These goals can be realized by developing the national economy by an average of 7% per year.

Reflecting this sharp expansion in the national economy, the traffic demand on the Korean National Railroad, taking care of as much as 45% and 90% of the total national passenger and freight traffic respectively, has made rapid strides recently, registering an annual average increase of 10.8% and 13.3% respectively in passenger and freight traffic over the past 5 years. It is expected that passenger and freight traffic on the Korean National Railroad will increase steadily from now on, reaching 13,218 million passenger-km (an increase of 63%) and 9,425 million ton-km (an increase of 64%) by 1971, the goal year of the present 5-year plan, and 20,022 million passenger-km (an increase of 146%) and 18,900 million ton-km (an increase of 228%) by 1981.

To answer this expected increase in traffic demands, the Korean National Railroad has set up a new 5-year plan for increasing its transportation capacity, with a total expected expenditure of 64,715 million Won, to be used for constructing new railroad lines, increasing line and station track capacities, improving tracks and structures and introducing new rolling stock. The plan is now well underway. However, it is noteworthy

that as much as 45% of the total expected funds are being directed toward increasing and improving rolling stock. Therefore, it is of foremost importance that the Korean National Railroad increase and improve its car bases and railroad workshops to take care of the inspection and repair of this increased rolling stock.

At present, the Korean National Railroad has four railroad workshops; at Seoul, Pusan, Yongdungpo and Inchon. With the exception of Inchon where new cars are manufactured, these workshops are engaged in the inspection and repair of the whole fleet of rolling stock now owned and operated by the Korean National Railroad, which numbers 261 SL's, 173 DL's, 153 DC's, 10 narrow-gauge DC's, 1,380 PC's and 11,403 FC's, and the manufacture and repair of various railroad supplies.

However, the average facilities at these workshops are superannuated and are already working at full capacity thus leaving no surplus capacity to take care of the additional new rolling stock which are expected to be rapidly put into service. Therefore, it is necessary to set up and carry out a drastic improvement plan as soon as possible.

Among the three railroad workshops mentioned earlier, the two workshops at Seoul and Yongdungpo are especially outmoded and, in addition, would be very difficult to enlarge. Consequently, it is expected that a large investment would be required for their overall improvement. Therefore, we are of the opinion that it will be very disadvantageous, from an economic view point, to improve these two railroad workshops at their present sites.

As far as the Seoul Workshop is concerned, it would seem more effective, from the standpoint of city planning for the Seoul Special City area, to improve the existing Seoul Station and use it as the central passenger station, and enlarge the existing Yongsan Freight Station and use it as the freight center for the Seoul area. Therefore with future developments in mind, it is considered most appropriate to move the Seoul Workshop out of the city center of Seoul.

Considering the Railroad Workshop Improvement Plan, and taking into consideration these various conditions, it is considered most effective and appropriate, from the point

of view, among others, of the improvement of major factories now being built by the Republic of Korea Government, to build a new railroad workshop, equipped with modern facilities, in the Taejon area, located in the geographic as well as transportation center of the Republic of Korea and on land that could be acquired easily. This new workshop would replace the existing Seoul and Yongdungpo Workshops (both of them to be abolished). It is planned to keep the Inchon Railroad Workshop, specializing in the manufacture of rolling stock, and the Pusan Railroad Workshop, located at the southern tip of the country and equipped with new facilities, intact as they are now.

For the inspection and repair of rolling stock converging in the Seoul area with its heavy transportation density, it is necessary to strengthen the car bases for light maintenance and repair of rolling stock by consolidating existing locomotive offices and passenger car and freight car offices located in this area into conveniently located Susaeg and Cheongryangri, and to establish there rolling stock inspection and repair facilities capable of making replacement of major rolling stock parts and light rolling stock repairs.

CHAPTER II

PRESENT STATUS OF KOREAN NATIONAL RAILROAD

CHAPTER II. PRESENT STATUS OF KOREAN NATIONAL RAILROAD

2.1 General description

All the railways in the Republic of Korea are owned and operated by the Korean National Railroad, which was separated from the Ministry of Transportation in September 1963, and now is serving as a subsidiary organ of that organization.

The Korean National Railroad consists of five Bureaus: the Transportation Bureau, Engineering Bureau, Mechanical & Electricity Bureau, Finance & Accounting Bureau and Supply Bureau. All function under the General Manager and Assistant General Manager and together make up the Head Office of the Korean National Railroad. Concerning local organs, there are altogether five Railroad Divisions: at Seoul, Taejon, Pusan, Sunchon and Yongju; and four Railroad Workshop: at Seoul, Pusan, Yongdungpo and Inchon. In addition, there are several other local organs such as the Railroad Construction Bureau.

As of 1965, there has been a total of 2, 980 operating km of railways with a total of 535 stations (including 146 simple stations), which are operated by a total of 29, 695 employees. Almost all the railway lines are single-track lines except for the Kyongu Line (445.6 km) and Kyongin Line (38.9 km). In addition, there are two narrow-gauge lines, the Suin Line and Su Yen Line which total 131 km. The average station-to-station distance is 5.7 km, or 40% over the corresponding figure for the Japanese National Railways, meaning that the Korean National Railroad is in a more advantageous position for the transportation of passengers and freight than JNR. But, at the same time, it is forced to keep its track capacity at a quite low level, especially on its single-track sections.

The traffic carried by the Korean National Railroad in 1966 is estimated to amount to 131, 890, 000 passengers or 8, 128, 000, 000 passenger-km (average distance of trip 61.68 km) and 25, 860, 000 tons or 5, 756, 000, 000 ton-km of freight (average distance of shipment 223 km). These figures indicate that the Korean National Railroad is carrying 45.9% of the total national passenger traffic in passenger-km and 90.3% (1965) of the

total national freight traffic in ton-km. Distribution of the total national passenger and freight traffic among various types of means of transportation in recent years is as shown in Table 2.1 and Table 2.2, which indicate that, although traffic by means of transportation other than railways is gradually increasing, the railway is still carrying a major part of the total national traffic; and that, when the facts that the average distance of movement of passenger and freight traffic is comparatively long and that there is no good sea-port in the Republic of Korea are taken into consideration, it is reasonable to judge that this trend — domination of railways — can be expected to continue for a considerable number of years.

Furthermore, traffic on the Korean National Railroad has been and is increasing steadily — by an annual average of 10.0% for passengers and 15.5% for freight for the last 12 years, or by 10.8% for passengers and 13.3% for freight for the last 5 years, far surpassing the development of GNP (by 5.9% for the last 12 years and 7.6% for the last 5 years). To cope with such a sharp increase in passenger and freight traffic, the transportation capacity of the Korean National Railroad, too, has been and is being increased as illustrated in Fig. 2.1, showing development of transportation capacity in the converted car-km and the total passenger-km.

To handle such traffic as indicated above, the Korean National Railroad holds various assets amounting to a total of 76,447 million Won as shown in Table 2.3.

Table 2.1 Change in the relative importance of various means of transportation (passenger-km)

(in million psgr.-km)

Year	Railway	Road	Ship	Air	Total
1960	4,935 (52.2)	4,344 (46.0)	147 (1.6)	21 (0.2)	9,447 (100)
1961	5,372 (53.0)	4,617 (45.5)	136 (1.3)	18 (0.2)	10,143 (100)
1962	5,869 (51.1)	5,461 (47.5)	154 (1.3)	15 (0.1)	11,499 (100)
1963	6,676 (49.7)	6,571 (48.9)	172 (1.3)	28 (0.2)	13,447 (100)
1964	7,353 (52.3)	6,459 (46.0)	195 (1.4)	58 (0.4)	14,065 (100)
1965	6,917 (45.7)	7,975 (52.6)	182 (1.2)	72 (0.5)	15,146 (100)

Note: Figures in parenthesis indicate percentage to total.

Table 2.2 Change in relative importance of various means of transportation (freight ton-km)

(in million ton-km)

Year	Railway	Road	Ship	Air	Total
1960	3,283 (89.5)	362 (9.9)	24 (0.7)	0.1	3,669 (100)
1961	3,486 (90.7)	323 (8.4)	32 (0.8)	0.1	3,841 (100)
1962	3,977 (90.1)	388 (8.8)	45 (1.0)	0.1	4,410 (100)
1963	4,358 (90.4)	429 (8.9)	36 (0.7)	0.2	4,823 (100)
1964	4,522 (89.1)	511 (10.1)	40 (0.8)	0.4	5,073 (100)
1965	5,044 (90.2)	503 (9.0)	39 (0.7)	0.6	5,587 (100)

Note: Figures in parenthesis indicate percentage to total.

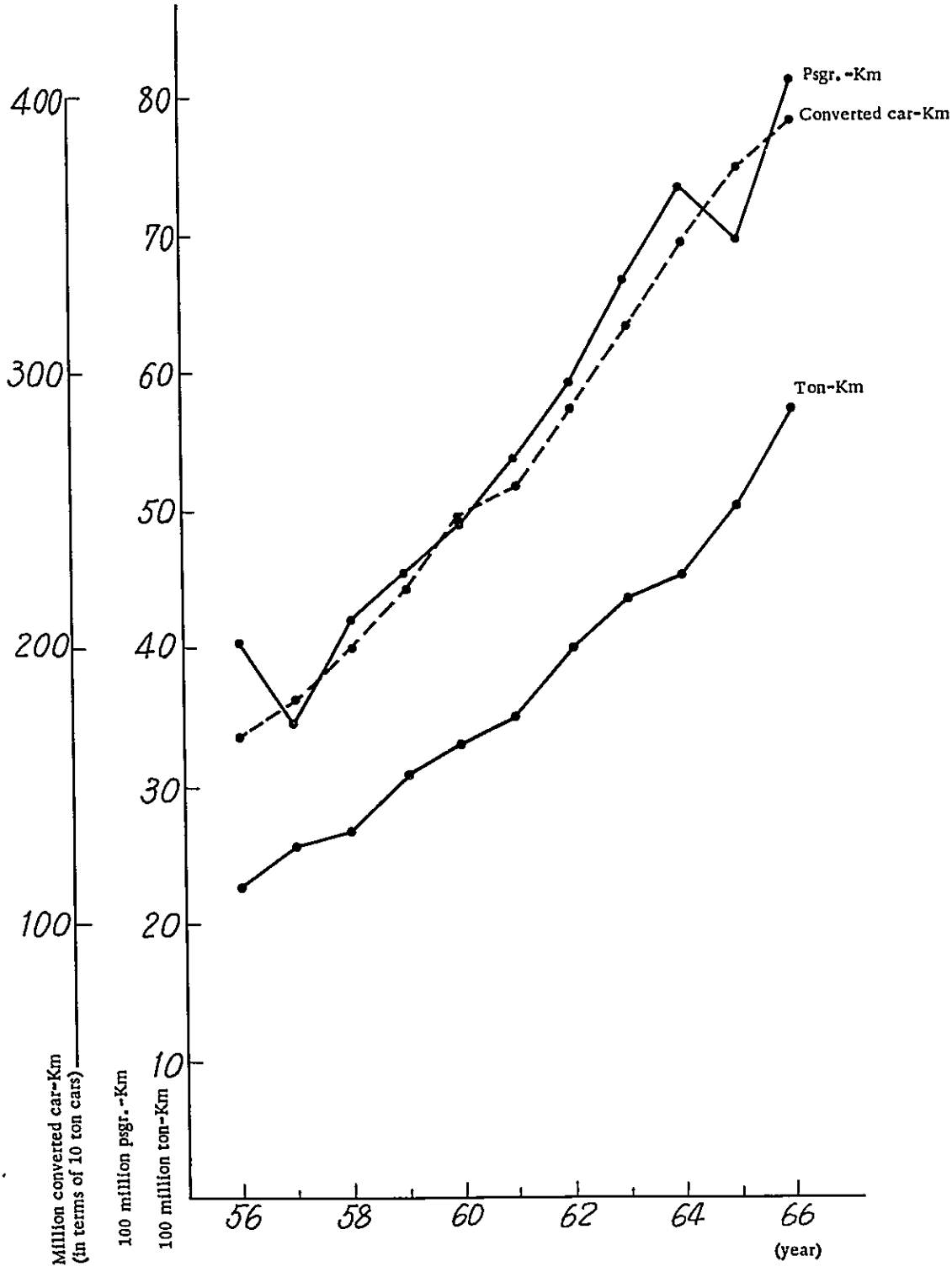
Table 2.3 Assets owned by Korean National Railroad

(in million Won)

Land	15,636 (20.5)
Buildings	2,336 (3.1)
Track & structures	38,870 (50.8)
Signal, tele-communication and electric-power facilities	4,300 (5.6)
Mechanical facilities	1,002 (1.3)
Rolling stock	14,278 (18.7)
Office equipment	25 (-)
Other assets	0.3 (-)
Total	76,447 (100)

Note: Figures in parenthesis represent percent against total.

Fig.2.1 Development in passenger-Km, ton-km and converted car-km



Among these assets held by the Korean National Railroad, railway rolling stock is as listed below. Dieselization is being pushed actively now, and about 45% of all the rolling stock holding had been dieselized by the middle of 1966 and it is expected that steam locomotives will totally disappear from the Korean National Railroad by 1968.

Motive power		Passenger and freight cars	
SL	261	PC	1, 380
DL	173	FC	11, 403
DC	153		

(as of December 1966)

2.2 2nd 5-Year Plan

As has been introduced in the foregoing section, following the 1st 5-year plan carried out from 1962-1966 to cope with the increasing traffic, the 2nd 5-year plan was prepared and put into effect for 1967-1971 aiming, among other goals, at expanding track capacity of major trunk lines; modernizing track facilities; strengthening train operation safety; modernizing motive power (completing dieselization); expanding and improving marshalling yard and car base facilities; accelerating replacement of worn-out rolling stock and ground facilities; and constructing the Saun Eub Line. Among these, foremost importance is being placed on the expansion of traffic capacity on the Chungang Line, Honam Line, Yongdong Line and Kyungbug Line. For these reasons, among the items covered by the current 5-year plan, first priority is given to the increasing of rolling stock and as much as 45% of the total budget for the plan is appropriated to the introduction and construction of new rolling stock.

Table 2.4 Fund appropriations for 2nd 5-year plan (for KNR)

Item	Domestic fund (million Won)	Foreign fund (thousand $)	Total in Won (million Won) (%)
1 Construction of new lines	4, 832	4, 869	6, 124 (9.5)
2 Improvement and additioning of yard & track capacities	10, 971	5, 204	12, 355 (19.1)
3 Improvement of track & structures	5, 816	11, 342	8, 825 (13.6)
4 Introduction & building of new rolling stock	18, 898	39, 109	29, 276 (45.3)
5 Rolling stock maintenance & manufacturing facilities	1, 387	6, 343	3, 071 (4.7)
6 Other facilities	631	1, 529	1, 031 (1.6)
7 Reserve fund	2, 169	7, 000	4, 027 (6.2)
Total	44, 704	75, 396	64, 709 (100)

CHAPTER III

THE LONG-RANGE PLAN FOR THE KOREAN NATIONAL RAILROAD

CHAPTER III. THE LONG-RANGE PLAN FOR THE KOREAN NATIONAL RAILROAD

3.1 National Economic Plan and the outlook for the future

The development of the economy of the Republic of Korea has been very conspicuous, as indicated by the GNP, registering an annual average increase of 5.9% in the last 12 years and of 7.6% in the last 5 years. In an effort to continue this sharp development in the national economy still further, the Government of the Republic of Korea, with its Economic Planning Board acting as the central organ, has set up the 2nd 5-year plan (1967-1971), following the 1st 5-year plan (1962-1966) which has just been completed. Further, the Government of the Republic of Korea is now mapping out a now active economic plan aiming, as its main objective, at increasing her GNP by an annual average rate of 7% by 1981, when the plan is completed. Outline of this plan is as shown in Table 3.1.

Table 3.1 Future economic outlook

Item	1965	1971	1976	1981	Average rate of increase (1965-1981)
Total population (in thousands)	28,377 (100)	37,429 (114)	35,710 (126)	39,224 (138)	2.0
GNP (in billion Won)	779 (100)	1,159 (149)	1,625 (208)	2,279 (293)	7.0
Civil consumption (in billion Won)	646 (100)	836 (129)	1,108 (172)	1,488 (230)	5.4
National income per capita (Won)	27,466 (100)	35,732 (130)	45,511 (166)	58,113 (213)	4.8
Civil consumption per capita (Won)	22,764 (100)	25,777 (114)	31,029 (136)	37,936 (167)	3.2

Note: Figures in parenthesis are index with 1965 as 100.

During these years, agriculture, forestry and fishery are expected to dwindle gradually, mining and manufacturing to increase, and the increased population is expected to become more concentrated in urban areas. Large cities, especially such as Seoul and Pusan, are expected to increase in population to over twice their present figures. (Fig. 3.1)

Table 3.2 Population and Employment

(in millions)

Item	1966	1971	1976	1981	Remarks
Total population	29.1 (100)	32.4 (111)	35.7 (122)	39.2 (134)	Annual increase by 2%
City population *	9.3 (100)	11.7 (126)	14.6 (157)	18.0 (194)	
Country population (Agr. & forestry)	19.8 (100)	20.7 (105)	21.1 (107)	21.2 (107)	
Employment population	9.5 (100)	10.9 (112)	12.9 (136)	13.9 (146)	Annual increase by 2.5%
Ratio of employment population (%)	32.6	33.6	34.2	35.5	

Note: * ... Cities with population over 50,000

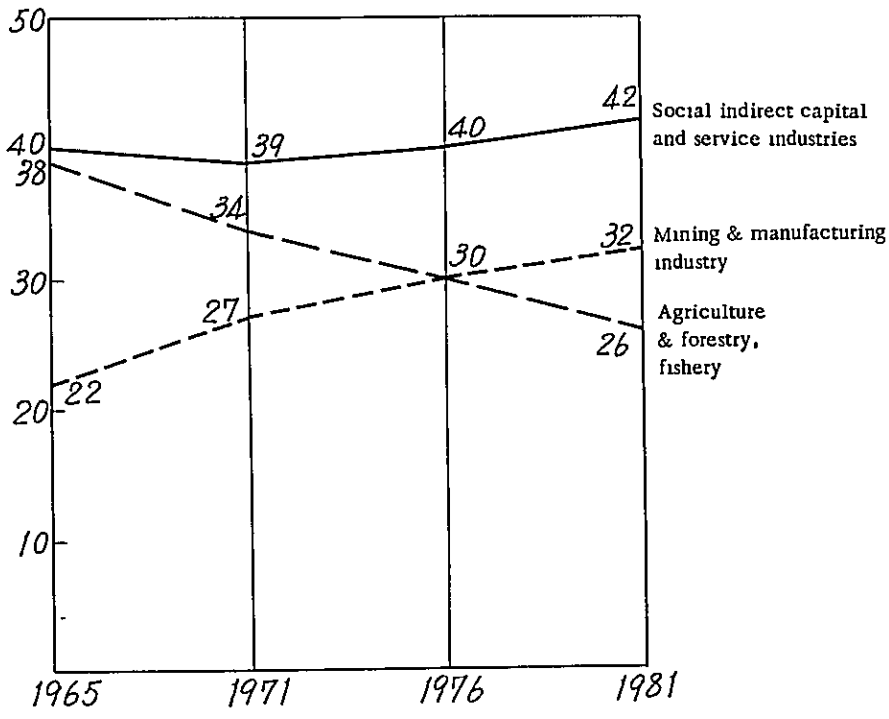


Fig. 3.1 Long-range prospect for industrial expansion

3.2 Future outlook for railway traffic and long-range planning

As has been stated in the foregoing section, traffic on the Korean National Railroad has increased at a high annual rate. Moreover, the railway traffic, both passenger and freight, is expected to continue increasing at a still higher rate, reflecting the sharp development of the economy of the country as a whole. The only losses forecast are due to the expected diversion of railway traffic to road transportation and expected decrease in the shipment of coal, now occupying as much as 40% of the total railway freight traffic in ton-km. But their effect on overall railway traffic is not so great and the Korean National Railroad is expected to continue to serve as the major means of passenger and freight transportation in the foreseeable years to come. A high rate of increase is expected in passenger and freight transportation on the Kyongpu Line; transportation of coal, ore and cement in the Yongju area; and urban traffic in large cities. In particular, urban and commuter transportation in and around Seoul and Pusan will develop to such a degree as to call for deep concern on the part of the public as well as the Korean National Railroad. (Fig. 3.2. Table 3.4)

Production of major commodities is expected to increase during the same years as shown in Table 3.3. Especially, the machinery and metallic industry is expected to increase by about eight times its present level and the chemical industry by about four times.

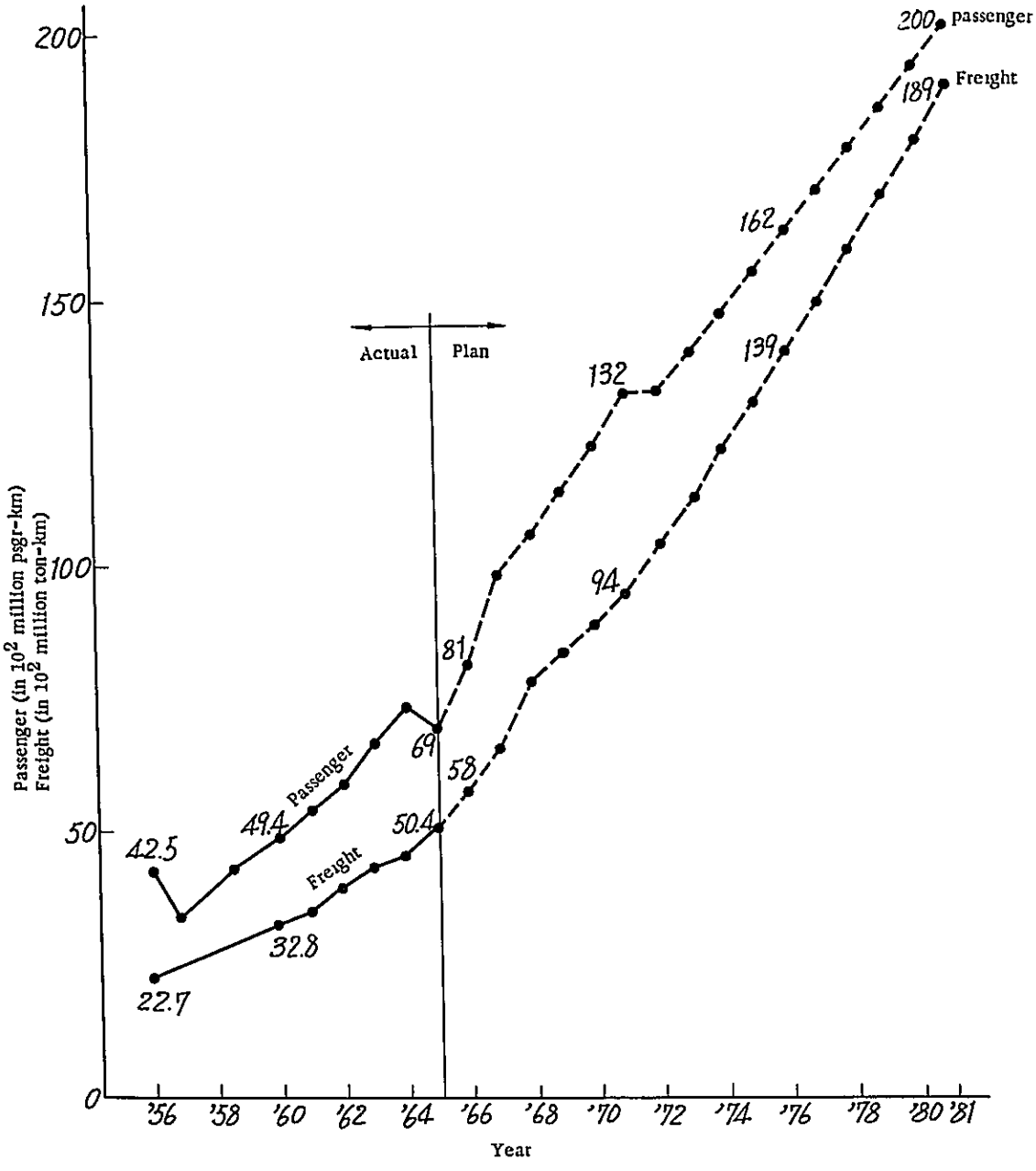


Fig. 3.2 Long-range prospect for railway passenger and freight traffic

Table 3.3 Expected increase in production of major commodities

Commodity	Unit	Base year 1965 (A)	Goal year 1981 (B)	(B)/(A) %
Rice	1,000 tons	3,501	5,672	162
Wheat & barley	"	1,856	3,062	165
Marine products	"	636	3,810	599
Cotton textiles	1,000 km	190	594	313
Cement	1,000 tons	1,610	8,990	558
Fartilizer	"	75	1,378	1837
Iron & steel	"	266	1,628	612
Coal	"	10,250	15,100	147
Electric power	million KWH	3,250	20,870	642
Petroleum products	1,000 barrels	9,950	80,300	807
Freight traffic	million ton-km	5,810	24,867	428
Passenger traffic	million psgr-km	15,074	72,506	481

Table 3.4 Long-range prospect for railway traffic

	Unit	1966	1971	1976	1981	Remarks
Passenger						
Passenger km	million-psgr-km	8,128 (100)	13,218 (163)	16,210 (199)	20,022 (246)	
Passenger car-km	thousand car-km	133,252 (100)	249,396 (187)	317,843 (239)	400,460 (301)	Average number of psgr per car
Converted car-km	"	148,596	271,841	345,621	436,502	61-53-51-50
PC	"		215,505	275,324	338,776	
DC	"		55,843	69,804	97,726	Rate of conversion:
DC (Narrow gange)	"		493	493	493	1.115-1.09
Passenger train km	km	18,584 (100)	31,425 (169)	39,662 (213)	51,292 (276)	

	Unit	1966	1971	1976	1981	Remarks
PC	Km	11,098 (100)	18,739 (169)	23,941 (216)	29,501 (266)	
DC	"	6,755 (100)	12,139 (179)	15,174 (224)	21,244 (314)	
DC (Narrow gauge)	"	730 (100)	547 (75)	547 (75)	547 (75)	
Freight						
Ton-km	million ton-km	5,756 (100)	9,425 (164)	13,948 (242)	18,900 (328)	Average cargo tonnage per car 20.48 - 21.5
FC km	thousand km	281,095 (100)	438,372 (156)	648,744 (231)	880,885 (314)	Rate of conversion: 0.868-1.036
Converted FC km	"	243,091 (100)	454,153 (187)	672,099 (276)	912,597 (376)	
Frt. train km	"	13,425 (100)	18,251 (136)	27,009 (201)	36,675 (273)	
Car kilometers						
Train km	thousand km	32,009 (100)	49,676 (155)	66,671 (208)	87,967 (275)	
Locomotive km	"	43,954 (100)	76,140 (173)	101,831 (231)	134,710 (306)	
DC	"	9,125 (100)	26,718 (293)	33,975 (373)	46,756 (513)	
DC (Narrow gauge)	"	837 (100)	602 (72)	602 (72)	602 (72)	
DL	"	25,485 (100)	48,820 (192)	67,254 (264)	87,352 (342)	
Number of rolling stock required						
Type of motive power	ea					
DC	"	153 (100)	235 (154)	294 (192)	411 (268)	
DC (Narrow gauge)	"	10 (100)	10 (100)	10 (100)	10 (100)	

	Unit	1966	1971	1976	1981	Remarks
DL	ea	SL (261) 173 (100)	405 (234)	559 (323)	727 (420)	
PC	"	1, 380 (100)	2, 472 (179)	3, 106 (225)	3, 903 (283)	
FC	"	11, 403 (100)	16, 003 (140)	22, 686 (199)	30, 737 (269)	

CHAPTER Ⅳ

ROLLING STOCK PLAN

CHAPTER IV. ROLLING STOCK PLAN

4.1 Past, present and future picture in car-km

The Korean National Railroad has been and is actively pushing forward motive power modernization programs (dieselization) to meet increased traffic demands and, accordingly, passenger and freight car-km, by steam locomotive-drawn trains is fast decreasing, being superceded by the rapidly increasing diesel locomotive-drawn passenger trains and diesel railcars. Viewing the converted passenger and freight car-km situation over the past 5 years, we find that diesel-drawn passenger and freight car-km have almost doubled while those by steam-drawn trains have remained almost at a standstill.

Viewing the same situation in light of the figures for the last 10 years, PC-km have increased by almost 200%, and FC-km by as high as 230%, as illustrated in Table 4.1.

It is estimated that the rolling stock-km for the Korean National Railroad in the future will increase as shown in Table 4.2. This estimate is based on the expected increase in traffic demand on the Korean National Railroad, based on the government's Long-range Economic Plan.

Table 4.1 Past record of car-km

(in car-km)

Year	PC-km	Index	FC-km	Index
1955	66, 279, 794	100	113, 450, 215	100
:	:	:	:	:
:	:	:	:	:
1960	85, 323, 809	126	177, 271, 202	155
1961	89, 442, 800	135	185, 509, 031	162
1962	92, 918, 036	140	209, 902, 569	184
1963	105, 918, 204	159	229, 554, 998	200
1964	123, 700, 992	186	238, 037, 955	210
1965	126, 946, 203	193	259, 117, 184	228

Table 4.2 Future prospect for car-km

(in thousand car-km)

Year	PC-km	Index			FC-km	Index		
1966	133, 252	100			281, 095	100		
1971	249, 396	187	100		438, 372	156	100	
1976	317, 843	238	127	100	648, 744	231	148	100
1981	400, 460	301	161	126	880, 885	314	200	136

This prospect is based on the theory that both PC and FC-km will nearly double in the next 10 years and triple five years after that, with an anticipated high rate of expected increase during the 1966-1971 period covered by the 2nd 5-year plan, and decreasing rates of increase on each five-year period after that. This is based on an aspect of the government's long-range economic plan which aims at bringing about an early recovery of transportation — first the railways followed by highway and marine transportation.

This forecast for railway car-km, though it seems rather optimistic when compared with the corresponding figures in the past 15 years (1945-1960) for the Japanese National Railways, which registered an increase of 226% in PC-km and 235% in FC-km, is nevertheless considered fairly adequate when the expected rate of future development of industries and concentration of population in large cities in the Republic of Korea are taken into consideration.

4.2 Past record: number of rolling stock and future plan

Table 4.3 shows the change in the number of rolling stock held by the Korean National Railroad for the past 15 years as classified by year and type.

Table 4.3 indicates that the number of steam locomotives has decreased by over half and, at the same time, motive power modernization has been increased by about 45% by the introduction of diesel locomotives and diesel railcars in the past 10 years, and that the general trend in rolling stock is advancing rapidly toward operation of more and more

smokeless high speed trains.

Table 4.3 Past record of number of rolling stock

(in cars)

Year	SL	DL	DC	PC	FC
1951	620	0	0	680	11, 100
1956	523 (100)	4	12	1, 147 (100)	11, 522 (100)
1961	350 (67)	95	18	1, 308 (114)	9, 455 (82)
1966	261 (50)	173	153	1, 380 (120)	11, 403 (99)

Note: Figures in parenthesis are index with 1956 as 100.

However, compared with the sharp advancement in the modernization of motive power as described above, centering on the introduction of high-quality diesel locomotives and railcars, development in the number of PC's and FC's is not so conspicuous. PC's increased by only 120% and FC's decreased by 99%, instead of increasing, over the past 10 years. This can be considered to have definitely contributed to the present shortage in passenger and freight transportation capacity now observed on the Korean National Railroad.

Table 4.4 shows the number of various types of rolling stock owned and operated by the Korean National Railroad in 1966, as classified by age (1-25 years old and 25 or over).

As can be understood from Table 4.4, apart from the newly-introduced modern DL's and DC's, PC's and FC's account for about 30% of the overage cars – a fact which bearing in mind the worn-out parts of these rolling stock, demonstrates that in the future it will be necessary to put more effort into the improvement and repair of rolling stock.

Table 4.4 Age of rolling stock as of 1966

Age	SL	DL	DC	PC	FC
1-25 years old	54	125	77	866	7, 656
25-year or over old	218	0	0	374	3, 108
Total	272	125	77	1, 240	10, 764

With this situation in mind, in an effort to eliminate the shortage now observed in traffic capacity and, at the same time, to ready itself for the increase in the traffic volume expected in the future, the Korean National Railroad has set up the Rolling Stock Increasing Plan as shown in Table 4.5.

Table 4.5 Rolling stock increasing plan

(in cars)

Year	1966	1971	1976	1981
DL	173 (100)	405 (234) (100)	559 (323) (138) (100)	727 (420) (180) (130)
DC	153 (100)	235 (154) (100)	294 (192) (125) (100)	411 (268) (175) (140)
PC	1, 380 (100)	2, 472 (179) (100)	3, 106 (225) (126) (100)	3, 903 (283) (158) (125)
FC	11, 403 (100)	16, 003 (140) (100)	22, 686 (199) (142) (100)	30, 737 (269) (192) (136)
SL	261 (100)	0 (0)	0 (0)	0 (0)

As shown in Table 4.5, the Korean National Railroad is planning to advance its dieselization program at a faster pace, and the number of DL's and DC's is expected to be increased respectively to as many as 420% and 268%; but on the other hand, SL's will be gradually withdrawn and completely disappear by 1968.

It is also apparent from that part of the plan dealing with PC's and FC's, including DC's, that the Korean National Railroad expects to increase their numbers to 179% for PC's, 154% for DC's and 140% for FC's by the end of the 2nd 5-year plan in 1971, thus reducing the excessive use of rolling stock due to the current shortage and attaining a safe, comfortable and speedy degree of transportation for passengers and freight. The long range plan includes increasing the number of PC's and DC's at lesser rates, by 125% or thereabout, during each 5-year period after that. FC's, however, follow a different trend. The Korean National Railroad is planning to up their number by about 150% during each of such succeeding 5-year periods, forcasting that the basic expansion of industry will be accomplished by the second 5-year plan and that there will be a sharp development of industry in each of the succeeding 5-year periods, taking into consideration the expected increase in the traffic demand on railways in these years.

Let us consider the various influences which may have had a bearing in the framing of the above-mentioned rolling stock plan.

(1) Average number of passengers per car

The number of passengers per car – used to judge the degree of standard service offered to passengers – is planned, as indicated in Table 4.6, to decrease gradually from 61 to 53, 51, and finally to 50, to assure easier occupency of seats in passenger cars by passengers.

The passenger loading factor (number of passengers accommodated/rated passenger capacity of car) has decreased from 75% to 63%. But it is still far from being satisfactory when compared with the comparable Japanese National Railways endeavour to bring this figure down from average 51% to 45-46% for its entire system. It is considered appropriate to set this goal, for 1981, at 50%, or 45-46 passengers per car.

Table 4.6 Basic values

	1946	1971	1976	1981
Average number of psgrs/car	61	53	51	50
Average tons/FC	20.48^{t}	21.5^{t}	21.5^{t}	21.5^{t}
FC turnround (days)	4.24	3.84	3.84	3.84

(2) Average tons per FC

The average tons per freight car, expressing the loading efficiency of freight cars, is now 20-21 tons, which seems to be somewhat low compared with the 40-50 ton average capacity of freight cars used on the Korean National Railroad. The Rolling Stock Plan now being prepared by the Korean National Railroad, however, is aiming at covering the expected increase in the number of cars by improving the car turnround from 4.24 days to 3.84 days, or from 23% to 26% in terms of freight car utilization efficiency.

Mention may be made of the fact that the Japanese National Railways is trying to reduce the freight car utilization efficiency from the present 27-28% to 24-25%, but that this is to help improve services to shippers by easing its freight car distribution service and helping distribute to shippers freight cars meeting their respective needs.

(3) Car-km/day

The Korean National Railroad is planning to improve the car-km/day records or the working efficiency of cars assigned to 410 km for DL's, 366 km for DC's and 290 km for PC's. These goal figures seem almost adequate, judging from comparable figures for the Japanese National Railways, which are at present registering 365 km for DL's, 396 km for DC's DC's and 311 km for PC's.

(4) Reserve car holding

The reserve car holding, the number of rolling stock on reserve status, consists of

operating reserve cars to be used for additional trains or substitute trains for regular trains put out of service due to accident, etc., and inspection and repair reserve cars in the shop for inspection and/or repair. The Korean National Railroad is planning a reserve car holding, combining operation and inspection-and-repair reserves, of 10% for DL's, 15% for DC's and 16% for PC's. It is being considered, however, to make it about 10% for operation reserve and about 8% for inspection-and-repair reserve, or a total of about 18%, judging from the peak in transportation expected for the future.

(5) Scrapping of rolling stock

Although the present Rolling Stock Plan of the Korean National Railroad covers only the required number of rolling stock directly related to transportation and says nothing about the number of cars to be scrapped, it is necessary to incorporating a plan to replace superannuated cars with new cars.

Taking all of the above into consideration, the number of rolling stock shown in Table 4.5, the rolling fleet the Korean National Railroad is planned to have in the future, seems to be a little insufficient for the transportation goal set. But it is judged that the Korean National Railroad will be able to meet the expected future transportation demands by making improvements other than increasing rolling stock, such as modernizing the transportation system or rationalizing operations and maintenance of rolling stock.

4.3 Observation on performances and particulars of rolling stock

4.3.1 Motive power

Performance and other particulars of the important types of diesel locomotives and diesel railcars now owned by the Korean National Railroad are as shown in Table 4.7, which demonstrates that all DC's are of the diesel-electric system, and that the major types are Type 3000 and Type 5000. Type 3000 is B-B wheel arrangement, mounted with a G-8 875 HP engine and is used for local line line-haul and shunting services, and Type 5000 is C-C wheel arrangement, mounted with a ST-9 1750 HP engine and used for main line passenger and freight services. All engines mounted are 2-cycle direct-injection

water-cool system diesel engines, the one for ST-9 being a 16-cylinder type and the one for G-8 an 8 cylinder type. Both were manufactured by General Motors. Soon another type of diesel locomotive will be introduced. This is a 4-cycle diesel engine 950 HP locomotive manufactured by the ALCO company and scheduled for operation on branch lines.

All DC's are KIHA types imported from Japan, except for several of the remodelled old-type DC's, and are mounted with 4-cycle non-air injection pre-combustion system 8 cylinder Type DMH-17H 180 HP twin engines. They are now operated by the Korean National Railroad for commuter and suburban services in 1M2T (M: Motored car, T: Trailer car) units.

Table 4.7 Statistics concerning DL's and DC's

(1) DL statistics

Type	Max. length (mm)	Max. width (mm)	Max. height (mm)	Tare weight (t)	Wheel arrange-ment	Engines	Number
DL's							
SW8-2000	13,423	3,099	4,426	94.4	B-B	8-567BC 800 HP	14
G8-3000	14,325	2,819	4,209	72.8	B-B	8-567CR 875 HP	52
G12-4100, 4000	14,325	2,819	3,759	78.5	B-B	12-567C 1310 HP	25
ST9-5000	18,509	3,251	4,561	136	C-C	16-567C 1750 HP	29
ST18-6100, 6000	18,603	3,251	4,572	147	C-C	16-567 D1 1800 HP	15
STP28-6300	18,891	3,127	4,660	-	C-C	16-567E 1800 HP	6
ALCO-3100	14,653	2,822	3,670	71.6	B-B	PL -532B 950 HP	49
DC's	21,500	3,055	3,885	39	B-B	BMH17H 180 HP	153

(2) Traction (electric) motors on DL's

Type	2000	3000	4000	5000	6000
Type	D-27	D-47	D57B1	D-37	D-57
1-hour rating (A)	900	925	925	925 (600V)	925 (600V)

(3) Diesel engines

Type	Max. length (mm)	Max. height (mm)	Max. width (mm)	Output (HP)	Weight
DMH17H	2,181	1,365	736	180	1,500 kg
8-567BC				800	17,000 lbs
8-567CR				875	18,000 lbs
12-567C				1,310	24,106 lbs
16-567C				1,750	32,106 lbs
16-567D				1,800	
16-567E				1,800	

In freight services, DL's are pulling an average train load of about 25 freight cars (1,000 tons), but some of them are pulling even more – max. 1,500 tons. In passenger services, DC's are pulling about 11.5 passenger cars (about 500 tons). Their scheduled speed is 22 km/h for freight trains and 40 km/h for passenger trains (limited express trains 78.5 km/h). But it is preferable to increase their scheduled speed to 30 km/h for freight trains and 50 km/h for passenger trains, to help increase track capacities. Further, the fact that the axle weights, about 20-25 tons/axle, are excessive for the bearing capacity of rails used by the Korean National Railroad, 22 ton on Class 1st line, stresses the need for careful maintenance of the tracks.

4.3.2 Passenger and freight cars

Particulars of PC's and FC's used by the Korean National Railroad are as shown in Table 4.8. All of them are bogie car types, whether PC's or FC's. This fact, together with the fact that taper roller bearings are employed on some of them, indicates that the Korean National Railroad is now able to meet the demands of high-speed train operation, the mode of the future. Further, the fact that the number of 50 ton large-size freight cars is increasing indicates that the Korean National Railroad is able to meet the rapidly growing trend of mass transportation or container transportation.

The only concern on the construction program for the passenger and freight rolling fleet owned by the Korean National Railroad is for the PC's, whose tare weight per passenger, 0.45 t, is excessive when compared with the comparable figure in the Japanese National Railways – 0.28 tons per passenger for its standard PC. It is hoped that it will gradually be reduced. FC's, too, show some need of improvement. It is recommended that existing FC's be remodeled to facilitate loading and unloading of cargoes, such as whole-side open type cars or open-roof type cars; to develop FC's for specified types of goods; and to develop special FC's for palletized or container-load goods, to make the Korean National Railroad ready for the imminent trend of faster door-to-door goods transportation expected in the near future.

4.3.3 Standardization of construction of rolling stock

It is important to plan to carry out standardization of rolling stock and their parts as soon as possible. It is necessary to standardize performances and construction of rolling stock by confirming future trends in the type and flow of passenger and freight transportation. Such a standardization will greatly contribute to the improvement and rationalization of the railway operation as a whole by not only improving rolling stock utilization by allowing easy exchange of parts but by making mechanization and simplification of rolling stock production and repair possible.

Table 4.8 Statistics concerning PC's and FC's

(1) PC's

Type	Max. length (mm)	Max. width (mm)	Max. height (mm)	Tare weight (t)	Wheal type	Truck type	Number
Dining cars	21,000	3,004	3,693	32	4BR	spring	50
2nd class cars	"	"	"	30	"	"	75
2nd class cars	"	"	"	38.5	"	"	
2nd & 3rd class composite cars	"	"	"	36	"	"	27
3rd class cars	"	"	"	36	"	"	1,050
3rd class cars	"	"	"	29.9	"	"	
3rd class cars	20,000	3,208	4,088	35.7	4BP	"	
3rd class, baggage & mail composite cars	21,000	3,255	4,208	36	4BR	"	77
Baggage & mail composite cars	21,000	3,004	3,693	31	4BR	"	115

(2) FC's

Type	Max. length (mm)	Max. width (mm)	Max. height (mm)	Tare weight (t)	Wheel type	Truck type	Number
Box cars	10,970	3,130	3,820	16.5	4BP	Arch bar	4,201
Box cars	13,950	2,970	3,980	19	4CP	Cast iron	
Box cars	13,420	2,816	3,558	16	4CP	Cast iron	
Open cars	11,260	2,770	2,187	15	4BP	Arch bar	5,339
Open cars	13,968	3,284	2,924	21.2	4CP	Cast iron	
Open cars	13,249	2,711	2,494	16	4CP	Cast iron	
Refrigerator cars	13,950	3,095	3,950	26	4CP	Cast iron	183
Tank cars	12,000	2,870		20.1	4DP	Cast iron	909
Flat cars	11,300	3,010	1,080	15.5	4CP	Cast iron	541
Cabooses	11,300	3,474	3,747	16.3	4BP	Arch bar	253

CHAPTER V

CAR BASE PLAN

CHAPTER V. CAR BASE PLAN

5.1 Present status of car bases

The car bases now maintained by the Korean National Railroad are as shown below, and their distribution is as illustrated in Fig. 5.1.

o Locomotive depots ..... at 17 points

		SL	DL	DC
1.	Susaeg	48 + 3	-	-
2.	Cheongryangri	-	34	-
3.	Suwon	-	-	6
4.	Chonan	-	3	-
5.	Taejon	30	17	6
6.	Lili	27	-	22
7.	Kimchon	-	7	-
8.	Taegu	-	-	21
9.	Pusan	22 + 1	31	15
10.	Kyongjo	16	-	-
11.	Masan	18	-	-
12.	Sunchon	22	-	2
13.	Kwangjo	13	-	-
14.	Mokpo	14	-	4
15.	Techon	-	56	4
16.	Yongju	9	18	-
17.	Pukpyong	13	7	2
	TOTAL	236	173	82

Note: (+3) (+1) are locomotives assigned to Workshop.

o DC depot ..... at one point

		DC
1.	Seoul	79 + 2

Note: (+2) are special cars.

o Passenger & freight car depot ..... at 10 points

1. Seoul
2. Cheongryangri
3. Inchon
4. Taejon
5. Lili
6. Taegu
7. Pusan
8. Sunchon
9. Andong
10. Pukpyong

Locomotives and DC's are assigned to respective locomotive depots or DC depots for attention, but PC's and FC's are not assigned to particular passenger and freight car depots. Because, with no reserves, they must be assigned to the most convenient depot to allow for more efficient use throughout the Korean National Railroad system.

The number of PC's and FC's now handled by each passenger and freight car shed is estimated to be as follows, based on the corresponding figures for 1956:

	PC	FC
Seoul	490	1, 160
Cheongryangri	56	1, 663
Inchon	28	870
Taejon	95	1, 120
Lili	77	740
Taegu	87	1, 020
Pusan	250	2, 330
Sunchon	104	590
Andong	142	1, 140
Pukpyong	51	770
TOTAL	1, 380	11, 403

5.2 Present and future outlook for number of trains and track capacity by line

The present number of trains and track capacity by line are as follows:

o Kyongpu Line (Seoul - Pusan 445.6 km), wholly doubletracked and with a maximum gradient 1‰, is the busiest line among all KNR lines and serves as the main traffic artery for the Republic of Korea running south to west and connecting such important cities as Seoul, Taejon, Taegu, and Pusan. Therefore, when considering the further concentration of population into urban areas accompanied by a steady increase in the traffic on this route expected for the future, this line will be further strengthened as the most important railway line in the Republic of Korea.

o Chungang Line (Cheongryangri - Kyongju, 382.7 km) is an industrial line and is operating an especially large number of freight trains (mostly coal trains) between Cheongryangri and Yongju. Yet this line is a single-track line with sharp gradients and is in pressing need of improvement to ease coal transportation. When the expected increase in the amount of production of cement utilizing the abundant coal and line deposits in Kangwon-do and the expected expansion of the eastern sea-board industrial zone linking Ulsan and Pusan are taken into consideration, it is certain that this line will remain an important industrial one in the future.

o Honam Line (Taejon - Mokpo 260.4 km), directly linking Seoul with such important cities in the south-western part of the country as Kunsan, Mokpo, Kwangju and Sunchon, is expected to have increased traffic in the future for both passengers and freight.

o Kyongin Line (Yongdungpo - Inchon 29.7 km), wholly double-tracked and serving the fast-expanding busy residential and industrial district just west of Seoul, is expected to have a sharp increase in passenger traffic, especially commuter traffic, in the future.

5.3 Car base plan

As was introduced in 5.1, the Korean National Railroad now has a total of 17 locomotive depots, one DC shed and 10 PC & FC depots.

As shown in table 4.5, the number of rolling stock is expected to increase sharply in

the future, reflecting the similarly sharp expansion in the amount of traffic expected for the future.

Under such an expected increase in the number of rolling stock, it is important to determine carefully the locations of car bases to which they should be assigned.

It is certain that distributing the future increase in the number of rolling stock to the existing car bases uniformly will result in the necessity for many additional facilities at each of these car bases with a correspondingly large amount of expenditures.

To avoid making such an uneconomical investment and to bring about a rationalized use of employees for inspection and repair, it is necessary to select only important car bases out of the existing car bases, taking into consideration the importance of each of the lines as stated in 5.1 above, and to strengthen facilities by concentrating on the ones chosen as the important car bases for the future; and to limit investment on the others, allowing them to maintain for now their present status. The ear bases labeled as non-important should be abolished gradually in the future as the situation permits.

Based on the above suggested policy, the following car base plan is suggested:

o Locomotive depots ..... at 9 points

1.	Seoul	5.	Sunchon
2.	Taejon	6.	Mokpo
3.	Pusan	7.	Jechon
4.	Kyongju	8.	Pukpyong

(Provided that Seoul will have two depots at Susaeg and Cheongryangri.)

o PC & FC (including DC) depots .....at 9 points

1.	Seoul	5.	Taegu
2.	Taejon	6.	Sunchon
3.	Lili	7.	Yongju
4.	Pusan	8.	Pukpyong

(Provided that Seoul will have two depots, at Susaeg and Cheongryangri.)

For Seoul:

Locomotives, DC's, PC's and FC's, will be concentrated at the Susaeg depot.

Some of the Locomotives, PC's and FC's for the Chungang Line and Kyong Chung Line will be assigned to Cheongryangri, where inspection and repair of all coal cars will be carried out.

Seoul Station will become a passenger-only station, transferring its existing freight service to Yonsan and its PC and FC depot to Susaeg.

Yonsan DC depot will be moved to Susaeg, and the existing track and related facilities will be turned into freight yards and FC storage tracks.

Above is the outline of our suggested car base plan for the Korean National Railroad and, accordingly, the estimated number of cars to be assigned to each of these car bases, as estimated according to Table 4.5, will be as shown in Table 5.1. This table shows the expected situation for 1981 with (A) indicating the expected assignments on the supposition that the existing car base situation is left unimproved and (B), the same, supposing our above outlined suggestions are employed.

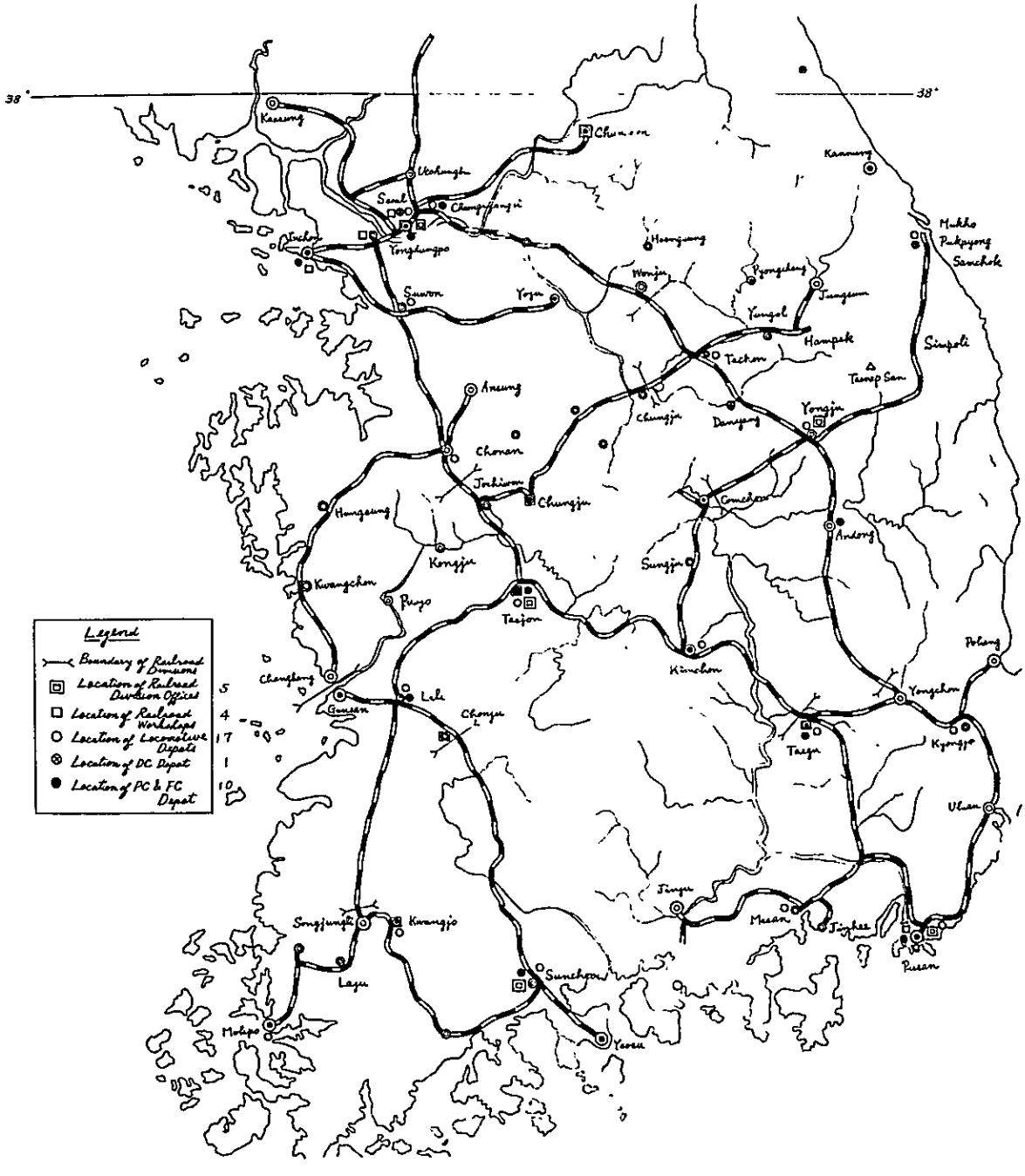
Table 5.1 Estimated car assignment to each car base for 1981

	1966					1981 (A)				1981 (B)			
	SL	DL	DC	PC	FC	DL	DC	PC	FC	DL	DC	PC	FC
Susaeg	(3) 48					87				87	203	1,469	5,470
Cheongryangri		34		56	1,663	61		158	4,487	61		158	4,487
Yonsan			(2) 79				203						
Seoul				490	1,160			1,390	3,130				
Inchon				28	870			79	2,340				
Suwon			6				15						
Chonan		3				5							
Taejon	30	17	6	95	1,120	85	15	270	3,030	151	30	270	3,030
Lili	27		22	77	740	48	56	211	2,000		56	211	2,000
Kumchon		7				13							
Sunchon	22		2	104	590	40	5	295	1,590	63	15	295	1,590
Kwangju	13					23							
Mokpo	14		4			25	10			25			
Taegu			21	87	1,020		54	246	2,750		54	246	2,750
Pusan	(1) 22	31	15	250	2,330	95	38	710	6,270	127	38	710	6,270
Kyongju	16					29				29			
Masan	18					32							
Jechon		56	4			100	10			132			
Yongsan	9	18				48					15	544	3,070
Andong				142	1,140			400	3,070				
Pukpyong	13	7	2	51	770	36	5	144	2,070	52			2,070
TOTAL	* (4) 232	173	** (2) 161	1,380	11,403	727	411	3,903	30,737	727	411	3,903	30,737

* Figure in parenthesis represent shunting loco. for backshop.

** Figure in parenthesis represent special cars.

Fig. 5.1 Locations of Railroad Divisions Workshops and Car Bases (Korean National Railroad)



CHAPTER VI

ROLLING STOCK INSPECTION AND MAINTENANCE SYSTEM

CHAPTER VI. ROLLING STOCK INSPECTION AND MAINTENANCE SYSTEM

6.1 Present status of rolling stock

Inspection and Repair System

6.1.1 Present status

For the maintenance of rolling stock of the Korean National Railroad, an inspection and repair system has been established by regulation covering all kinds of rolling stock held. All maintenance should be carried out according to these regulations. But the present status is such that, under the sharply increasing traffic and ensuing shortage in the number of various kind and types of rolling stock, the cars are utilized at such high ratios that it is very often impossible to put them to regular (periodical) inspection and repair as specified by these regulations.

The inspection and repair frequencies for the various kinds of rolling stock owned by the Korean National Railroad as specified by the regulations are as summarized in Table 6.1.

Table 6.1 Rolling Stock Inspection and Repair System

Kind of rolling stock	Class of Inspection	Inspection frequency (once per)	where performed
DL	Daily insp.	Day	Locomotive depot
	Bi-weekly insp.	2-weeks	"
	Monthly insp.	1 month	"
	Tri-monthly insp.	3 months	"
	Half yearly insp.	6 months	"
	Yearly insp.	1 year	Railroad workshop
	Two-year insp.	2 years	"
	4 year insp.	4 years	"
	6 year insp.	6 years	"
	8 year insp.	8 years	"
	Temporary	As required	"

Kind of rolling stock	Class of Inspection	Inspection frequency (one per)	where performed
DC	Daily insp.	Day	DC depot
	Bi-weekly insp.	2 weeks	"
	Monthly insp.	1 month	"
	Tri-monthly insp.	3 months	"
	Half-yearly insp.	6 months	Railroad workshop
	Yearly insp.	1 years	"
	General insp.	2 years	"
	Temporary insp.	as required	"
PC	Daily insp.	Day	PC & FC depot
	Partial insp.	1 month	"
	Ordinary insp.	8 months	"
	General insp.	16 months	Railroad workshop
	Temporary insp.	as required	"
FC	Lubrication	1 month	PC & FC depot
	Partial insp.	4 months	"
	Ordinary	8 months	"
	General	24 months	Railroad workshop
	Temporary	as required	"

6.1.2 Present Contents of Inspection and Repair, Man-hours and Inspection periods (in-shop days)

Contents of inspections, inspection and repair man-hours required and number of days required for repair now in practice at the railroad workshops of the Korean National Railroad are as summarized in Table 6.2, and Table 6.3.

Table 6.2 Contents of inspection and repair of rolling stock

(A)

Kind of rolling stock	Classification	Yearly insp.	2-year insp.	4-year insp.	6-year insp.	8-year insp.
DL	Car body	Condition insp.	Condition insp.	Condition insp.	Car body general repair & painting	Condition insp.
	Truck & running gear	Disassembling of main parts	Disassembling of main parts	Disassembling of main parts	Disassembling inspection	Disassembling of main parts
	Air brake	Function insp.	Disassembling of main parts	Disassembling of main parts	Disassembling inspection	Disassembling of main parts
	Foundation brake	Disassembling of main parts	Disassembling of main parts	Disassembling of main parts	Disassembling inspection	Disassembling of main parts
	Power transmission devices	Disassembling insp.	Disassembling insp.	Disassembling insp.	Disassembling insp.	Disassembling insp.
	Electrical equipment	Status inspection Insulation test Dielectric test	Disassembling insp. (Fuel pump and MM)	Disassembling insp. (MM exchange)	Disassembling insp.	Disassembling insp.
	Engine & engine parts	Disassembling of main parts	Disassembling of main parts	Disassembling of main parts	Disassembling of main parts	Disassembling insp.
	Couplers	Disassembling insp.	Disassembling insp.	Disassembling insp.	Disassembling insp.	Disassembling insp.
	Meters	Status insp.	Disassembling insp.	Disassembling insp.	Disassembling insp.	Disassembling insp.

(B)

Kind of rolling stock	Classification	6-month insp.	Yearly insp.	General insp.
DC	Car body	Status insp.	Disassembling of main parts, painting	Painting
	Truck & running gear	Status insp.	Disassembling insp.	Disassembling insp.
	Air brake	Disassembling of main parts	Disassembling insp.	Disassembling insp.
	Foundation brake	Status insp.	Disassembling insp.	Disassembling insp.
	Power transmission device	Disassembling of main parts	Disassembling insp.	Disassembling insp.
	Electrical equipment	Disassembling of main parts (Insulation resistance)	Disassembling insp. (Insulation resistance)	Disassembling insp. (Insulation test, Dielectric test)
	Engine & engine parts	Disassembling of main parts	Disassembling insp.	Disassembling insp.
	Couplers	Status insp.	Disassembling insp.	Disassembling insp.
	Meters	Status insp.	Disassembling insp.	Disassembling insp.

(C)

Kind of rolling stock	Classification	General inspection
PC	Car body	Painting
	Trucks & running gear	Disassembling inspection
	Air brake	"
	Foundation brake	"
	Couplers	"
	Meters	"

(D)

Kind of rolling stock	Classification	General inspection
FC	Car body	Painting
	Trucks & running gear	Disassembling inspection
	Air brakes	"
	Foundation brake	"
	Couplers	"

Table 6.3 Man-hours and numbers of days required for inspection and repair of rolling stock

Kind of rolling stock	Class of inspection	Inspection turnround (once per)	No. of days required for insp.	Man-hours	Cost for materials in Won	Conducted at
DL	Daily insp.	Day	2 hrs.	30	1,700	Loco depot
	Bi-weekly insp.	2 weeks	4 hrs.	100	8,984	"
	Monthly	One month	5 hrs.	130	14,686	"
	Tri-monthly	3 months	6 hrs.	190	56,106	"
	Half-yearly	6 months	8 hrs.	280	91,106	"
	Yearly	1 year	3 days	490	421,500	Railroad workshop
	2 year	2 years	4 days	630	372,500	"
	4 year	4 years	5 days	970	654,500	"
	6 year	6 years	8 days	1850	1,060,000	"
	8 year	8 years	10 days	5960	1,251,500	"
	Temporary insp.	as required	2 days	660	154,413	"

Kind of rolling stock	Class of inspection	Inspection turnround (once per)	No. of days required for insp.	Man-hours	Cost for materials in Won	Conducted at
DC	Daily insp.	Day	2 hrs.	20	1,020	DC depot
	Bi-weekly insp.	2 weeks	4 hrs.	70	2,942	"
	Monthly insp.	One month	6 hrs.	100	16,605	"
	Tri-monthly insp.	3 months	8 hrs.	150	171,899	"
	Half-yearly	6 months	5 days	1520	307,000	Railroad workshop
	Yearly	1 year	10 days	2800	576,500	"
	General	2 years	12 days	3710	996,000	"
	Temporary insp.	as required		280	127,637	"
PC	Daily insp.	Day	3.5 hrs.			PC depot
	Partial insp.	30 dyas	14 hrs.			"
	Ordinary	8 months	14 hrs.	170		"
	General	16 months	22 days	2160	247,300	Railroad workshop
	Temporary insp.	as required	8 days	1160	65,000	"
FC	Daily insp.	Day				
	Lubrication	One month	0.5 hr.	3		PC & FC depot
	Partial insp.	4 months	2 hrs.	12		"
	Ordinary	8 months	10 hrs.	56		"
	General	24 months	12 days	250	62,000	Railroad workshop
	Temporary insp.	as required	9 days	120	14,000	"

6.2 Rolling stock inspection and repairing system

6.2.1 Fundamental ideas on the maintenance of rolling stock

(a) Relationship between rolling stock operation and maintenance

In using railway rolling stock, it is necessary to transport as much traffic as possible and earn as much income as possible using a limited number of rolling stock at a high rate of efficiency. To attain this objective, it is preferable to cut the number of out-of-service days down to the lowest possible minimum and thus improve the working efficiency of rolling stock in use.

Further, under the present situation of short track capacities, it is necessary to maintain safe and reliable transportation for passengers and freight to meet the demands of traffic placed on the railway. Judging from this, it is considered necessary to assure adequate maintenance of rolling stock, to keep trains in a condition assuring safe operations and, at the same time, to keep them operating as efficiently as possible.

It is necessary to plan a maintenance program for rolling stock, taking these conditions, as well as the cost of maintenance required, into consideration.

(b) Suggestions for the maintenance of rolling stock

As guiding principles, two basic systems for rolling stock maintenance are suggested; they are:

(i) Maintenance of rolling stock after they have gone out of service due to damage, etc. (post-accident maintenance)

(ii) Maintenance of rolling stock before they are unservicable, determined according to the data on the possibility of wear and damage to parts, obtained by statistically processing the actual maintenance and repair records from the past. (preventive maintenance).

The basic idea of preventive maintenance is to minimize wear and loss of rolling stock with the least possible amount of maintenance cost, and, thus, to insure economic and efficient train operations. Any rolling stock maintenance system adopted in the future should take these points into consideration.

(c) Clarification of ranges of assignment of rolling stock for maintenance

The rolling stock assignment system presently practiced by the Korean National Railroad is such that DL's, DC's and SL's, or motive power cars only are assigned to either the Locomotive depots or DC depots, but PC's and FC's have no assignment to PC or FC depots, as the latter two are operated throughout the entire system of the Korean National Railroad as required.

On the other hand, repair work at railroad backshops has no definite areal demarcations; it is only specified that all SL's are to be repaired either at Seoul or

Yongdungpo workshops, all DL's at the Pusan workshop, and all DC's at the Seoul workshop.

To insure full rolling stock maintenance such as preventive maintenance and a sufficient supply of new parts for replacement for the future, it is necessary to establish a definite area of responsibility for each rolling stock depots (Locomotive, DC and PC and FC depots) Each, in addition to regular backshop duties would also perform inspections and minor repairs. It is recommended, with the exception of FC's, that assignments of rolling stock be clarified for each depot and workshop.

(d) Contents of inspection

For the contents of inspections to be made, there are certain specifications for each kind of rolling stock covering the range of overhauling, responsibility for inspection, and repair works to be made. These include non-destructive inspection of axles, replacement of designated parts, etc.; prohibitive regulations concerning heating machining on designated parts, etc.; limits to replacement or repair to worn or deteriorated parts, and accuracy specifications. However, it is necessary to specify for these items in even greater detail.

Rolling stock is destined, through its use and the lapse of time, to deteriorate and finally to have a lessened working efficiency resulting in trouble or accidents. Therefore, it is necessary to restore them before they reach this point. For this purpose, it is necessary to re-study the inspection and repair times (frequencies) still further and clarify them more definitely.

(e) Number of days required for repair (in-shop days)

As was stated in the foregoing, it is necessary to heighten the utilization ratio (working efficiency) of rolling stock to carry out a maximum degree of transportation with a limited number of rolling stock. And, for this, it is preferable to bring the out-of-service ratio of rolling stock down to the smallest possible minimum. Again, it is of vital importance to endeavour to perform high-quality repair work to keep the rolling stock in operation with the least possibility of break down and, at the same time, to

cut the number of days and the number of man-hours required for repair to the minimum. For this, it is necessary:

i) To establish and effectively utilize a spare parts system,

ii) To prepare and effectively utilize machining and repair records for important points concerning rolling stock,

iii) To maintain effective adjustment between and control of each working process and to carry out parallel work, if possible,

iv) To establish work standards and improve working methods,

and

v) To introduce mechanization and automation.

6.2.2 Inspection and repair turnrounds (Inspection turnround)

The present turnrounds of overall inspections for the rolling stock owned by the Korean National Railroads are as shown in Table 6.4, which also shows the corresponding figures for the Japanese National Railways.

The inspection turnround should be decided, as stated earlier in this chapter, according to the performances, construction of the rolling stock concerned, used materials, utilization situation, condition of tracks concerned, etc. But it is judged that, apart from steam and diesel locomotives, inspection turnrounds for DC's, PC's and FC's can be made still longer by improving car constructions, repairing facilities, machining techniques etc., in addition to carrying out regular (periodical) inspections and repairs. Therefore, it is preferable to make it longer - 3 years for DC's, 24 months for PC's and 36 months for FC's- in the future.

The suggested goal for turnrounds of overall inspections for the end of each 5-year period involved in the Economic Plan are as shown in Table 6.5.

Table 6.4 Present turnrounds of overall inspections

Kind of car	Korean National Railroad	Japanese National Railways
DL	8 years	4 years
DC	2 "	3 "
PC	16 months	24 months
FC	24 "	36 "

Table 6.5 Suggested turnround goal for overall inspections

Kind of car	1966	1971	1976	1981
DL	8 years	8 years	8 years	8 years
DC	2 "	2 "	3 "	3 "
PC	16 months	16 months	24 months	24 months
FC	24 "	24 "	36 "	36 "

6.2.3 Number of days required for repair (in-shop days)

The number of in-shop days for the railway rolling stock is such that it can be adequately reduced, as stated above, by employing the spare parts system, adjusting and controlling various working processes, modernizing working methods, standardizing rolling stock construction, etc., which can also bring about increased performances and lowered maintenance cost for the rolling stock at the same time.

The present and suggested planned in-stop days for the rolling stock owned by the Korean National Railroad are as shown in Table 6.6, which also shows the corresponding situation in the Japanese National Railways.

Table 6.6 Suggested planned in-shop days for repair of rolling stock

Kind of rolling stock	Class of inspection	1966	1971	1976	1981	JNR (1966)
		days	days	days	days	days
DL	Yearly	3	3	2	2	
	2-year	4	4	3	3	
	4-year	5	5	4	4	8
	6-year	8	8	7	7	
	8-year	10	10	10	10	10
	Temporary	3	3	3	3	3
DC	Half-yearly	5	4	3	3	
	Yearly	10	8	7	6	5
	General	12	10	9	8	6.5
	Temporary	3	3	3	3	3
PC	General	22	11	9	7	6.5
	Temporary	14	8	5	3	2.5
FC	General	12	7	6	4	2.2
	Temporary	9	4	3	2	1.2

As it is judged that the number of in-shop days can be drastically cut in the future by various modernization and rationalization measures such as improving facilities of the railroad backshops and establishing a spare parts system, it is hoped that the Korean National Railroad will do its utmost to attain this objective referring to the suggested planned in-shop days shown in Table 6.6 and the suggested standard inspection and repair processes shown in Table 6.7, Table 6.8 and Table 6.9.

Table 6.7 Suggested standard process for general inspection and repair for DC's

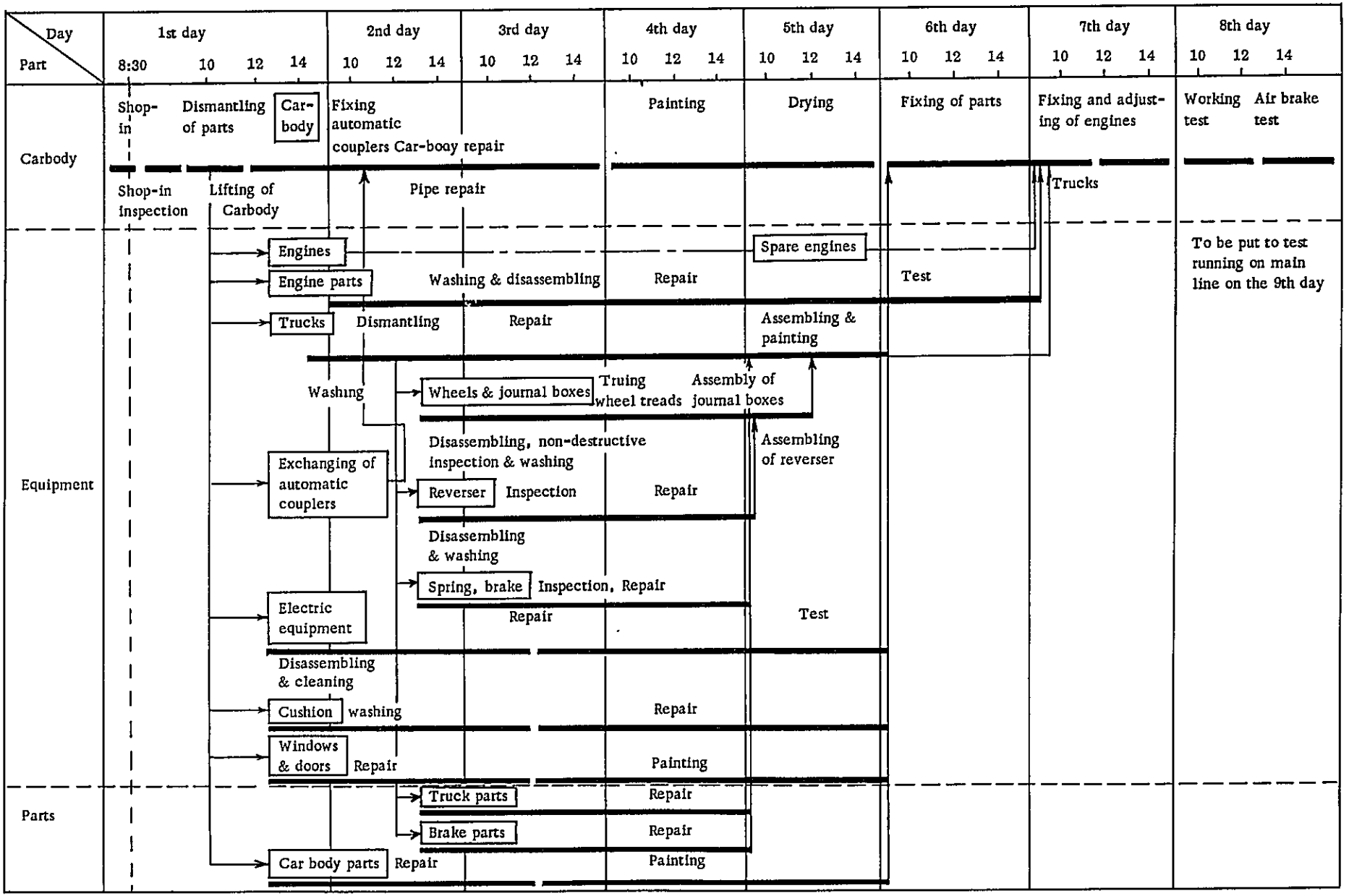


Table 6.8 Suggested standard process for general inspection and repair for PC's

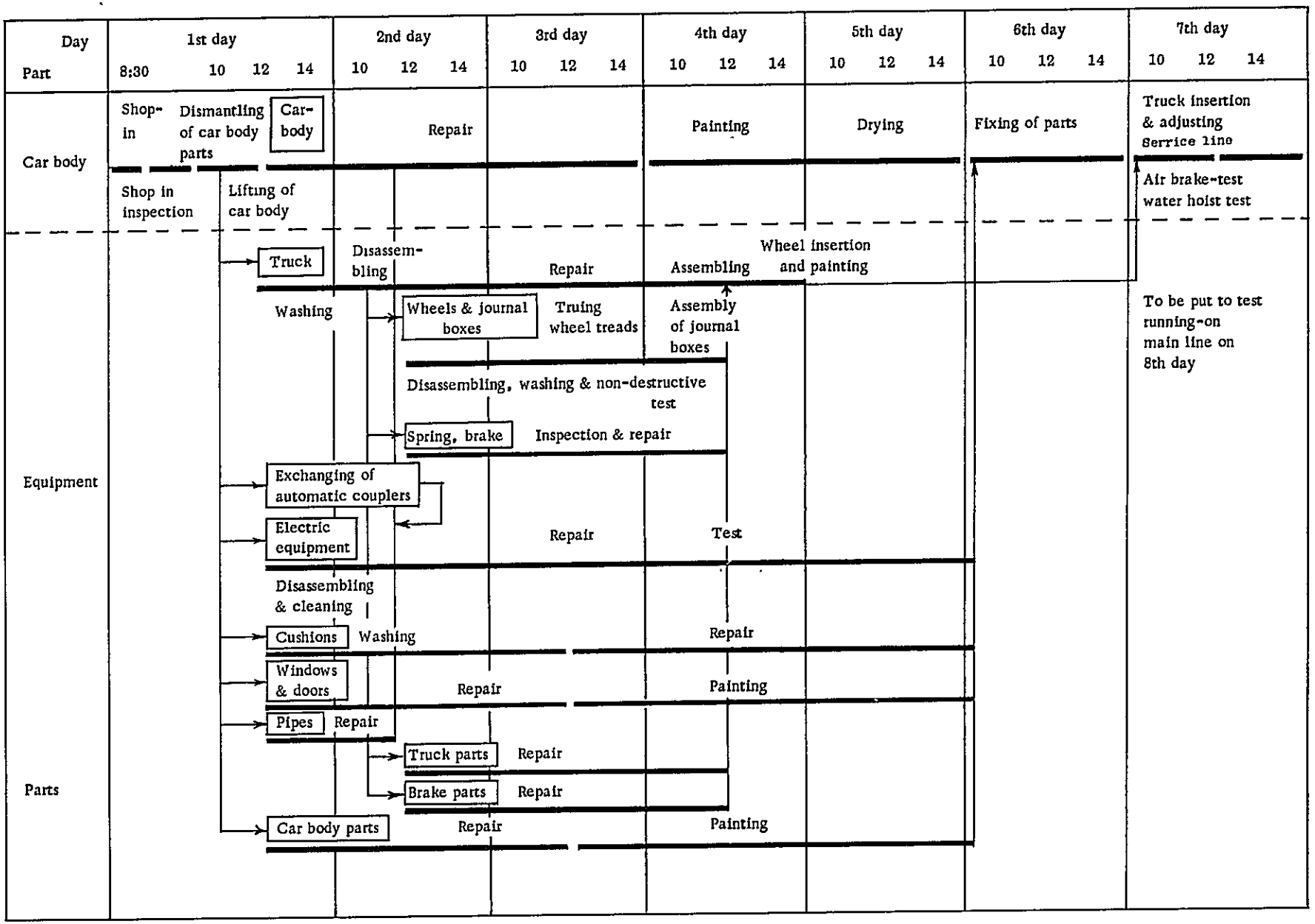
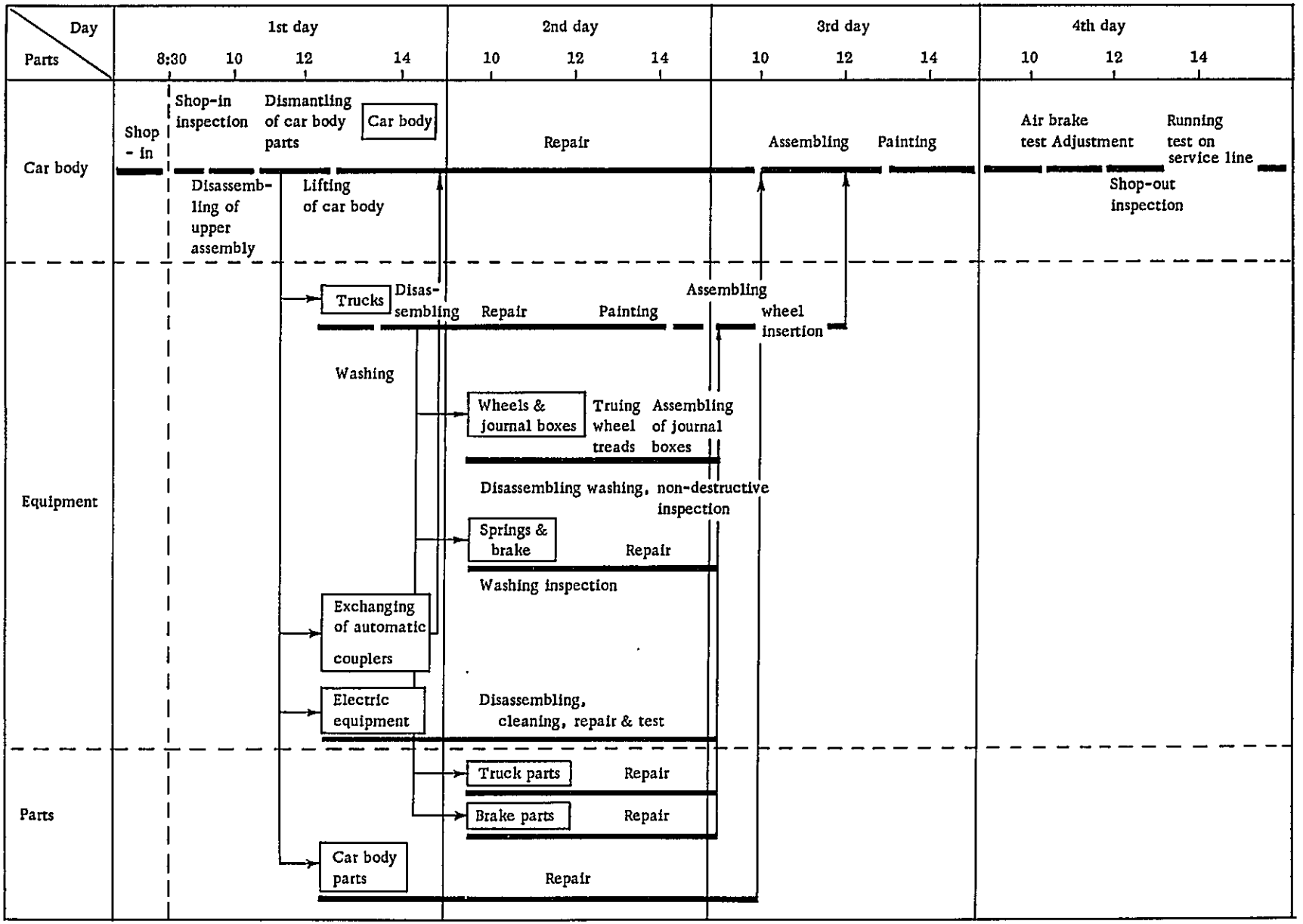


Table 6.9 Suggested standard process for general inspection and repair for FC's



6.2.4 Man-hours for repairing

Table 6.10 indicates the suggested planned values of man-hours required for inspection and repair for various kind of rolling stock based on our judgement that the same man-hours for the Korean National Railroad can be reduced by 30% in the future by enforcing modernization of works through the improving and modernizing of facilities, improving shop layout, mechanizing intra-shop transport works, etc. The present corresponding figures for the Japanese National Railways are also shown in the same table for reference.

Table 6.10 Suggested goal figures for man-hours for inspection and repair of rolling stock

Kind of car	Kind of inspection	1966	1971	1976	1981	JNR (1966)
DL	Yearly insp.	490	490	460	420	
	2-year insp.	630	630	570	510	
	4-year insp.	970	970	880	780	3520
	6-year insp.	1850	1850	1660	1480	
	8-year insp.	5960	5960	5370	4770	5760
	Temporary insp.	660	660	660	660	380
DC	Half yearly insp.	1520	1370	1320	1130	
	Yearly insp.	2800	2520	2380	1960	1790
	General insp.	3710	3340	3160	2600	2550
	Temporary insp.	280	280	280	280	180
PC	General insp.	2160	1950	1840	1520	780
	Temporary insp.	830	750	700	580	138
FC	General insp.	250	225	210	180	167
	Temporary insp.	120	115	110	90	55

CHAPTER Ⅶ

WORKSHOP IMPROVEMENT PLAN

CHAPTER VII. WORKSHOP IMPROVEMENT PLAN

7.1 Present status of workshops

As shown in Fig.5.1, the Korean National Railroad has four workshops — Seoul, Yongdungpo, Pusan and Inchon. There are in all 173 diesel locomotives, 261 steam locomotives and 163 diesel railcars, assigned to 17 locomotive depots and one motive power depot for maintenance purposes. There are also 1,380 passenger cars and 11,403 freight cars, not assigned to any particular office, but in use over the entire system.

Of the four workshops, the Inchon Workshop is intended exclusively for the building of both passenger and freight cars, and the other three are in charge of their repair. Apart from this, the Pusan Workshop is also designed for diesel locomotive repair, the Seoul for steam locomotive and railcar repair, and the Yongdungpo for steam locomotive repair.

Table 7.1 shows the present personnel assigned to the four workshops mentioned above. The Fiscal 1965 figures for car building and repair by workshop are as shown in Tables 7.2 and 7.3.

Table 7.1 Workshop personnel and facilities (1965)

	Unit	Seoul	Yongdungpo	Pusan	Inchon	Total
Personnel	person	1,789	1,064	1,072	893	4,818
Area	m^2	261,557	127,436	207,934	116,103	713,030
Buildings	m^2	45,350	28,999	41,062	29,203	144,614
Equipment		551	421	467	337	1,776
Power used	KWH/year	275,674	174,474	120,049	121,436	691,633
Amount of water used	m^3/year	22,360	8,358	10,075	4,515	45,308

Table 7.2 Number of cars built (Inchon Workshop, 1965)

	1963	1964	1965	1966
New passenger cars	150	100	100	44
New freight cars	200			385
Remodeled passenger cars	29	20	10	
Remodeled freight cars	100			
Freight cars restored from substitutes for passenger cars		350		
New heating cars			10	
Light passenger cars			1	
Tank cars				30

Table 7.3 Number of cars repaired (1965)

	Seoul	Yongdungpo	Pusan	Inchon	Total
Steam locomotives					
General repair	72	48			120
Partial repair	76	53			129
Temporary repair	20	8			28
Heating cars	26				26
Diesel locomotives					
8-year inspection			17		17
6-year "			19		19
4-year "			1		1
2-year "			5		5
1-year "			46		46
Railcars					
General inspection	38		13		51
One year "	10		1		11
6-months "	32		8		40

	Seoul	Yongdungpo	Pusan	Inchon	Total
Passenger cars					
Major repairs	332	235	313		880
Minor "	95	56	58		209
Freight cars					
Major repairs	1, 732	1, 105	1, 632		4, 469
Minor "	456	294	619		1, 369

Table 7.4 shows the amount of work done and expenses required at the workshops, with the exception of Inchon.

As regards organization, the four workshops are practically the same. They are also similar to those of the Japanese National Railways, except that they lack the labor section dealing with labor problems and the product engineering section designated for engineering and industrial engineering.

The equipment of the workshops is, on the whole, in fairly good working order. But most of the equipment is superannuated and naturally shows the effect of this in both efficiency and workmanship. It is therefore an urgent necessity to introduce more modern machinery. Table 7.5 shows the number of machines already past their durable years of service, as classified by machines.

Table 7.4 Amount of work done and expenses

	Seoul	Yongdungpo	Pusan	Total
Amount of work done (man-hours)				
Rolling stock repairs	2, 866, 820 (66%)	2, 002, 750 (73%)	1, 613, 170 (60%)	6, 482, 720 (67%)
Other repairs	1, 475, 670 (34%)	728, 500 (27%)	1, 076, 260 (40%)	3, 280, 450 (33%)
Total	4, 342, 490 (100%)	2, 731, 250 (100%)	2, 689, 430 (100%)	9, 763, 170 (100%)

	Seoul	Yongdungpo	Pusan	Total
Expenses (1,000 Won)				
Personnel expense	177,562 (23%)	110,866 (22%)	120,106 (20%)	408,534 (22%)
Material expenses	125,352	41,761	65,175	232,288
Overhead expenses	16,180	15,916	58,217	90,358
Cost of materials	454,477 (59%)	328,026 (66%)	345,215 (59%)	1,127,718 (60%)
Total	773,571	496,614	588,713	1,858,898

Table 7.5 Workshop equipment according to durability (1961. 10)

		Total	Seoul	Pusan	Yongdungpo	Inchon	%
Total	Total	1,699	554	459	426	210	
	Superannuated	1,114	352	293	311	158	66
	Still serviceable	585	502	166	115	102	34
Machinery	Total	1,129	362	258	320	189	
	Superannuated	796	241	189	246	120	71
	Still serviceable	333	121	69	74	69	29
Prime mover	Total	22	9	5	6	2	
	Superannuated	19	8	3	6	2	86
	Still serviceable	3	1	2			14
Testing equipment	Total	41	16	15	6	4	
	Superannuated	20	7	8	4	1	49
	Still serviceable	21	9	7	2	3	51
Pumps	Total	51	14	21	9	7	
	Superannuated	29	11	7	6	5	57
	Still serviceable	22	3	14	3	2	43
Hoisting equipment	Total	148	59	57	21	11	
	Superannuated	69	42	22	2	3	47
	Still serviceable	79	17	35	19	8	53
Pneumatic equipment	Total	77	16	22	26	13	
	Superannuated	53	11	16	18	8	69
	Still serviceable	24	5	6	8	5	31

		Total	Seoul	Pusan	Yongdungpo	Inchon	%
Weigh bridge	Total	1				1	
	Superannuated						
	Still serviceable	1				1	100
Traverser	Total	11	5	3	2	1	
	Superannuated	9	4	3	2		82
	Still serviceable	2	1			1	18
Electrical equipment	Total	26	10	8	3	5	
	Superannuated	10	3	4	3		38
	Still serviceable	16	7	4		5	62
Miscellaneous	Total	193	63	70	33	27	
	Superannuated	109	25	41	24	19	56
	Still serviceable	84	38	29	9	8	44

7.2 Locations of the workshops

The three workshops of Seoul, Yongdungpo and Inchon are in the northern extremity of the country, fairly close to each other. The Pusan Workshop alone is in the southern extremity.

The rolling stock of the Korean National Railroad, as shown in Fig. 5. 1, is located in 28 areas and among the five Railroad Divisions, It is therefore necessary to make a careful study of possible future locations and operations of workshops to enable them to function as backshops for those car bases.

Since the Korean National Railroad is the main artery of traffic of the nation, there is a strong national need for the stepping up of transport capacity, motive power modernization and operation speed up, in order that the governments economic development project may be most successful and the congestion of city traffic due to the increase of population be alleviated. To cope with the situation it is imperative for the national railroad to consider the rearrangement and modernization of workshops, while endeavoring to boost both line and rolling stock capacity.

From this point of view, special attention should be paid to the study of the Seoul and

Yongdungpo Workshops.

(a) Seoul Workshop (Yongsan)

(1) It will become absolutely necessary to improve the present Seoul Station into a station designed for passengers only in the near future and develop Yongsan Station into a freight station. There is no room for further improvement of the Seoul Workshop at its present site; it is now absolutely essential to find another suitable location for this workshop.

(2) The amount of work that can be possibly performed at the Seoul Workshop has already reached the saturation point; it is no longer possible to expand its capacity. Even if it could be expanded, it would require an enormous investment.

(3) Moreover, the structures and equipment of the workshop are too old to be remodeled or otherwise improved by repair work.

(4) It is being demanded that the workshop be shifted to a location outside of the city area in accordance with special city planning.

(b) Yongdungpo Workshop

(1) This particular workshop was originally a private workshop intended for the manufacture of railroad supplies. But owing to the lack of investment, the workshop evidences neither sufficient capacity for car repair nor sufficient storage tracks for incoming and outgoing cars.

(2) This workshop is likely to prove a public nuisance because the tracks for incoming and outgoing cars not only cross the main road at a grade, but are also adjacent to private housing.

(3) The present site is so unfavorably located that it would require an enormous investment to enlarge the workshop to any great extent.

(4) As in the case of the Seoul Workshop, both the structures and the equipment of the workshop are superannuated.

If a wide view is to be taken of the present and future of the Korean National

Railroad, with the scale and scope of the entire system taken into account, it seems desirable that the present four workshops, now scattered over the country, be concentrated into two workshops. In other words,

(a) Both the Seoul and Yongdungpo Workshops should be gradually reduced in scale and finally abolished. The present site of the Seoul Workshop should be used as the freight station and freight yard for Yangsan, and the Yongdungpo Workshop should serve as a railroad supply depot.

(b) The Inchon Workshop should continue to manufacture cars.

(c) The Pusan Workshop is a good railroad terminal. Besides being a favorably located port city, Pusan is adequately provided with the facilities and equipment required for workshops. The workshop should therefore be kept as it stands. In the future the plant should be modernized and used primarily as a workshop for the repair of diesel locomotives.

(d) It is advisable to construct in the Taejon area an integrated workshop reducing the present Seoul and Yongdungpo Workshops. The Taejon region is comparatively near the Seoul area and is easily accessible to the trunk lines, such as the Kyongpu Line, Chungang Line, Honam Line and Chalia Line.

As regards the facilities for inspection and repair at the rolling stock bases, the number of rolling stock to be repaired on a temporary basis is expected to be quite large because about one-third of the entire assigned stock of the railroad is concentrated in the Seoul area. For this reason, it would be inadvisable to plan undertaking all repairs at the proposed Taejon Workshop, since such an attempt would likely lead to degeneration in car utilization efficiency and the extra cost of car dead-heading. It would therefore be necessary to provide at rolling stock bases facilities for light repair or replacement of parts, work that would not require "shopping-in". All required parts would be supplied from the Taejon Workshop.

If, as described in Chapter V, the locomotives, railcars, passenger cars and freight cars are assigned principally to Susaeg, and some of the locomotives, and passenger and

freight cars of the Chungang Line and the Kyongchung Line to Cheongryangri, it would be possible to conduct temporary locomotive repairs at either Susaeg or Cheongryangri, railcar and passenger car repairs at Susaeg, and freight car repairs at both Susaeg and Cheongryangri.

(Reference) Outline of Inspection and Repair at the Susaeg Car Base

As regards inspection and repair facilities to be provided at Susaeg along the line suggested above, the locomotive depot and passenger and freight car (including railcars) depot are to be set up at the Susaeg base, where virtually all the temporary locomotive and car repairs will be made. Table 7.6 shows an estimate of the funds to be required for the temporary repair of locomotives and cars at the Susaeg base.

Table 7.6 Estimated cost of inspection and repair at Susaeg

(in 10, 000 Won)

	Amount required	Remarks
Buildings	7, 467	DL 2, 560 DC PC FC 4, 907
Equipment	4, 748	DL 2, 344 DC PC FC 2, 404
Structures	1, 493	DL 512 DC PC FC 981
Total	13, 708	

7.3 Location of new workshop

Fig.7.1 shows the respective features of the three proposed sites for the new workshop (provisionally called A, B and C), mentioned as a result of the recent inspection tour.

7.3.1 Proposed site A

Located about one km north of the Ochung Signal Station, this site lies along the Kyongpu Line. The National Railroad has already bought up the greater part of the land to use as a future yard. It is an oblong piece of land, about 150 m wide and 2, 000 m long.

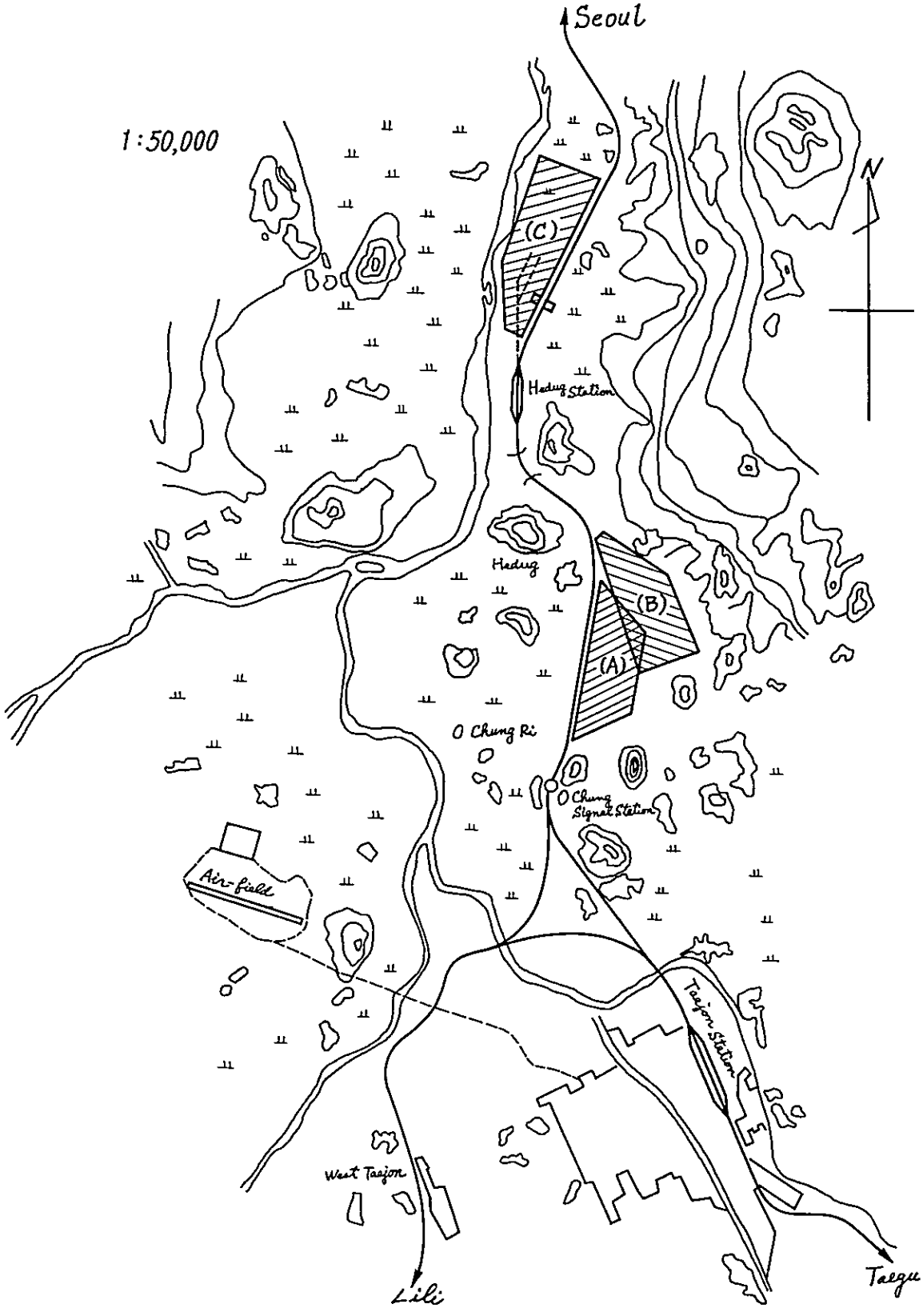


Fig. 7.1 Proposed Sites for the Taejon Workshop

Since, however, hilly terrain lies adjacent to the east of this site, an enormous amount of money would be needed to construct a workshop here, not only for additional land purchase, but also for such work as cutting and banking.

7.3.2 Proposed site B

(a) This piece of land lies between the hilly terrain of site A and the mountainous region to the east; the area is about 1, 500 m long and 400 m wide. Although it generally covers cultivated fields, a certain amount of grading seems necessary before it can be used as a site for a workshop.

(b) Since it will be necessary to build a spur to the proposed workshop from the northern end of area A, both the grade and curve of the main line will have to be improved accordingly.

7.3.3 Proposed site C

(a) This site is adjacent to the northern part of Hedug Station. Sandwiched between the main line and Kobchung, this tract of land measures about 400 m wide and 2, 000 m long. Some amount of embankment would turn it into suitable land for workshop use.

(b) Already quite spacious in area, it is capable of being enlarged in the future.

(c) It will be very convenient for shopping in and out cars.

(d) The price of the land is expected to be reasonable.

A comparison of the three proposed sites shows that C seems the most suitable of the three. The Korean National Railroad may or may not find a better site than the proposed site C. In any event, the matter needs further study and consideration before the final decision is made.

7.4 Planning for the Taejon Workshop

As pointed out in 7.2, the Taejon and Pusan Workshops are destined to play an important part in keeping the rolling stock of the Korean National Railroad in good repair.

The Taejon Workshop will come under the jurisdiction of the three Operating

Divisions of Seoul, Taejon and Sunchon; the Pusan Workshop, under the two Operating Divisions of Pusan and Yongju. The two workshops are to take charge of the following types of rolling stock:

Taejon Workshop ..... The diesel locomotives, passenger cars and freight cars assigned to the three above-mentioned operating divisions, as well as all railcars.

Pusan Workshop ..... The diesel locomotives, passenger cars and freight cars of the two above-mentioned operating divisions.

It may be mentioned that the manufacture and repair of rolling stock parts will be concentrated, as far as feasible, in the Taejon Workshop. Chief among such parts will be brake blocks, diesel railcar engines, springs, air brakes, and services such as casting, forging and millwork.

The main features of the plan for the two proposed workshops are as follows:

(a) Job mechanization and the lay out of buildings and equipment in accordance with assembly-line operation will be planned in order to shorten work time.

(b) Automatic operations will be widely employed to raise efficiency.

(c) Care will be taken to see that the work of moving rolling stock and parts is mechanized and at the same time attention will be given to the layout of working areas in order to shorten transportation distances.

(d) Care will be taken to see that all equipment required be provided with safeguards for the prevention and elimination of accidents to personnel and rolling stock.

(e) Improvement of work climate and welfare facilities for the workers.

(f) Securing trial run tracks within the yard.

7.5 Anticipated results of the proposed plan

The modernization of the Pusan Workshop and the construction of the Taejon Workshop, if carried out according to plan, would undoubtedly prove to be a valuable asset in creating fine backshops for the Korean National Railroad. They are expected to produce the results outlined below:

Located in the center of the railroad network of the nation, the Taejon Workshop is bound to play a central role in car distribution service, and will undoubtedly be a most suitable location, not only for supplying rolling stock parts, but also for rolling stock maintenance.

The Pusan Workshop at the southern end of the Korean Peninsula is located in the best port city of the nation. Naturally enough, Pusan constitutes an important terminal for both passengers and freight, and is therefore in a most suitable position for collecting motive power, passenger cars and other types of rolling stock for repair purposes.

Both the Taejon and Pusan Workshops are thus well worth modernizing with special emphasis being placed on mechanization. It is to be expected that if and when these workshops become modernized, their capacity for rolling stock repair will improve tremendously, work processes will be shortened and this will eventually lead to a reduction of expenses.

By concentrating equipment in the Taejon Workshop, so as to facilitate the supply of rolling stock parts to all parts of the country, it will become possible for the National Railroad to turn out and supply quickly large quantities of good, low-priced parts.

The effects, as envisioned, are bound to lead to improvement in the quality of rolling stock. Trouble to rolling stock will be considerably lessened. Intervals between periodical repairs will become longer and longer, and the number of days required for "shopping-in" rolling stock will be shortened. Rolling stock will thus be able to remain in service longer than ever before.

It may further be stated that, if the rolling stock of the National Railroad is increased threefold, as no doubt it will be, and the conditions of the workshops remain unaltered and unimproved, then the personnel required would also increase roughly threefold to about

12, 000 (excepting the personnel of the Inchon Workshop). But the proposed improvement of the Pusan Workshop and construction of the Taejon Workshop would help prevent the necessity for large personnel increases. If the proposed changes are implemented, 1, 200 additional persons will be employed, an increase of about 30%, instead of the threefold to be required otherwise.

As will be described later, the cost of constructing the Taejon Workshop with a view to modernizing and rationalizing the work of maintaining three times as many cars and locomotives as both Seoul and Yangdungpo Workshops would otherwise be required to repair would be about 7, 900 million Won. If the Seoul and Yangdungpo Workshops were to be enlarged to such an extent as would prove equal to the task of maintaining increased rolling stock, the cost, including the purchase of the required land, would require, instead, about 11, 000 million won. It will therefore be more economical to build the proposed Taejon Workshop than to attempt to improve the present facilities at the Seoul and Yangdungpo Workshops.

7.6 When to build the Taejon Workshop

The Korean National Railroad, by 1968, is slated to eliminate steam traction completely to increase the number of diesel locomotives and railcars, as well as passenger and freight cars. But as stated in 7.1 and 7.2 above, the present scale of the existing workshops is not equal to meeting these demands. Moreover, the facilities and equipment of the workshops are too superannuated to be suitable for the upkeep of modernized rolling stock.

As suggested in 6.2, for the maintenance of rolling stock efforts must be made to see

(a) that as few cars and locomotives as possible are put out of service for more efficient turn around.

(b) that the highest possible safety standards for all operations be maintained; and

(c) that the cost of maintaining rolling stock be kept as low as possible.

To attain these objectives it is necessary to see that the construction of the Taejon Workshop is undertaken as soon as feasible and the facilities for inspection and repair of

rolling stock are modernized as promptly as possible.

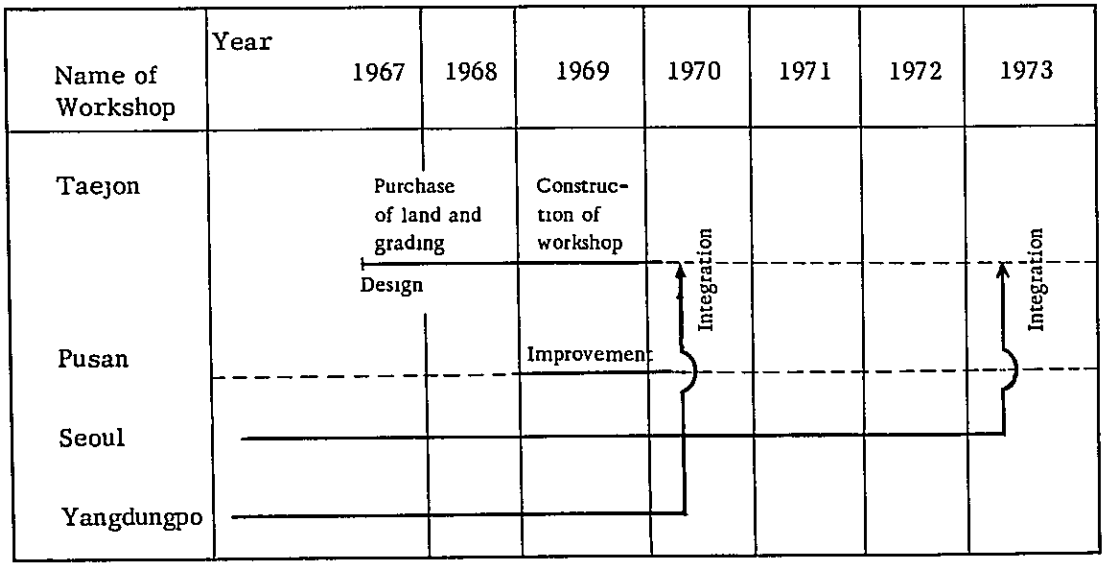
Since, as already pointed out, it would be very difficult, if not impossible, to step up the capacity of the Seoul and Yangdungpo Workshops to such an extent as would meet the anticipated future advance of rolling stock in both quality and quantity, it seems desirable that work in connection with the construction of the Taejon Workshop be started some time in 1968 when steam traction is expected to come to an end in Korea, and that the project be completed in three years.

As regards the Pusan Workshop, since the number of rolling stock in "shop" is expected to increase markedly in 1971, it is necessary to take steps to improve the facilities of this workshop in line with the project of building the Taejon Workshop.

It is therefore desirable that efforts be made gradually to see that the Seoul and Yangdungpo Workshops are either fused or abolished as the work of constructing the Taejon Workshop and improving the Pusan Workshop progresses.

Table 7.7 shows the estimated progress of the Taejon Workshop construction and work schedules for improving other workshops:

Table 7.7



CHAPTER Ⅷ

NEW WORKSHOP CONSTRUCTION PLAN

CHAPTER VIII. NEW WORKSHOP CONSTRUCTION PLAN

8.1 Basic figures for the equipment plan

8.1.1 Number of cars to be assigned

The size of the workshop is determined by the number of cars to be repaired, the number of days the cars are in shop, the type of repairs, and so on. For the number of cars by types of train for each year and the allocation of cars, the figures stated in Chapter IV and Chapter V are adopted. The number of cars by kinds is inferred from the ratio of the number of various kinds as of 1966, and thus the number, by kinds, assigned to Pusan Workshop and Taejon Workshop is estimated as shown in Table 8.1.

8.1.2 Cycle of inspection and repair and rate of shop-in

The cars under the charge of the workshop are to be shopped-in to the workshop to undergo periodical repairs at a specified time in accordance with established rules for the cycle of inspection and repair, or at any time when repairs are necessary.

The number of cars for each workshop to undergo repairs during a year is calculated by determining the shop-in rate from the cycles of repair as broken down by the kinds of car and the classes of repair.

For the system of inspection and repair of each kind of car, the present system of the Korean National Railroad is adopted. However, it is assumed that the cycles of repair for diesel railcars, passenger cars and freight cars will be extended as stated in Chapter VI. The number of cars shopped in for temporary repair is calculated by estimating the annual rate of occurrence of repair to the total number of cars of each kind under each shop's charge. In other words, it is anticipated that the annual rate of occurrence of repairs for which diesel locomotives represent 20% will decrease considerably by 1981, because the quality of maintenance work for rolling stock will then be greatly inproved. The rate of occurrence of repair for diesel railcars is estimated at 10% taking the present JNR situation as reference. The rate of occurrence of repair of passenger cars at present is very high,

Table 8.1 Chronological change of number of rolling stock under charge

Kinds of rolling stock		Estimate for 1966	Taejon Workshop			Pusan Workshop		
			1971	1976	1981	1971	1976	1981
DL	Sw - 8 G - 8 G - 12	91	103	143	186	91	125	163
	ST - 9 ST - 18 STP - 28	50	57	78	102	50	69	89
	ALCO	49	55	77	99	49	67	88
	Total	190	215	298	387	190	261	340
DC		153	235	294	411	-	-	-
PC	Superior class & 2nd class	125	141	170	213	91	106	130
	2nd - 3rd class 3rd class 3rd class, baggage & mail cars Baggage & mail cars	1,269	1,380	1,750	2,190	860	1,080	1,370
	Total	1,394	1,521	1,920	2,403	951	1,186	1,500
FC	Box cars	4,201	3,160	4,500	6,100	2,720	3,850	5,210
	Gondola cars	5,339	4,040	5,700	7,730	3,450	4,880	6,620
	Refrigerator cars	183	143	200	267	120	176	230
	Tank cars	909	690	980	1,330	590	840	1,130
	Flat cars	541	400	570	780	340	490	660
	Caboose cars	253	190	270	370	160	230	310
	Total	11,426	8,623	12,220	16,577	7,380	10,466	14,160
SL		261						

being 24.1%. But it is expected that it will decrease as the rolling stock is modernized and a periodical maintenance system is put into practice. Thus the estimate for the future is 10%, roughly the same as in JNR. Freight cars also are similarly dealt with, and it is presumed that the rate will decrease from the present 15.2% to about 10% in 1981.

The cycles of inspection and repair in different years are given in Table 8.2, and the shop-in rates are shown in Table 8.3.

8.1.3 Number of rolling stock repaired

(Number of rolling stock shopped-in)

The annual number of rolling stock repaired can be determined as the product of the shop-in rate for each class of repair and the number of rolling stock.

In calculating the average daily number of rolling stock repaired, the annual work days are taken as 270 days per year assuming that the present annual work days at the workshops continue as at present. The number of rolling stock repaired, as calculated from the various values stated above, is shown in Tables 8.4, 8.5 and 8.6, and the average daily number repaired, in Tables 8.7 and 8.8.

Table 8.2 Cycles of inspection and repair

Kind of rolling stock	Class of inspection & repair	Year			
		1966	1971	1976	1981
DL	1-year inspection	1 year	1 year	1 year	1 year
	2-year inspection	2 years	2 years	2 years	2 years
	4-year inspection	4 years	4 years	4 years	4 years
	6-year inspection	6 years	6 years	6 years	6 years
	8-year inspection	8 years	8 years	8 years	8 years
	Temporary inspection	Not fixed	Not fixed	Not fixed	Not fixed
DC	6-month inspection	6 months	6 months	9 months	9 months
	One-year inspection	1 year	1 year	1.5 year	1.5 year
	General inspection	2 years	2 years	3 years	3 years
	Temporary inspection	Not fixed	Not fixed	Not fixed	Not fixed
PC	General inspection	16 months	16 months	2 years	2 years
	Temporary inspection	Not fixed	Not fixed	Not fixed	Not fixed
FC	General inspection	2 years	2 years	3 years	3 years
	Temporary inspection	Not fixed	Not fixed	Not fixed	Not fixed

Table 8.3 Shop-in rate

Kind of rolling stock	Class of inspection and repair	Year		
		1971	1976	1981
DL	One-year inspection	0.500	0.500	0.500
	2-year inspection	0.125	0.125	0.125
	4-year inspection	0.125	0.125	0.125
	6-year inspection	0.125	0.125	0.125
	8-year inspection	0.125	0.125	0.125
	Temporary inspection	0.300	0.250	0.200
DC	6-month inspection	1.000	0.667	0.667
	One-year inspection	0.500	0.333	0.333
	General inspection	0.500	0.333	0.333
	Temporary inspection	0.300	0.200	0.100
PC	General inspection	0.752	0.500	0.500
	Temporary inspection	0.241	0.200	0.100
FC	General inspection	0.500	0.333	0.333
	Temporary inspection	0.152	0.100	0.100

Table 8.4 Number of rolling stock repaired at Taejon Workshop

Kinds of rolling stock	Class of inspection and repair	Year		
		1971	1976	1981
DL	One-year inspection	107	150	195
	2-year inspection	27	37	48
	4-year inspection	27	37	48
	6-year inspection	27	37	48
	8-year inspection	27	37	48
	Temporary inspection	65	75	78
	Total	280	373	465
DC	6-month inspection	235	196	275
	One-year inspection	118	98	137
	General inspection	117	98	137
	Temporary inspection	71	60	41
	Total	541	452	590
PC	General inspection	1,144	960	1,202
	Temporary inspection	367	384	240
	Total	1,511	1,344	1,442
FC	General inspection	4,312	4,069	5,520
	Temporary inspection	1,311	1,220	1,658
	Total	5,623	5,289	7,178

Table 8.5 Number of rolling stock repaired at Pusan Workshop

Kinds of rolling stock	Class of inspection and repair	Year		
		1971	1976	1981
DL	One-year inspection	95	131	170
	2-year inspection	24	33	43
	4-year inspection	24	33	43
	6-year inspection	24	33	43
	8-year inspection	24	33	43
	Temporary inspection	57	65	68
	Total	248	328	410
PC	General inspection	715	593	750
	Temporary inspection	229	237	150
	Total	944	830	900
FC	General inspection	3,690	3,485	4,715
	Temporary inspection	1,122	1,047	1,416
	Total	4,812	4,532	6,131

Table 8.6 Number of rolling stock repaired in the Korean National Railroad

Kinds of rolling stock	Class of inspection and repair	Year		
		1971	1976	1981
DL	One-year inspection	202	281	365
	2-year inspection	51	70	91
	4-year inspection	51	70	91
	6-year inspection	51	70	91
	8-year inspection	51	70	91
	Temporary inspection	122	140	146
	Total	528	701	875
DC	6-month inspection	235	196	275
	One-year inspection	118	98	137
	General inspection	117	98	137
	Temporary inspection	71	60	41
	Total	541	452	590
PC	General inspection	1,859	1,553	1,952
	Temporary inspection	596	621	390
	Total	2,455	2,174	2,342
FC	General inspection	8,002	7,554	10,235
	Temporary inspection	2,433	2,267	3,074
	Total	10,435	9,821	13,309

Table 8.7 Average daily number of rolling stock repaired at Taejon Workshop

Class of inspection and repiar		FY 1971		FY 1976		FY 1981	
		Average number shopped in	Average number shopped in (with increment due to fluctuation)	Average number shopped in	Average number shopped in (with increment due to fluctuation)	Average number shopped in	Average number shopped in (with increment due to fluctuation)
DL	One-year inspection	0.40	0.48	0.56	0.67	0.72	0.87
	2-year inspection	0.10	0.12	0.14	0.16	0.18	0.21
	4-year inspection	0.10	0.12	0.14	0.16	0.18	0.21
	6-year inspection	0.10	0.12	0.14	0.16	0.18	0.21
	8-year inspection	0.10	0.12	0.14	0.16	0.18	0.21
	Temporary inspection	0.24	0.29	0.28	0.33	0.29	0.35
	Total	1.04	1.25 (2)	1.40	1.64 (2)	1.73	2.06 (2)
DC	6-month inspection	0.87	1.04	0.73	0.87	1.02	1.22
	One-year inspection	0.44	0.53	0.36	0.44	0.51	0.61
	General inspection	0.44	0.52	0.36	0.44	0.51	0.61
	Temporary inspection	0.27	0.32	0.22	0.27	0.15	0.18
	Total	2.02	2.41 (3)	1.67	2.02 (3)	2.19	2.62 (3)
PC	General inspection	4.24	5.08	3.55	4.26	4.45	5.35
	Temporary inspection	1.36	1.63	1.42	1.71	0.89	1.07
	Total	5.60	6.71 (7)	4.97	5.97 (6)	5.34	6.42 (7)
FC	General inspection	15.97	19.16	15.07	18.08	20.44	24.53
	Temporary inspection	4.86	5.83	4.52	5.42	6.14	7.37
	Total	20.83	24.99 (25)	19.59	23.50 (24)	26.58	31.90 (32)

Table 8.8 Average daily number of rolling stock repaired at Pusan Workshop

Class of inspection and repair		FY 1971		FY 1976		FY 1981	
		Average number shopped in	Average number shopped in (with increment due to fluctuation)	Average number shopped in	Average number shopped in (with increment due to fluctuation)	Average number shopped in	Average number shopped in (with increment due to fluctuation)
DL	One-year inspection	0.35	0.42	0.49	0.58	0.63	0.76
	2-year inspection	0.09	0.11	0.12	0.15	0.16	0.19
	4-year inspection	0.09	0.11	0.12	0.15	0.16	0.19
	6-year inspection	0.09	0.11	0.12	0.15	0.16	0.19
	8-year inspection	0.09	0.11	0.12	0.15	0.16	0.19
	Temporary inspection	0.21	0.25	0.24	0.29	0.25	0.30
	Total	0.92	1.11 (1)	1.21	1.47 (2)	1.52	1.82 (2)
PC	General inspection	2.65	3.18	2.20	2.64	2.77	3.33
	Temporary inspection	0.85	1.02	0.89	1.07	0.56	0.67
	Total	3.50	4.20 (5)	3.09	3.71 (4)	3.33	4.00 (4)
FC	General inspection	13.67	16.40	12.91	15.49	17.46	20.95
	Temporary inspection	4.16	4.99	3.88	4.65	5.24	6.29
	Total	17.83	21.39 (21)	16.79	20.14 (20)	22.70	27.24 (27)

8.1.4 Number of days rolling stock is in workshop proper and number of rolling stock in workshop at the same time

Under consideration is a plan to shorten considerably the number of days required for repairs as stated in Chapter VI. Target values are shown in Table 6.6. The number of days the rolling stock is in the workshop proper is given the values shown in Table 8.9, Figures ascertained by deducting the number of days of repair outside the workshop proper from the total number of days of repair.

The number of rolling stock in the workshop proper at the same time is calculated from the average daily number of rolling stock repaired as shown in the preceding section and

the number of days the rolling stock is in the workshop proper. The values determined are shown in Tables 8.10 and 8.11. In this case, the fluctuation of the shop-in is estimated at 20% as in the case of JNR, which was used as a basic figure for the equipment plan.

8.1.5 Work volume of rolling stock repair

To calculate the work volume of rolling stock repair at workshop the target values of man-hours for repair stated in Section 2, Chapter VI are used for unit man-hours, and the figures in Tables 8.4 and 8.5 are used for the annual number of rolling stock repaired.

As for the man-hours for repair of rolling stock parts supplied to depots from workshops, they are estimated as shown in Table 8.12, applying JNR's annual requirement for man-hours per vehicle.

Table 8.9 Rolling stock: number of days in workshop proper

Kinds of rolling stock	Class of inspection and repair	1966			1971			1976			1981		
		A	B	C	A	B	C	A	B	C	A	B	C
DL	One-year inspection	3			3	0.5	2.5	2	0.5	1.5	2	0.5	1.5
	2-year inspection	4			4	0.5	3.5	3	0.5	2.5	3	0.5	2.5
	4-year inspection	5			5	0.5	4.5	4	0.5	3.5	4	0.5	3.5
	6-year inspection	8			8	1	7	7	1	6	7	1	6
	8-year inspection	10			10	1	9	10	1	9	10	1	9
	Temporary inspection	3			3	1	2	3	1	2	3	1	2
DC	6-month inspection	5			4	0.5	3.5	3	0.5	2.5	3	0.5	2.5
	One-year inspection	10			8	1	7	7	1	6	6	1	5
	General inspection	12			10	1	9	9	1	8	8	1	7
	Temporary inspection	3			3	1	2	3	1	2	3	1	2
PC	General inspection	22			11	0.5	10.5	9	0.5	8.5	7	0.5	6.5
	Temporary inspection	14			8	0.5	7.5	5	0.5	4.5	3	0.5	2.5
FC	General inspection	12			7	0.5	6.5	6	0.5	5.5	4	0.5	3.5
	Temporary inspection	9			4	0.5	6.5	3	0.5	2.5	2	0.5	1.5

Note: A Number of days for repair
B Number of days incidental to repair
C Number of days the rolling stock is in workshop proper.

Table 8.10 Number of rolling stock in Taejon workshop proper at the same time

Class of inspection and repair		1971		1976		1981	
		Number of rolling stock in workshop	Number of rolling stock in workshop (with increment due to fluctuation)	Number of rolling stock in workshop	Number of rolling stock in workshop (with increment due to fluctuation)	Number of rolling stock in workshop	Number of rolling stock in workshop (with increment due to fluctuation)
DL	One-year inspection	0.99	1.19	0.83	1.00	1.08	1.30
	2-year inspection	0.35	0.42	0.34	0.41	0.44	0.53
	4-year inspection	0.45	0.54	0.48	0.58	0.62	0.75
	6-year inspection	0.70	0.84	0.82	0.99	1.07	1.28
	8-year inspection	0.90	1.08	1.23	1.48	1.60	1.92
	Temporary inspection	0.48	0.58	0.56	0.67	0.58	0.69
	Total	3.87	4.65 (5)	4.26	5.13 (5)	5.39	6.47 (6)
DC	6-month inspection	3.05	3.66	1.82	2.18	2.55	3.06
	One-year inspection	3.06	3.67	2.18	2.61	2.54	3.04
	General inspection	3.90	4.68	2.90	3.49	3.55	4.26
	Temporary inspection	0.53	0.63	0.44	0.53	0.30	0.37
	Total	10.54	12.64 (13)	7.34	8.81 (9)	8.94	10.73 (11)
PC	General inspection	44.49	53.39	30.23	36.27	28.94	34.73
	Temporary inspection	10.19	12.23	6.40	7.68	2.22	2.67
	Total	54.68	65.62 (66)	36.63	43.95 (44)	31.16	37.40 (38)
FC	General inspection	103.81	124.50	82.89	99.47	71.56	85.87
	Temporary inspection	16.99	20.41	11.31	13.57	9.21	11.05
	Total	120.80	144.91 (145)	94.20	113.04 (113)	80.77	96.92 (97)

Table 8.11 Number of rolling stock in workshop proper at Pusan Workshop at the same time

	Class of inspection and repair	1971		1976		1981	
		Number of rolling stock in workshop	Number of rolling stock in workshop (with increment due to fluctuation)	Number of rolling stock in workshop	Number of rolling stock in workshop (with increment due to fluctuation)	Number of rolling stock in workshop	Number of rolling stock in workshop (with increment due to fluctuation)
DL	One-year inspection	0.88	1.06	0.73	0.88	0.94	1.13
	2-year inspection	0.31	0.37	0.31	0.37	0.40	0.48
	4-year inspection	0.40	0.48	0.43	0.52	0.56	0.67
	6-year inspection	0.62	0.74	0.73	0.88	0.96	1.15
	8-year inspection	0.80	0.96	1.10	1.32	1.43	1.72
	Temporary inspection	0.42	0.50	0.48	0.58	0.50	0.60
	Total	3.43	4.11 (4)	3.78	4.55 (5)	4.79	5.75 (6)
PC	General inspection	27.80	33.37	18.67	22.40	18.06	21.67
	Temporary inspection	6.36	7.63	3.95	4.74	1.39	1.67
	Total	34.16	41.00 (41)	22.62	27.14 (27)	19.45	23.34 (23)
FC	General inspection	88.84	106.60	71.0	85.20	61.13	73.36
	Temporary inspection	14.55	17.46	9.69	11.63	7.87	9.44
	Total	103.39	124.06 (124)	80.69	96.83 (97)	69.00	82.80 (83)

Table 8.12 Man-hours per vehicle for repair at depots

Kinds of rolling stock	Class of repair	Estimate of man-hours in KNR
DL	Ordinary repair at Depots	180
DC	"	150
PC	"	20
FC (Bogie)	"	4.6

The man-hours for repair of rolling stock at Taejon Workshop and Pusan Workshop as calculated by using the above-mentioned values are shown in Tables 8.13 and 8.14. But, as stated in the following section, 8.1.6, the man-hours required by the Pusan Workshop for concentrated work will be transferred from Pusan to the Taejon Workshop since it has been decided that this type of work should, as for as possible, be performed at Taejon.

8.1.6 Concentrated work and work on principal parts

Share of work on concentrated parts between the two workshops is assumed to be as shown in Table 8.15. The work volume in this connection is calculated from the number of rolling stock under charge for each year, following JNR's actual performance data per assigned vehicle. The volume of work on plate springs and coil springs is calculated from the number of rolling stock to be repaired each year, by using the rate of repairs applicable in JNR. The output and man-hours for the respective kinds of work are shown in Table 8.16.

8.1.7 Manufacture of stores

To carry out repairs smoothly without waste of time, it is necessary to manufacture some parts in the railroad's own workshop and store them there. The rate of manufacture of such parts for store in the Korean National Railroad's workshops is estimated in terms of man-hours, as given in Table 8.17, by using the JNR's values for reference.

8.1.8 Indirect work and other work

Indirect work, workshop machinery repair work, equipment work and building repair or similar work are considered in the same way as the stores manufacturing work. That is, the ratio of those works to the rolling stock repair is estimated and then the work volume is determined as shown in Table 8.18.

Table 8.13 Work volume of rolling stock repair at Taejon Workshop

(Unit: man-hour)

Kinds of rolling stock	Class of inspection and repair	Year		
		1971	1976	1981
DL	One-year inspection	52,430	69,000	81,900
	2-year inspection	17,010	21,090	24,480
	4-year inspection	26,190	32,560	37,440
	6-year inspection	49,950	61,420	71,040
	8-year inspection	160,920	198,690	228,960
	Temporary inspection	42,900	49,500	51,480
	Depot service	38,700	53,640	69,660
	Total	388,100	485,900	564,960
DC	6-month inspection	321,950	258,720	310,750
	One-year inspection	297,360	233,240	268,520
	General inspection	390,780	309,680	356,200
	Temporary inspection	19,880	16,800	11,480
	Depot service	35,250	44,100	61,650
	Total	1,065,220	862,540	1,008,600
PC	General inspection	2,230,800	1,766,400	1,827,040
	Temporary inspection	275,250	268,800	139,200
	Depot service	30,420	38,400	48,060
	Total	2,536,470	2,073,600	2,014,300
FC	General inspection	970,200	854,490	993,600
	Temporary inspection	150,770	134,200	149,220
	Depot service	39,670	56,210	76,250
	Total	1,160,640	1,044,900	1,219,070
TOTAL		5,150,430	4,466,940	4,806,930

Table 8.14 Work volume of rolling stock repair at Pusan Workshop

(Unit: man-hour)

Kinds of rolling stock	Class of inspection and repair	Year		
		1971	1976	1981
DL	One-year inspection	46,550	60,260	71,400
	2-year inspection	15,120	18,810	21,930
	4-year inspection	23,280	29,040	33,540
	6-year inspection	44,400	54,780	63,640
	8-year inspection	143,040	177,210	205,110
	Temporary inspection	37,620	42,900	44,880
	Depot service	34,200	46,980	61,200
	Total	344,210	429,980	501,700
PC	General inspection	1,394,250	1,091,120	1,140,000
	Temporary inspection	171,750	165,900	87,000
	Depot service	19,020	23,720	30,000
	Total	1,585,020	1,280,740	1,257,000
FC	General inspection	830,250	731,850	848,700
	Temporary inspection	129,030	115,170	127,440
	Depot service	33,950	48,140	65,140
	Total	993,230	895,160	1,041,280
Sub-total		2,922,460	2,605,880	2,799,980
Consignment (man-hours to be transferred to Taejon Workshop)	Air brake valve	21,890	29,080	40,080
	Spring	114,140	115,100	154,470
	Engine	31,170	40,310	49,870
	Total	△ 167,200	△ 184,490	△ 244,420
TOTAL		2,755,260	2,421,390	2,555,560

Table 8.15 Share of repair of parts by workshops

Classification	Taejon Workshop	Pusan Workshop
Concentrated parts:		
Casting work	o	
Air brake work	o	
Spring work	o	
Wood work	o	
Principal parts:		
Engine	o	
Main generator	o	o
Traction motor	o	o
Wheel	o	o
Automatic coupler	o	o

Note: Each workshop takes charge of works marked with a circle.

Table 8.16 Volume of work on concentrated principal parts

Kinds of work	Year	Taejon Workshop		Pusan Workshop		Remarks
		Output	Man-hours	Output	Man-hours	
Foundry work:						
Steel casting	1971	181 t	37,630	-	-	
	1976	245	50,930	-	-	
	1981	321	66,730	-	-	
Brake shoes	1971	4,036 t	48,430	-	-	
	1976	5,367	64,400	-	-	
	1981	7,025	84,300	-	-	
Cast iron in general	1971	237 t	29,570	-	-	
	1976	280	34,930	-	-	
	1981	331	41,540	-	-	
Bronze	1971	140 t	17,470	-	-	
	1976	140	17,470	-	-	
	1981	142	17,710	-	-	

Kinds of work	Year	Taejon Workshop		Pusan Workshop		Remarks
		Output	Man-hours	Output	Man-hours	
White metal	1971	60 t	650	-	-	
	1976	60	650	"	"	
	1981	60	650	-	-	
Air brake work : K-valves		pieces				
	1971	28,299	35,410	-	-	
	1976	40,155	50,200	"	"	
	1981	54,403	67,810	"	"	
A-valves &. relay valves		pieces				
	1971	10,662	25,380	-	-	
	1976	13,372	31,820	"	"	
	1981	17,617	41,930	"	"	
Lumbering	1971	3,252 m^3	32,520	-	-	
	1976	4,539	45,390	"	"	
	1981	6,096	60,960	-	-	
Automatic coupler work		pieces		pieces		
	1971	8,263	45,690	6,646	36,750	
	1976	11,491	63,550	9,292	51,380	
	1981	15,427	85,310	12,480	69,010	
Spring work : Bolster springs		pieces				
	1971	13,539	226,640	"	"	
	1976	13,659	228,670	"	"	
	1981	18,346	307,110	"	"	
Bearing springs		pieces				
	1971	1,361	7,520	-	-	
	1976	1,230	6,800	"	"	
	1981	1,511	8,350	"	"	
Side dump door stoppers		sets				
	1971	28,266	18,370	"	"	
	1976	28,794	18,720	-	-	
	1981	39,012	25,360	-	-	
Engine work : DL engines	1971	70	66,080	-	-	The number of main generators is the same as the number of engines.
	1976	92	86,440	-	-	
	1981	113	106,390	"	"	
DC engines	1971	514	215,040	"	"	
	1976	428	179,760	"	"	
	1981	572	240,240	"	"	

Kinds of work	Year	Taejon Workshop		Pusan Workshop		Remarks
		Output	Man-hours	Output	Man-hours	
Traction motors	1971	252	-	230	-	
	1976	354	-	310	-	
	1981	454	-	402	-	
Whell: DL wheels		axles		axles		
	1971	538	-	478	-	
	1976	740	-	660	-	
	1981	958	-	854	-	
DC. PC. FC. wheels		axles		axles		
	1971	27,392	-	21,292	-	
	1976	27,184	-	21,340	-	
	1981	36,232	-	28,520	-	

Table 8.17 Man-hours for manufacture of stores

(Unit : man-hour)

Kinds of rolling stock	Ratio to the man-hours for repair of rolling stock	Taejon Workshop			Pusan Workshop		
		1971	1976	1981	1971	1976	1981
DL	3 %	11,640	14,580	16,950	10,330	12,900	15,050
DC	1.2	12,780	10,350	12,100	-	-	-
PC	7.0	177,550	145,150	141,000	110,950	89,650	87,990
FC	5.0	58,030	52,250	60,950	49,660	44,760	52,060
Total		260,000	222,330	231,000	170,940	147,310	155,100

Table 8.18 Volume of indirect and other works

(Unit: man-hour)

Kinds of work	Ratio to man-hours for rolling stock repair	Taejon Workshop			Pusan Workshop		
		1971	1976	1981	1971	1976	1981
Indirect work (1)	7.90 %	406,880	352,890	379,750	217,670	205,860	201,890
Machinery repair (2)	0.49	25,240	21,890	23,550	13,500	12,770	12,520
Equipment repair (3)	7.80	401,730	348,420	374,940	214,910	203,260	199,330
Building repair or similar work (4)	0.07	3,610	3,130	3,370	1,930	1,820	1,790
Work incidental to removal (5)	0.20	10,300	8,930	9,610	5,510	5,210	5,110
Total (2)+(3)+(4)+(5)		440,880	382,370	411,470	235,850	223,060	218,750

8.1.9 Volume of work at each workshop

The total work volume at a workshop can be given as the sum of man-hours for rolling stock repair and man-hours for other kinds of work. Assuming that the repairs of air brake valves, springs and engines at the Pusan Workshop are consigned to the Taejon Workshop, and the casting and lumbering are counted in the work of Taejon Workshop, the total work volume of each workshop is calculated as shown in Table 8.19.

8.1.10 Personnel needed by each workshop

The number of employees is to be determined from the total work volume. The number of workers in charge of transportation within the workshop and the number of the administrative staff are to be calculated from the number of workmen. In other words, the present ratio, about 20%, of the administrative staff to the actual work staff will presumably rise to about 33% as the advancement of production techniques and modernization of rolling stock and equipment will require more personnel characterized by higher standards of knowledge and judgement; hence this 33% is used to calculate the number. The annual working man-hours per capita is taken at 2190. The formulae are as follows:

Number of workmen = Annual total man-hours/Annual working man-hours per capita

Number of workers in charge of transportation
= Number of workmen x 6.2%

Number of administrative staff = Number of workmen x 33.1%

The result of these calculations are summarized in Table 8.20.

Table 8.19 Total work volume of Taejon and Pusan Workshops

(Unit: man-hour)

Workshop / Kinds of work	Taejon Workshop			Pusan Workshop		
	1971	1976	1981	1971	1976	1981
Rolling stock repair:						
DL	388,100	485,900	564,960	344,210	429,980	501,700
DC	1,065,220	862,540	1,008,600	-	-	-
PC	2,536,470	2,073,600	2,014,300	1,585,020	1,280,740	1,257,000
FC	1,160,640	1,044,900	1,219,070	993,230	895,160	1,041,280
Consigned to Taejon Workshop	-	-	-	△167,200	△184,490	△244,420
Total	5,150,430	4,466,940	4,806,930	2,755,260	2,421,390	2,555,560
Various other kinds of work:						
Work consigned	167,200	184,490	244,420	-	-	-
Casting	133,750	168,380	210,930	-	-	-
Lumbering	32,520	45,390	60,960	-	-	-
Stores manufactures	260,000	222,330	231,000	170,940	147,310	155,100
Indirect work	406,880	352,890	379,750	217,670	205,860	201,890
Others	440,880	382,370	411,470	235,850	223,060	218,750
Total	1,441,230	1,355,850	1,538,530	624,460	576,230	575,740
TOTAL	6,591,660	5,822,790	6,345,460	3,379,720	2,997,620	3,131,300

Table 8.20 Number of personnel needed by each workshop

(Unit: person)

Workshop / Job classification	Taejon Workshop			Pusan Workshop		
	1971	1976	1981	1971	1976	1981
Number of workers	3,010	2,659	2,897	1,543	1,369	1,430
Number of workers in charge of transportation	187	165	180	96	85	89
Number of administrative staff	996	880	959	513	453	474
Total	4,193	3,704	4,036	2,152	1,907	1,993

8.2 Workshop Improvement Plan (centered on Taejon Workshop)

8.2.1 The Scale of the Project

(a) Repair capacity

The construction plan for the Taejon Workshop and the improvement plan for the Pusan Workshop are to be determined on the basis of basic figures for the equipment plan in 8.1 and the repair capacity as shown in Table 8.21. If the number of rolling stock to be repaired in Fiscal 1981 were taken as a basis for workshop improvement, it would still be difficult to take care of the repair of all the rolling stock in 1976. In other words, the capacity of the main building of the workshop would be found insufficient to meet the required demands for repair, because repair turnrounds and number of days required for repair would not be rationalized perfectly in 1976.

It would be extremely difficult, if not impossible, to prolong to any great extent intervals between periodical reapirs or shorten the number of days required for car repair in short order. It seems advisable to adopt for the Taejon Workshop a main shop capacity calculated on the basis of the number of repair cars as of Fiscal 1981 and the in-shop days for repair as of Fiscal 1976. In this case the main building of the workshop will have, in 1981, some spare capacity, which may lead to a slight increase in the investment in the building fund. But such an increase is not likely to affect the whole project to any serious extent. Much the same thing applies to the improvement plan for the Pusan Workshop.

Table 8.21 Repair Facilities

		DL	DC	PC	FC
Taejon Workshop	Average number of incoming cars per day	2	3	7	32
	Capacity of the main building	6	53		126
Pusan Workshop	Average number of incoming cars per day	2	0	4	27
	Capacity of the main building	-	27		83

(b) Concentrated work and work on Main Parts

Concentrated work, as shown in 8.1, includes casting, air brake work, repair of springs, engines etc. Table 8.22 shows the planned concentrated work and number of main parts to be reapírs for Fiscal 1981. This table will be used for the scale of both Taejon Workshop and Pusan Workshop equipment with regard to production and repair of the main parts.

(c) Other kinds of work

In regard to other kinds of work, such as the manufacturing of spare parts, stores and indirect works, the basic values are based on data from the Japanese National Railways.

Table 8.22 Production of Concentrated Parts and Repair of Principal Parts

		Taejon Workshop	Pusan Workshop
Casting	Steel casting	400 t	-
	Brake shoes	8,000 t	-
	Cast iron in general	330 t	-
	Bronze	150 t	-
	White metal	60 t	-
Air brake valve work	K-valves	55,000 pieces	-
	A-valves, relay valves	18,000 pieces	-
Lumbering		7,000 m^3	-
Automatic couplers		16,000 pieces	13,000 pieces
Spring work	Bolster springs	18,500 pieces	-
	Bearing springs	1,500 pieces	-
	Side dump door stoppers	39,000 sets	-
Engine work	DL engines	120 sets	-
	DC engines	580 sets	-
Wheel	DL wheels	960 axles	900 axles
	Other wheels	37,000 axles	29,000 axles

(d) Power equipment (compressed air, electric power receiving and distributing equipment, boiler, gas equipment)

To determine the capacity of power equipment of the Taejon Workshop, the relationship between the scale of the workshop and the capacity of the power installations in JNR was investigated for reference. The capacity of power equipment necessary for the Taejon Workshop is shown in Table 8.23.

Table 8.23 Power Equipment

	Capacity	Remarks
Air compressor	1, 100 kw	220 kw x 5 sets; 7 kg/cm^2; 140 m^3/min.
Boiler	31 t/hr	
Power reception and distribution	10, 400 kvA	
Acetylene gas	60, 000 l/hr	Gas pressure 1.3 kg/cm^2
Water supply	3, 100 m^3/day	

8.2.2 Building area for each unit of repair facilities (Taejon Workshop)

Based on the scale of the equipment arrangement stated above, the building areas required for the respective units of repair facilities are calculated as shown in Table 8.24. In this estimation, the area necessary for the repair of car bodies is determined by the size of the rolling stock of Korean National Railroad and the area for the repair of parts is taken from the standards adopted by JNR.

Plan 1 and Plan 2 in the table refer to those given in Figs. 8.1, 8.2 and 8.3. The alternative plan is suggested in line with the partial amendment of the plan as stated in the intermediate report. The outline is given below.

Plan 1. A stationary system is adopted for the repair of passenger cars and freight cars. In other words, in the car body repair shop repairs are made to the car body while it is fixed on a car body support, with an overhead crane being used to carry it from the disassembly shop to the car body repair shop. At the same time, the truck

and wheels of any kind of rolling stock are carried by traverser to the bogie repair shop, where the work is made with the line working system.

Plan 2: A false truck and traverser are used, when repairing the car body of DC's and PC's, to perform the line working system. Freight cars are repaired in the same way as in Plan 1, by a stationary system. The truck and wheels are repaired in the same way as in plan 1.

8.2.3 Machinery by Units of Repair Facilities (Taejon Workshop)

(a) Number and capacity of machinery

As regards the decision of machinery to be installed, it is desirable to have the following equipment on the assumption that the workshop operation will be mechanized and automatized as far as possible as stated in Chapter VII, Workshop Improvement Plan.

i. Mechanization and automatization of work

Forging of brake shoes, manufacture and repair of springs, repair of air brake valves, repair of automatic couplers, lumbering, painting, cleaning of parts and automatic operation of power equipment, inspection and repair of engines, cleaning of window frames and washing of bedding or seat cushions, etc.

ii. Automatization of tests and inspections

Detection of axle flaws, (magnetic powder method, ultrasonic detection), testing of air brake valves, detection of flaws in springs, etc.

The requirements of machines as broken down by kinds of repair according to the foregoing policy, are calculated in Table 8.25.

Table 8.24 Building area for each unit of the repair facilities

(Unit: m^2)

Repair facilities	Plan 1	Plan 2
Disassembly and assembly of locomotives	3,168	3,168
Dismounting and mounting of DC & PC parts	-	2,040
Disassembly of freight cars	2,040	2,040
Trucks (Bogies)	9,000	9,000
Car body of passenger cars	15,840	10,200
Car body of diesel railcars	-	2,040
Car body of freight cars	19,800	15,840
Fabric and window frames	900	900
Wood work	2,640	2,640
Electrical parts	3,280	3,280
Engine repairs	3,560	3,560
Painting	3,660	6,120
Axles and wheels	4,000	4,000
Machining	1,600	1,600
Iron work finishing	4,500	4,800
Automatic couplers	700	700
Air brake valves	750	750
Tank car cleaning	450	450
Weighbridge and servicing	790	950
Shop-in check shed	2,346	1,632
Tools	1,000	1,000
Reclamation	550	518
Machine repairs	1,900	1,900
Building repairs	700	600
Transportation	500	500
Brake shoes others *	4,800	4,800
Springs	1,000	1,000
Forging	1,900	1,900
Lumbering	2,400	2,400
Power equipment	1,150	1,150
Offices **	5,500	5,500
Miscellaneous houses	3,000	3,000
Storage house	10,000	10,000
Dining hall	4,320	4,320
Dressing rooms	4,320	4,320
Total	122,064	118,618

Note : * ... Including cast iron, cast steel and bronze.
** ... Including shop-side offices.

Table 8.25 List of Machines Classified by Units of Repair Facilities

Unit of repair facilities	Total number of machines		Number and capacity of principal machines
	Plan (1)	Plan (2)	
Overhauling and assembling of locomotives	11	15	(1) 2 overhead cranes (60t x 30 m) (2) 2 overhead cranes (15t x 20 m) 1 underfloor equipment attaching and removing device (load 20t x lift 800 mm)
Freight car overhauling	1	1	1 overhead crane (10t x 20 m)
Bogie	60	61	2 bogie painting devices 4 ultrasonic flaw detectors 3 magnetic defect detectors 2 bogie testing devices 1 bogie washing device 5 overhead cranes (10t x 20 m) (1) 2 overhead cranes (5t x 20 m) (2) 3 overhead cranes (5 t x 20 m)
Passenger car car body	31	27	(1) 4 overhead cranes (30t x 30 m) 7 grinding machines for miscellaneous use 8 a.c. welding machines 2 hydraulic pumps (20kg/cm^2)
Diesel railcar car body	4	4	2 lifting jacks (40 t) 1 overhead crane (7.5 t x 20 m) 1 dielectric testing device (5 kVA)
Freight car car body	31	37	(1) 6 overhead cranes (20 t x 20 m) (2) 12 overhead cranes (10 t x 20 m) 10 grinding machines for miscellaneous use (dimension of the grinding wheel, 300 mm) 13 a.c. welding machines (200 - 450 A)
Sewing, window sash	14	14	1 seat cushion washing machine 6 sewing machines 2 circular saws 1 window sash washing machine

Unit of repair facilities	Total number of machines		Number and capacity of principal machines
	Plan (1)	Plan (2)	
Wood working	16	16	2 band saws (diameter and width of saw wheel 520 mm x 38 mm respectively, table 610 mm x 560 mm) 4 circular saws (diameter, 610 mm x Table 720 mm x 1,630 mm) 2 dust collectors 4 chamfering machines (Table 900 mm x 1,500 mm, the size of material to be worked on, 380 mm wide) 4 planers (Table 300 mm x 2,000 mm, width of plane 300 mm x speed 2,500 r.p.m.)
Electric parts	45	45	1 traction motor testing machine 1 dielectric testing machine (3 kVA x 5,000 V) 1 Shering bridge 1 layer short circuit testing machine (7,500 V) 1 motorgenerator (for testing purpose, 5 kW) 2 overhead cranes (10 t x 15 m) 2 armature lathes (11 kW, swing 1110 mm)
Inspection and repair of engine	54	54	1 parts washing device (10.4 m x 3.4 m x 2 m x jet 240 l/h) 1 cylinder boring machine (Bore work 150 - 350 mm x depth 1,140 mm x 2 heads) 1 cam shaft through boring machine (diameter of bore 66 x 110 mm, length 350 mm) 1 crank shaft grinding machine 2 valve grinding machines 5 fuel injection pump testing machines 2 oil flushing machines 2 overhead cranes (15 t x 20 m) 1 overhead crane (15 t x 15 m) 1 overhead crane (10 t x 15 m) 1 horsepower testing machine (350 - 2,000 PS) 2 horsepower testing machines (140 - 700 PS) 1 engine preheating testing machine

Unit of reapir facilities	Total number of machines		Number and capacity of principal machines
	Plan (1)	Plan (2)	
Painting	36	39	(1) 4 passenger car painting machines (portable, maximum discharge 700 cc/min. air pressure, 2 - 3 kg/cm^2) (2) 8 painting machines as above (1) 3 passenger car body drying machines (million kilocalorie) (2) 2 drying machines as above (1) 2 freight car painting machine and automatic painting equipments. (2) 4 painting machines as above (1) 2 units of freight car body drying equipment. (200,000 kilocalorie) (2) 4 units of drying equipment as above 2 units of electrostatic painting equipment for parts painting 2 paint mills (18ℓ) 2 paint rollers (10ℓ)
Wheels and axle	45	45	4 journal lathes (swing above bed, 1,270 mm, swing above carriage 930 mm x 2 heads) 3 wheel center lathes (swing above bed 1,270 mm, x swing above carriage, 930 mm x center to center distance, 2,700 mm x 2 heads) 2 type boring and turning lathes (diameter of table 1,500 mm) 2 type boring and turning lathes (diameter of table 1,000 mm) 2 wheel presses (maximum pressure, 400 t x diameter of ram, 500 mm x stroke 900 mm) 5 wheel lathes (workable diameter of wheel 1,250 mm x maximum distance between face plates, 3,300 mm x main motor 25/15 kW) 1 wheel conveyer 4 wheel lathes (center to center distance 2,500 mm x swing above bed 620 mm x motor 19 kW) 2 ultrasonic flaw detectors (vertical) 2 ultrasonic flaw detectors (oblique angle)

Unit of repair facilites	Total number of machines		Number and capacity of principal machines
	Plan (1)	Plan (2)	
Roller bearing	6	6	1 unit of washing equipment 1 flaw detector 2 jib cranes (1 t x 3 m) 2 inner-race pull out machines
Machining	125	125	35 No. 2 lathes 8 No. 3 lathes 5 No. 4 lathes 6 No. 2 vertical milling machines 3 No. 3 vertical milling machines 4 radial boring machines (swing 1,600 mm) 10 vertical drilling machines (swing 540 mm x drilling range 40 mm) 6 turret lathes 3 vertical boring machines (diameter of table 1,000 mm x maximum diameter 1,250 mm x maximum height 600 mm) 1 saddle planing machine (Planomiller) (1,200 mm x 3,500 mm x 1,000 mm) 2 overhead cranes (5 t x 15 m) 1 overhead crane (1 t x 15 m) 2 duplex head milling machine (table 700 mm x 660 mm x table travel 700 mm x stroke of main shaft 350 mm x motor 11 kW)
Iron work & finishing	105	105	30 a.c. welding machines (200 - 400 A) 3 presses (50 t x 7,150 mm stroke) 4 presses (15 t x 300 mm stroke) 5 brake beam lathes 6 upright drilling machines (Swing 450 mm x drilling range 40 mm (steel)) 2 high frequency induction hardening devices (40kW x hardening range 300 mm ø x 600 mm) 2 overhead cranes (3 t x 30 m)
Automatic coupler	40	40	1 automatic coupler overhauling machine 1 jet washing device 2 automatic metal depositing machines 1 automatic coupler assembling machine 2 yoke rivet fastening machines (200 kg/cm^2) 3 profile shapers (Stroke 700 mm x table 690 mm x 400 mm x 430 mm)

Unit of repair facilities	Total number of machines		Number and capacity of principal machines
	Plan (1)	Plan (2)	
Air brake valve	74	74	1 shot blast (turn-table type, projecting amount 80 kg x 2 x driving motor 3.7 kW x operating air volume 25 m^3/min) 2 valve seat lapping machines (lapping number 12 - 120/min, 8 fixed together) 2 valve seat lapping machines (Avalve, 3 fixed together) 2 plane lapping machines (dia. of lapping plate 610 mm x 40 r.p.m. x ring dia. 245 mm) 5 automatic testers for K valves 5 valve testers for A valves and Relay valves
Tank car washing	2	2	1 washing device (chemical washing device 35 m^3, hot water washing device 35 m^3, pump 15 m^3/min, life head 20 m) 1 hydraulic testing machine (pump 1.5 m^3/min)
Weighbridge and servicing room	5	5	1 weighbridge (30 t) 1 dielectric testing machine (5 kVA, primary 400 V, secondary 10 kV) 1 engine testing device 1 lubrication testing equipment 1 wiring testing machine
Incoming passenger car inspection shed	4	4	3 a.c. welding machines (200 - 400 A) 1 dielectric testing machine (primary 400 V x secondary 10 kV)
Tool	44	44	8 No.1 lathes 5 No.2 lathes 4 vertical milling machines (No.2) 3 universal milling machines (No.2) 2 universal grinders (Swing 250 mm x center to center distance 700 mm x diameter of grinding wheel 150 mm) 3 grinders (for drill maximum 75 mm ϕ) 3 grinders (for cutting tool, 40 mm x 40 mm) 2 grinders (for milling 100 mm ϕ - 760 mm ϕ) 2 electric hammers (1/2 t) 1 broaching machine (maximum pulling out force 5,000 kg x pulling stroke 900 mm)

Unit of repair facilities	Total number of machines		Number and capacity of principal machines
	Plan (1)	Plan (2)	
Reclamation	21	21	2 non-ferrous metal sorting devices 2 bolt and nut's thread cleaning machines 2 presses (10 t) 6 gas cutting machines 1 furnace (heavy oil, 700 mm x 600 mm x 1,000 mm) 3 furnaces (coke, 1,200 mm ϕ x 530 mm)
Workshop machinery repair	18	18	2 No.2 lathes 2 No.3 lathes 1 universal milling machine (No.2) 1 slotting machine (dimension of table 850 mm x stroke 320 mm x movement of table, transverse 500 mm x lengthwise 600 mm x motor 7.5 kW) 1 gear shaper (maximum diameter 500 mm x width 180 mm x module 7) 1 bevel gear cutting machine, max. dia. 430 mm x module 8) 1 hobbing machine (max. tooth dia. 900 mm x width 450 mm x module 13) 1 gear tooth chamfering machine (max. dia. of gear wheel 457 mm x length 360 mm) 1 overhead crane (5 t) 1 universal machine tool
Building repair	15	15	1 automatic planing machine 1 hand planing machine 1 band saw 1 circular saw 2 a.c. welding machines (100A - 200A) 2 a.c. welding machines (200A - 400A)
Transportation	32	32	2 forklift trucks (0.5 t) 12 forklift trucks (1 t) 4 forklift trucks (2 t) 5 trucks (7 t) 3 shunting engines (25 t x 180 PS) 2 passenger automobiles 2 microbuses

Unit of repair facilities	Total number of machines		Number and capacity of principal machines
	Plan (1)	Plan (2)	
Brake block casting	64	64	2 cupolas (8 t) 1 set of brake block casting line 1 low frequency induction furnace for general casting (0.5 t x 100 kVA) 1 electric furnace (1 t) 1 set of sand disposing device 2 overhead cranes (3 t x 20 m) 1 low frequency induction furnance for bronze casting (0.5 t) 1 overhead crane (1 t)
Spring repair	29	29	1 buckle heater (buckle 800°C x 5 min. x 50 kVA) 1 buckle removing machine 1 jet washing device 1 magnetic flaw detector (AC 200 V x 100 A x 2 P) 1 low temperature heating furnace (Size 2,000 mm x 400 mm x 7,200 mm x capacity 200 V x 300 kW x high voltage transformer (100 kVA) 1 shot blast
Forging	30	30	3 pneumatic hammers (1 t) 2 pneumatic hammers (1/2 t) 1 crank press (100 t) 1 bolt forging machine 1 normalizing furnace
Lumbering	15	15	1 chain saw 1 band saw for rough lumbering 2 band saws for medium lumbering 1 band saw for smaller lumbering 1 4-side wood planing machine
Power facilities	32	32	5 air compressors (balanced-opposed-piston type, 220 kV) 5 boilers (6,300 kg/hr.) 1 acetylene gas producer (continuous gas flow 60,000 ℓ/hr x pressure 1.3 kg/mm^2) 3 water supply sterilizing devices

Unit of repair facilities	Total number of machines		Number and capacity of principal machines
	Plan (1)	Plan (2)	
Office building	2	2	1 set of air conditioning equipment 1 business machine
Various houses	4	4	1 fire engine (large) 2 fire engines (small) 1 set of fire alarm
Storage house	3	3	1 yard crane (5 t x 25 m) 1 elevator (1 t) 3 units of material handling equipment (1 ton lift) 2 units of same (0.5 t)
Dining hall	1	1	1 set of kitchen equipment
Dressing room	1	1	
Total	1020	1030	

8.2.4 Layout of Buildings and Machinery

(a) Layout of buildings

As pointed out in 8.2.2, the arrangement of buildings was planned according to the area of land and classified by work which is divided into three processes: 1st process (concerning car body), 2nd process (parts) and 3rd process (concerning stores manufacturing) Distances to be covered in the movement of goods and the weight of the goods were taken into account, so that the operations might be carried out as efficiently as possible. Fig.8.1 shows a general plan of work, and Figs.8.2 and 8.3 a general layout of buildings, based on the space allocation scheme given as Table 8.24. Figs.8.4, 8.5 and 8.6 illustrate how the shops for car bodies of DL, passenger cars and freight cars will be arranged. Fig.8.5 shows how car bodies of passenger cars (both PC and DC) and freight cars will be repaired by the use of overhead crane as described in (b), and Fig.8.6 shows how an assembly line will be adopted for shifting car bodies by the use of traverser.

(b) Flow of work

Figs.8.7 and 8.8 show an outline of the flow of work, such as the building of car bodies, trucks and wheels, and painting, as planned according to (a) above.

(c) Layout of equipment

The machines as shown in 8.2.3 (a), are to be installed in the buildings, as arranged in (a) above, according to function. In order to make the flow of work as smooth as possible, care must be taken to see that the distance over which parts move in the workshop is shortened and that proper space is allocated for the layout of equipment. With this in mind, the layout of equipment for axles, trucks, engines, car body painting, automatic painting of freight cars, automatic couplers, brake blocks, casting, bronzing, springs, lumbering, etc., was mapped out as shown in Figs.8.9 - 8.19.

(d) Motive power, wiring and piping

As regards the scale of equipment for electric, steam, air, gas, water and other sources of power, the plan is as described in 8.2.1 (d). The layout of the power facilities is shown in Figs.8.2 and 8.3.

Fig. 8.1 Allocation of Shops

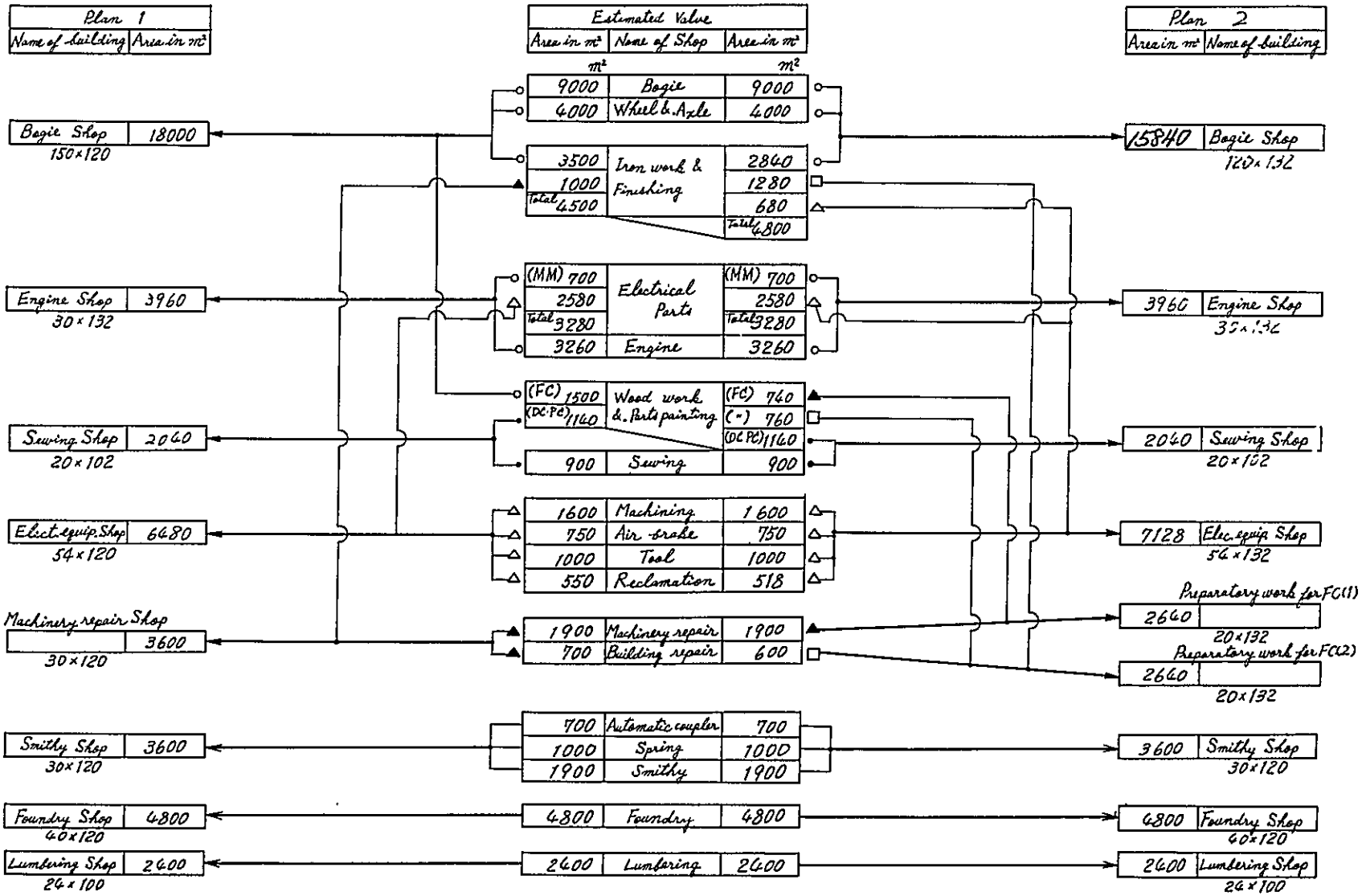
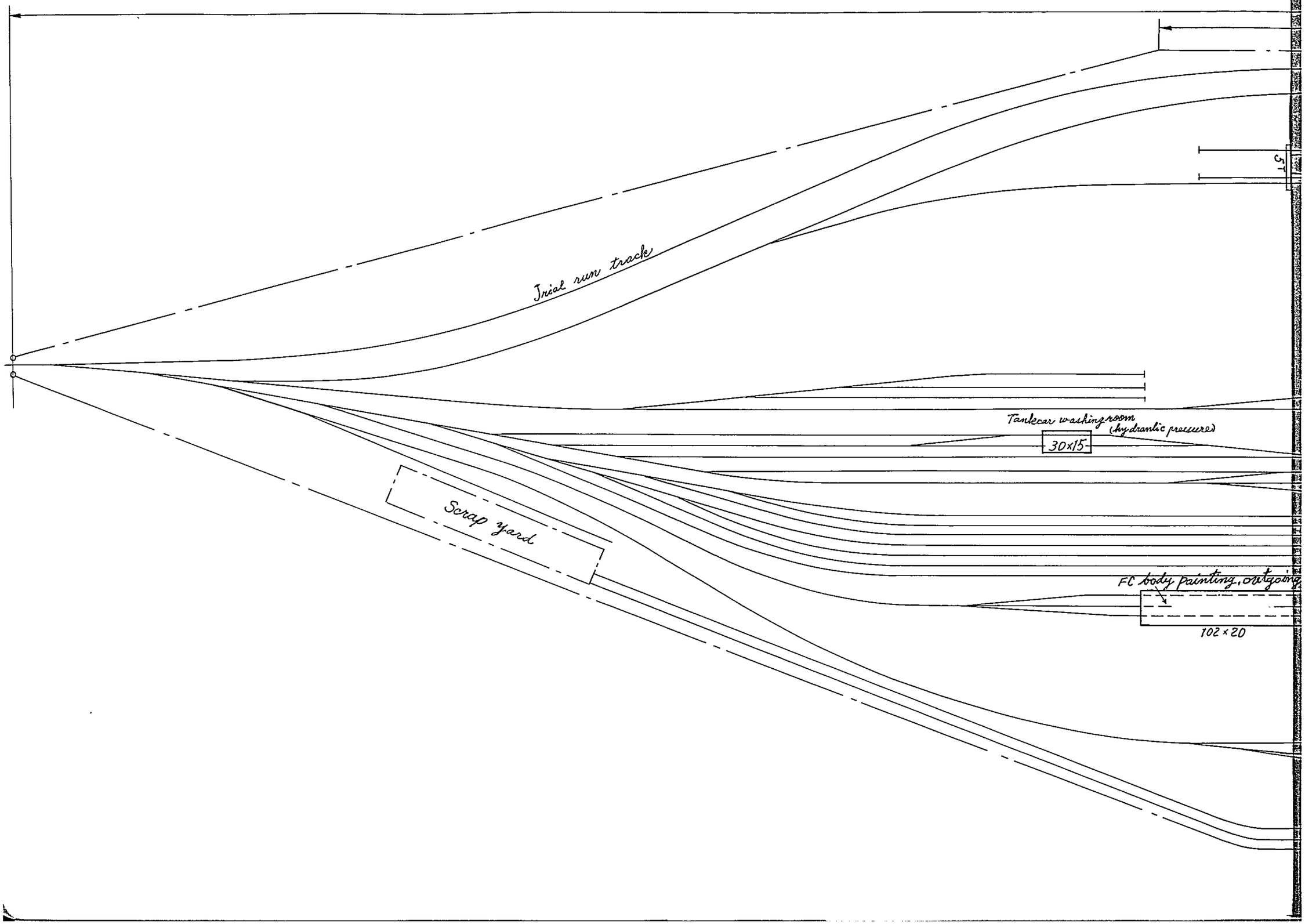


Fig. 8.2 Lay-out of building (B



building (Plan 1) Scale: 1/2,000

1,500m
800

480m

Storage house
(50×100)×2

Transport center

5T

Foundry shop
60×120

Sewage disposing plant

Acetylene gas generating plant

5T

Lumbering shop
100×24

30T
トラバーサー

DC,PC body painting shop
108×15

3T

Smithy Shop
Automatic coupler shop
30×120

DC.PC body shop
30T×1 " " 30T×1
120×132

Iron work Shop
Machine repair shop
30×120

20

Sewing shop

15

CD,PC incoming and outgoing inspection room
102×35

Power house
Power receiving station

blic pressured)

FC incoming inspection room

10T×1

FC body temporary repair shop
102×28

FC body shop
20T×1 20T×1 " " " 20T×1
150×132

30T
Traverser

Bogie shop
Wheel shop
10T×1 10T×1 10T×1 10T×1 5T×1 5T×1

Iron work shop

FC preperatory work Shop
150×120

Dining room
80×54

Office

body painting, outgoing inspection room
102×20

Weigh bridge
20×8

Servicing room
30×21

60T×2

Locomotive shop

Engine, MM
54×132

5T×1

Electric equipment, Air brake, Tool, Machinery Shop
54×120

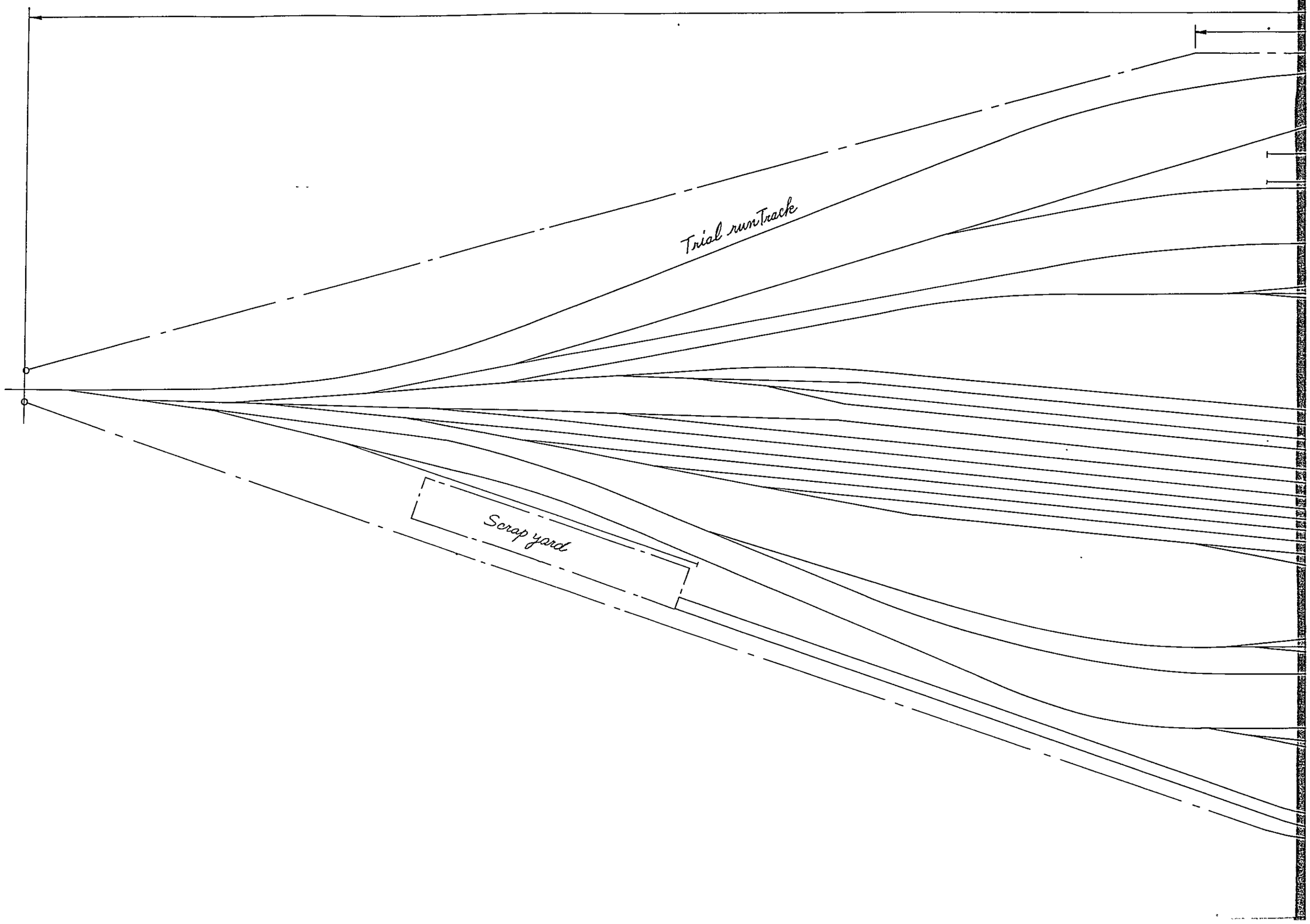
Dressing room
Bath room
80×54

Name card rack

Guard

Public road

Fig. 8.3 Lay-out of buildings (Pla



buildings (Plan 2) Scale: 1/2,000

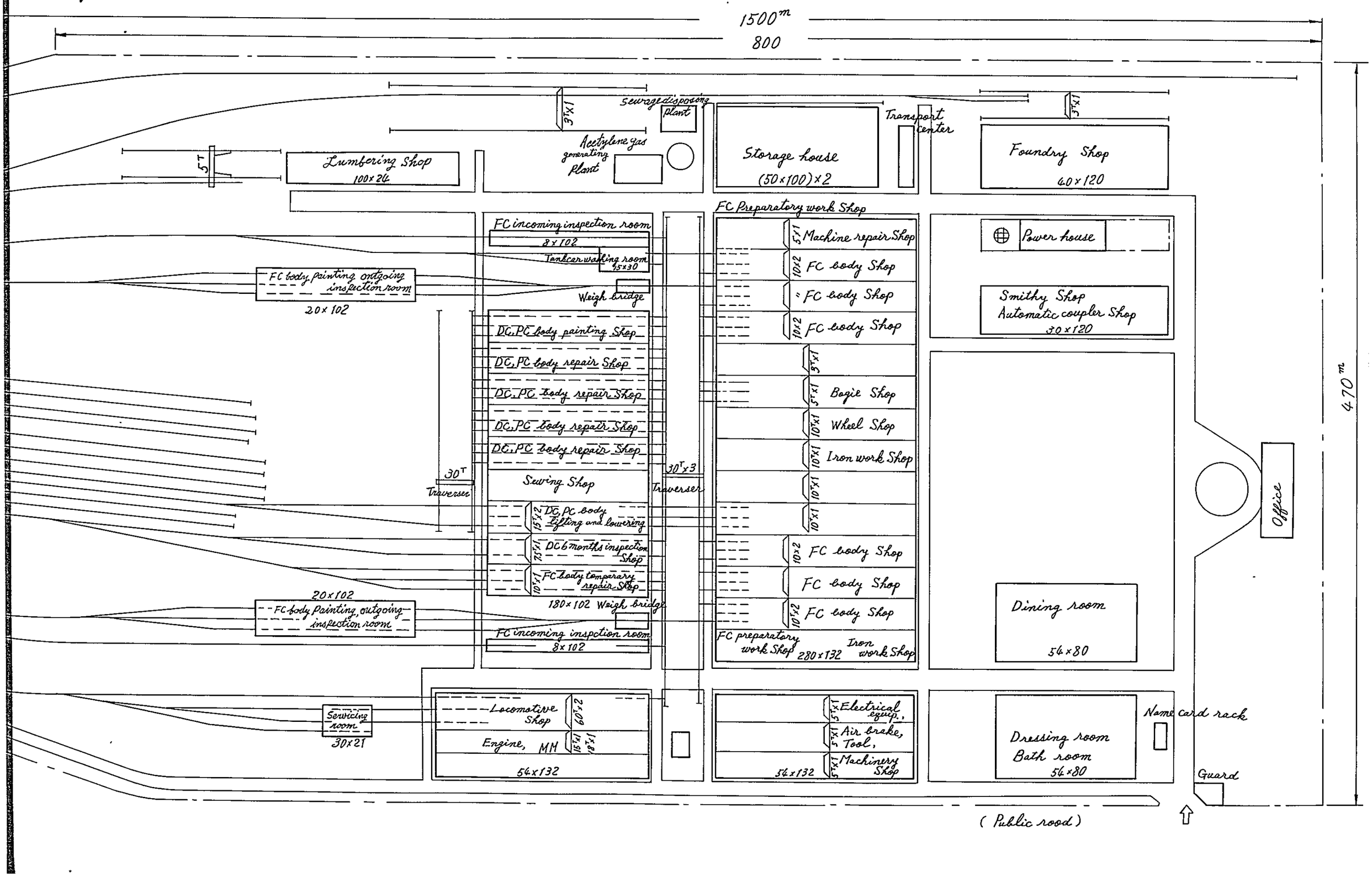
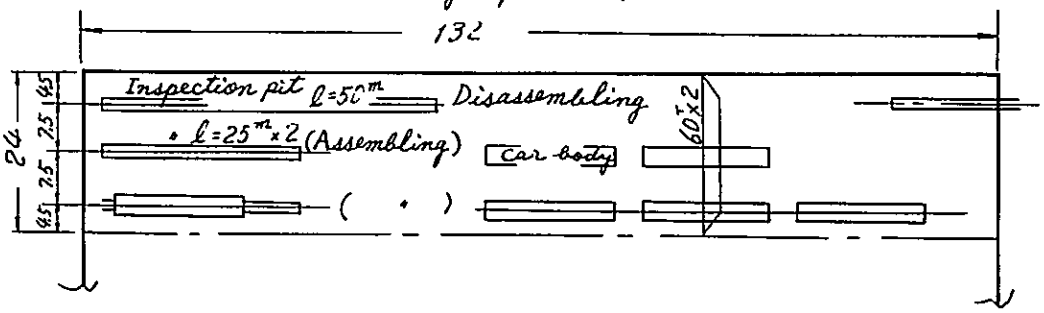
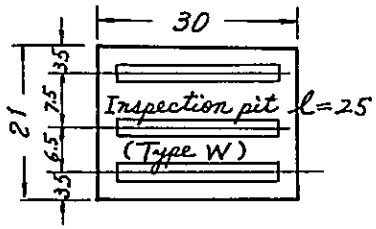


Fig. 8.4 Lay-out of DL car body Shop. Servicing room and FC painting Shop, outgoing car inspection Shop

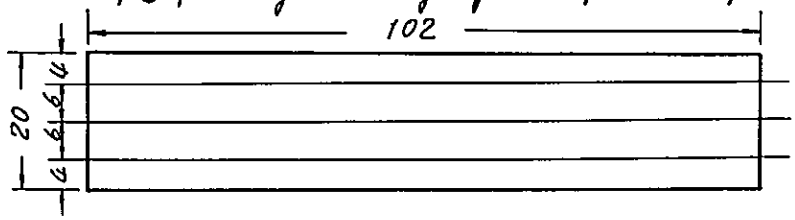
DL Car body repair Shop



Servcing room (for DL & DC)



FC painting and outgoing car inspection Shop



Tank car washing room

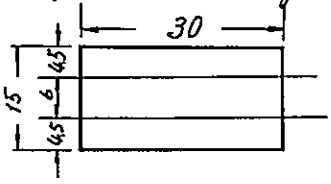
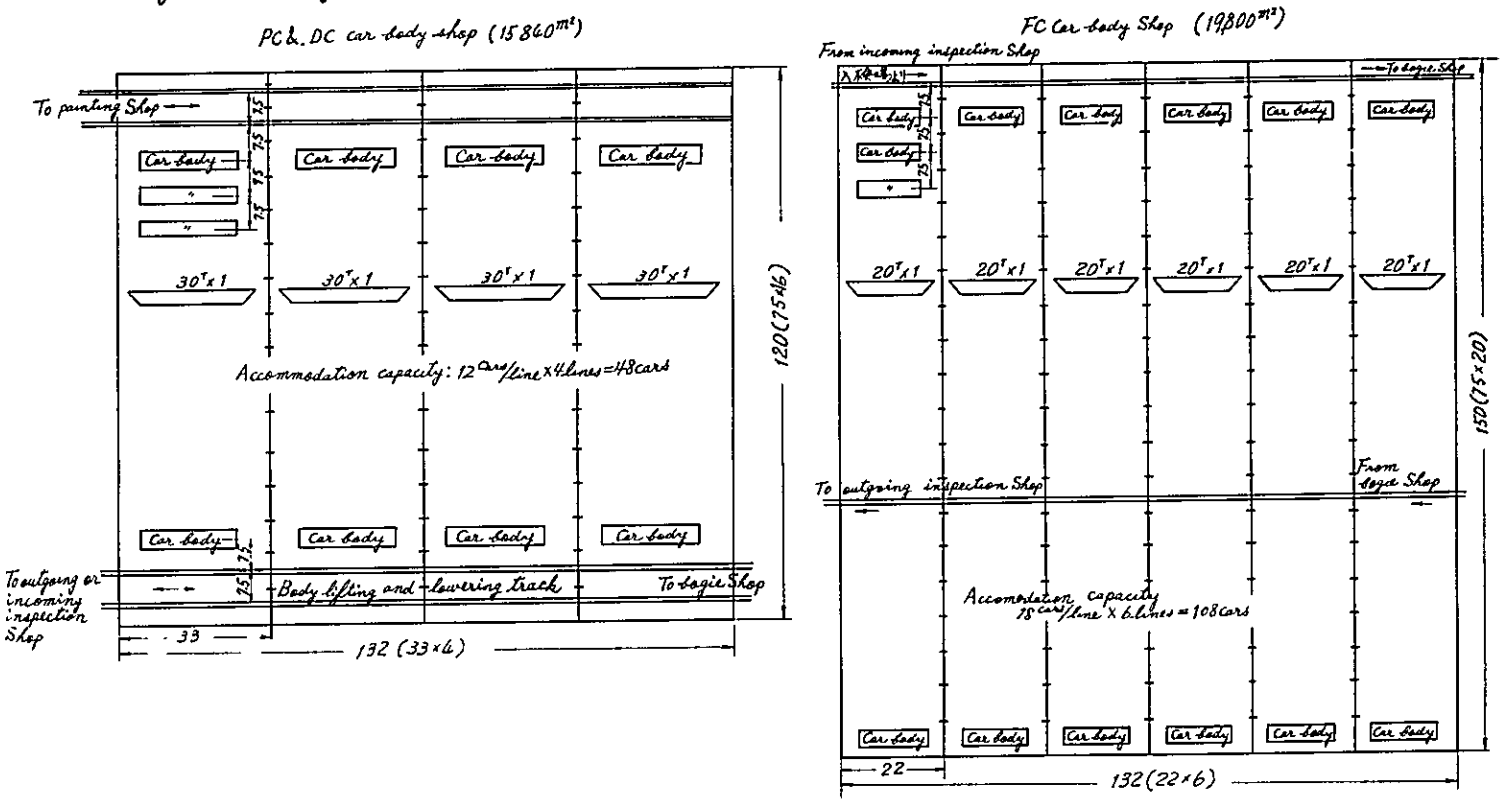
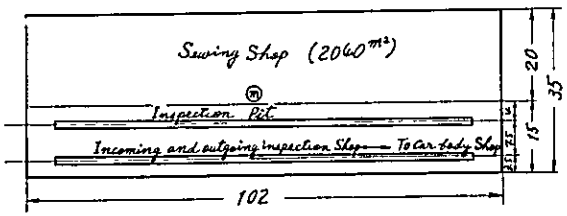


Fig. 8.5 Lay-out of PC & DC car body Shop and FC car body Shop (Plan 1)



PC & DC Incoming and outgoing inspection Shop, and sewing Shop



FC incoming inspection Shop and car body repair (temporary) Shop

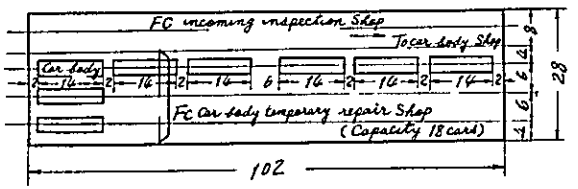


Fig. 8.6 Lay-out of PC & DC car body Shop and FC car body Shop (Plan 2)

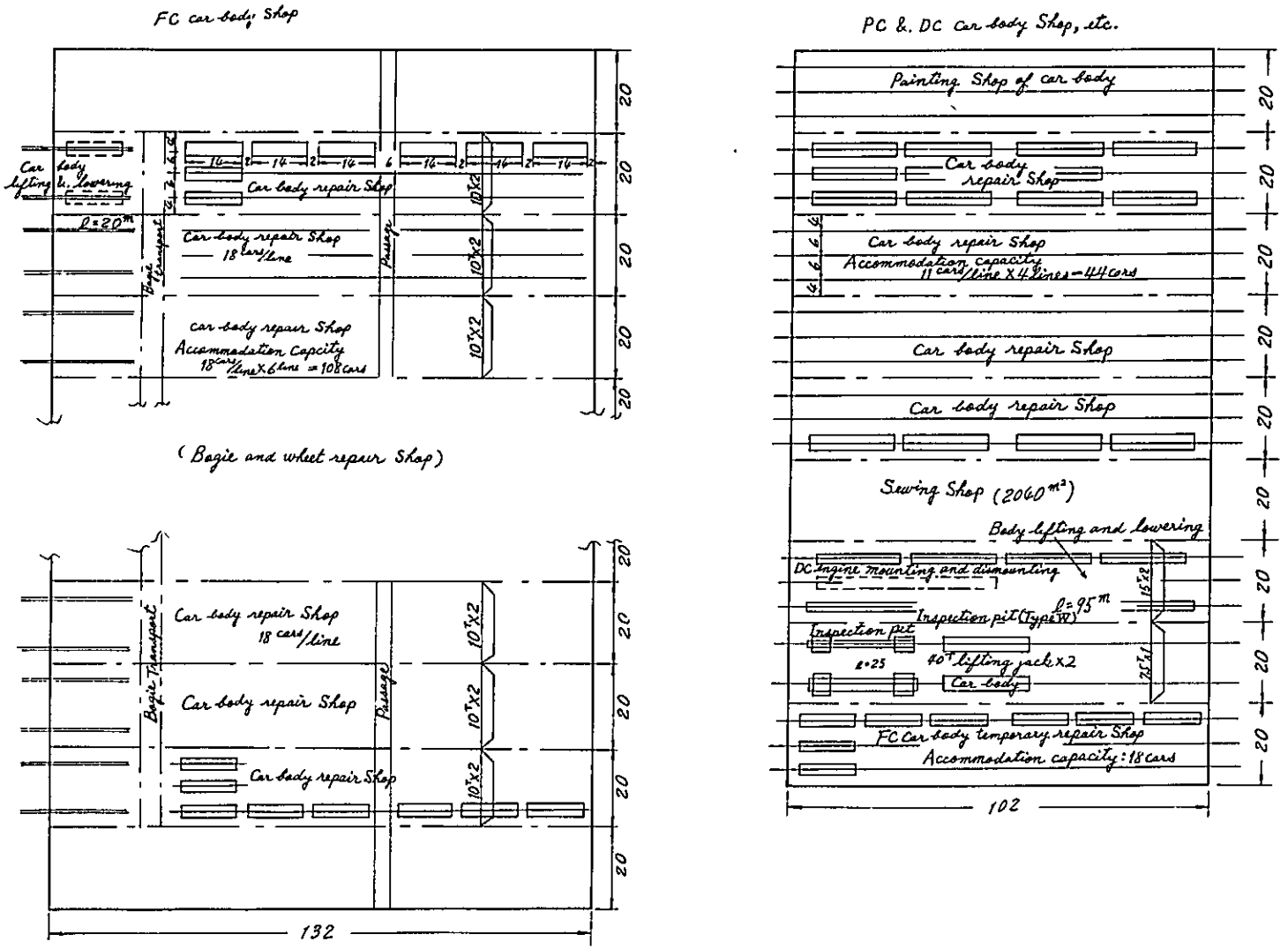


Fig. 8.7 Work flow chart (Plan 1)

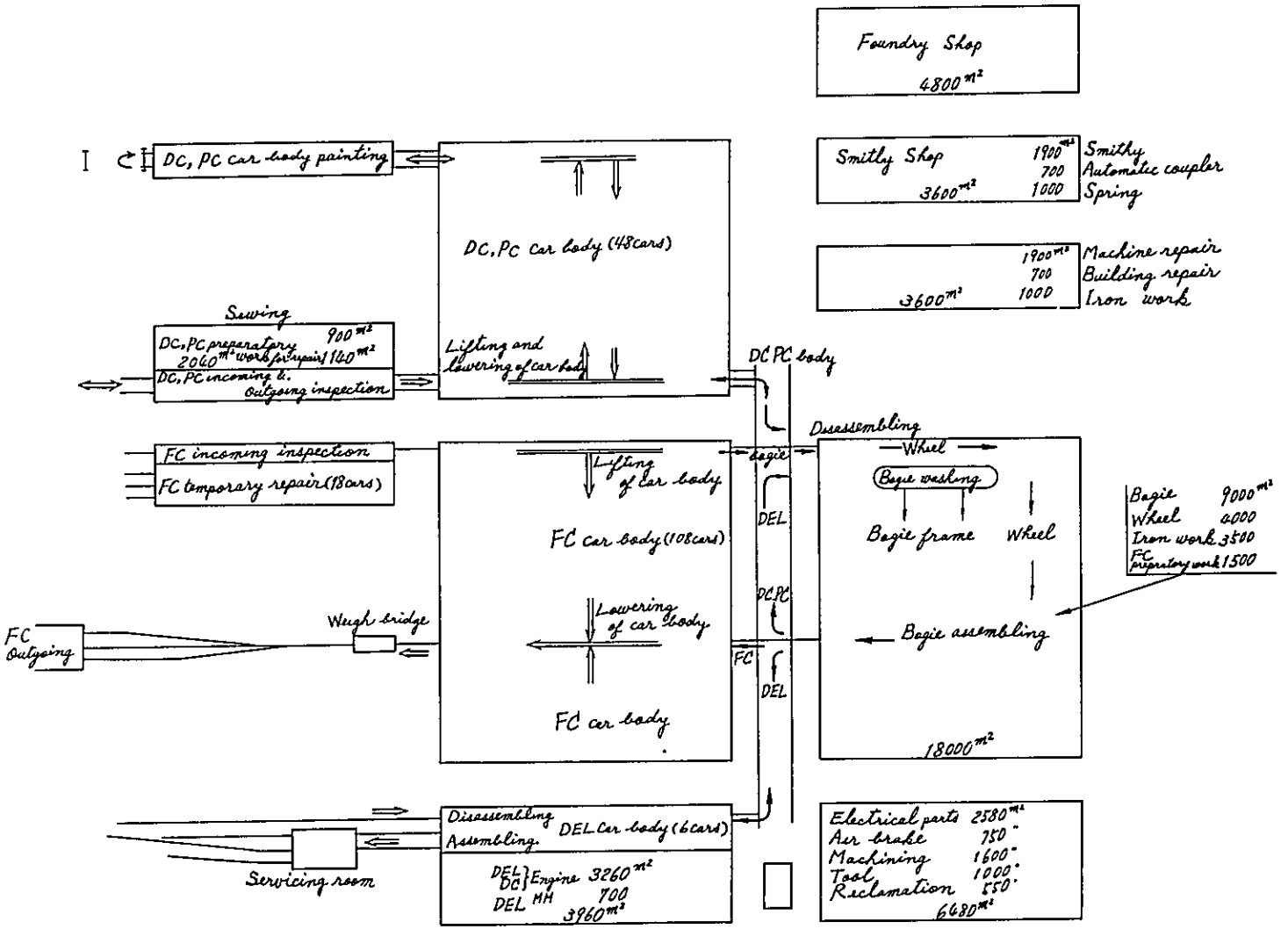


Fig. 8.8 Work flow chart (Plan 2)

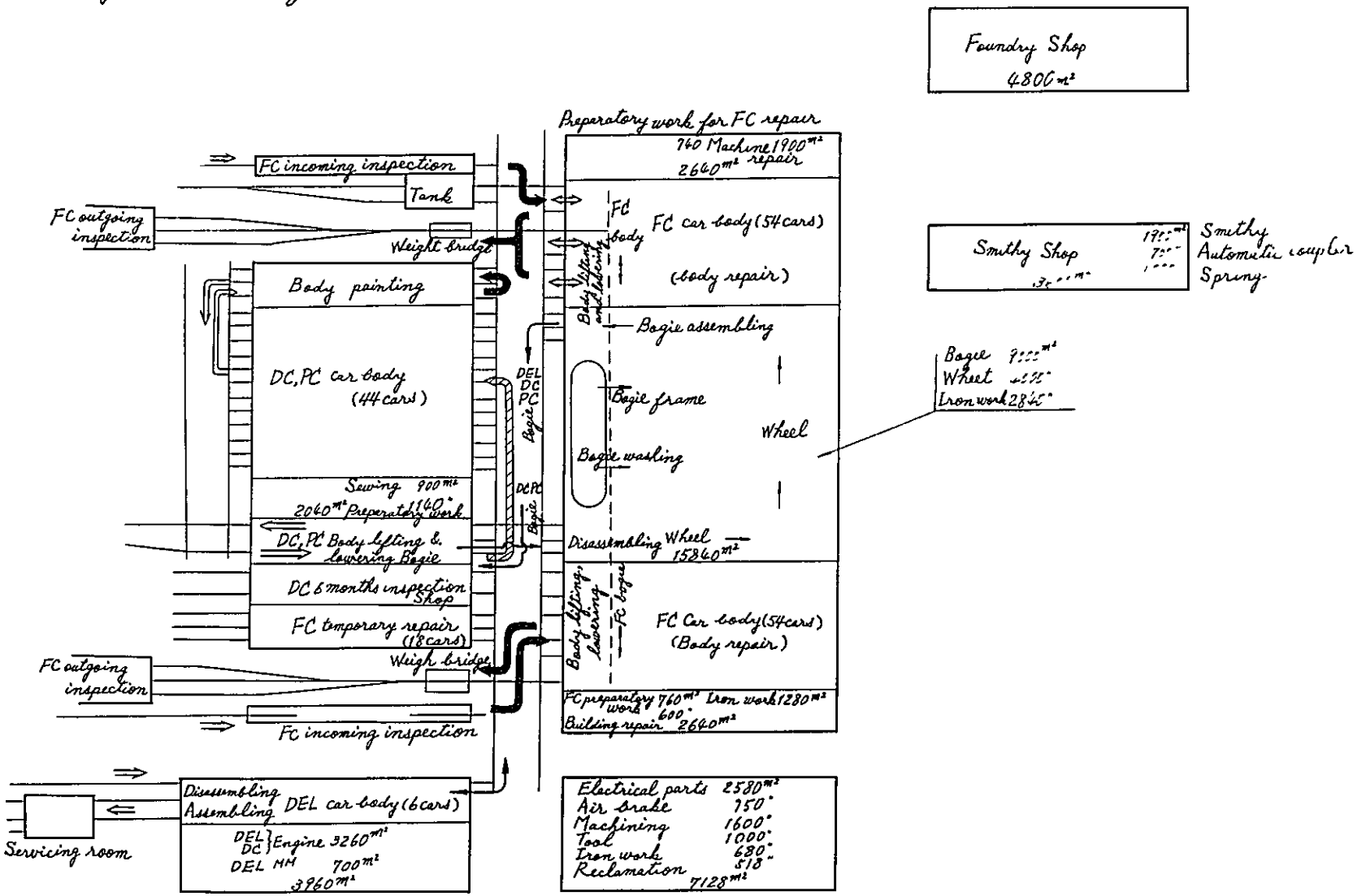


Fig. 8.9 Repair facilities for wheels, axles and bogies (Plan 1)

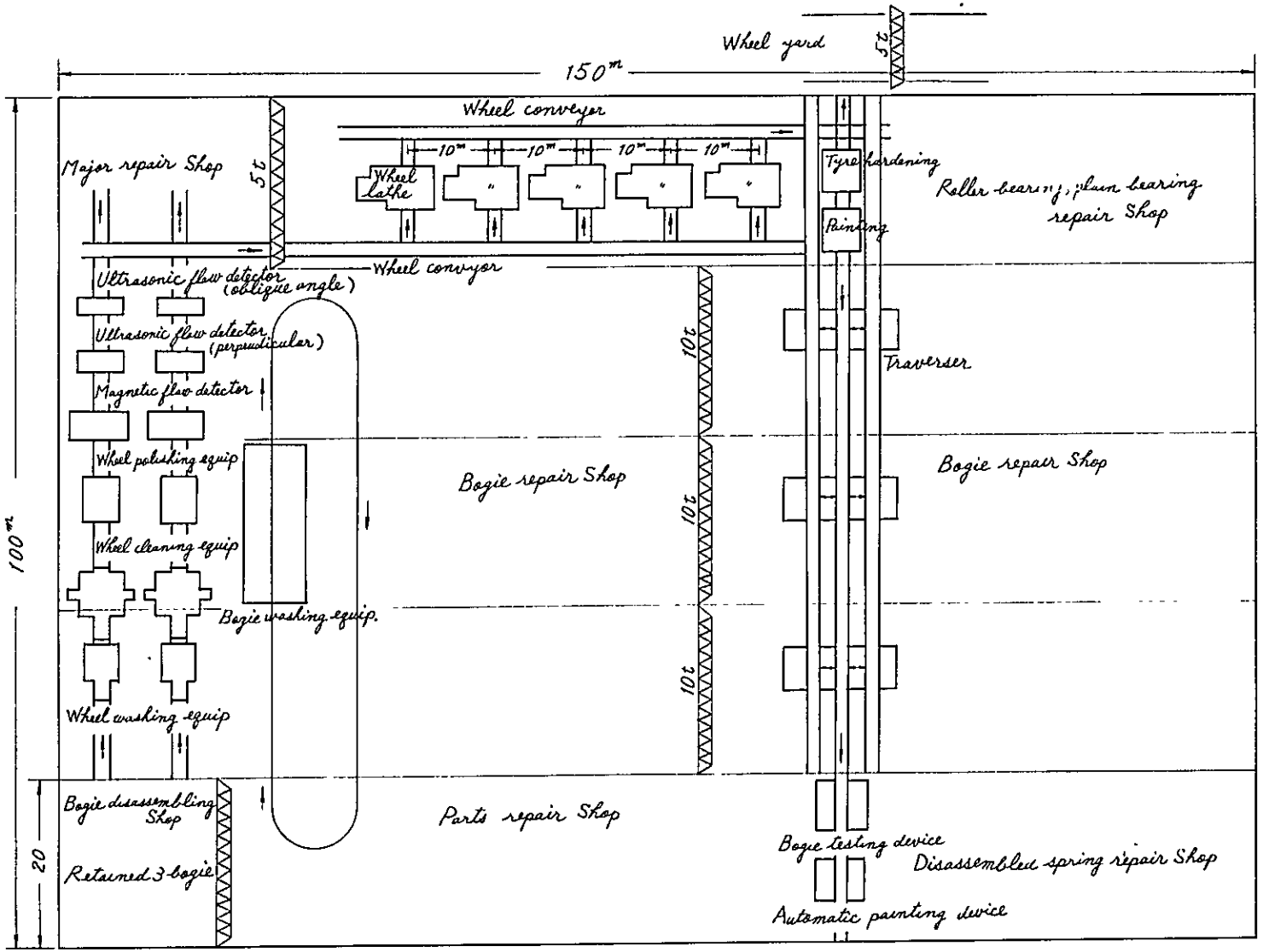


Fig. 8. 10 Repair facilities for wheels, axles and bogies. (Plan 2)

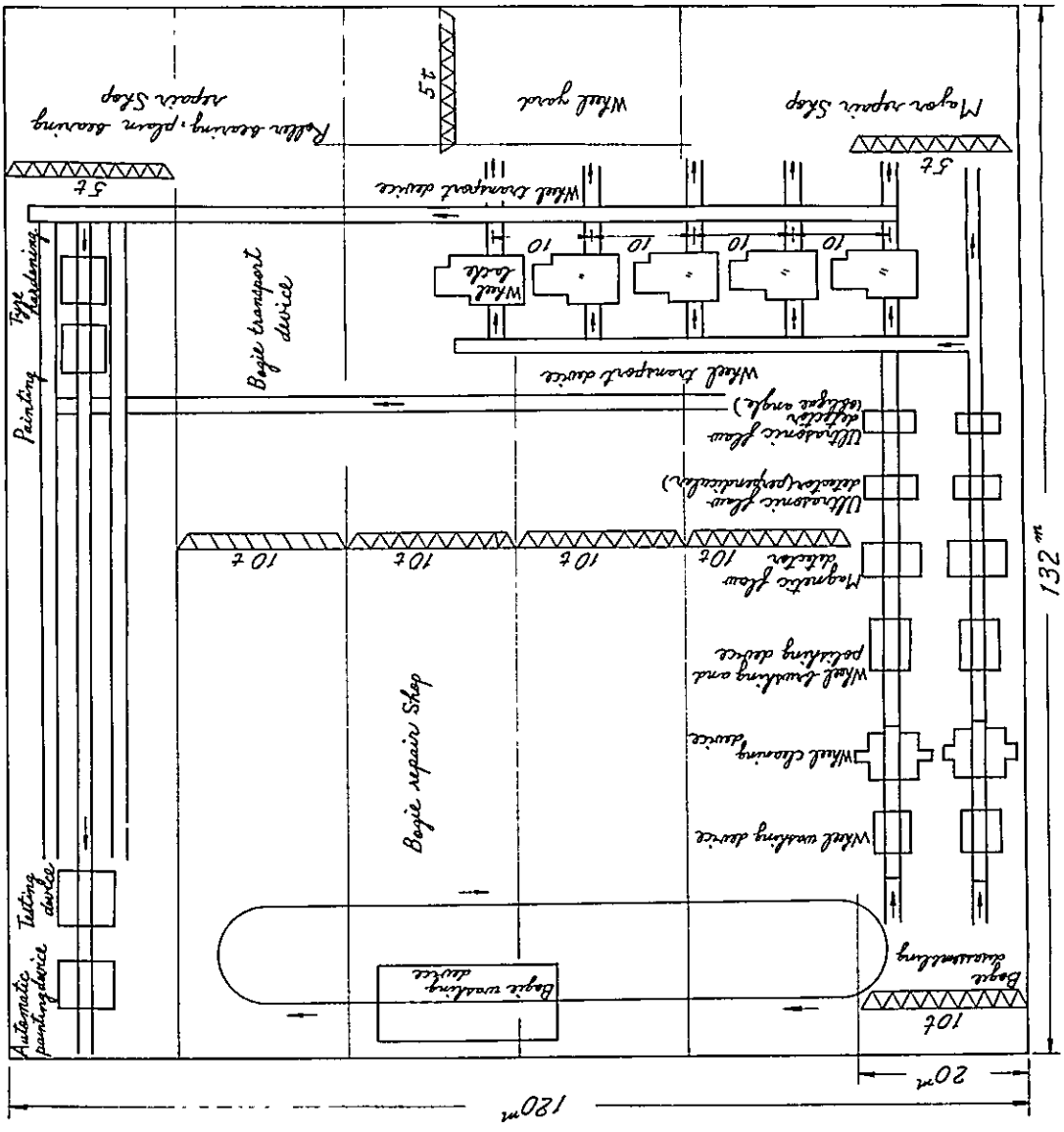


Fig. 8. 11 Inspection and repair facilities for diesel engines

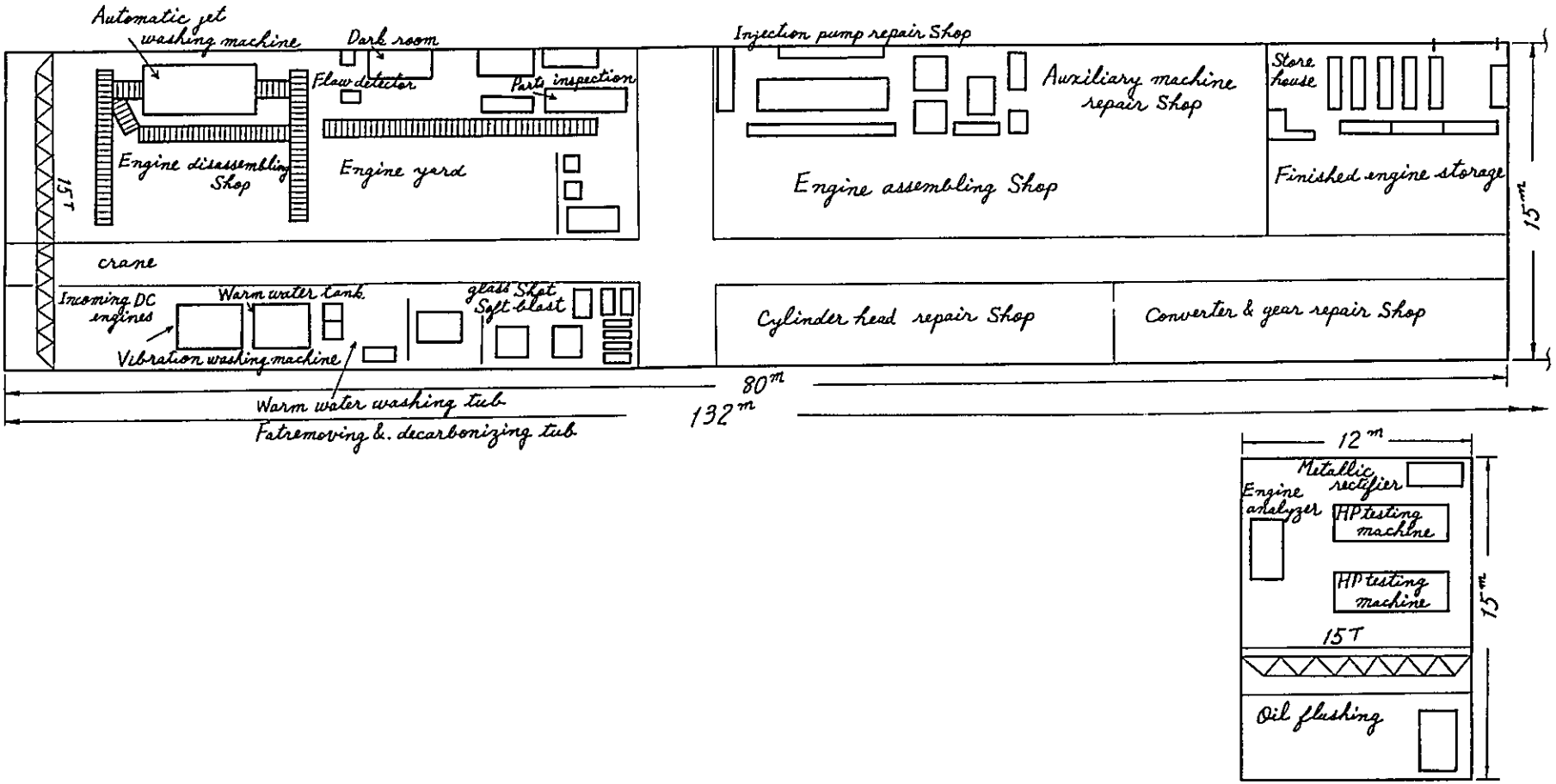
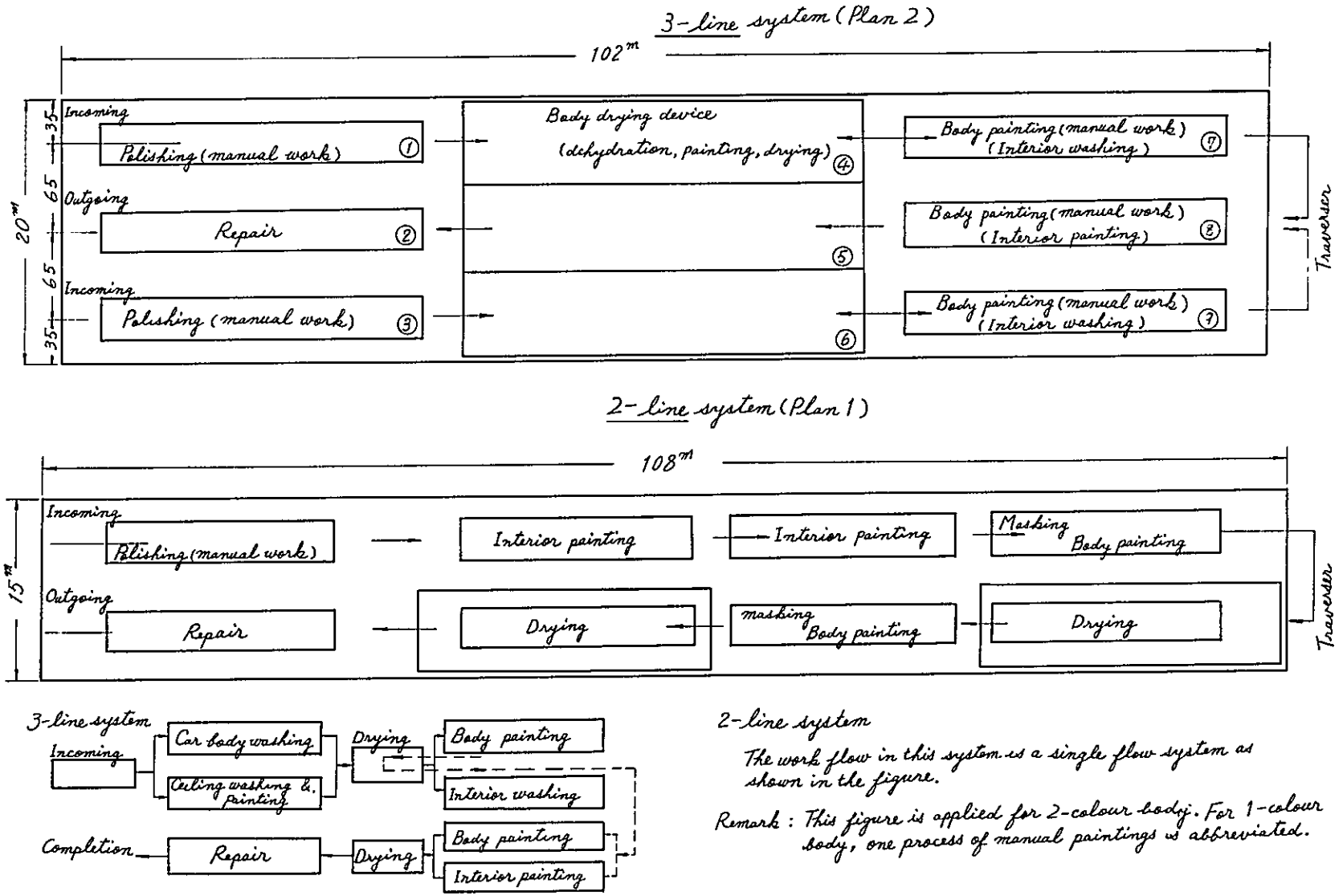


Fig. 8.12 Car body painting facilities



2-line system

The work flow in this system is a single flow system as shown in the figure.

Remark : This figure is applied for 2-colour body. For 1-colour body, one process of manual paintings is abbreviated.

Fig. 8.13 FC automatic painting equipment

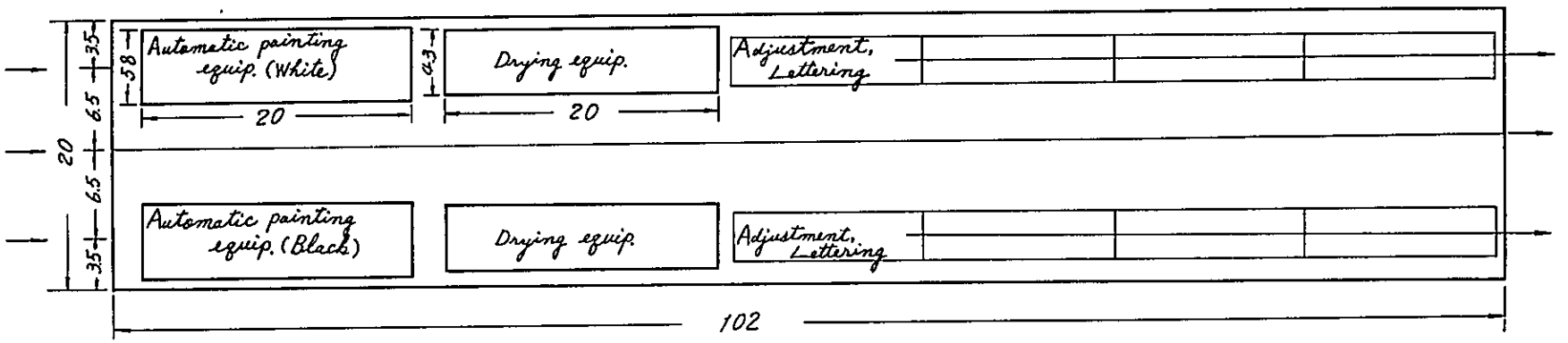


Fig. 8.14 Automatic coupler repair facilities

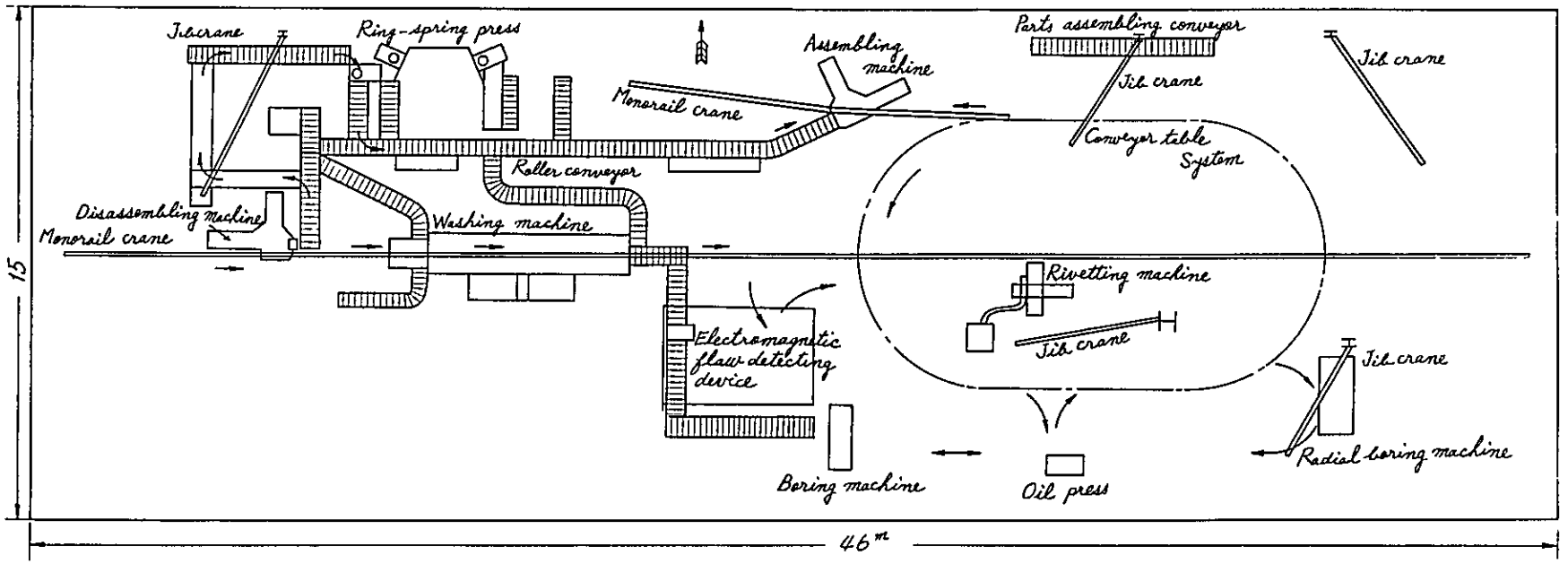
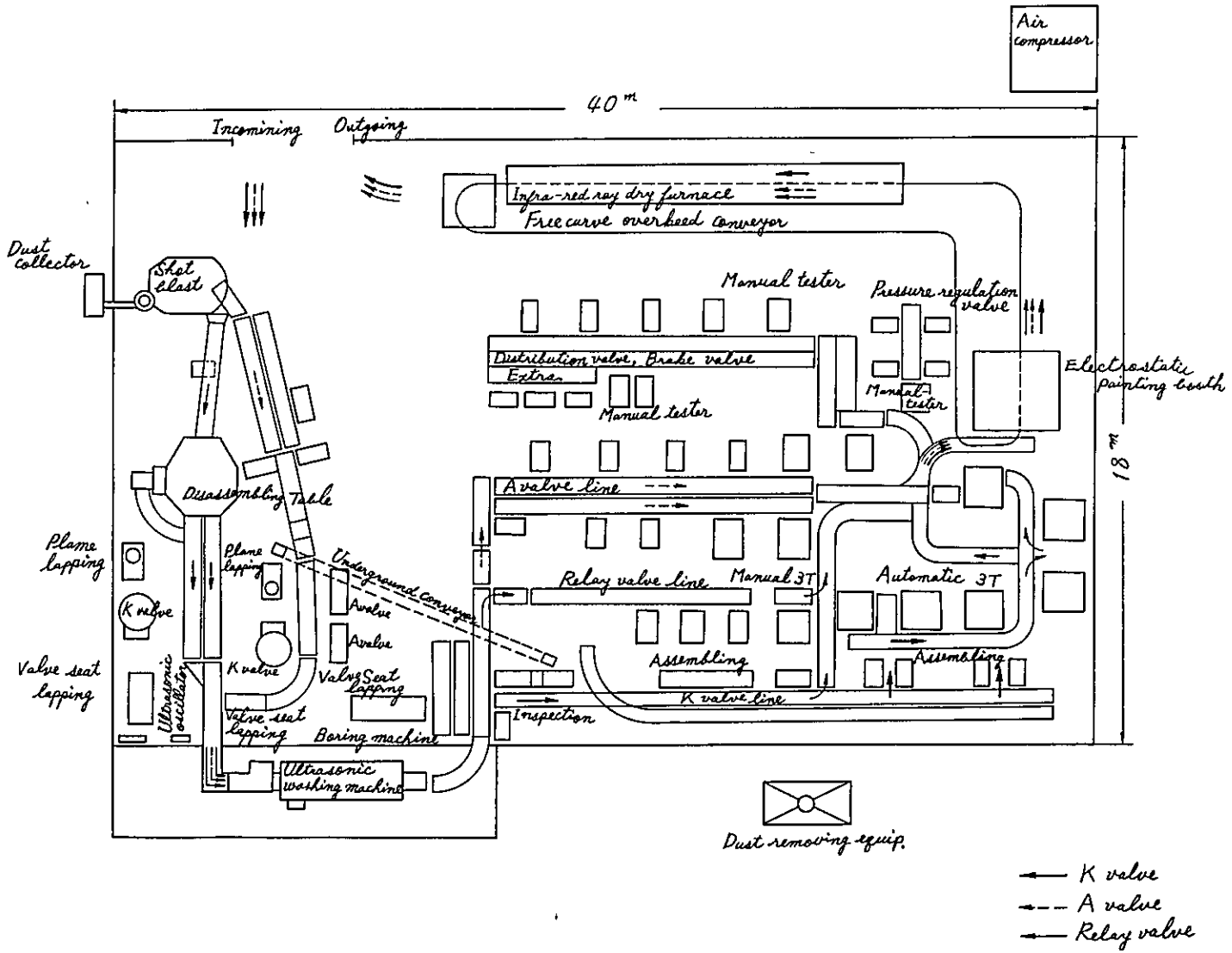


Fig. 8.15 Air brake valve repair facilities



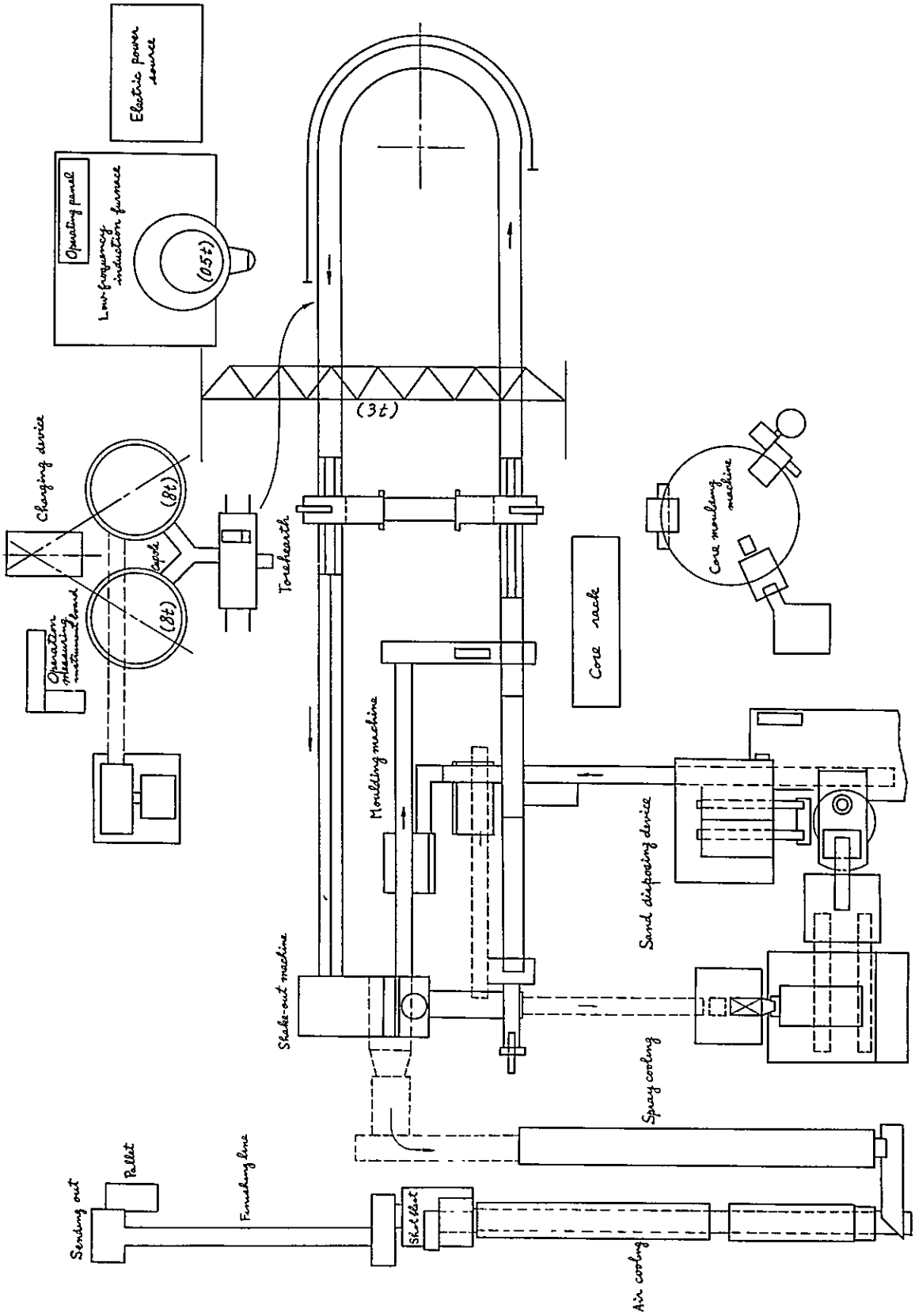


Fig. 8.16 Brake shoe casting facilities

Fig. 8.17 Casting facilities of iron, steel and bronze

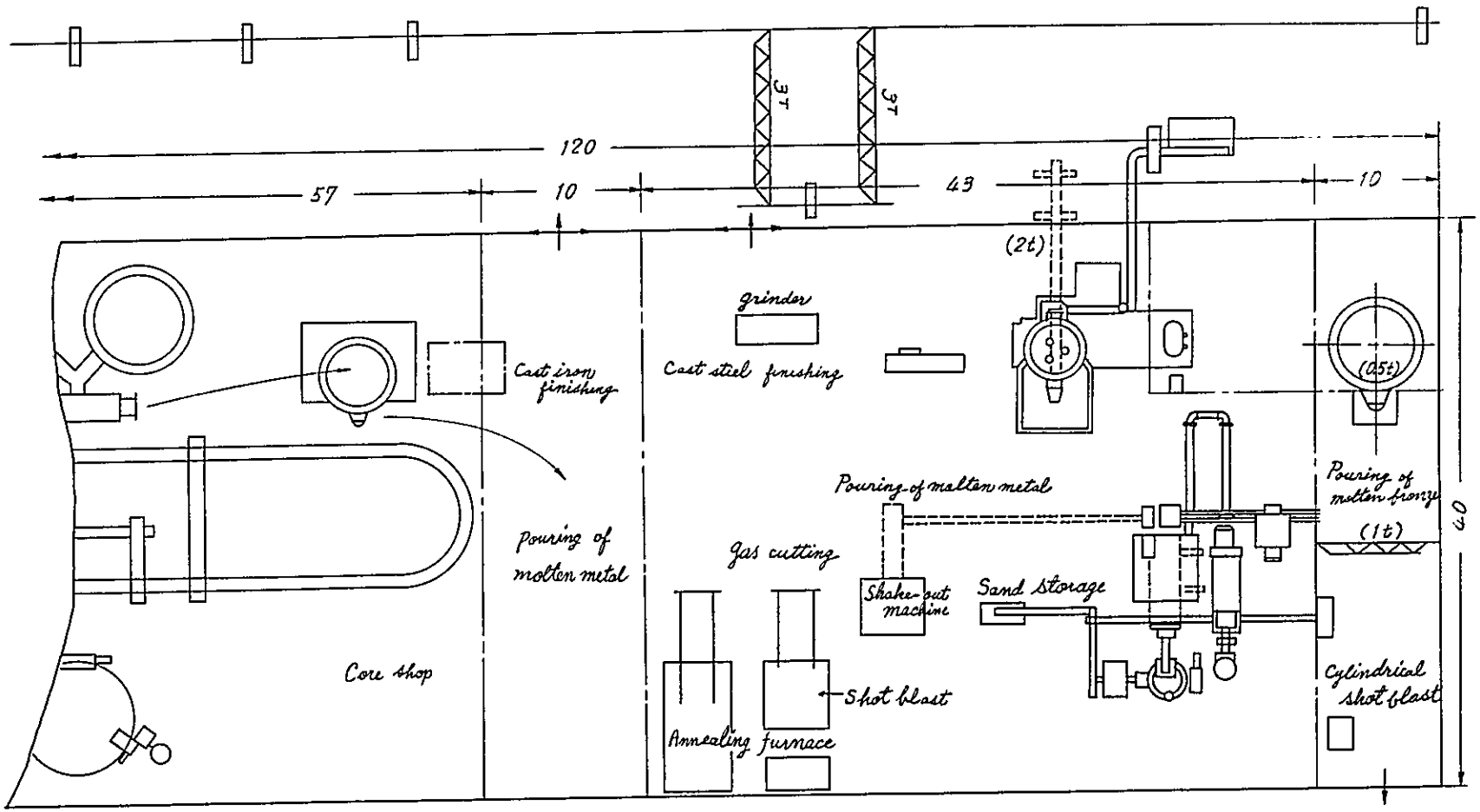
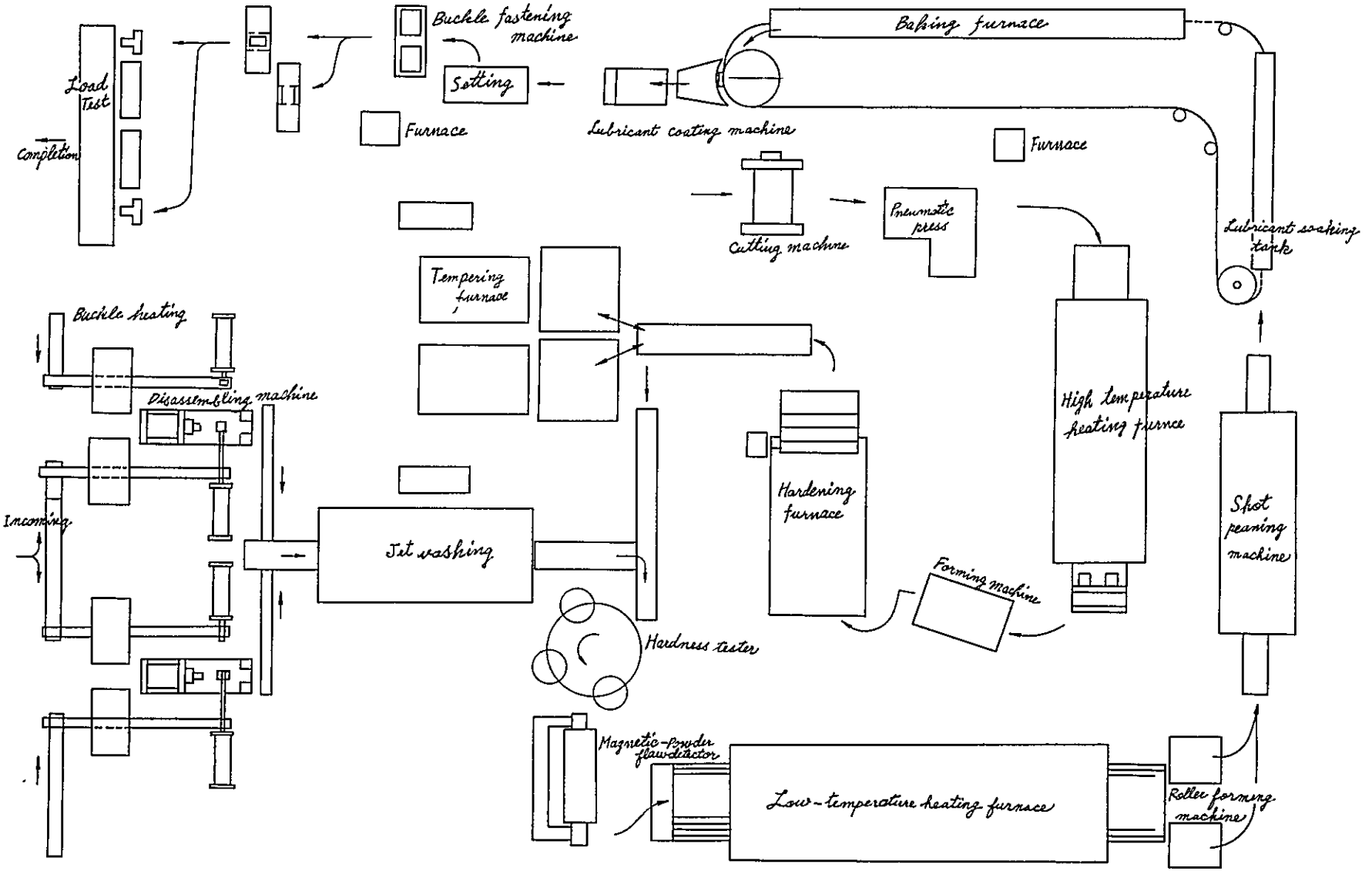


Fig. 8.18 Spring inspection and repair facilities



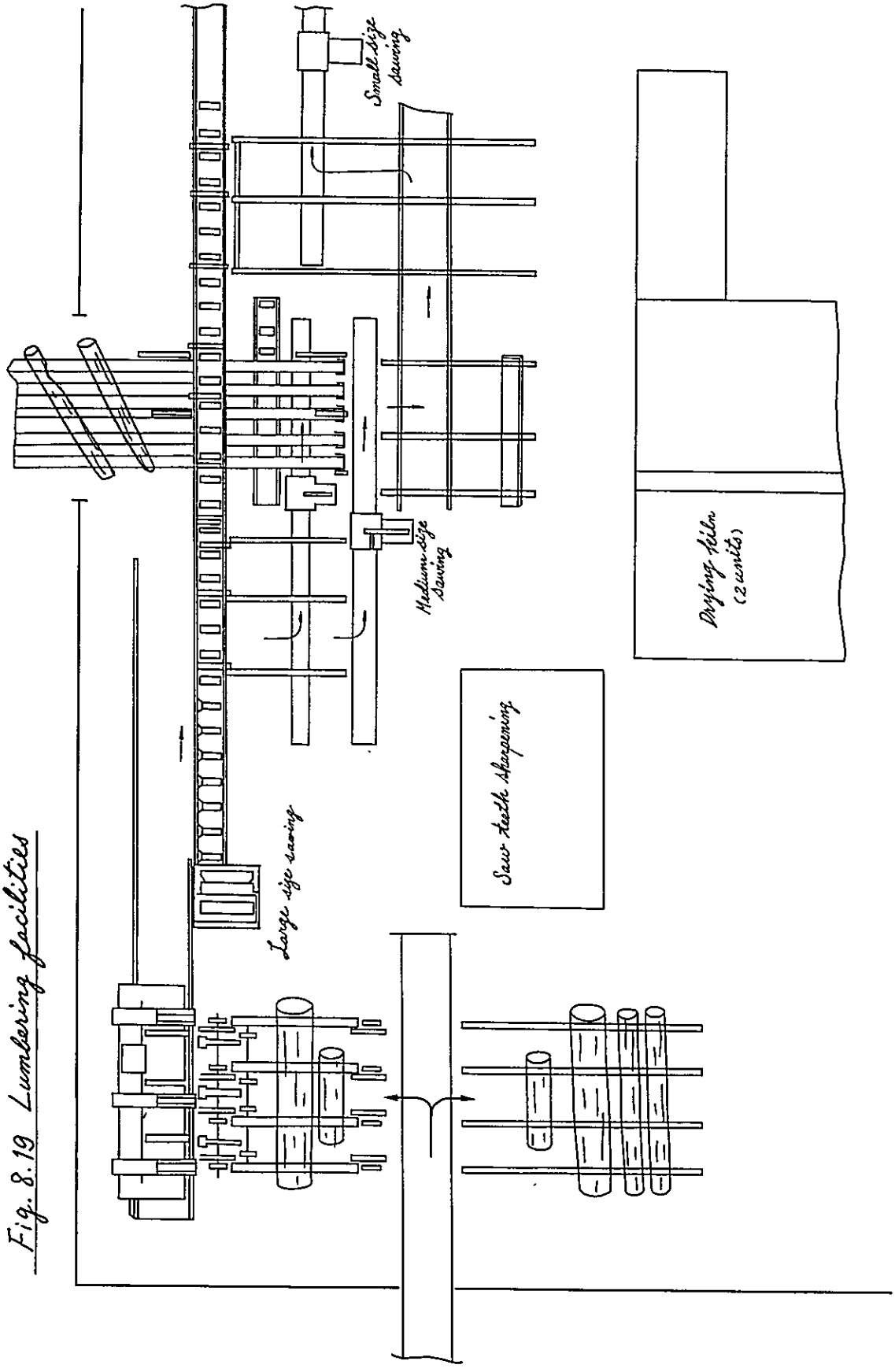
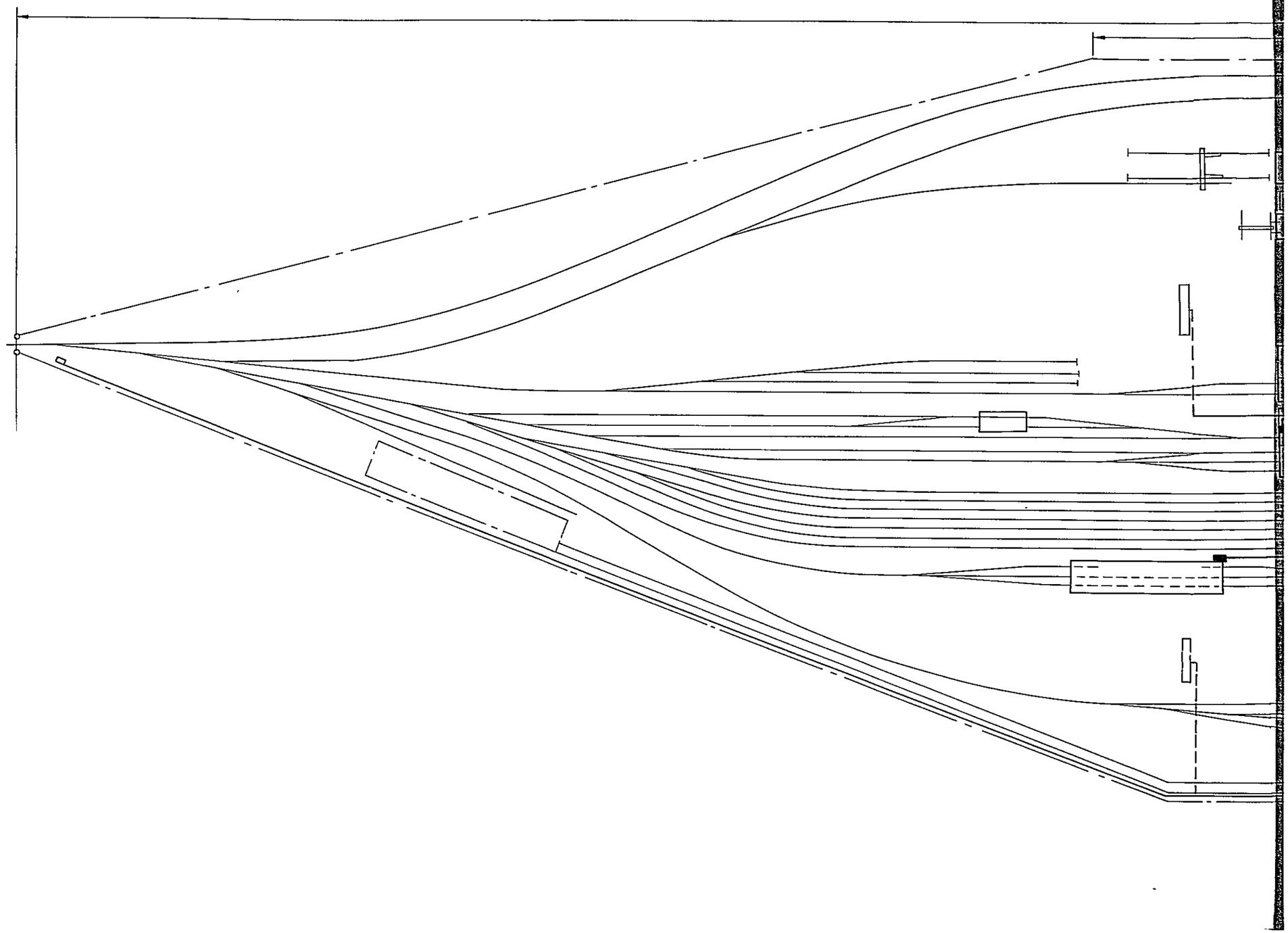


Fig. 8.19 Lumbering facilities

Fig. 8.20 Electric wire arrange



c wire arrangement (Plan 1)

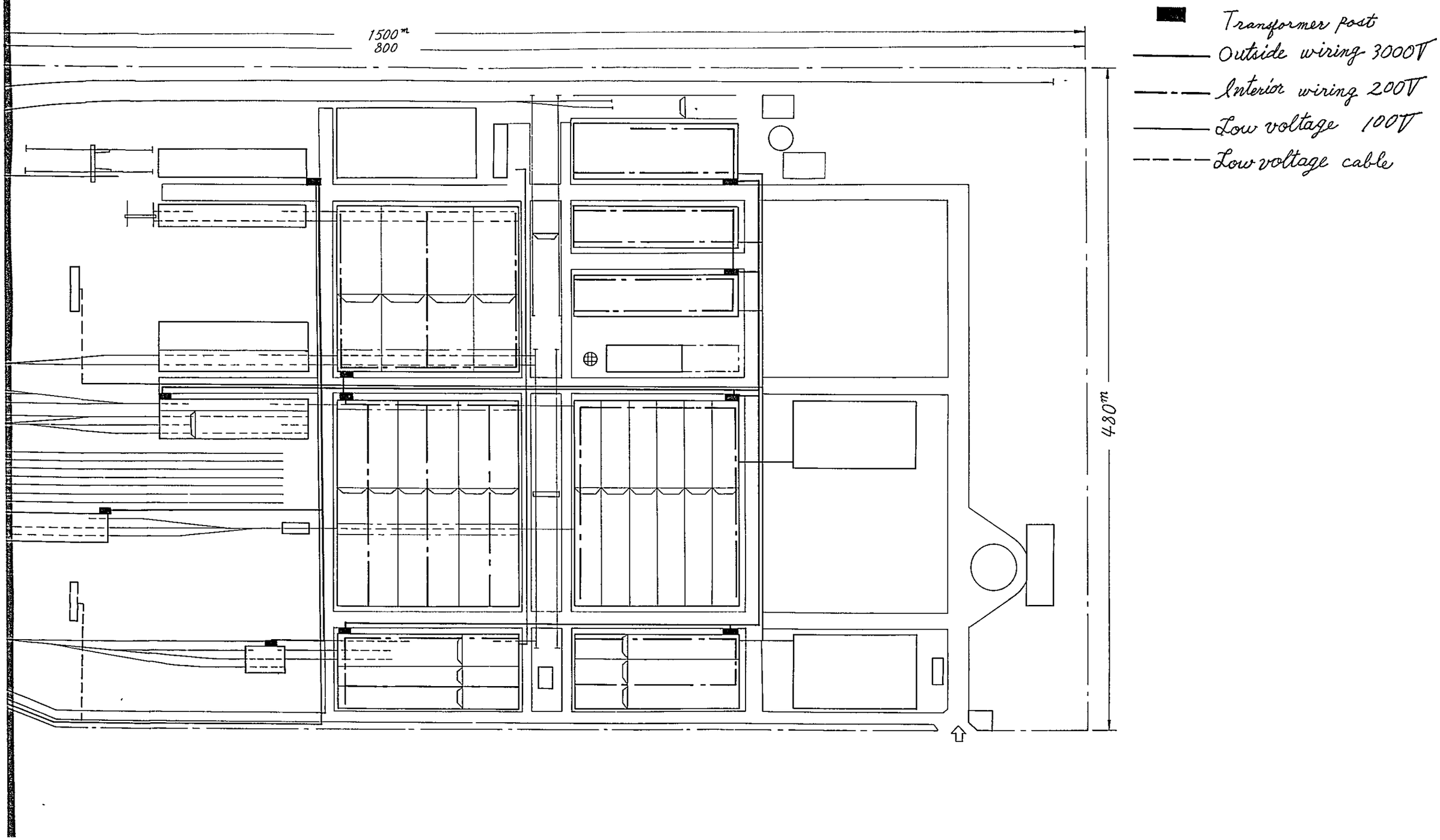


Fig. 8.21 Electric wire a

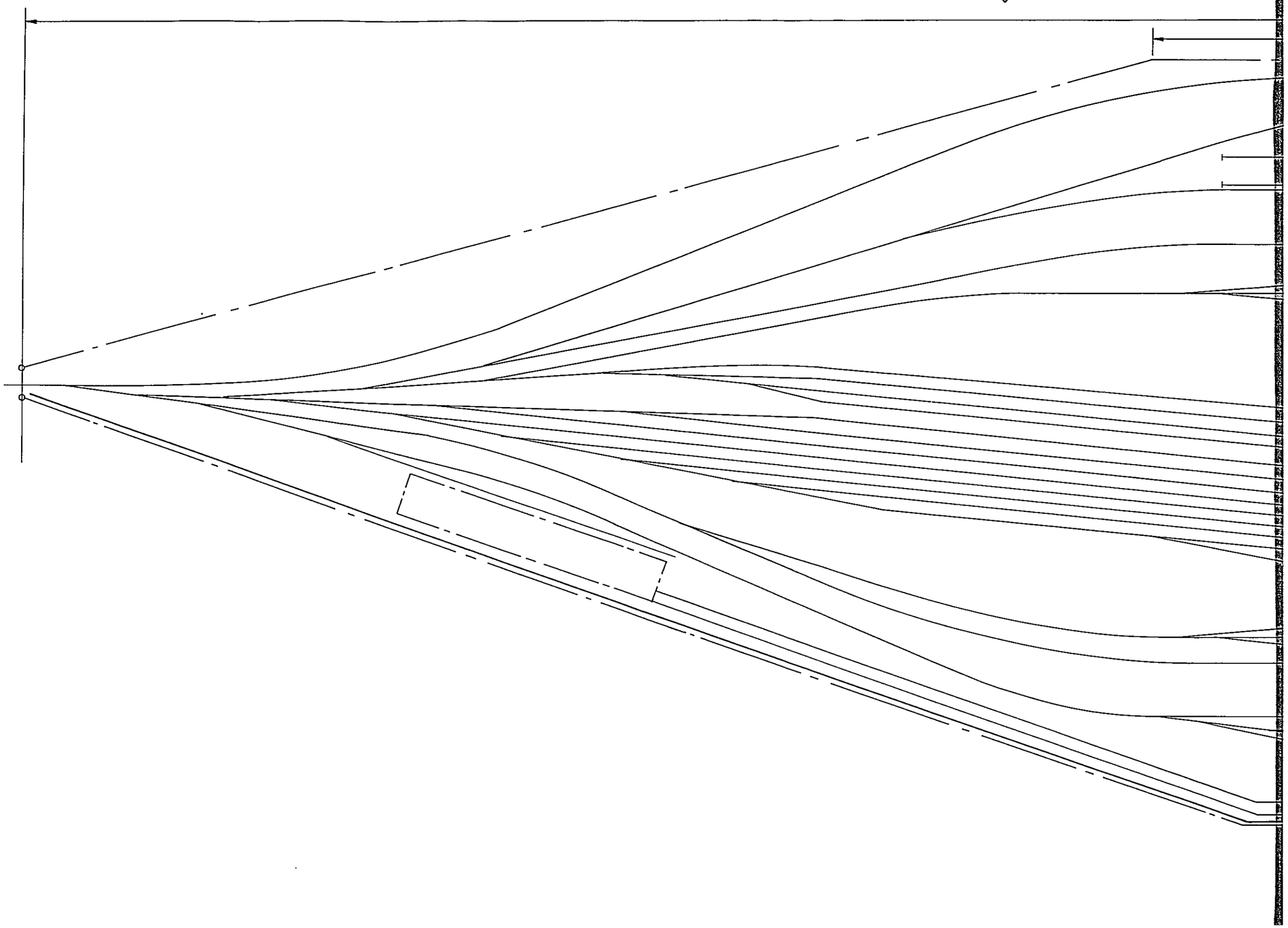
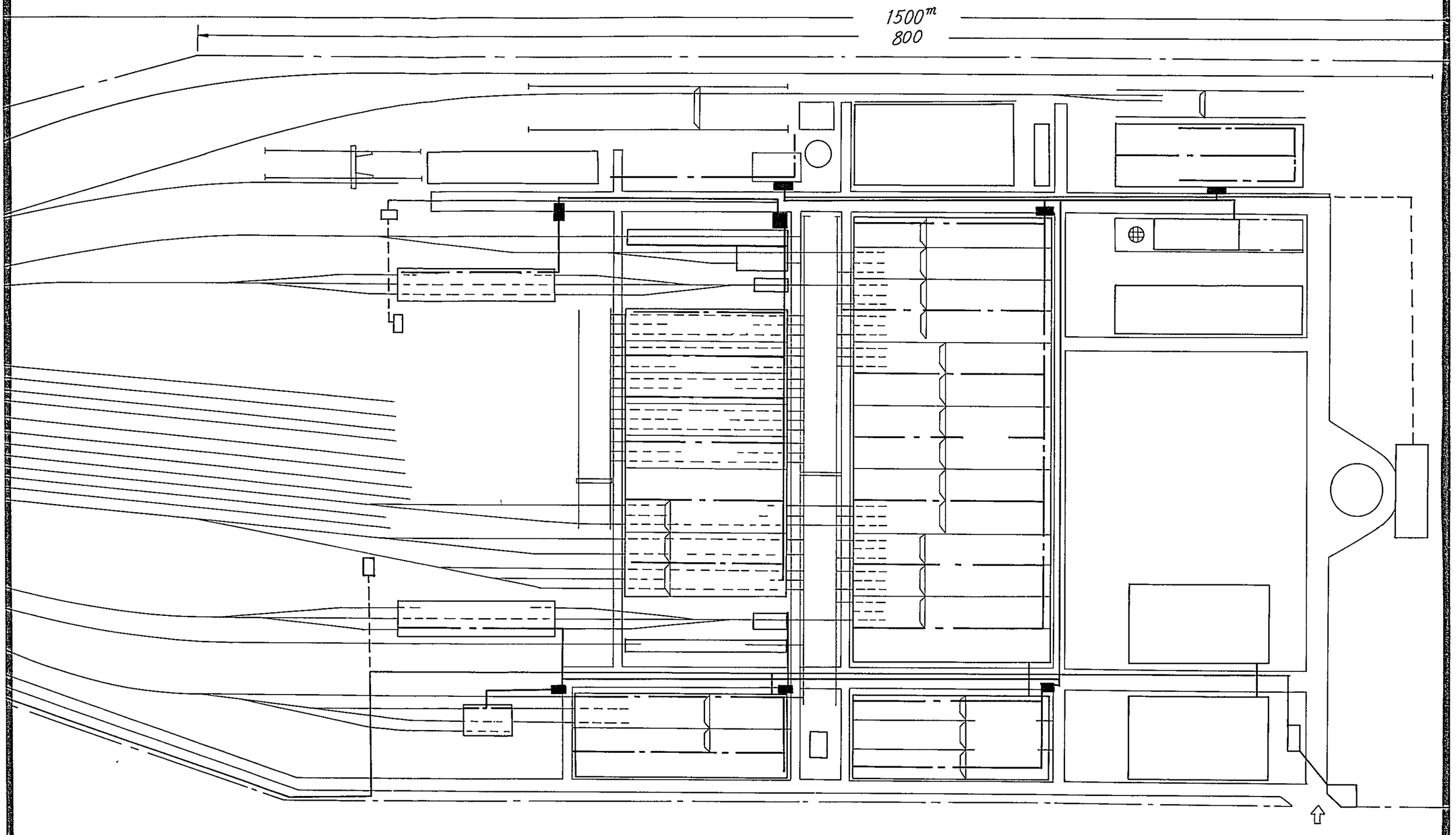


Fig. 8.21 Electric wire arrangement (Plan 2)



Plan 2)

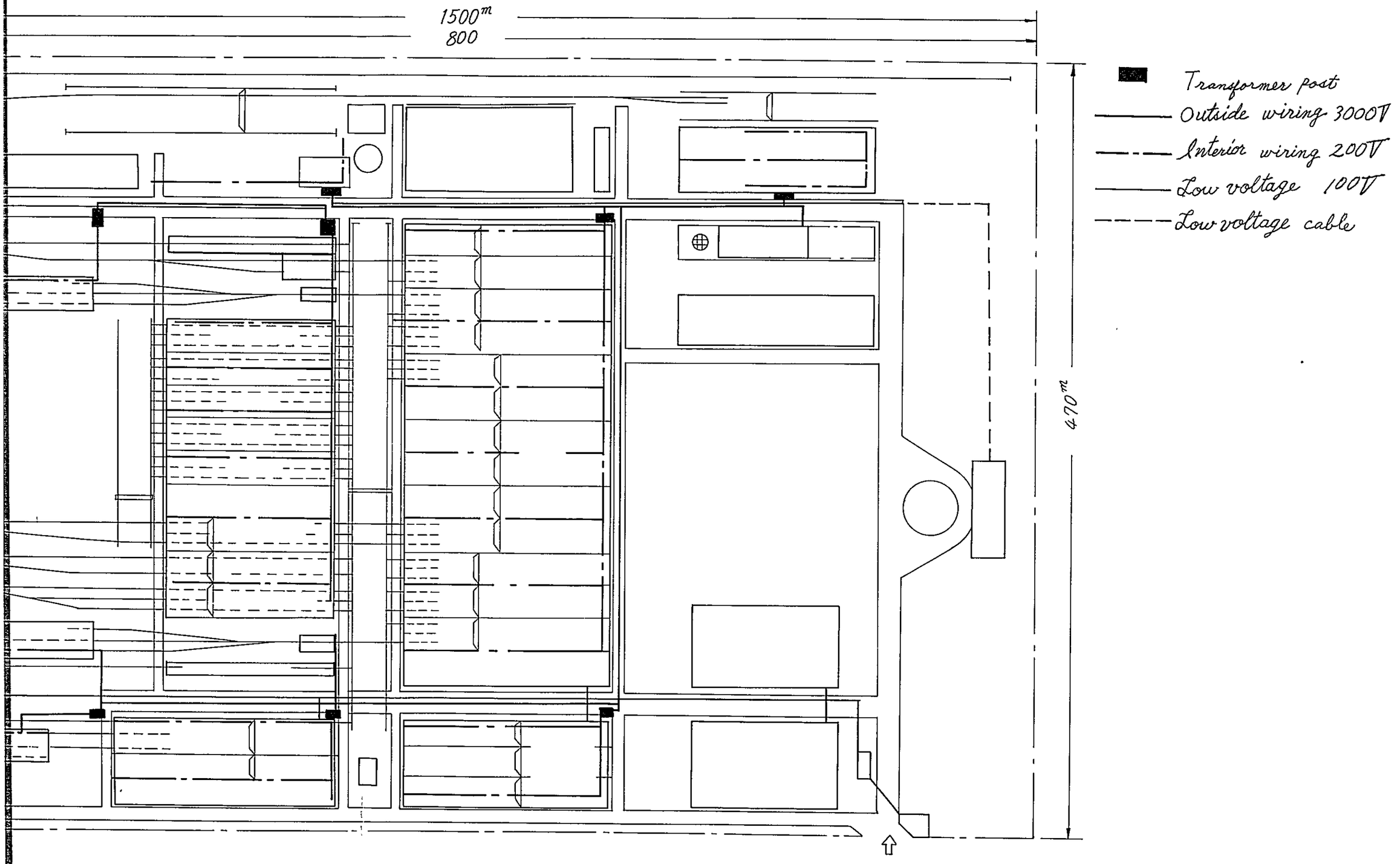

1500m
800
470m
Transformer post
Outside wiring 3000V
Interior wiring 200V
Low voltage 100V
Low voltage cable

Fig. 8.22 Water supply and

ater supply and drainage facilities (Plan 1)

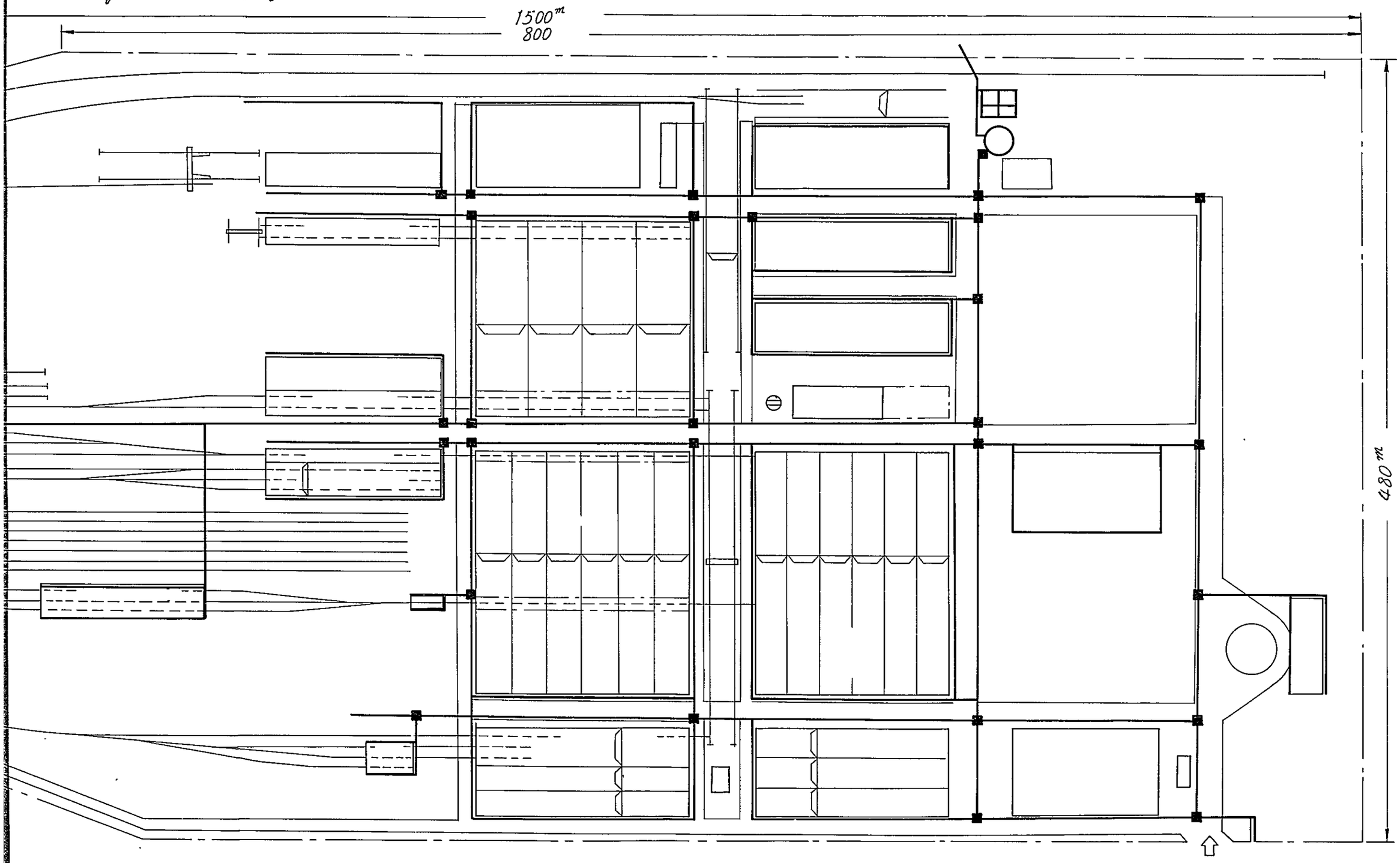


Fig. 8.23 Water supply as

ter supply and drainage facilities (Plan 2)

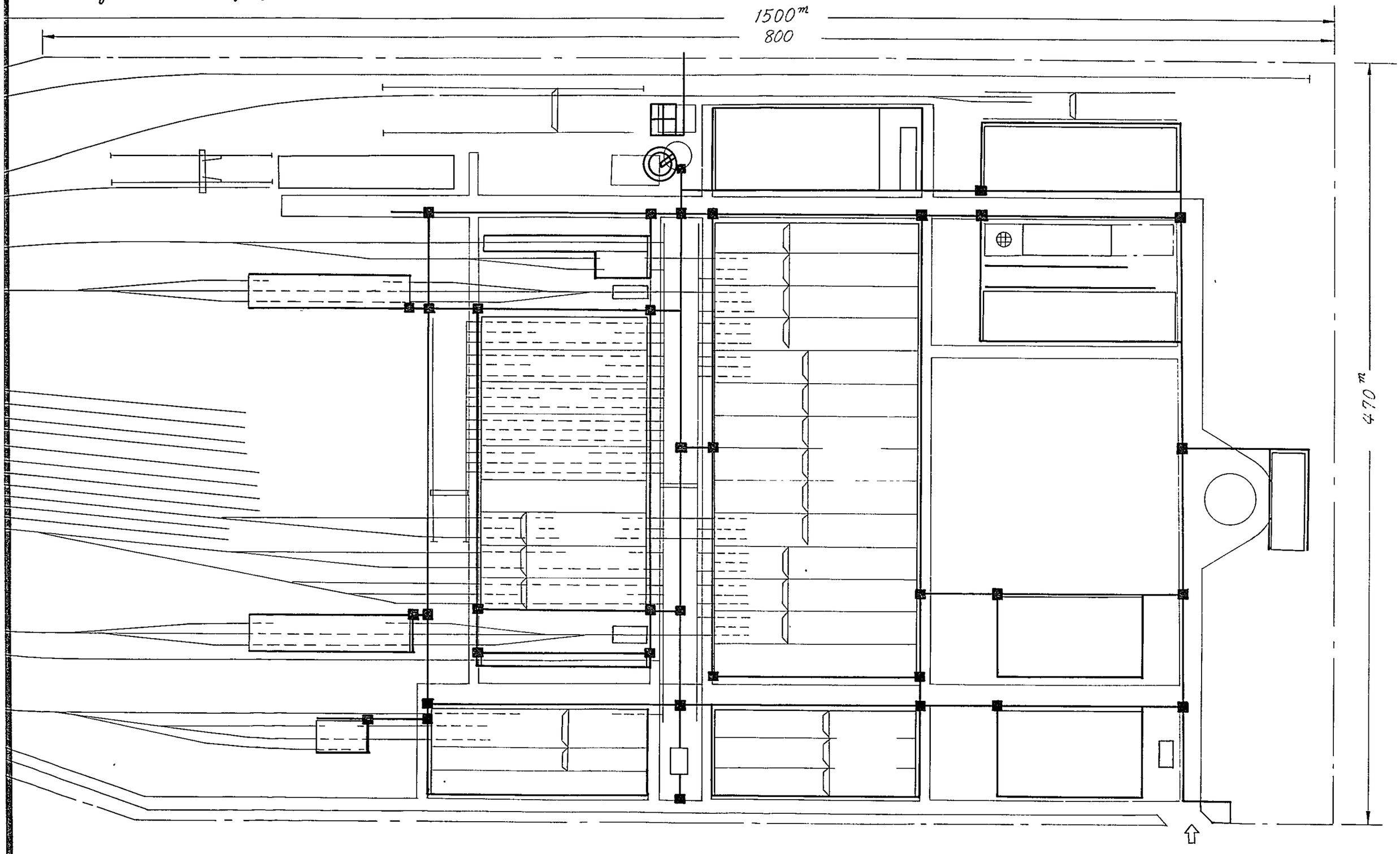
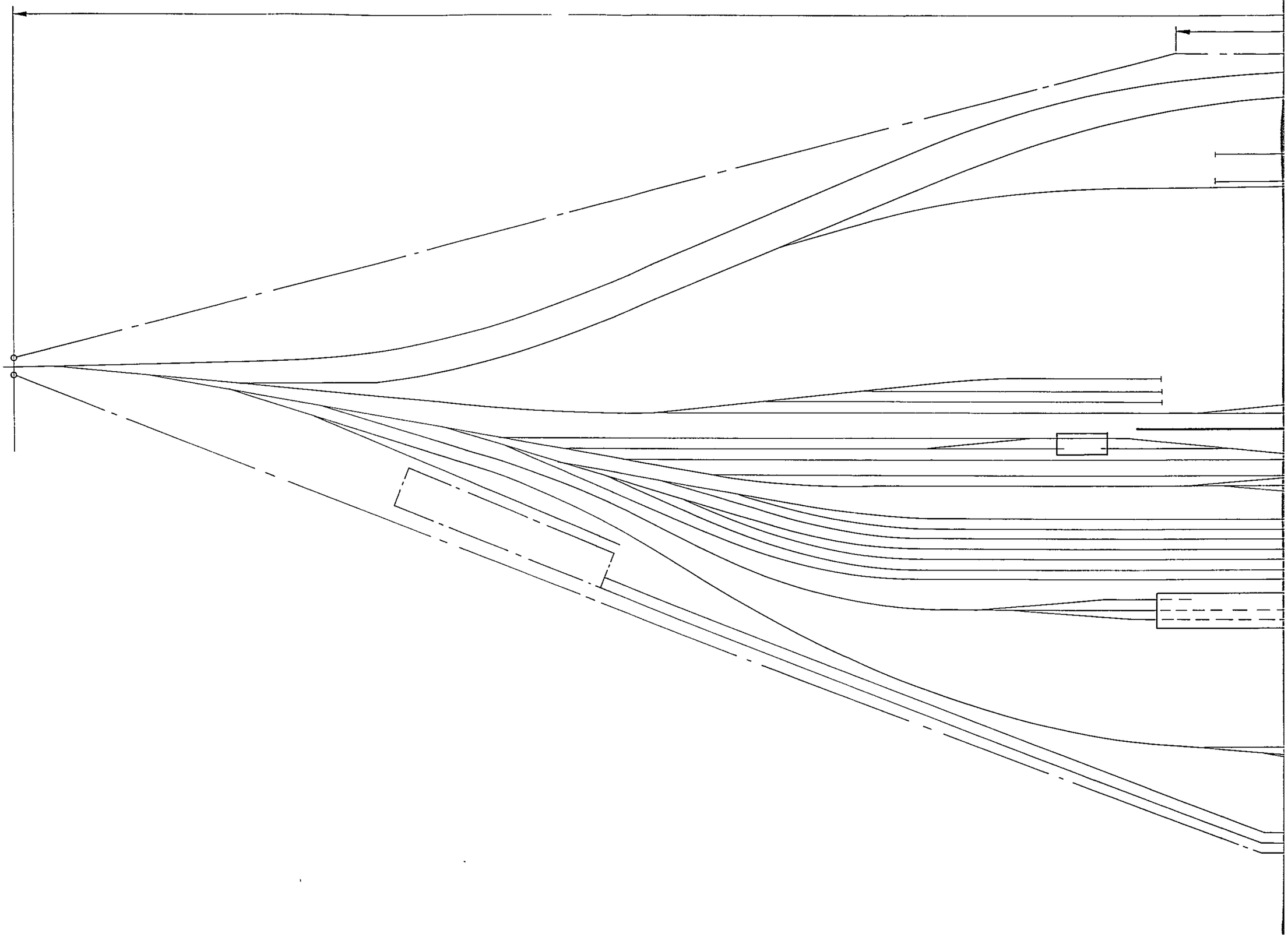


Fig. 8.24 Steam pipe and Air



n pipe and Air pipe arrangement (Plan 1)

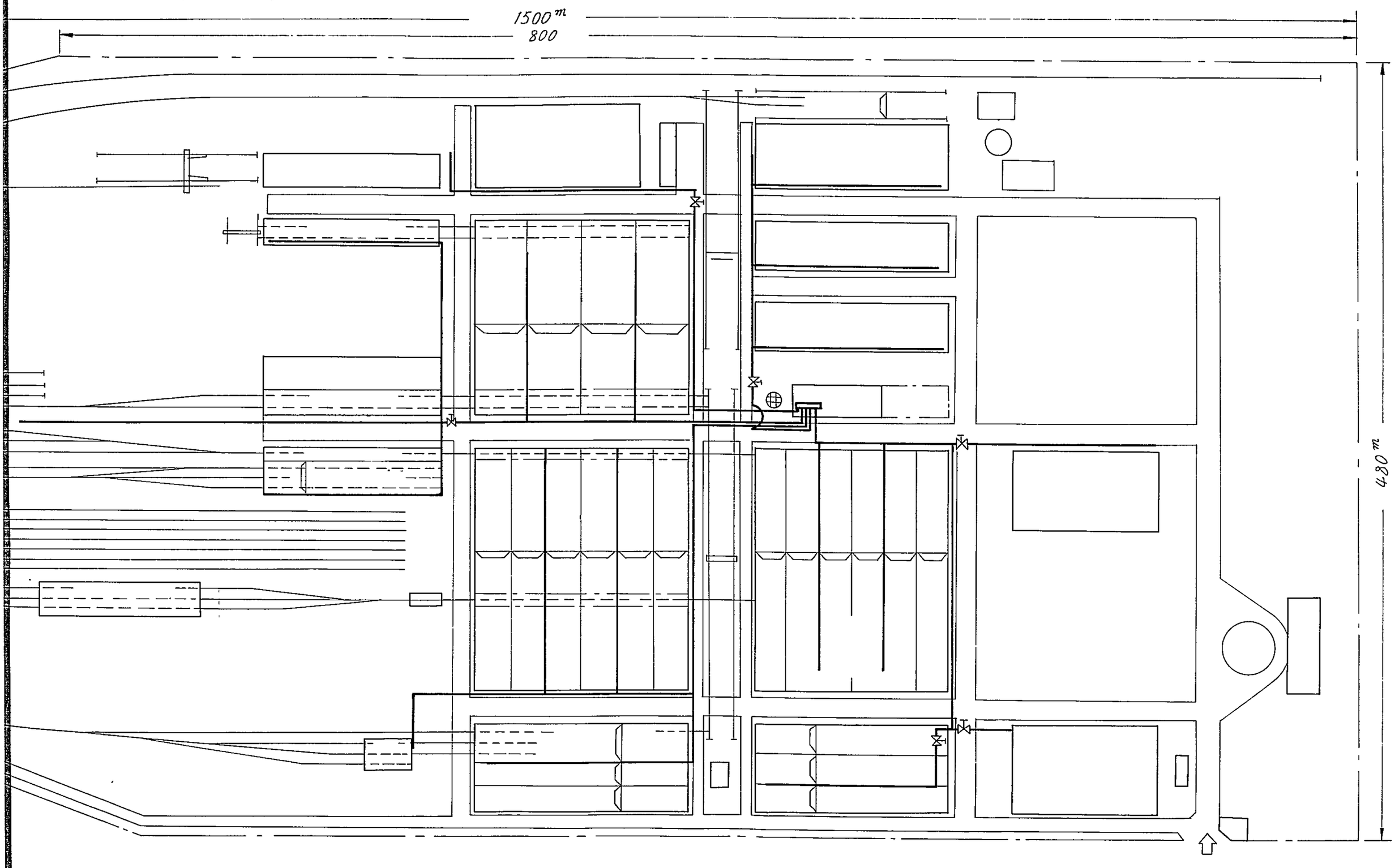
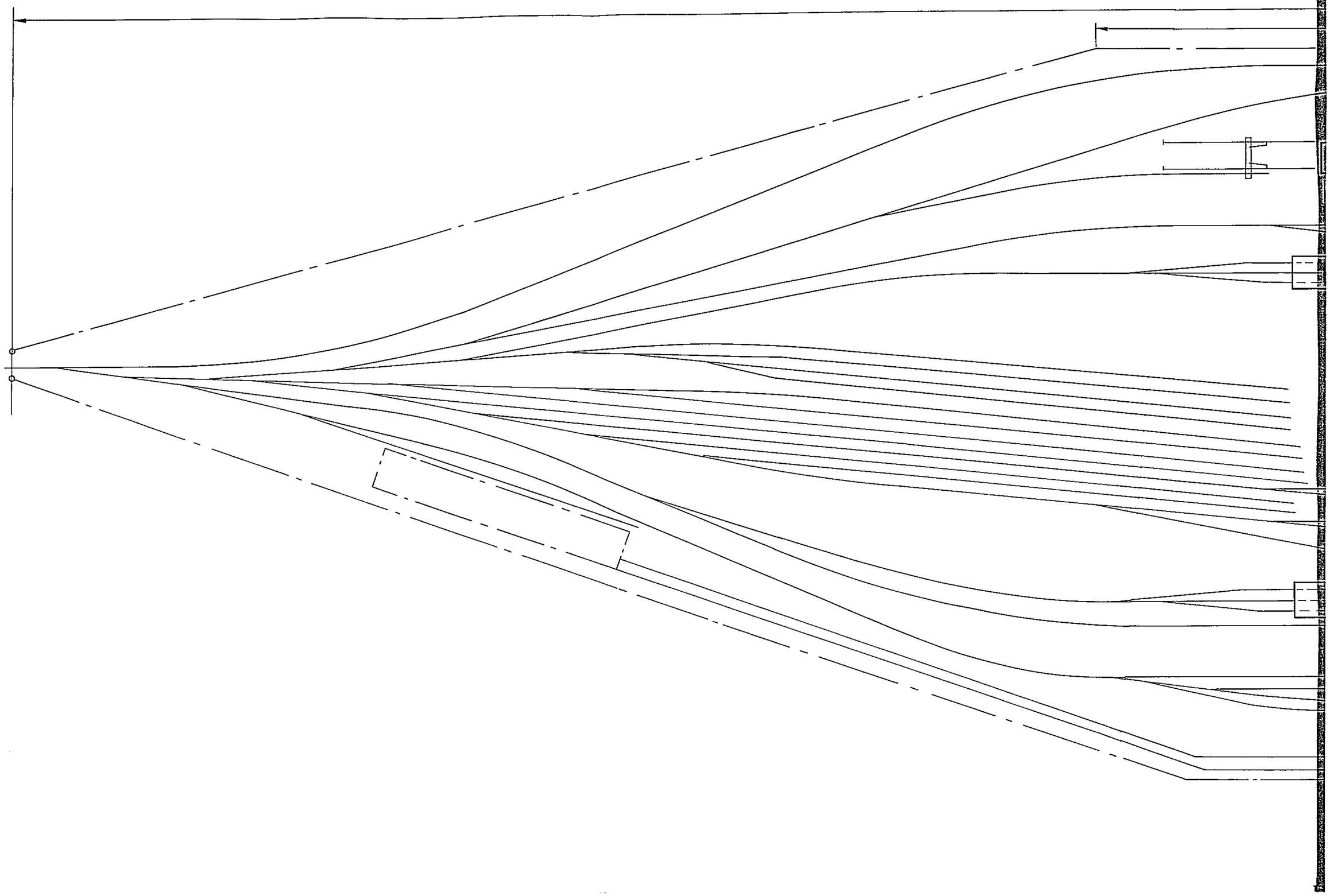


Fig. 8.25 Steam pipe and Air pipe arra



pe and Air pipe arrangement (Plan 2)

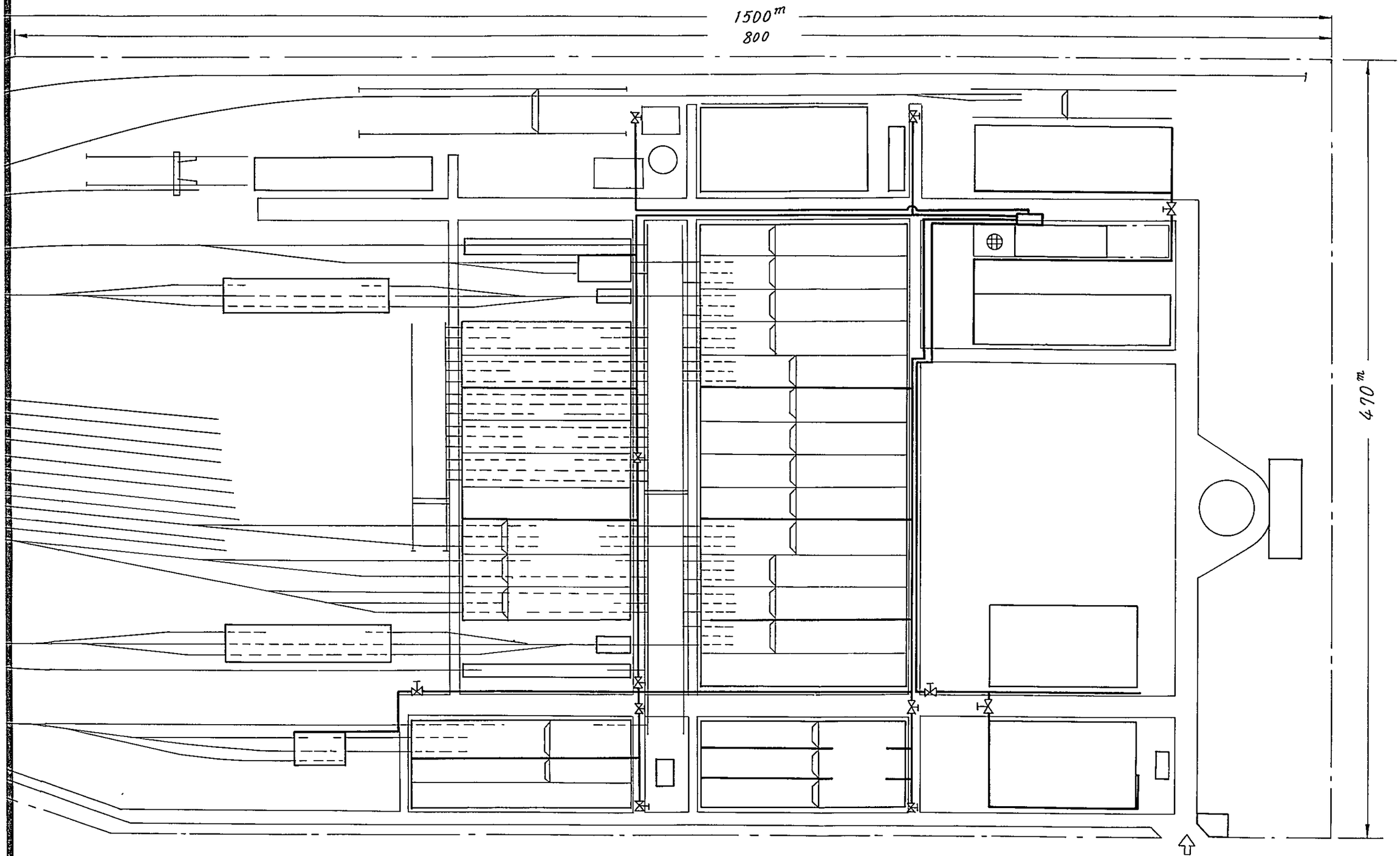
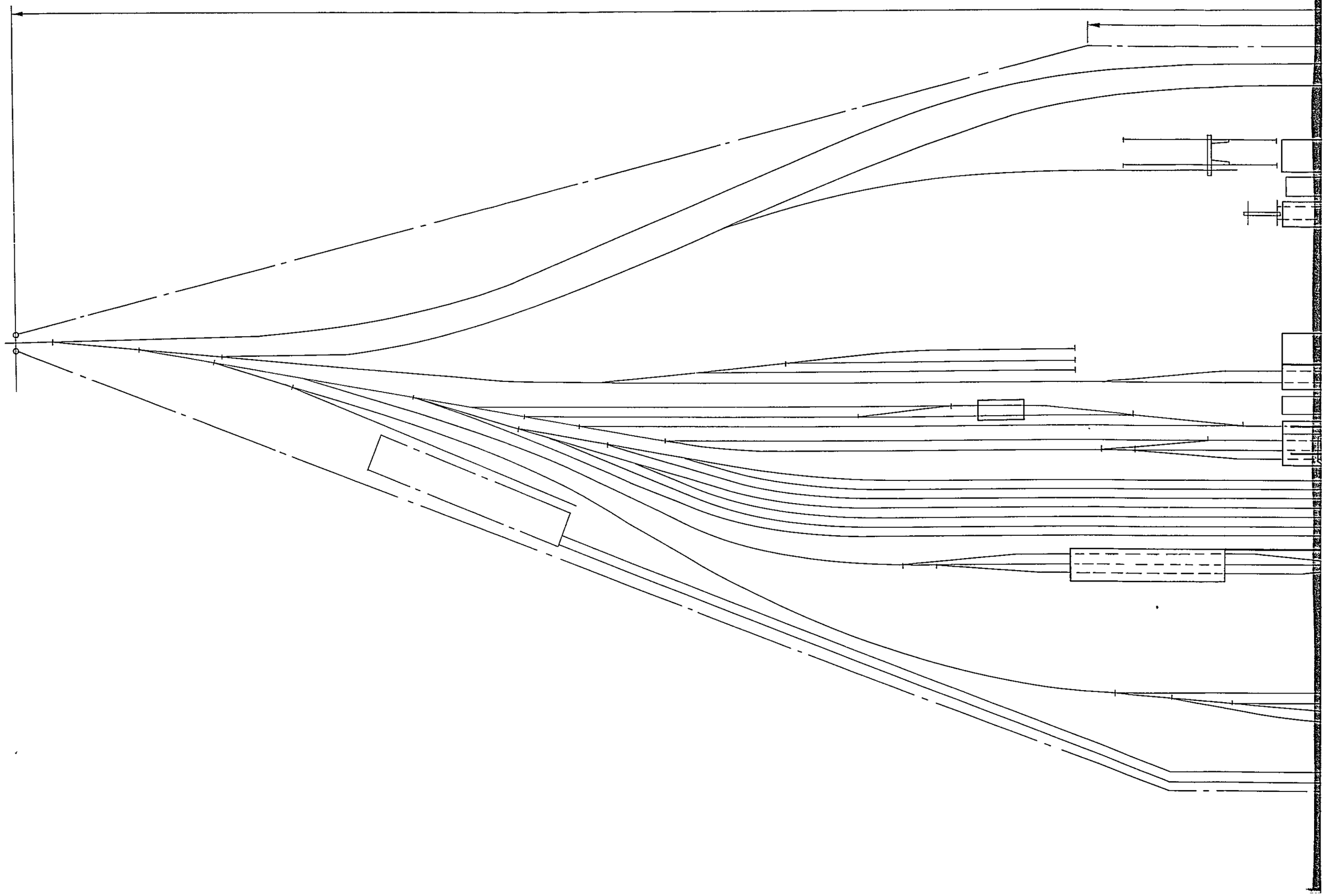
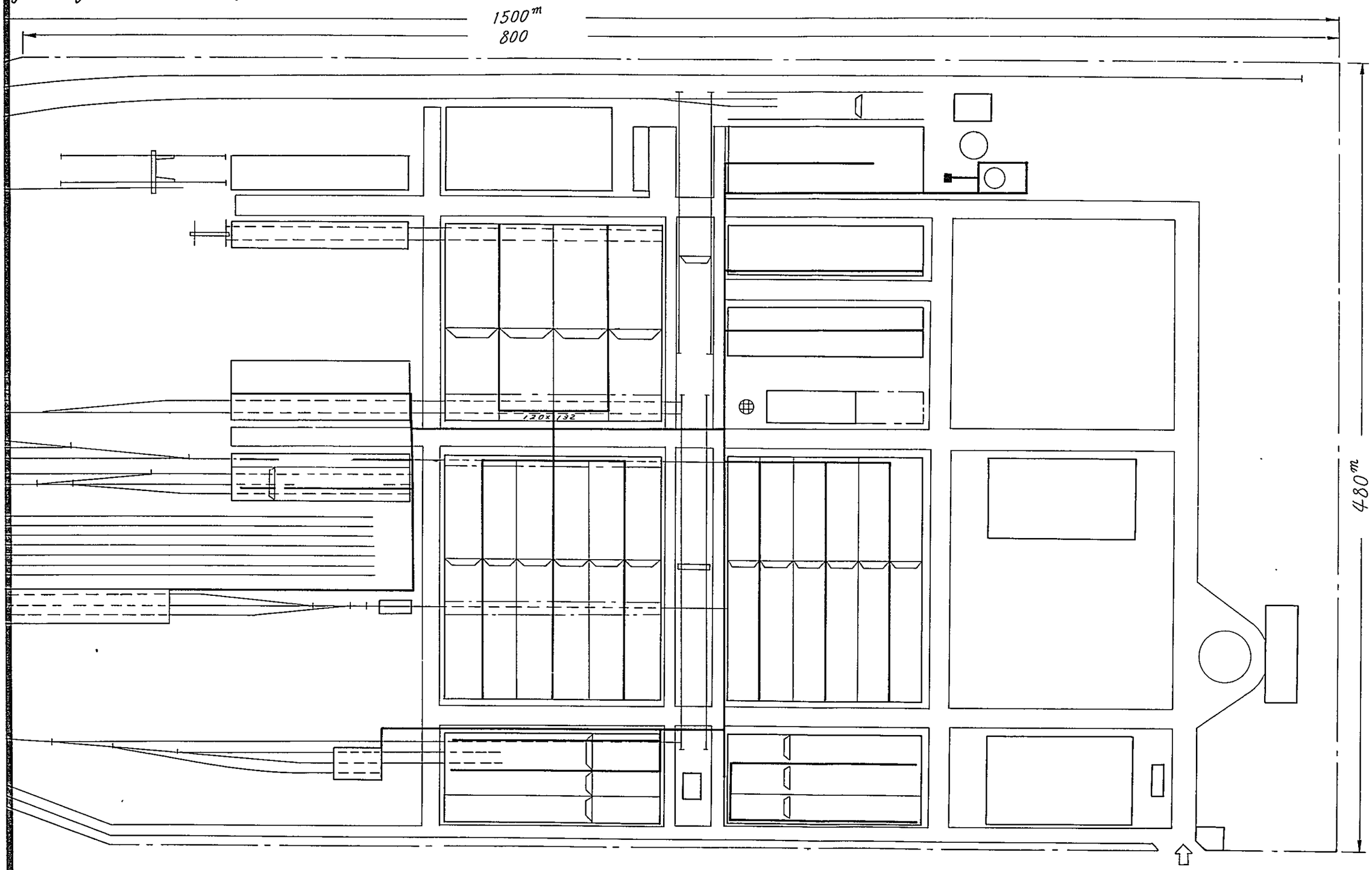


Fig. 8.26 Acetylene gas pipe arrangem



tylene gas pipe arrangement (Plan 1)



Wiring and piping for the supply of motive power will be so arranged that the required power can be procured, both in quality and quantity, so as to facilitate inspection and repair work, uninfluenced by climatic and other conditions. Figs.8.20 - 8.26 illustrate the way in whcih electric power, steam, gas, air and water will be supplied.

8.2.5 Building area

The building area can be determined in relation to the layout of the buildings. But at the same time the necessity for tracks to and from the repair workshop, and tracks for stand-by rolling stock has to be taken into account.

In the case of the Japanese National Railways, a comparison between the workshop areas and buildings areas on the premises shows that, on the whole, the land area is about four or five times that of the building area. If the land area is smaller than that proportion, efficiency in work is generally affected. On the other hand, if the land area is too large, a waste of space is liable to result.

It is therefore desirable that in determining the area of the Taejon Workshop the ratio of the land area to the building area be about 1 : 4.5, as shown in Table 8.26. According to Plan 1, the required land area would be 540, 000 m^2, and according to Plan 2, about 530, 000 m^2.

Table 8.26 Land area

(Unit : m^2)

	Plan 1	Plan 2
Total building area	122, 064	118, 618
Land area	540, 000	530, 000

According to our survey, we recommend that the Taejon Workshop be about 500 m wide and 1, 500 m long. Fig.8.2 shows the size, as suggested in Plan 1, and Fig.8.3, the size suggested in Plan 2.

8.2.6 Estimate of cost of the Taejon Workshop

The cost of the Taejon Workshop construction was estimated on the basis of the area of the buildings required for each unit of repair facilities (as in 8.2.2) and of the equipment enumerated in 8.2.3. In making the estimate, however, the price of land and the contingent expenses, such as for land grading, were not included since no exact figures were available. Then again, in estimating the unit building price, it was assumed that no special foundation work would be required. As regards tracks leading from the station to the workshop, no estimate was made concerning these because no details were available for station yard improvement, and the possible distance over which such tracks would be laid.

Table 8.27 shows the total estimate of the cost and Tables 8.28 and 29 show the estimate for equipment.

Table 8.27 Summary table of fund requirements

(Unit : 1,000 Won)

	Plan 1		Plan 2	
	Quantity	Amount in Won	Quantity	Amount in Won
Total	-	7,972,914	-	7,736,222
Land	540,000 m^2	-	530,000 m^2	-
Buildings	122,064 m^2	3,549,473	118,618 m^2	3,228,952
Structures		674,658		651,621
Tracks		151,779		213,333
Electric lines		441,968		420,621
Telecommunications		8,823		8,823
Machinery and equipment	1,020 units	2,769,928	1,030 units	2,836,587
Automobiles		5,915		5,915
Furniture		370,370		370,370

Note: 1. "Buildings" includes incidental facilities.

2. "Structures" includes passageways, water supply, drainage, fences and pits.

3. "Electric lines" includes power distribution wirings.

4. "Machinery and equipment" includes mounting, wiring and piping.

5. Amounts are calculated by the exchange rate that 1 Won equals 1.37 yen.

Table 8.28 Fund requirements by units for repair facilities in Plan 1

Repair facilities	Buildings		Equipment		Structures, etc. (in 1,000 Won)
	Area in m^2	Amount in 1,000 Won	Number	Amount in 1,000 Won	
Disassembly & assembly of locomotive	3,168	115,308	11	59,114	12,390
Disassembly of freight cars	2,040	46,222	1	10,947	15,141
Trucks (Bogies)	9,000	233,333	60	144,865	70,000
Car body of passenger cars	15,840	528,000	31	110,784	123,200
Car body of diesel railcars	-	-	4	16,785	-
Car body of freight cars	19,800	586,667	31	104,507	154,000
Fabric & window frames	900	20,000	14	17,741	7,000
Wood work	2,640	68,444	16	9,633	20,533
Electrical parts	3,280	87,630	45	109,178	21,067
Engine repairs	3,560	91,926	54	143,844	12,289
Painting	3,660	73,778	36	98,815	28,467
Axles and wheels	4,000	103,704	45	336,803	31,111
Roller bearings	-	-	6	8,174	-
Machining	1,600	41,481	125	266,523	12,444
Iron work finishing	4,500	116,667	105	118,337	35,000
Automatic couplers	700	18,148	40	44,189	5,444
Air brake valves	750	19,444	74	54,516	5,833
Tank car cleaning	450	5,833	2	15,326	1,411
Weighbridge and servicing	790	14,037	5	21,894	7,789
Shop-in check shed	2,346	40,422	4	9,487	18,247
Tools	1,000	25,926	44	81,519	7,778
Reclamation	550	14,259	21	24,923	4,278
Machinery repairs	1,900	49,259	18	59,990	14,778
Building repairs	700	18,148	15	5,430	5,444
Transportation	500	9,259	32	58,968	3,889
Forging of brake shoes	4,800	124,444	41	165,008	22,667
Iron casting in general	-	-	4	18,464	-
Steel casting	-	-	16	95,713	-
Bronze casting	-	-	3	12,495	-
Repair of springs	1,000	25,926	29	57,180	7,778
Forging	1,900	49,259	30	56,414	14,778
Lumbering	2,400	62,222	15	43,642	18,667
Power equipment (air, water, steam, electricity, gas)	1,150	28,704	32	181,064	75,532
Offices	5,500	198,148	2	81,738	2,778
Misc. houses	3,000	50,000	4	16,421	-

Repair facilities	Buildings		Equipment		Structures, etc. (in 1,000 Won)
	Area in m^2	Amount in 1,000 Won	Number	Amount in 1,000 Won	
Store house	10,000	222,222	3	32,476	51,852
Dining hall	4,320	112,000	1	31,381	640
Dressing rooms	4,320	112,000	1	7,298	4,444
Common facilities	-	-	-	38,342	460,559
Equipment incidental to buildings (Heater, etc.)	-	236,653	-	-	-
Total	122,064	3,549,473	1,020	2,769,928	1,277,228

Table 8.29 Fund requirements by units for repair facilities in Plan 2

Repair facilities	Buildings		Equipment		Structure, etc. (in 1,000 Won)
	Area in m^2	Amount in 1,000 Won	Number	Amount in 1,000 Won	
Disassembly & assembly of locomotives	3,168	115,308	11	59,114	12,430
Dismounting and mounting of DC & PC parts	2,040	52,108	4	32,111	
Disassembly of freight cars	2,040	46,222	1	7,407	15,141
Trucks (Bogies)	9,000	233,333	61	151,069	70,000
Car body of passenger cars	10,200	241,778	27	110,784	63,467
Car body of diesel railcars	2,040	52,889	4	16,785	15,867
Car body of freight cars	15,840	409,778	37	135,159	115,793
Fabric & window frames	900	20,000	14	17,741	7,000
Wood work	2,640	68,444	16	9,633	20,533
Electrical parts	3,280	87,630	45	101,880	21,067
Engine repairs	3,560	91,926	54	143,844	27,689
Painting	6,120	120,889	39	114,140	47,600
Axles and wheels	4,000	103,704	45	336,803	31,111
Roller bearings	-	-	6	8,174	-
Machining	1,600	41,481	125	266,523	12,444
Iron work finishing	4,800	124,444	105	118,337	37,333
Automatic couplers	700	18,148	40	44,189	5,444
Air brake valves	750	19,444	74	54,516	5,833
Tank car cleaning	450	5,833	2	15,326	1,411
Weighbridge & servicing	950	16,407	5	21,894	9,033
Shop-in check shed	1,632	24,178	4	9,487	12,693
Tools	1,000	25,926	44	81,519	7,778

Repair facilities	Buildings		Equipment		Structure, etc. (in 1,000 Won)
	Area in m^2	Amount in 1,000 Won	Number	Amount in 1,000 Won	
Reclametion	518	13,430	21	24,923	4,029
Machinery repairs	1,900	49,259	18	59,990	14,778
Building repairs	600	15,556	15	5,430	4,667
Transportation	500	9,259	32	58,968	3,889
Forging of brake shoe	4,800	124,444	41	165,008	22,667
Iron gasting in general	-	-	4	18,464	-
Steel casting	-	-	16	95,713	-
Bronze casting	-	-	3	12,495	-
Repair of springs	1,000	25,926	29	57,180	7,778
Forging	1,900	49,259	30	56,414	14,778
Lumbering	2,400	62,222	15	43,642	18,667
Power equipment (air, water, steam, electricity, gas)	1,150	28,704	32	181,064	75,532
Offices	5,500	198,148	2	81,738	2,778
Misc. houses	3,000	50,000	4	16,421	-
Storage house	10,000	222,222	3	32,476	51,852
Dining hall	4,320	112,000	1	31,381	640
Dresaing rooms	4,320	112,000	1	7,298	4,444
Common facilities	-	-	-	31,547	528,232
Equipment incidental to buildings (heater, etc.)	-	236,653	-	-	-
Total	118,618	3,228,952	1,030	2,836,587	1,294,398

8.2.7 Pusan Workshop improvement plan

Various data concerning the extent of the expansion of Pusan Workshop are defined in 8.2.1, "The scale of the project". It is desirable to carry out the project, as early as possible, along with the Taejon Workshop project with a view to meeting the increase and modernization of rolling stock. This was also emphasized in 7.6.

According to the plan for the construction of the Taejon Workshop which was already made clear, the manufacture and repair of parts are to be concentrated at Taejon as far as possible. Therefore, it will be possible to divert the parts repair shops at the Pusan Workshop to rolling stock repair.

Except for the diesel locomotive repair facilities, it is desirable to renew and increase various repair facilities for passenger and freight cars at the Pusan Workshop in order to guarantee the quality of rolling stock maintenance and possibly diminish the rolling stock repair expenses in the future as at Taejon Workshop. Also, the layout of shops and the arrangement of machinery must preferably be planned in a similar way to that at the Taejon Workshop.

(Appendix)

Consideration of the Electrification Project

1. Electrification Project for Korean National Railroad

A study is being made of a project to electrify the Chungang Line and the Kyongpu Line after completing the dieselization project. No decision has yet been reached as to when it should be carried out.

The following points are considered in connection with the electrification project:

(1) Sections to be electrified

A. For operation of trains hauled by electric locomotives

- (Kyongpu Line (Seoul - Pusan)
- (Chungang Line (Cheongryangri - Yongju)
- (Yongdong Line (Yongju - Mukko)
- (Te Bag Line (Jechon - Jungsun)

B. For operation of multiple-unit electric trains

- (Kyongin Line (Seoul - Inchon)
- (Kyongpu Line (Seoul - Suwon)
- (Chungang Line (Cheongryangri - Yongpyong)

This project does not include any consideration of a plan for electrifying lines within Seoul and Pusan city to alleviate commuter congestion. A separate study is now being made concerning this project.

(2) Rolling stock project

A plan for rolling stock increases in line with the electrification project is underway, as tabulated below:

	1966	1971	1976	1981
Electric locomotive	0	66	134	170
Electric car (motored)	0	40	120	200
Electric car (trailer)	0	40	120	200
Diesel locomotive	173	303	343	473
		(405)	(559)	(727)
Diesel railcar	153	195	195	211
		(235)	(294)	(411)

Note: Figures in parenthesis represent the number of railcars where electrification has not taken place.

Also, it is auticipated that one trailer corresponds to one passenger car and number of FC's does not vary irrespective of electrification.

The main features of the electrification system being considered are, as follows:

A.C. 25, 000 V	
Output of electric locomotive	3, 300 KW
Output of electric car (railcar)	480 KW
IMIT unit	

2. Car bases and workshop project

2.1 As regards car bases and workshops in case the electrification project materializes, little alteration of the plan, already described in the previous chapters, will be found necessary. Since, in the event of electrification, the diesel railcars and passenger cars assigned to Susaeg or Cheongryangri will have been largely replaced by electric cars, either of these two places may well be used as a base for electric cars.

As regards a base for electric locomotives, it may become possible to assign them to either Jechon or Taejon. It will only be necessary to make some investment for electric facilities at the base chosen.

2.2 In the event that the electrification project is realized, the diesel locomotives which are assigned to the Taejon Workshop and part of the diesel locomotives at the Pusan Workshop will be replaced by electric locomotives. The diesel locomotives are dieselelectric, and although large-size traction motors will be used instead of diesel engines, apart from a few additions of electrical equipment, such as rectifiers and transformers, the change from diesel-locomotives to electric will not seriously affect the picture of the Taejon Workshop. A little additional investment will be all that is required to refit the workshop to prepare it for the maintenance of electric rolling stock.

It must be born in mind, however, that this electrification project does not embrace

any plan for urban traffic, including subways. It is therefore desirable that an integral study be made of the electrification project in further detail.