REPORT

BY

DIESEL RAILCAR SURVEY TEAM

IN INDONESIA

(PROJECT NO. I-22 RAIL BUS)

II

1974

OVERSEAS TECHNICAL COOPERATION AGENCY

JAPAN

REPORT

BY

DIESEL RAILCAR SURVEY TEAM

IN INDONESIA

(PROJECT NO. F - 22 RAIL BUS)

II

DECEMBER, 1971

OVERSEAS TECHNICAL COOPERATION AGENCY

JAPAN

CONTENTS

I <u>Case Study on Diesel Railcar Operation and Maintenance</u>

1. Case study on Diesel Railcar Operation

(1) Basic Conditions for drafting Plan requested by the Indonesian Government.

i) Lines of Diesel Railcar operation

a. Djakarta - Tjikampek - Tjirebon

b. Djakarta - Tjikampek - Bandung

c. Djakarta - Bogor

d. Djakarta - Merak

e. Surabaja - Malang

f. Surabaja - Banjuwangi

g. Surabaja - Madiun

h. Semarang - Surabaja

i. Semarang - Tegal

j. Semarang - Jogjakarta

ii) Replacement of trains is not necessary

iii) The total number of cars are not always limited to 12 cars

(2) The merits of diesel railcar trains are:

i) Shuttle use at the Terminal station

ii) Easy to partition and to combine the diesel rail car trains according to the volume of passengers or inspection of cars.

iii) Diesel railcars are light in weight and are short in the wheel-base and therefore give only a limited impact on the rails. Particularly lateral pressure on the tracks, which usually causes much trouble on local lines, has been proved to be small as a result of field tests, and this enables diesel railcars to develop a permissible speed 5 Km/h higher and also to takes curves at a speed 5 Km/h higher than the case of other types of cars.

iv) Operating cost is very small. According to the statistics of the Japanese National Railways (J.N.R.) in 1970, operating cost of each kind of train per Km. are shown as;

Electric railcar train	¥ 38.- (¥360 = US$1.00)
Electric locomotive train	¥138.-
Diesel railcar train	¥ 54.-
Diesel locomotive train	¥131.-
Steam locomotive train	¥228.-

(3) For designing the operating plan, the undermentioned matters are considered as appropriate for operation maintenance and repairing.

i) Mono class, mono type of cars.
One car has one engine driver's cab on one end.

ii) To adopt the same type of engines with same horse-power is most preferable, and as for the lines which have a steep gradient, a supercharger can be utilized to obtain more necessary horse-power.

iii) For greater profitability, to operate the Diesel railear trains in good time zone and to increase the car Kms per day as much as possible. A decrease in the dead run to Jogjakarta Workshop for repairing and the adoption of maintenance-free-type parts are necessary.

iv) For optimum operation of diesel railcar trains in day time, in some cases inspection should be done at night time.

v) Centralized use of diesel railcar train.

a. It is very important to use the diesel railcar centralized in one base (depot) as much as possible. The allocation of one or two sets of diesel railcars in different locations should be strictly avoided on account of the waste in operation and repairing. This means for one to nine car, one spare car is necessary, and two spare cars for up to 19 cars in operation.

Specifically if a small number of cars are allocated for different locations, the number of necessary spare cars must be increased. On the contrary, centralized use of diesel railcars in one base reduces the number of spare cars, and they can easily be diverted each other even in cases of emergency.

b. For operating a diesel railcar train, it is very important to maintain and repair cars to keep them in good condition. Therefore, the facilities for repairing and an inspection staff are also very important. In the case of centralized use, it is very easy to use spare cars, spare parts and spare staff and drivers. It is considered preferable to establish the diesel railcar base (depot) in Djakarta, Semarang and Surabaja one by one, according to plans or dieselization in these areas.

vi) Unit of Car.

One unit comprises two cars.

Total number of cars to be allocated are considered not enough for the time being, therefore it is desirable to put them in the regular inspection according to the smallest number of cars. From this stand point, a car with two driver's cabs is considered, however, on the contrary a car price rises and passenger seats are decreased as a result. Therefore it is most preferable that one unit be comprised of two cars.

vii) Commuter train for market (Pasar).

As a diesel railcar has its engine and accessories under its floor, it is not preferable to allow passenger to dangle themselves or their cargoes outside of the cars when coming to and from the market. (Pasar) When the diesel railcar for commuter services is operated in the morning, it is proposed to set up a market commuter coach or train if available. This means that certain coaches of a certain commuter train are designated for the use of passengers to the market. This type of operation is in use in the Tokyo area with satisfactory results.

(4) General description of case study:

This case study was made from a viewpoint to locating the smallest number of diesel railcars in the three big areas of Djakarta - Semarang and Surabaja as a first step in the introduction of diesel railcars. The number of rail cars are based mainly on the volume of passenger commuter services during the morning hours.

i) However, in the case of Djakarta - Morak section, it is considered that the application of diesel railcar train shows the biggest results by the operation of a fast direct train for connecting ferry boat.
The capacity of a ferry boat is about 1,000 passengers. However, according to the statistics of the field survey, we are informed that 70% of passengers use road transport, buses or private cars. It this be the case, although our plan calls for two sets of diesel railcar train, one train comprising six cars, it is believed that one four-car train is sufficient at the

start of diesel railcar operation. The plan should be amended to connect more cars according to an increase on passenger volume.

ii) Surabaja - Banjuwangi Section.

This distance is very long and daytime trains often mean a waste of time for passengers, so planned are the direct night trains. This line also connects with the ferry boat to Bali Island. The present train consists of seven coaches up to Djember. However, between Djember and Banjuwangi, the gradient is 18 ‰ and the hauling capacity of the locomotive is small, the engine being able to haul only two coaches.

For the diesel railcar trains, 4 cars with 250 HP engine are planned for service.

(5) On operation diagram of the diesel railcar train in the Djakarta area.

1) Djakarta - Kota carriage depot is most preferable as the area for the diesel railcar base. Layout and facilities of the base are mentioned later, but simultaneous fueling facilities for six diesel railcar are urgently needed. At the start, Bukit duri diesel lecomotive depot is available as a transitory diesel railcar depot. In the Djakarta area, passenger volume is so large that one train should consist of six cars.

a. Djakarta - Tjikampek - Tjirebon

chart - 1 referred

b. Djakarta – Tjikampek – Bandung

chart – 1 referred

D1, D3, Trains as shown in chart-1 serve as commuters but stop only at important stations. Permissible speed of train is 5 Km/h higher than that of loco hauling train. D2, D4 are almost the same in services. It is classified as a fast train.

D101 – D106 serve as local trains (stop at many stations). After arrival of train D1 at Djakarta Kota station, 4 of 6 cars serve as train D102, but the remaining 2 cars are to be inspected up to train D106. Between D3 – D104, a trip inspection should also be conducted.

c. Djakarta – Bogor chart-2 referred

Shuttle use by six cars. Inspection and repairing are done at night time.

d. Djakarta – Merak chart-2 referred

For connecting ferry boat service to Sumatra, two sets of six-car trains are required. As a result of the diesel railcar operation and rehabilitation of tracks, arrival time is expected to be shortened. These trains serve as direct fast trains.

Inspection and maintenance are conducted at night time.

2) For the whole Djakarta area, a total number of 34 cars are required, which consists of 30 nos. for use and 4 nos. for spares.

3) Allocation of Diesel rail cars in Djakarta area.
First allocation should be for the Djakarta - Tjirebon, and Djakarta - Bandung line. Since the 12 diesel railcars on these lines are without spare diesel railcars, one set of diesel engine, torque converter and one car-set of bogie trucks are required. This will shorten the repairing period in workshop, since it will require only removing and fixing the engine set from and to the car body.

(6) Surabaja area.

1) As a diesel railcar depot, Sidotopo is most preferable.
In this area, two types of diesel engines are to be allocated; namely 180 HP engine and 250 HP engine powered up by supercharger. Therefore, either provide 2 diesel reilcars of different horsepowers as spare cars, or 2 diesel railcars of 250 horsepowers. Between these, 2 diesel railcars of 250 horsepowers are preferable.

a. Surabaja - Banjuwangi chart-3 referred.
The distance between these two stations is about 300 Kms and between them there are only a few large cities. However, this line is very important in connecting Java with Bali Island. To utilize the time and to connect the train with western and central Java, one set of fast night train and one set of day time fast train are required. On this line there is a steep gradient 18‰ for about 40 kilometers in distance. Hence the engine must be of 250

HP type. One train consists of four cars.

b. Surabaja - Malang chart-3 referred.

This line also has a steep gradient of 21 ‰ for about 32 kilometers in distance. Therefore the Diesel rail car operation is considered using a 250 HP engine. For this line two sets of 4 car-trains are jointly used with the Banjuwangi line.

Inspection of cars are done at night time.

c. Surabaja - Madium chart-4 referred.

For this line one four-car train is enough. Morning commuter services are handled by two sets of diesel rail-cars in both directions between Surabaja and Madium.

Daytime trains serve as fast trains.

Inspection and maintenance are to be conducted at night time.

d. Surabaja - Semarang. Chart-5 referred.

Morning commuter services are handled by two sets of diesel railcar trains composed by four cars in both directions.

Then one set of daytime fast train operates between both cities. Inspection and maintenance are done in morning time.

2) For the whole Surabaja area, a total of 4x2x3 = 24 cars in use are necessary. We planned the diesel railcar depot for the train between Surabaja - Semarang in Surabaja Sidotopo. However this base may be shifted to Sematang depot at actual planning

if necessary. For this operation two spare cars with 250 HP engine are required.

3) Surabaja Pasarturi and Surabaja Kota Stations are not connected by rail. The passangers from Banjuwangi - Malang and Madiun to Semarang or Djakarta directions and vice versa should change trains at Surabaja gubeng or Surabaja Kota stations and go to Surabaja Pasarturi by motor car or Betja which takes more than 30 minutes. This is the bottleneck in the Surabaja area.

(7) Semarang area

Diesel railcar depot is preferable in or near the Semarang diesel loco depot.

a) Semarang - Tegal Chart-6 referred

One set of 4 car_train is available on this line. This train serves as a commuter train to Semarang in the morning and then serves as a local train between Tegal and Semarang. Inspection of cars is done at night time.

b) Semarang - Jogjakarta Chart-6 referred

Two sets of 4 cars trains are necessary. Each set of train serves as a morning commuter train. Daily, four sets of trains are operated as fast train connecting these two cities in three hours. This is the same hour of operation as the buses which are connecting these two big cities.

Inspection is conducted at night time.

(8) Revision of time table

To carry out diesel rail car operation, it is necessary to revise the time table.

2. Case study on operation and maintenance expenses

As to operation and maintenance expenses, Table 1 and Table 2 are referred, and the calculation and its method are shown as follows.

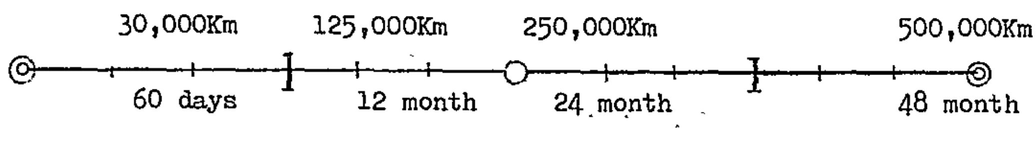
(1) Basic data for calculation.

1) Inspection period.

In this report, the inspection period used by JNR is used for the surpose of calculation, by the reason that the survey time was not enough to obtain exact data.

a. Outline of inspection and repair in JNR

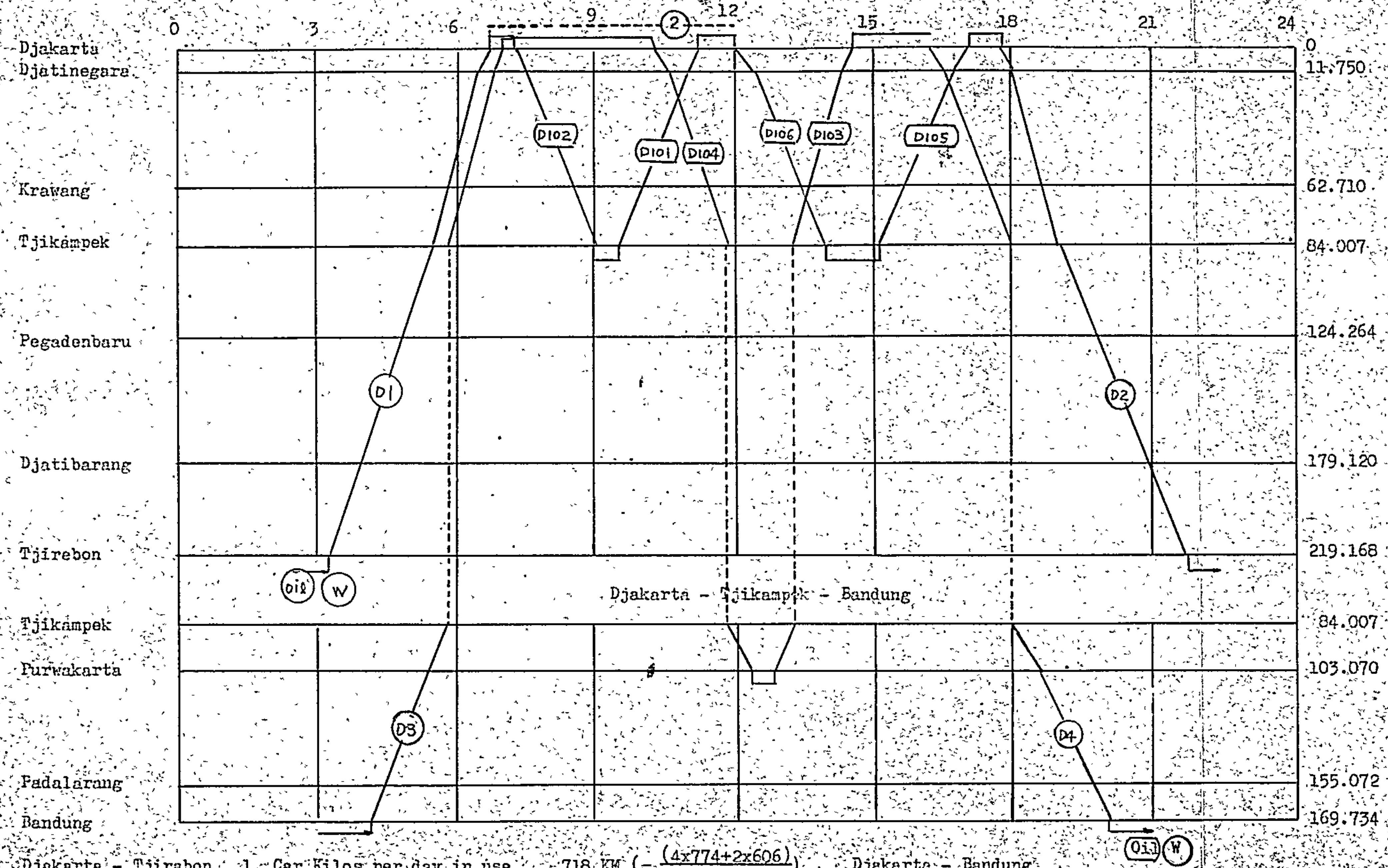
	Running	Kilos	Time limit
Workshop	Maximum	Standard	
General overhaul	500,000 KM	450,000 KM	48 month
Principal parts inspection	250,000 KM	225,000 KM	24 month
Diesel depot			
Rogular inspection (B) I	125,000 KM	112,500 KM	12 month
Regular inspection (A)		30,000 KM	60 days
Trip inspection Special inspection.			2 days (average)



Diesel Railcar Operation Diagram

Chart - 1

Djakarta - Tjikampek - Tjirebon



Djakarta - Tjirebon
1. Car Kilos per day in use 718 KM $\left(= \frac{4x774+2x606}{6}\right)$
2. Train Kilos per day 774 KM
3. Car Kilos per year 718x6x365=1,572,420 KM

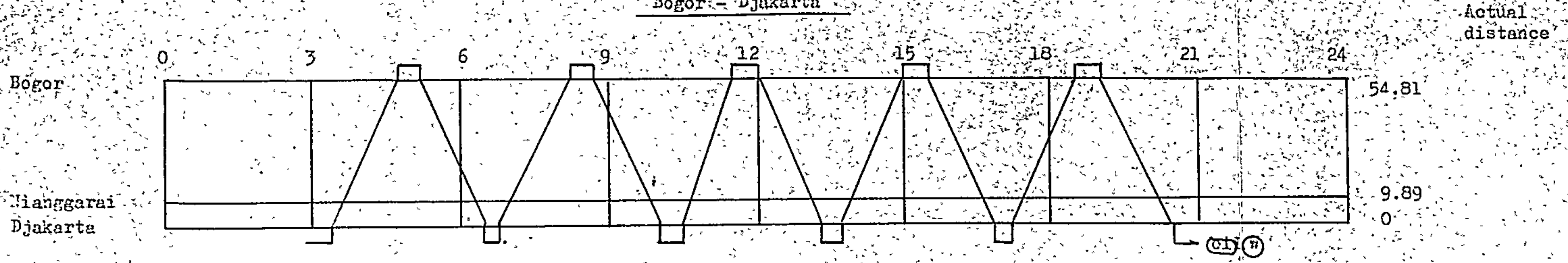
Oil : Fuel oil
W : Watering

Djakarta - Bandung
1. Car Kilos per day in use 546 KM
2. Train Kilos per day 546 KM
3. Car Kilos per year 546x6x365=1,195,740 KM

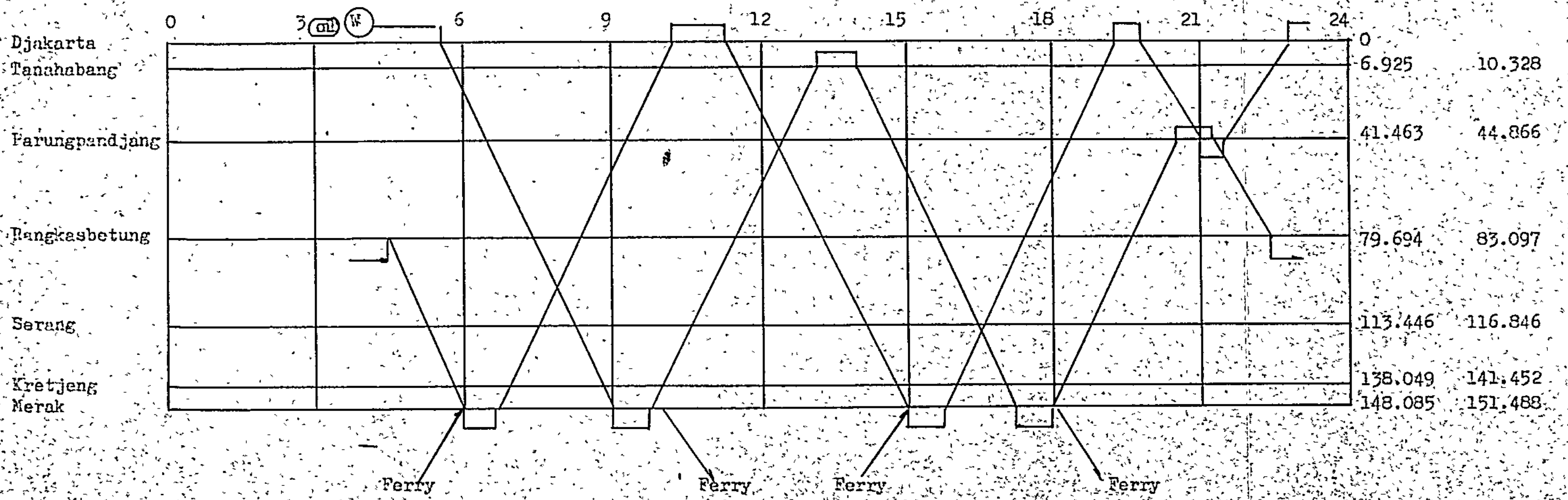
Chart - 2

Diesel Railcar Operation Diagram

Bogor - Djakarta



Djakarta - Merek

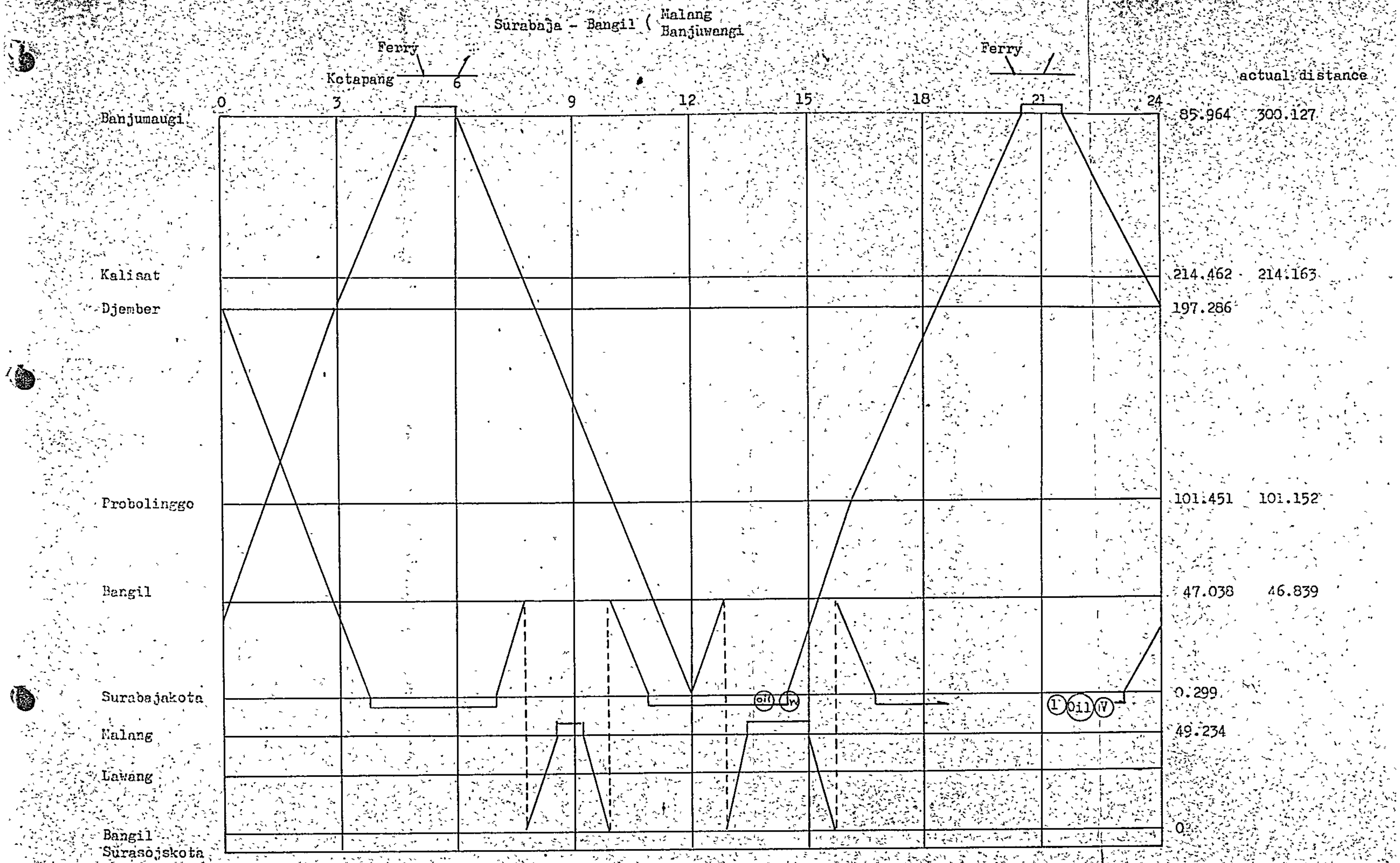


Bogor - Djakarta

1. Car kilos per day in use 546 KM
2. Train Kilos per day 546 KM
3. Car Kilos per year 546x6x365=1,195,740 KM

Djakarta - Merak

1. Car kilos per day in use 538 KM
2. Train Kilos per day 1,222 KM
3. Car Kilos per year 538x12x365=2,358,192 KM

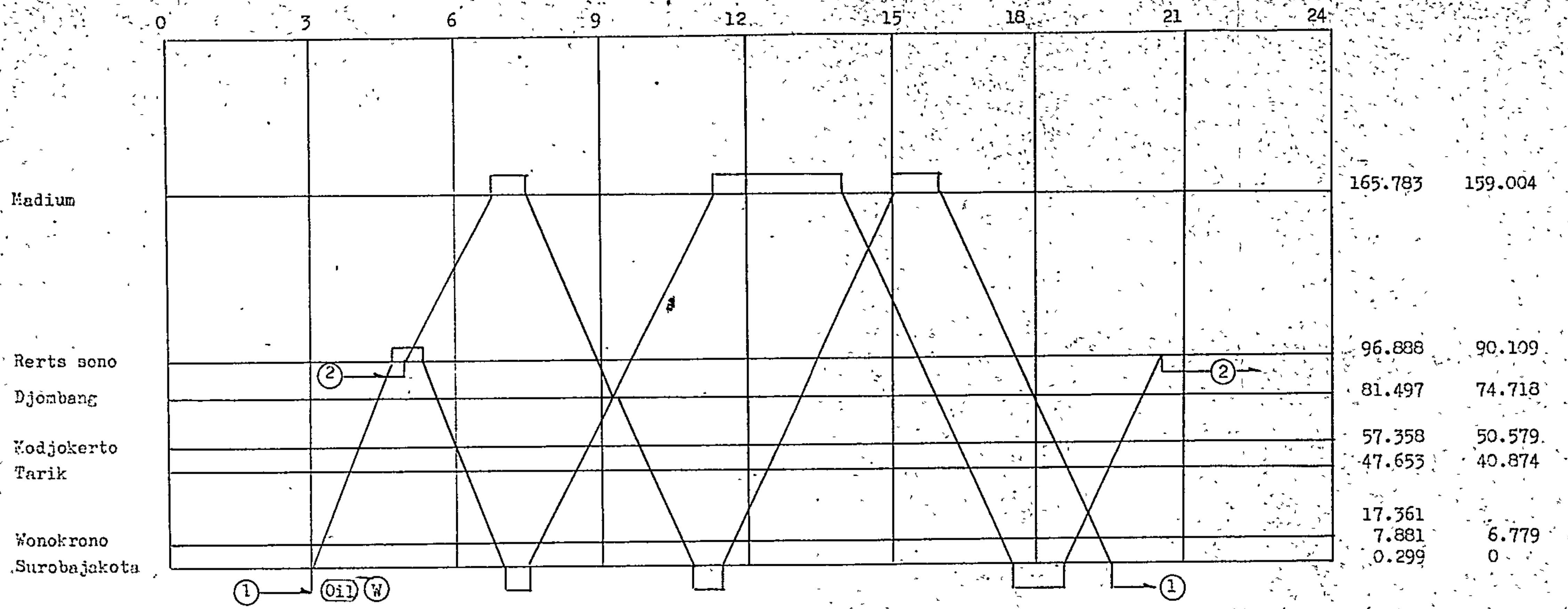


1. Car kilos per day = dia 1 900.381
dia 2 685.215
average 793 KM

2. Train Kilos per day 1586 KM
3. Car Kilos per year 793x8x365=2.314.976 KM

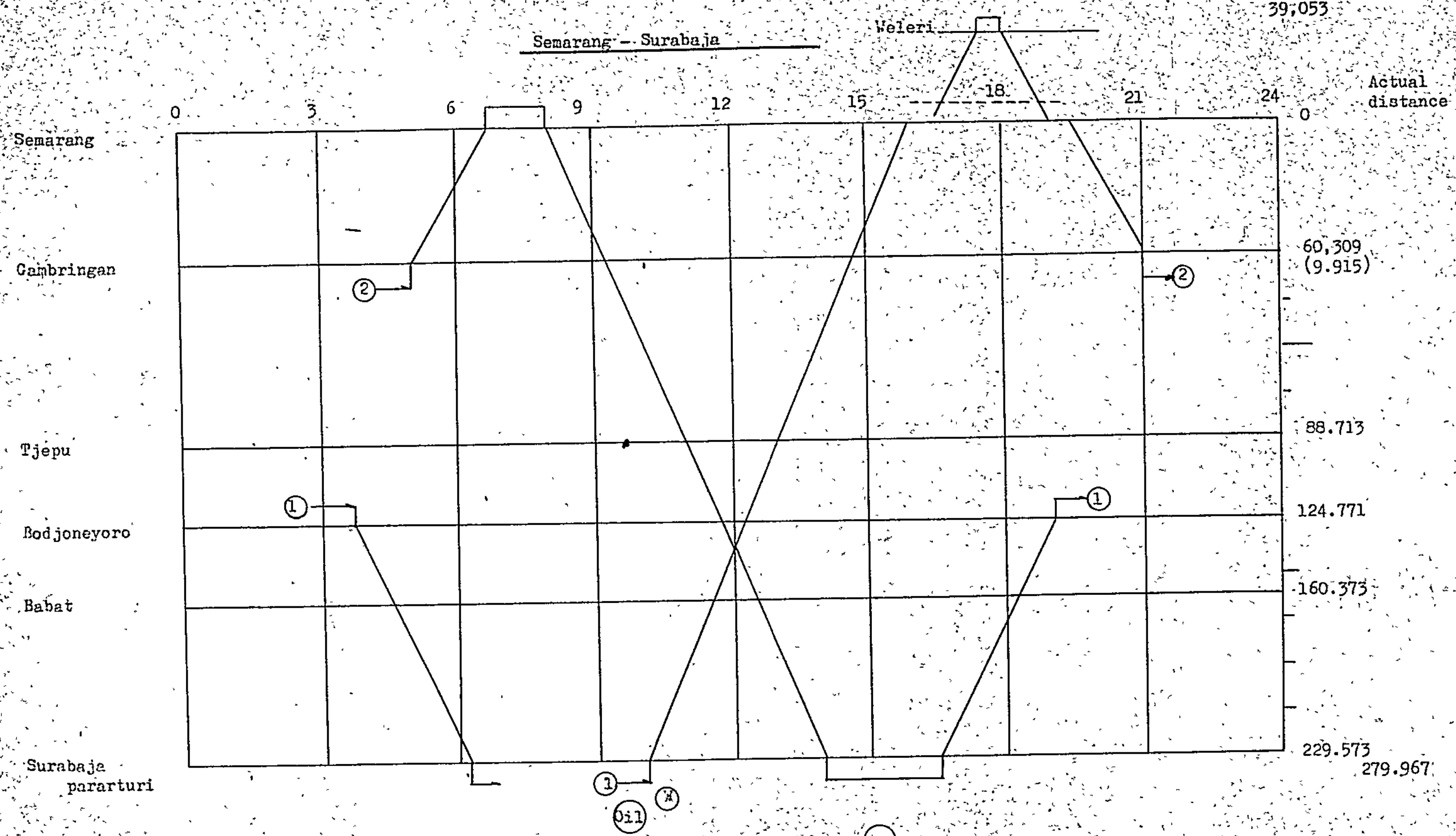
Chart - 4.

Surabajakota - Madiun



1. Car kilos per day — dia ① 588.335
   dia ② 545.807
   total 1.134.142
   average 567.071 car kilos/day
2. Train kilos per day — 1.134 KM
3. Car kilos per year — 567x8x365=1.655.640 KM

Chart 5

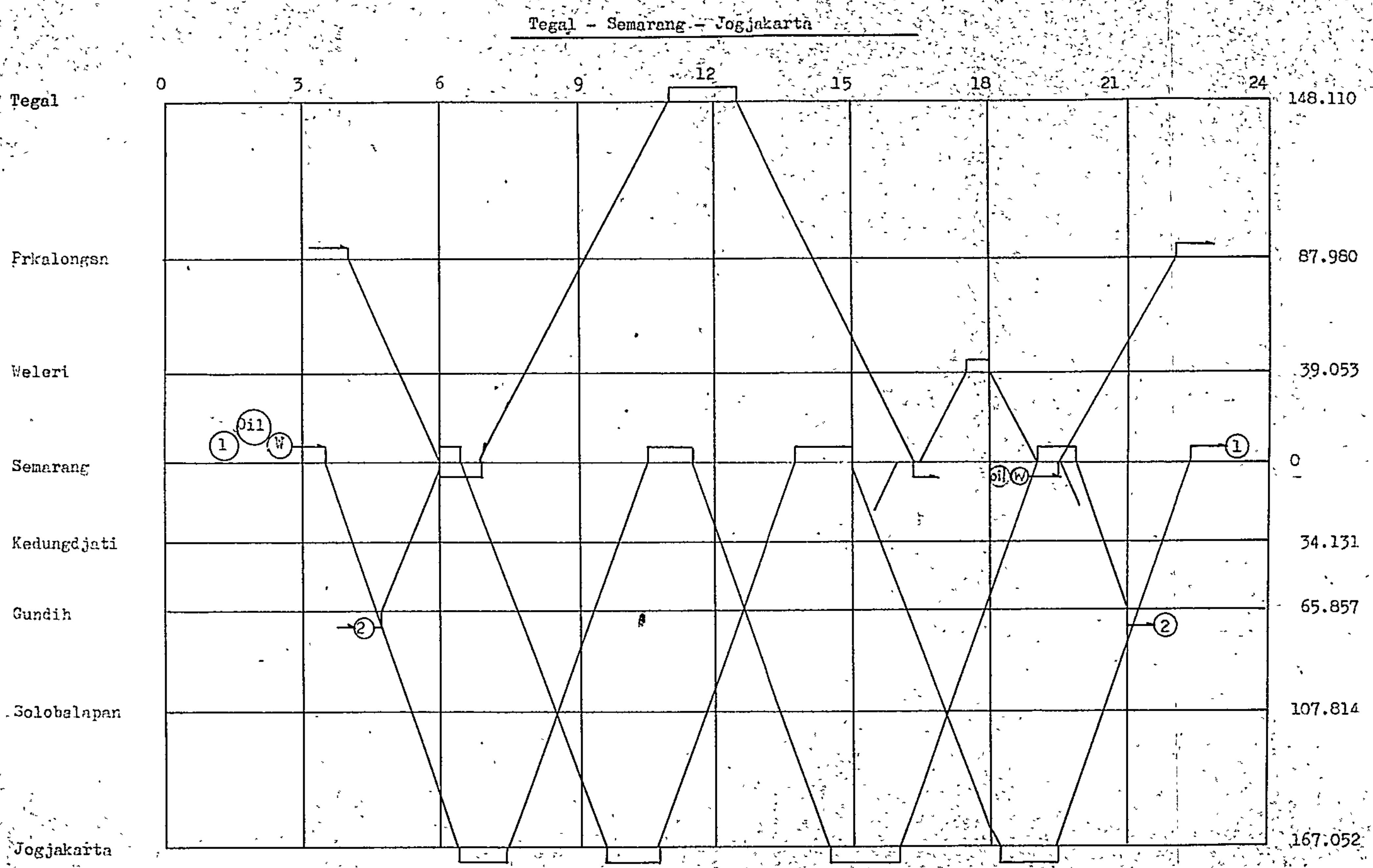


1. Car kilos per day
   - dia 1   474.131
   - dia 2   444.878
   - 919.009
   - average car kilos per day
   - 459.5
2. Train kilos per day   919 KM
3. Car kilos per year   459.5x8x365=1.341.740 KM

Oil fueling

W watering

Chart - 6



Tegal - Semarang

1. Car kilos per day = 472.18
2. Train kilos per day = 472.18
3. Car kilos per year = 472.18x4x365 = 689.383 KM

Semarang - Jogjakarta

1. Car kilos per day dia.1. 734.065
dia.2 734.065
average 734.065 KM
2. Train kilos per day 1468.130 KM
3. Cor kilos per year 734.065x8x365=2.143.462 KM

b. Outline of inspection and repair in P.N.K.A.

	Running Kilos	Time limit (hrs)
General overhaul	about 450,400Km	24,000
Two-yearly	about 225,200Km	12,000
Yearly	about 117,600Km	6,000
Half-yearly	about 58,800Km	3,000
3-monthly	about 29,400Km	1,500
Monthly	about 9,800Km	500
Half-monthly	about 4,900Km	250
Weekly check	about 2,450Km	125
Daily check	about 350Km	24

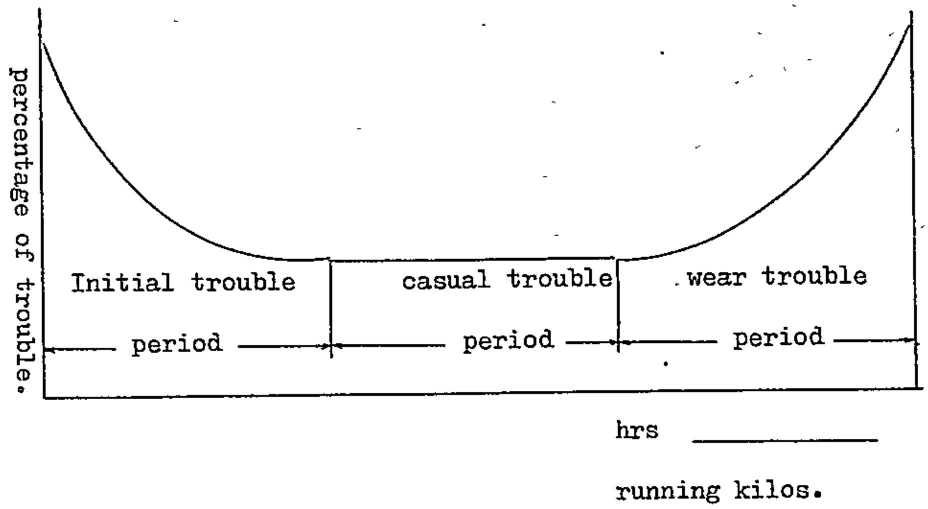
ii) Trouble pattern.

Under the theory of reliability on machines and apparatus, generally speaking, it is said that machines and apparatus, after being newly made or after regular inspection, with a lapse of time in use, pursue a period of initial trouble, casual trouble and wearing trouble as shown in Fig. 1.

As the result of analystic study for trouble characteristics of machines and apparatus on diesel railcar, etc., the following matters become clear.

Trouble pattern

Fig 1



a. By analyzing the trouble data on machines and apparatus, it is shown that there are very few cases where machines and apparatus have a wearing type trouble tendency.

b. Dismantling check in a short period will cause initial troubles or unnecessary repairs of parts which are still capable for use.

This shows that ercessive handling sppils the machines and apparatus. So in this calculation, the case of JNR inspection period is adopted to avoid such troubles eaplained as above.

iii) Standard man hour 1 m.h. = Rp. 20.

	P.N.K.A. man hour	JNR man hour
Regular inspection (B)(Yearly)	250	15
Regular inspection (A) (Two monthly)	48	8
Trip inspection (Equivalent to daily check)	2 x 2 = 4	0.5 /car.

The case of P.N.K.A. man hour is hereby adopted.

iv) Standard number of days consumed for repairing.

	P.N.K.A.	J.N.R.
General overhaul	45 days	10 days
Principal parts inspection (two yearly or 225,000KM)		7 days
Regular inspection		
(B) (yearly or 112,500 KM)		1-2 days
Regular inspection (A) (60 days or 30,000 KM)		0.5 day

v) Prices of materials and brake block etc. consumed in depot.

a, Engine oil; 15 litre/1,000 KM à Rp.72.- P.N.K.A.

b. Transmission oil;
4 litre/1,000 KM à Rp.72.- P.N.K.A.

c. Brake block; ¥920/1,000 KM à Rp.1,200/1,000 KM J.N.R.

d. Generator, dynamo, electric fan, window glass, engine parts etc. available for repair in Work Shop.

¥226,270/car = Rp.300,000/car - à Rp.450,000/car

e. Expendables (Packing, injection nozzle, valve filter etc) in depot.

JNR price (1970) ¥123,120/car = Rp.162,000 -

à Rp.200,000/car.

vi) Workshop expenses

a. Unit price of general overhaul

P.N.K.A. Rp.136,500 (1969) Rp.110,000 (1970)

J.N.R. (1970) ¥2,741,000 = Rp.3,560,000 -

à Rp.4,000,000

b. Unit price of Principal parts inspection(two year)

P.N.K.A. Rp.45,500 (1969) Rp.37,000 (1970)

JNR (1970) ¥1,812,000/car = Rp.2,360,000 -

à Rp.2,400,000.-

This figures show PNKA's overhaul and inspection are not enough. JNR's figures are hereby adopted for satisfactory overhaul and inspection.

(2) Djakarta - Tjikampek - Tjirebon.

1) a. Total number of cars in use. 2x3x1 = 6x1 = 6

b. Engine horsepower = 180 Hp.

c. Balancing speed at max gradient 6‰ is 60 KM/H.

d. Car Kilo per day in use 718 KM

e. Train Kilo per day 774 KM

f. Car Kilos per year 718x6x365 = 1,572,420 KM

ii) Prices of materials and brake block etc. consumed in depot.

a. Engine oil 72x15x1,572 = Rp.1,698,213

b. Transmission 72x4x1,572 = Rp.452,856

c. Brake block 1,200x1,572 = Rp.1,886,900

d. Parts 4,500 x 6 = Rp.2,700,000

e. Expendables in depot.

200,000x6 = Rp.1,200,000

Total in depot: Rp.7,937,971

iii) Workshop expenses.

Number of cars for general overhaul and principal inspection per year;

$1,572,240 \times \frac{1}{450,000} = 3.\underline{49}$ cars per year.

Price of general overhaul;

$4,000,000 \times 3.\underline{49}$ = Rp.13,960,000

Price of principal parts inspection;

$2,400,000 \times 3.\underline{49}$ = Rp.8,376,000

Total price in Work Shop: Rp.22,336,000

iv) Expenses in Dopot

Regular inspection (B) 3.49x2 = 6.98 cars/year

Regular inspection (A) $1,572,420 \times \frac{1}{30,000} = 52.6$ cars/year

Inspection (A) man-hours 48x52.6 = 2,524.8 man-hours

at PNKA figures

Inspection (B) 250 x 6.98 = 1,745 mh.

Trip inspection including special repair

labor shift x man-hour x days = 2x4x365 = 2,920 mh.

Total m.h. 7,189 mh.

1 man-hour = Rp. 20 1 day = 8 hrs.

20x8x7,189 = Rp. 1,150,240

v) Fuel consumption

By statisties in JNR, fuel consumption of a 180 Hp diesel engine is 0.41 litro/KM

Yearly consumption of fuel oil

0.41 x 1,572,421 = 644,692 litre

Rp. 12.50 x 644,692 = Rp. 8,058,625

vi) Number of engine drivers required

Average driving distance per day per person.

150 KM (P.N.K.A.) 134 KM (JNR)

774 (Train Kilos per day) ÷ 150 = 5.15 ÷ 6 persons

Average salary Rp. 4,000)
Premium Rp. 4,000) Rp. 8,000

8,000 x 12 x 6 = Rp. 576,000

vii) Number of conductors required.

Average riding distance per day per person.

150 KM

774 ÷ 150 = 5.15 ÷ 6 persons.

Average salary Rp.4,000)
Premium Rp.4,000) Rp. 8,000

8,000 x 12 x 6 = Rp. 576,000

Expenses grand total Rp. 40,634,836.—

(3) Djakarta – Tjikampek – Bandung

i) Total number of cars in use

6 X 1 = 6

Engine horsepower: 180 HP

Balancing speed at max gradient

16 ‰ 27 K/H

Car kilo per day in use 546 KM

Train kilo per day 546 KM

Car kilo per year

546x6x365 = 1,195,740 KM

ii) Expenses consumed in depot

Engine oil:
72x15x1,195=Rp.1,291,399

Transmission oil:
72x4x1,195 =Rp.344,373

Brake block:
1200x1,195 =Rp.1,434,888

Parts:
450,000x6 =Rp.2,700,000

Expendables in depot:
200,000x6 =Rp.1,200,000

Total: Rp.6,970,660

(4) Djakarta – Bogor

i) Total number of cars in use

6 X 1 = 6

180 HP

13 ‰ 41,5 K/H

546 KM

546 KM

1,195,740 KM

ii) Consumed in depot

Rp. 1,291,399

Rp. 344,373

Rp. 1,434,888

Rp. 2,700,000

Rp. 1,200,000

Total: Rp. 6,970,660

iii) Workshop yearly expenses	iii) Workshop yearly expenses
Number of cars per year to be put in general overhaul	
$1,195,740 \times \frac{1}{450,000} = 2,657$ cars	2,657 cars
Price of general overhaul	
4,000,000x2,657=Rp.10,628,000	Rp 10,628,000
Price of principal inspection	
2,400,000x2,657=Rp.6,376,800	6,376,800
Total Rp.17,004,800	Total: Rp.17,004,800
iv) Expenses in depot repairs and maintenance	iv) Expenses in depot
Number of cars to be repaired	
Regular inspection (B)	
2,657x2 = 5,314 cars	5,314 cars
Regular inspection (A)	
$1,195,740 \times \frac{1}{30,000} = 39,858$ cars	39,858 cars
Inspection (A) man-hours	
48x39,858 = 1,913 mh	1,913 mh
Inspection (B) man-hours	
250x5,314 = 1,328 mh	1,328 mh
Trip inspection including special repair	
2x4x365 = 2,920 mh	2,920 mh
Total: 6,161 mh	Total: 6,161 mh

Total expenses

20x8x6,161 = Rp. 985,920

v) Fuel consumption

0.41x1,195,740=490,253.4 litre

125x490,253 ≐ Rp.6,128,267

vi) Engine drivers expenses

Number of drivers required

546÷150 = 3.<u>64</u> = 4 persons

8,000x12x4 Rp. 384,000

vii) Conductors expenses

546÷150 = 3.<u>64</u> = 4

8,000x12x4 = Rp. 384,000

Expenses grand total:

Rp. 31,857,647

(5) Djakarta – Merak

i) Total number of cars in use

6 x 2 = 12 cars

Engine horsepower = 180 HP

Balancing speed at max

gradient 8

43.5 K/H

Car kilo per day in use 538 KM

Total Rp. 985,920

v) Fuel consumption

490,253.4 litre

Rp. 6,128,267

vi) Engine drivers expenses

4 persons

Rp. 384,000

vii) Conductors expenses

4 persons

Rp. 384,000

Grand Total:

Rp. 31,857,647

(6) Surabája – Malang
– Banjuwangi

i) Total number of cars in use

4 x 2 = 8 cars

250 HP

18 ‰

32 K/H

793 KM

Train kilo per day 1,222 KM

Car kilo per year

538x12x365 = 2,358,192 KM

ii) Expenses consumed in depot

Engine oil

15x72x2,358 = Rp.2,546,640

Transmission oil

4x72x2,358 = Rp. 679,104

brake block

1,200x2,358 = Rp.2,829,600

Parts

450,000x12 = Rp. 5,400,000

Expendables

200,000x12 = Rp. 2,400,000

Total: Rp.13,855,344

iii) Workshop yearly expenses

Number of cars per year to be put in general overhaul and principal inspection

$$2,358,192 \times \frac{1}{450,000} = 5.\underline{24} \text{ cars}$$

General overhaul expenses

$$4,000,000 \times 5.\underline{24} = \text{Rp.}20,960,000$$

1,586 KM

2,314,976 KM

ii) Expenses consumed in depot

Engine oil

15x72z2,314 = Rp.2,500,174

Transmission oil

4x72x2,314 = Rp. 666,713

braks block

1,200x2,314 = Rp.2,777,971

Parts

P.450,000x8 = Rp.3,600,000

Expendables

200,000x8 = Rp.1,600,000

Total: Rp.11,144,858

ii) Workshop yearly expenses

$$2,314,976 \times \frac{1}{450,000} = 5.\underline{144} \text{ cars}$$

$$4,000,000 \times 5.\underline{144} = \text{Rp.}20,577,200$$

Principal parts inspection expenses

2,400,000x5.24=Rp.12,576,000

Total: Rp.33,536,000

iv) Expenses in depot for repair and maintenance

Regular inspection (B)

5.24x2 = 10.48

Regular inspection (A)

$2.358.192 \times \frac{1}{30,000} = 78.6$ cars

Inspection (A) man-hours

48x78.6 = 3,772

Inspection (B) man-hour

250x10.48 = 2,620

Trip inspection including special repair

2x4x365 = 2,920

Total: 9,312 man-hour

Total price

20x8x9,312 = Rp. 1,489,920

v) Fuel consumption

0.41x12.5x2,358=Rp.12,085,734

2,400,000x5.144=Rp.12,346,320

Total: Rp.32,923,520

iv) Expenses in depot

5.144 x 2 = 10.289

$2,314,976 \times \frac{1}{30,000} = 77.2$ cars

48x77.2 = 3,705

250x10.29 = 2,572

2x4x365 = 2,920

Total: 9,197 man-hour

20x8x9,197 = Rp. 1,471,520

v)

$0.41 \times \frac{250HP}{180HP} = 0.567$

12.5x0.567x2,314,976 =

Rp. 16,416,062

vi) Number of engine drivers

1,222÷150=8.14= 9 persons

Drivers expense

8,000x12x9= Rp.864,000

vii) Number of train conductors

1,222÷150=8.14= 9 persons

viii) Conductor expenses

8,000x12x9 = Rp.864,000

Expenses grand total:

Rp. 62,694,998

vi)

$1{,}586\times\frac{1}{150}$ =10.5= 11 persons

8,000x12x11=Rp.1,056,000

vii)

$1{,}586\times\frac{1}{150}$ = 10.5 = 11

viii)

8,000x12x11= Rp.1,056,000

Expenses grand total:

Rp.64,067,960

(7) Surabaja - Madium

i) Total number of cars in use

4 x 2 = 8 cars

Engine horsepower 180 HP

Balancing speed at max.

gradiant 7 56.5 K/H

Car kilos per day in use

567 KM

Train kilos per day 1,134 KM

Car kilos per year

1,655,640 KM

ii) Expenses consumed in depot

Engine oil

15x72x1,655=Rp.1,788,091

(8) Semarang - Surabaja

i)

4 x 2 = 8 cars

180 HP

6

60 K/H

4.60 KM

920 KM

1,341,740 KM

ii) Expenses consumed in depot

Engine oil

15x72x1,341=Rp.1,449,079

Transmission oil

4x72x1,655=Rp.476,824

Brake block

1,200x1,655=Rp.1,986,768

Parts.

450,000x8 = Rp.3,660,000

Expendables

200,000x8=Rp.1,600,000

Total: Rp.9,451,683

iii) Workshop yearly expenses number of cars per year to be put in in general overhaul and principal parts inspection

$1,655,640 \times \frac{1}{450,000} = 3.\underline{68}$ cars

General overhaul expenses:

4,000,000x3.68=Rp.14,720,000

Principal parts inspection expenses

2,400,000x3.68=Rp.8,832,000

Total: Rp.23,552,000

iv) Expenses in depot

Number of cars to be repaired

Regular inspection (B)

3.68x2 = 7.36 cars

Transmission oil

4x72x1,341=Rp.386,421

Brake block

1,200x1,341=Rp.1,610,088

Parts

450,000 x 8 = Rp.3,600,000

Expendables

200,000x8 = Rp.1,600,000

Total: Rp.8,645,583

iii) Workshop yearly expenses

$1,341,740 \times \frac{1}{450,000} = 2.\underline{98}$ cars

4,000,000x2.98=Rp.11,920,000

2,400,000x2.98=Rp.7,152,000

Total: Rp.19,072,000

iv) Expenses in depot

2.98 x 2 = 5.96 cars.

Regular inspection (A)

$1,655,640\times\frac{1}{30,000} = 55.\underline{2}$ cars

Inspection (A) man-hours

48x55.2 = 2,650 mh

Inspection (B) man-hour

250x7.36 = 1,840 mh

Trip inspection including special repair

2x4x365 = 2,920 mh

Total man-hour 7,410 mh

Expenses

20x8x7,410 = Rp.1,185,600

v) Fuel consumption

0.41x1,655,640=678,812

12.50x678,812=Rp.8,485,155

vi) Engine drivers cost

$1,134\times\frac{1}{150}=7.\underline{56}$ = 8 persons

8,000x12x8 = Rp. 768,000

vii) Train conductors cost

$1,134\times\frac{1}{150} = 7.56 = 8$

8,000x12x8 = Rp.768,000

Expenses grand total

Rp.44,210,438

$1,341,740\times\frac{1}{30,000} = 44.\underline{7}$ cars

48x44.7 = 2,146 mh

250x5.96 = 1,490 mh

2x4x365 = 2,920 mh

Total 6,556 mh

Expenses

20x8x6,566 = Rp. 1,048,960

v) Fuel consumption

0.41x1,341,740=550,113

12.5x550,113=Rp.6,876,412

vi) Engine drivers cost

$919\times\frac{1}{150} = 6.\underline{12} = 7$ persons

8,000x12x7 = Rp.672,000

vii) Train conductors cost

$919\times\frac{1}{150} = 6.12 = 7$

8,000x12x7 = Rp.672,000

Expenses grand total

Rp.36,986,960

(9) Semarang – Togal

i) Total number of cars in use

4 x 1 = 4 cars

Engine horsepower 180 Hp

Balancing speed at max

gradient 7 ‰

56.5 K/H

Car kilos per day in use

472 KM

Train Kilos per day 472 KM

Car kilos per year

689,383 KM

ii) Expenses consumed in depot

Engine oil

15x72x689 = Rp.744,533

Transmission oil

4x72x689 = Rp.198,542

brake block

1,200x689 = Rp.827,260

Parts:

4x450,000 = Rp.1,800,000

Expendables

200,000x4 = Rp.800,000

Total Rp.4,370,335

(10) Semarang – Jogjakarta

i) Total number of cars in use

4 x 2 = 8 cars

180 Hp.

11 ‰

45.5 K/H

734 KM

1,468 KM

2,143,462 KM

ii) Expenses consumed in depot

15x72x2,143 = Rp.2,314,938

4x72x2,143 = Rp.617,317

1,200x2,143 = Rp.2,572,154

450,000x8 = Rp.3,600,000

200,000x8 = Rp.1,600,000

Total: Rp.10,704,409

iii) Yearly workshop expenses number of cars per year to be put in general overhaul and principal inspection

$689,383 \times \frac{1}{450,000} = 1.53$ cars

General overhaul expenses

4,000,000x1.53=Rp.6,120,000

Principal parts inspection

2,400,000x1.53=Rp.3,672,000

Total: Rp. 9,792,000

iv) Expenses in depot for repair and maintenance

Number of cars to be repaired

Regular inspections (B)

1.53 x 2 = 3.06 cars

Regular inspection (A)

$689,383 \times \frac{1}{30,000} = 23.0$ cars

Inspection (A) manhours

48 x 23 = 1,104 mh

Inspection (B) manhour

250 x 3.06 760 mh

Trip inspection

2 x 4 x 365 = 2,920

Total man hour 4,784 mh

Expenses 20x8x4,784=Rp.765,440

iii) Workshop expenses

$2,143,462 \times \frac{1}{450,000} = 4.76$ cars

4,000,000x4.76=Rp.19,040,000

2,400,000x4.76=Rp.11,424,000

Total: Rp. 30,464,000

iv) Expenses in depot

4.76 x 2 = 9.52 cars

$2,143,462 \times \frac{1}{30,000} = 71.45$ cars

48 x 71 = 3,408 mh

250 x 9.5 = 2,380 mh

2,920 mh

Total man hour 8,708 mh

Expenses 20x8x8,708=Rp.1,393,280

v) Fuel consumption

0.41x689,383=282,674 litres

12,5x282,674=Rp.3,533,087

vi) Engine drivers cost

$472x\frac{1}{150} = 3.1 \doteqdot 4$ persons

8,000x12x4=Rp.384,000

vii) Train conductors cost

8,000x12x4 = Rp.384,000

Grand total: Rp. 19,228,862

v) Fuel comsumption

0.41x2,143,462=878,819 litres

12.5x878,819=Rp.10,985,237

vi) Engine drivers cost

$1,468x\frac{1}{150} = 9.7 \doteqdot 10$ persons

8,000x12x10=Rp.960,000

vii) Train conductors cost

8,000x12x10 = Rp.960,000

Grand total: Rp.55,466,926

All these figures are shown in Table 1 and Table 2.

(11) Suitable number of spare cars.

i) Spare cars.

The most economical figure of spare cars for repairing and inspection in relation to number of cars in use is:

The case in J N R (Express with one engined) 1970

The ratio in use in inspection and repair

$$\frac{\text{cars in use}}{\text{cars in inspection \& repair}} = \frac{850}{94} \doteqdot 9$$

This means, if the number of cars in use is less than nine cars, the necessary number of sparerail cars is one, therefore the use of less than eight cars is not economical. Similarly, the most economical allocation of diesel railcar is less than

9N, but close to 9N is most economical

N : Free number 1, 2, 3 ....

The case of P.N.K.A., allocate the 9N number of cars in one area. However, one unit of railcars is two. It is most desirable to centralize the cars at least 18 in one Depot. This means that for 18 cars will have two spare cars. This is the most reasonable allocation for operation.

By this plan, at the final state of the first stage.

Djakarta cars in use		30	spare	3 or 4
Surabaja	"	24	"	2
Semarang	"	12	"	2

ii)Spare parts.

At P.N.K.A., the shortage of spare parts has become the cause why the days required for repair at the workshop and depot is so long.

For example, it is in a condition where the diesel locomotive wastefully left in dead condition for more than a year at the workshop due to lacking of the cylinder head. Indirectly, this fact has on the other hand has made the important part of the workshop to become dead-spaced. It is of common sense that cylinder head and its spare parts be possessed on hand. Careful consideration must be made on the preparation of spare parts.

(12) Layout and facilities of diesel railcar depot.

i) Inspection and repairs to be held in depot.

a. Trip inspection.

Daily checks should be descontinued and period of trip inspections in accordance with the vehicle conditions, running lines, types of vehicles, types of trains, inspection conditions of brake blocks, expendables such as engine oil, etc., oil contents of various parts, piston stroke elongation of brake cylinders, etc., should be decided.

The contents of inspections are brake block change, supply of engine lubrication oil, adjustment of piston stroke of brake cylinder, brake test, etc., functional check and aspect check of each parts.

b. Regular inspection (A), inspection for 30,000 Km or for every 60 days, trip inspection plus fail safe parts inspection, functional inspection and performance checking.

c. Regular inspection (B), inspection for 1,254 Km or within 12 months, regular inspection (A) plus checking of engine valve system, cylinder body and propeller shaft parts in standing position.

ii) List of facilities required in depot.

a. Trip inspection.

Inspection pit with lighting.

Compressed air pipe

Fueling device with tank.

Watering and draining devices.

Low voltage electric wiring.

b. Regular inspection (A).

Diesel car shed.

Inspection pit (with both side of rails) and lighting.

Secondary wiring for electric welding.

Low voltage electric wiring.

Lubrication oiling and draining devices.

Watering and draining devices.

Compressed air pipe.

c. Regular inspection (B) for repairing.

Diesel car shed.

Inspection pit with lighting.

Compressed air pipe.

Secondary wiring for electric welding.

Low voltage electric wiring.

Engine dismantling device (if necessary).

Overhead crane	5 tons
Lifting jack	40 tons
Monorail crane	1 ton

Universal machine tool.

Furnace.

Parts washing bath.

Air compresser.

Nozzle tester.

General test device.

A. C. welder.

Lubrication oiling and draining device.

Silicon rectifier (Battery charger).

Fork lift (1 - 1.5 tons).

d. Workshop in depot.

Machining shop, blacksmith, finishing shop

Woodworking shop, electric testing room.

Electric and gas welding room. Parts washing room.

Nozzle tester room. Compresser room, oil test room.

Oil treatment room. Tool room, spare parts stockage

repair record room etc.

iii) Layout of diesel railcar depot.

Fig. 2 shows one example of diesel railcar depot.

The length of car shed is decided by that of one unit of train.

Regular Inspection is to be made usually in train unit.

On the contrary, repairing is done by each car.

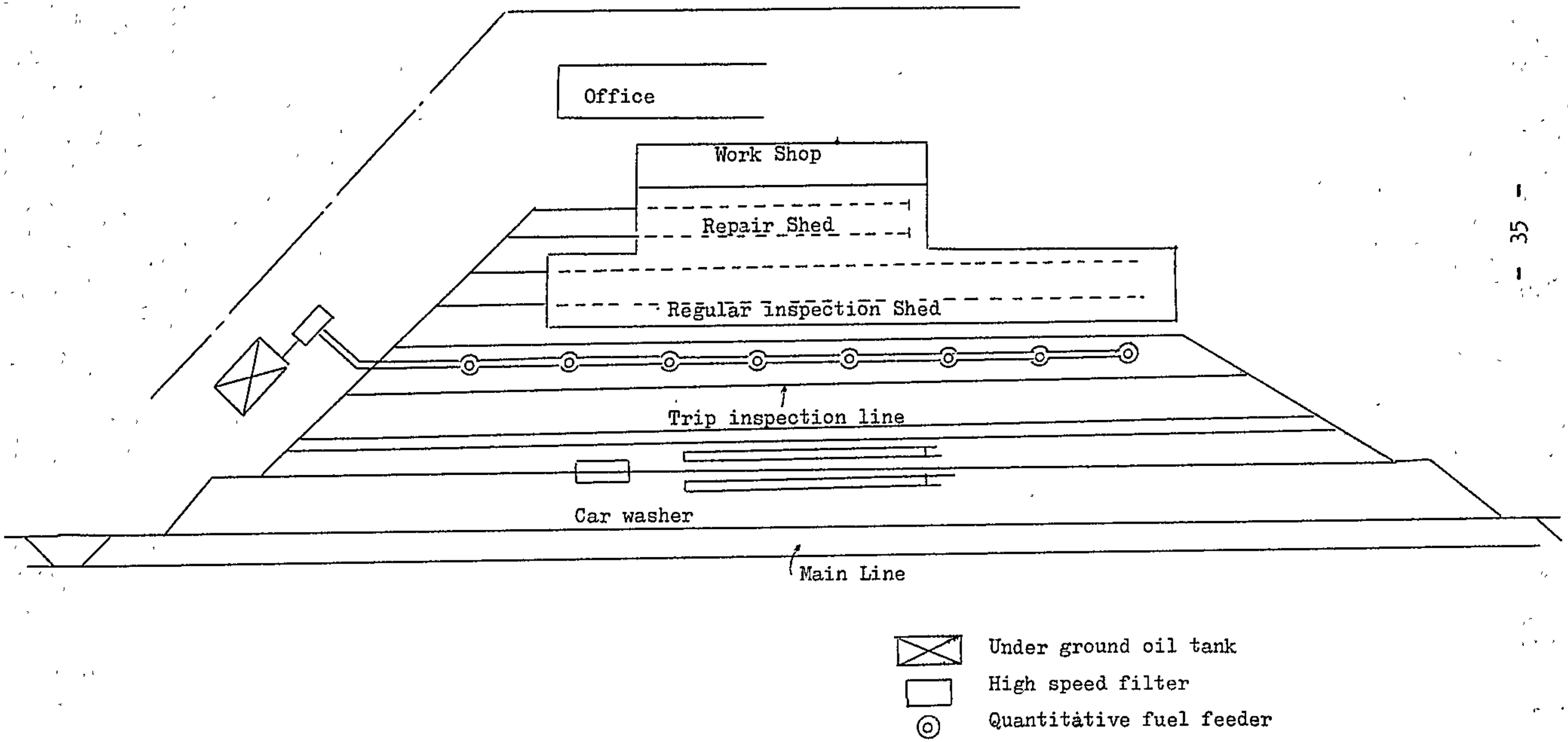
Running check line should also be served as fueling line.

It is desirable that both ends of the depot line are connected with main line as shown in Fig. 2.

iv) Dead run between Diesel workshop and depot should be decreased. The facilities of diesel loco depot and diesel railcar depot are almost the same, therefore it is preferable to utilize the existing diesel loco depots when the number of railcars is small, and if possible, the check should be made in depot up to the yearly check. The reason why the facilities of present diesel-loco depot are said to be insufficient is because facilities of nearly all depots do not differ so much from those in the time when steam locomotives were being used. In regards to diesel locomotive and diesel railcar depots, it would be desirable to make reconsiderations when an enormous volume of diesel railcars are to be invested.

Fig. 2

One example of diesel vailcar depot



(13) Time required for inspection and repairs at the depot.

This case study has been planned under severe conditions. The facilities and layout of diesel car depots have been considered that which is capable of performing this operation. There are some inspections and repairs which have been scheduled for performance during the night time, however, from the true nature of mankind, it would be desirable to perform inspections and repairs during daytime.

During the time when the entire stationed number of diesel railcars are few, portions of inspections and repairs must be performed during the night time, however, as the entire number of stationed vehicles are increased (Resultantly, spare vehicles are increased), it would be desirable to convert to inspections during the daytime.

(14) Adoption of electric railcar train on Bogor - Djakarta.

As mentioned in 1 (2) iv), electric railcar train is most economical. Adoption of electric car trains on the Bogor - Djakarta line is expected most feasible because electrification is already made in this line. However diesel - railcar - ization is feasible as a transition period.

It is necessary to survey electric railcar operation on this line.

Table 1: Repairing and Operation Cost

Expense \ Nos. of D.C. operated \ Section	Djakarta - Tjirebon 6 x 1 = 6 180 HP engine	Djakarta - Tjikampek 6 x 1 = 6 180 HP engine	Djakarta - Bogor 6 x 1 = 6 180 HP engine	Djakarta - Merak 6 x 2 = 12 180 HP engine
Car kilos per day in use KM	718	546	546	538
Train kilos per day KM	774	546	546	1,222
Car kilos per year KM	1,572,420	1,195,740	1,195,740	2,358,192
Expenses consumed in Depot Rp.				
Engine oil Rp.	1,698,214	1,291,399	1,291,399	2,546,640
Transmission oil Rp.	452,857	344,373	344,373	679,104
Brake block Rp	1,886,900	1,434,888	1,434,888	2,829,600
Parts Rp.	2,700,000	2,700,000	2,700,000	5,400,000
Expendables in Depot Rp.	1,200,000	1,200,000	1,200,000	2,400,000
Total Rp.	7,937,971	6,970,660	6,970,660	13,855,344
Expenses in workshop				
General overhaul				
Nos. of cars	349	266	266	524
Expenses Rp.	13,960,000	10,628,000	10,628,000	20,960,000
Principal parts inspection				
Nos. of cars	349	266	266	524
Expenses Rp.	8,376,000	6,376,800	6,376,800	12,576,000
Total Rp.	22,336,000	17,004,800	17,004,800	33,536,000
Expenses in Depot repairs				
Inspection A man-hour	2,524	1,913	1,913	3,772
Inspection B man-hour	1,745	1,328	1,328	2,620
Trip inspection including Special repair	2,920	2,920	2,920	2,920
Total man-hour	7,189	6,161	6,161	9,312
Prices Rp.	1,150,240	985,920	985,920	1,489,920
Fuel consumption Rp.	8,058,625	6,128,267	6,128,267	12,085,734
Engine drivers expenses Rp.	576,000	384,000	384,000	864,000
Train conductors expenses Rp.	576,000	384,000	384,000	864,000
Grand total Rp.	40,634,836	31,857,647	31,857,647	62,694,998

REPAIRING AND OPERATING COST

Table 2

Expenses / Section / Nos. of D. Cars Operated	Surabaja-Malang-Banjuwangi	Surabaja--Madiun	Semerang-Surabaja	Semarang-Tegal	Semarang-Jogjakarta
	4 x 2 = 8 250 HP Engine	4 x 2 = 8 180 HP	4 x 2 = 8 180 HP	4 x 1 = 4 180 HP	4 x 2 = 8 180 HP
Car Kilos per day in use KM	793	567	460	472	734
Train Kilos per day KM	1,586	1,134	920	472	1,468
Car Kilos per year KM	2,314,976	1,655,640	1,341,740	689,383	2,143,462
Expenses consumed in Depot					
Engine Oil Rp.	2,500,174	1,788,091	1,449,079	744,533	2,314,938
Transmission Oil Rp.	666,713	476,824	386,421	198,542	617,317
Brake block Rp.	2,777,971	1,986,768	1,610,088	827,260	2,572,154
Parts Rp.	3,600,000	3,600,000	3,600,000	1,800,000	3,600,000
Expendables in depot	1,600,000	1,600,000	1,600,000	800,000	1,600,000
Total Rp.	11,144,858	9,451,683	8,645,588	4,370,335	10,704,409
Expenses in Workshop					
General overhaul Nos. of cars	5,155	368	298	153	476
Expenses	20,577,200	14,720,000	11,920,000	6,120,000	19,040,000
Principal Inspection					
Nos. of cars	5,144	368	298	153	476
Expenses	12,346,320	8,832,000	7,152,000	3,672,000	11,424,000
Total	32,923,520	23,552,000	19,072,000	9,792,000	30,464,000
Expenses in Depot repairs					
Inspection A man-hour	3,705	2,650	2,146	1,104	3,408
Inspection B man-hour	2,572	1,840	1,490	760	2,380
Trip inspection incl. special special repair.	2,920	2,920	2,920	2,920	2,920
Total man-hour	9,197	7,410	6,556	4,784	8,708
Prices Rp.	1,471,520	1,185,600	1,048,960	765,440	1,393,280
Fuel consumption Rp.	16,416,062	8,485,155	6,876,412	3,533,087	10,985,237
Engine drivers Expen. Rp.	1,056,000	768,000	672,000	384,000	960,000
Train conductor Expen. Rp.	1,056,000	768,000	672,000	384,000	960,000
GRAND TOTAL	64,067,960	44,210,438	36,986,960	19,228,862	55,466,926

II Diesel Railcars in J. N. R.

1. Introduction

The first internal combustion engine railcar in Japan dates back to 1909 when a steam railcar was run between Minato machi and Aihara on the Kansai line near Osaka. Since then, with a soaring demand for transport, the number of railcars has increased to more than 5,300 as of March 1971.

Development in 1953 of the hydraulic transmission system lad to longconsict train operation .... a boon to JNR confrontes by the urgent need to rationalize its management. Diesel railcars became indispensable on locol lines and their number increased year after year. The rolling stock began improving ..... so much as to be finally used for limited express trains.

Today, diesel railcar trains are greatly contributing to the improvement of inter urban traffic in the districts where the railway is yet to be electrified .

Along with the number of rolling stock, startling improvement is seen also in the car utilization efficiency, and the per diam car Kilometers (the average of running kilometers per day used), which was 212.3 Km in 1952, increased to 466.0 Km in 1966. For diesel railcars for limited express alone, it has come to reach about 740 Km.

The number of diesel railcars in JNR, as at the end of 1967, is estimated to be 5036. Under the third Long-Range Plan, it is to be increased to 5,400 by 1971, the last year of the plan.

This means that about

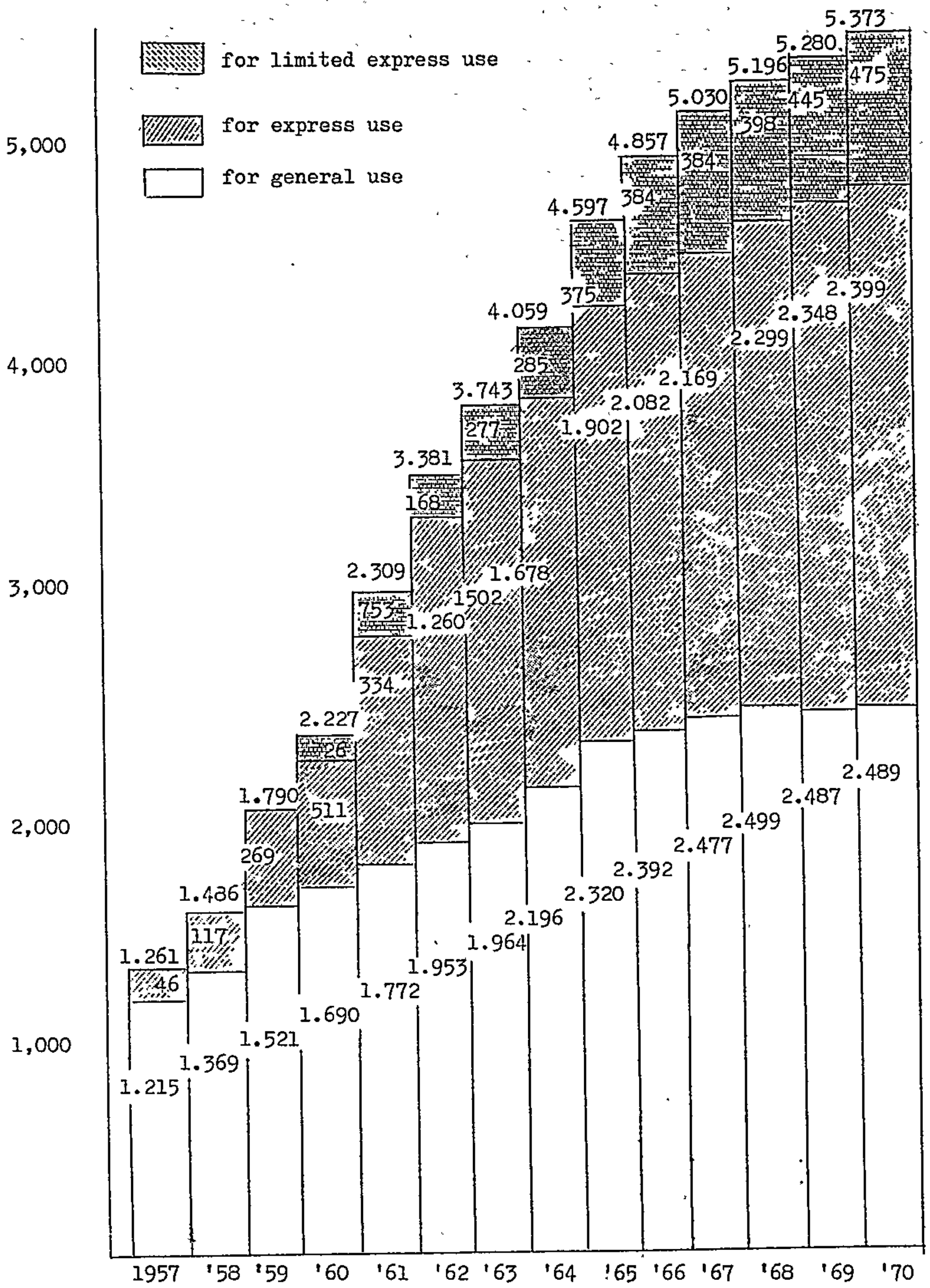


Fig. 1 Number of Diesel Railcars in J.N.R.

400 more Diesel rail cars are to be made by then. Besides, there are about 700 superannuated ordinary type railcars, and it is considered to be more advantageous to replace these as soon as possible. Under the Long-range plan those to be scrapped and replaced must be decided upon. A considerable number of new diesel railcars will thus have to be produced by 1971.

Among the conventional type diesel railcars, two-engined rolling stock were used in greater numbers in order to meet the demand for speedier operation of trains. But now higher speed of trains with such two-engined railcars has become impossible for limited express trains and high-speed trains having to operate on grade sections. Besides, the cost of a new two-engined railcar and its maintenance cost are rather high. Therefore, to meet the need for improvement, and to keep up with the trend of the time, JNR in 1965 produced a prototype. Diesel railcar of a new series with far greater horse-power, which is not only superior in capacity but also economical in production, operation and maintenance. High in riding quality and equipped with an automatic air-conditioning device, it is capable of running at 120 Km/h, and is expected to write a new page in the history of Diesel railcars.

2. Construction of Diesel Railcar

Diesel railcars of the JNR are varied not only in the internal equipment but also interior structure, according to whether they are used for local services or for express services

Their characteristics can be summed up as follows:

a. Usually each diesel railcar is equipped with an engine or engines and has no trailer to haul. However, the railcars of the latest types (KIHA 90, KIHA 81 type, made in 1966 as a proto type, and put into production in 1967, and also KIHA 180, KIHA 181 in 1968 and KIHA 65 in service 1970), which are equipped with engines of a great capacity so as to run at a high speed of 120 Km/h to cope with the traffic demand of late, are able to haul trailers with their surplus power.

b. The engine, hydraulic converter, etc., are installed under the floor and, hence, the floor surface can be used most effectively.

c. One engine or two engines are used depending upon the utilized line of the railcar. However, all engines used are high speed diesel engines of the standard JNR designs. Benefits to be derived from this standardization of engines both in use and maintenance are immeasurable.

d. The hydraulic trans-mission system is adopted for the transmission of power and this makes multiple unit control possible.

2.1 Type.

The standard types now in use are shown in Table 1. Local service railcars are composed of three different types: KIHA 20, 22 and 25 are used in the areas where single-car operation is needed and, therefore, have the motorman's cab at both ends, while KIHA 25, which is used in local service (where trains of 2 or more railcars are operated), has the motorman's cab at one end only. Some of these cars are equipped with a toilet room, and others are not KIHA 30, 35 and 36 type railcars for commuter trains have 3 doors on each side.

The suburban service Diesel cars are KIHA 23, 24, 45 and 46 with single engine, and KIHA 53 with double engines.

Those used in express trains are KIHA 27, 28 and KIRO 28 with single engine, and KIHA 56 and 58, with double engines. KIHA 90 and 91 types have an out put of 300 P.S. or 500 P.S. as against 180 PS or 180 x 2 = 360 PS for Diesel railcars, and KIHA 65, KIHA 180 and 181, KIRO 180 type have an output of 500 PS. This makes them faster and more economical in operation. Further, various new techniques have been introduced to make them not only modern but also serviceable as the basis for further development of Diesel railcars in JNR. KIHA 80, 81 and 82, KIRO 80 and KISASHI 80 are the special de luxe Diesel railcars for the limited express trains.

Generally speaking, the railcars have through gangways, so that they can be used both in long trains and short trains, and at any time and place, to meet the volume of traffic.

2.2 Performance

The railcar has a maximum running speed of 95 Km/h, while its balanced speed with capacity passengers are shown in Table 2. Even on the JNR lines with many steep grades, the railcar train can develop a sufficient running speed, by coupling directly the engine and the axle.

The limited express Diesel railcar train is consisted of 2 railcars with single engine, and 4 railcars with double engines. This train develops 110 Km/h of the maximum speed at level and 83 Km/h of the balanced speed at the grade of 10

Table 2 Balanced Up hill Speed of Diesel Railcars.

Type	Balanced Speed (Km/h)			
	10 ‰	15 ‰	20 ‰	25 ‰
With one engine	53	45	38	32
With two engines	95	87	55	51
Train with both above combined 1 : 1	92	57	49	43
New type with one engine(500HP)	115	75	70	63

3. Diesel Railcar Operation.

JNR's Diesel railcar operation has made speedy progress since the railcars equipped with hyaraulic torque converter for multifle control were first completed.

At first, Diesel railcar trains were operated mainly on local lines for the purpose of saving the cost of train operation and thereby rationalizating the management of JNR as a whole. Today, however, Diesel railcar trains are used even for express service between cities, winning an ever-increasing fine reputation. The Diesel express train "Hatsukari" started its operation on the Ueno-Aomori line of 751.2 Km in December 1960. Furthermore, in October, 1961, new type Diesel limited express trains were put into service and the railway net work connecting main cities all over Japan by limited express was completed.

Diesel railcars of the Japanese National Railways totalled 5,373 in March 1971, and their operation area aggregated 19,017 Km, which is equal to 91.0 % of the entire operating kilometerage of the JNR. The train kilometerage of Diesel railcar trains averages 470,702 kilometers per day or about 35.7 % of the entire passenger train-kilometerage.

Table 3 Diesel Railcar Operations at the End of Fisical Year

1959 - 1970

	No. of Diesel Railcar	Diesel railcar train kilometer per day (Km)	Diesel Railcar train Km/Total passenger train (%)	Track Km of Diesel railcar train (Km)	Diesel railcar operating Km/Total operating Km (%)
1959	1,788	199,000	23.9	15,232	75.0
1960	2,227	258,634	29.0	17,341	85.0
1961	2,809	328,661	32.4	18,575	90.5
1962	3,381	359,975	34.7	18,748	91.4
1763	3,743	287,678	35.9	18,866	91.3
1964	4,059	402,764	36.0	18,953	91.4
1965	4,597	420,561	35.3	19,157	92.3
1966	4,857	429,758	35.4	19,229	92.6
1967	5,030	430,818	35.1	19,243	92.6
1968	5,196	430,547	33.7	19,086	91.6
1969	5,280	425,907	32.8	19,072	91.5
1970	5,373	470,702	35.7	19,017	91.0

Table 4 Number of Diesel Railcars Classified by Service

March 1971

Kind of Service	Type			No.of cars
For limited express train	Hydraulic	DML30	Single engined	99
		DMH17	Single engined	118
			Double engined	266
	Trailer			12
	Total			495
For express train	Hydraulic	DML30	Single engined	95
		DMH17	Single engined	1,075
			Double engined	1,229
	Trailer			3
	Total			2,402
For ordinary Train	Hydraulic	DMH17	Single engined	2,334
			Double engined	141
	Mechanical			-
	Trailer			2,475
	Total			2,475
Rail Bus				-
Grand Total				5,372
Diesel motored wagon				1

3.1 Service with Diesel railcars.

Diesel railcar operation in the JNR, as mentioned before, started with passenger service on local lines to save the cost of operation, and, at the same time, to increase the service revenue, there by contributing to the rationalization of JNR management. A typical example is found in the Chiba area, cast of Tokyo, where all steam locomolive trains have been replaced with three to six unit railcar trains which are being operated at one-hour intervals.

Under this Dieselization program for the Chiba area, which began in September 1954 with 91 Diesel railcars, a total of 293 is now in operation. The result is that while the car kilometerage, namely, the transportation capacity, against the same volume of transportation remains almost the same as in the case of the ordinary passenger train, as much as a 50 percent increase is recorded in the train kilometerage. This shows that the composition of the train is well-matched to the volume of transportation, and that the operation intervals have been greatly improved. Another fact that deserves attention is that in the case of Diesel railcars, which require only a single person to operate them, there is virtually no need of increasing the operating manpower even in the face of a 50 per cent increase in train kilometerage.

It must of course be taken into consideration that in the case of railcar trains the limited speed is 5 Km/h or so higher on the same track than in the case of steam locomotive trains, and this, coupled with high a acceleration resulting from large P.S. per ton, makes a great speed-up possible.

Easy switchback at the terminals and climination of the need for coal and water supply account for the great mobility of Diesel railcars. The number used to compose the trains can also be easily increased or decreased according to the volume of traffic for most effective operation, and the high speed serves to keep the operation efficiency high. This makes it possible to use only 80 percent or an even smaller number of Diesel railcars compared with the number formerly used when ordinary passenger trains were first replaced with Diesel railcar trains.

These facts, combined with the low cost of fuel plus the need of only a one-man crew, bring the yield from investment to more than 15 per cent in the case of Diesel railcar operations.

Today, Diesel railcar trains are operated even on trunk lines, including those where electrification is scheduled to be carried out. It is to be noted that by reason of their high speed they have began to be used in large numbers for rapid service between large cities, or between large cities and tourist spots.

Meanwhile, rapid service with Diesel railcars, which in March 1957 covered only 1,345 kilometers a day was as much as 39,408 kilometers a day as of March 1968.

3.2 Composition of Diesel railcar trains.

In the JNR, Diesel railcar trains consisting of two or more cars within a maximum of 14 are operated with multiple unit control in most of the service areas, although single car operation is adopted in some specific cases. The most salient features of Diesel railcar trains are, as mentioned before, that a single person is able to operate them, and that when necessary, the number of cars used in the train can be regulated to fit the actual state of traffic.

The separation and combining of Diesel railcar trains are often seen in J.N.R. For example, Diesel limited express train "Isokaze" departs from Osaka with 13 cars. but at Kokura it is separated into two trains, of which one train is routed to Sasebo with six cars, and the other to Miyazaki with seven cars.

3.3 Operating speed of Diesel railcars.

Diesel railcars are light in weight and are short in the wheel-base. Therefore, they give only a limited impact on the rails. In particular lateral pressure on the tracks, which usually causes much trouble on local lines, has been proved to be small as a result of field tests, and this enables Diesel railcars to develop a maximum speed of 100 Km/h, the speed limit in the top-class service areas, and also to take curves at a speed 5 Km/h higher than in the case of other types of cars.

Diesel railcars equipped with one 180 P.S. engine are most commonly in use but on routes with heavy gradients cars with two such engines are used. For example, for express trains, one-engine and two-engine cars are combined so that the required P.S. can be obtained. In this case, P. S per ton is set at 5-8. The comparison of speeds between Diesel railcar trains and ordinary steam locomotive trains for passenger service is shown in Table 5.

Table 5 Operating speed of Diesel Railcars

Section	Distance Km	Kind of train	Running time (Hr - Min)			Scheduled speed Km/h	
			SL,EL or DL	DC	Running time reduced	SL,EL or DL	DC
Sapporo-Hakodate	286.3	Limited express	SL 6-09	4-46	22.5% 1-23	41.6	60.1
Osaka-Aomori	1,045.8	Limited express	DL.EL 16-20	15-35	4.6% 0-45	64.0	67.2
Izumo-shi Osaka	412.1	Express	DL 9-28	8-08	14.3% 1-20	43.6	50.7
Kyoto-Matsue	253.5	Express	DL 7-33	6-45	10.6% 0-48	33.4	37.3
Ueno-Akita	570.8	Limited Express	EL.DL 9-15	7-54	11.5% 1-21	61.7	72.3

3.4 Fuel oil and supervision of engine lubricating oil

The fuel oil used for the Diesel railcars is the ordinary one for high speed Diesel engines. The sulphur content of the fuel oil is specified at less than 1.2%. However, recently a tendency of an increase in sulphur content has been noticed. A basic study on certain effects of the fuel oil containing 0.8 - 1.2% sulphur, such as the wear on the cylinder and piston rings, have been underway, and field tests arc also being made.

The supervision of engine lubricating oil is most important for the maintenance of engines since the period of inspection and repairs of engine depends on it. JNR now uses DG class (American Petroleam Institute Standard 1958) heavy duty oil for engine lubrication instead of the ordinary Diesel engine oil which was used till some time ago. The conversion is based on the findings obtained from tests that the heavy duty oil is highly effective in curbing the wear of cylinders, piston rings, bearing metals, etc.

The engine lubricating oil is flashed after every 24,000 Km or more run, and in between, spot tests (or blotting tests) are conducted, using blotting paper, to check the lubricating efficiency of the oil.

3.5 Training of crew and staff for inspection

The crew of the Diesel railcar and the staff for inspection and repair in the shed are trained in 8 training schools and

28 employee education centers, for a period of 5.3(858 hours) and 6.0 months (780 hours), respectively. The engine crew which has been re-oriented may also be assigned to the post of the crew, after 2 months (312 hours) training.

3.6 Diesel railcar shed

The Diesel railcars are generally allocated to the engine sheds. However, the number of Diesel railcars in J.N.R. is increasing year by year and in certain districts, such as Chiba, the number of the railcars allocated to the railcar sheds reaches 215 and more. One hundred and forty limited express Diesel railcars are allocated and maintained at Mukomachi railcar depot.

3.7 Results of Diesel railcar operation.

JNR now has 5,373 Diesel railcars in operation, and they are giving quite satisfactory results.. The average kilometerage per car in use exceeds 448 Km/day and in some cases is even as much as 1,000 Km or more. A fact which should be particularly emphasized is that of all these Diesel railcars, only 8.3 percent normally are undergoing regular inspection or repairs, which means that 91.7 percent are being maintained in serviceable condition. As for disorders, the latest records show that only 0.27 per 1,000,000 car kilometers are affected, attesting to a far more satisfactory state of operation than other types of cars.

Table 6 performance of Diesel railcar Operation

April 1970

Number of Diesel railcars		5,373
Running Kilometers of Diesel railcar (Km)		$19,904 \times 10^3$
Car-Kilometer per day (Km)		448
Showing of employment	In use (%)	84.4
	Stand by (%)	7.3
	Under inspection and repair(%)	8.3

4. Maintenance of Diesel Railcar.

The inspection and repair of Diesel railcars are conducted in the car operating and repair depots through out the country. In addition, large scale repair work is carried out in the 20 workshops throughout the country.

The car body of Diesel railcar is not much different from that of passenger cars and electric railcars, but the Diesel railcar is additionally equipped with engine-control equipment and power transmission gears. The fact that the engine in particular, need a special machine tool for repairing and efforts to reduce repair costs and increase the accuracy of work have led to a centralization of repair as far as possible.

At present the repair work of the Diesel engines is conducted at the following works.

4.1 Inspection system

Inspection and repair of Diesel railcar are classified as overhaul inspection, principal parts inspection, regular inspection (B), regular inspection (A), trip inspection and special inspection. A certain running kilometerage and a certain cyclic period are specified for each of the above inspections.

Overhaul inspection: periodicity in running kilometers 500,000 Km

No. of month limited or 48 months.

All parts are overhauled, detailed inspection is carried out and necessary repairs are made.

Principal parts inspection 250,000 Km or 24 months

Principal parts, such as engine, power transmission system, are taken out and change with already inspected ones; running gears, brake system, measuring instruments and couplers are taken out, inspected and repaired.

Reqular inspection (B) 125,000 Km or 12 months

Regular inspection (A) plus engine valve devices, parts of cylinder body and propeller shaft are checked in standing position.

Regular inspection (A) 30,000 kilometer or in 60 days

Trip inspection plus fail safe parts inspection, function check and action check..

Trip inspection.

Brake block change, supply of engine lubrication oil, adjustment of piston stroke of brake cylinder, brake test, etc., function check and aspect check of each part.

Special inspection.

This is the inspection carried out occationally when trouble has occured or any-change, including improvement in functions, has been made.

Of the above inspections, the overhaul inspection and principal parts inspection are conducted in the work shop and other inspections at the operating depot.

4.2 Inspection schedule.

Studies have long been made concerning the schedules of inspection and repair conducted in workshop as to each kind of rolling stock, and efforts have been made to minimize the number of deep required for repair and to raise the working rate of rolling stock.

Also, efforts devoted to the standardization of design of Diesel engine and speed change gear have played an important role in facilitating inspection and repair techniques, providing suitable inspection and repair equipments and determining the deterioration limit at which the Diesel railcar parts are put to repair.

For inspection and repair, information concerning the condition of rolling stock is always kept up to date by controlling a chronological record of principal parts, so that the condition of rolling stock at the time of the next inspection may be anticipated. As a result, materials and man-hours required at the time of inspection can be known in advance, the number of days required at the time of inspection can also be known in advance, and the number of days required for inspection and repair at the work shop can be reduced.

The flow chart of engine repair is given in Fig. 7 and an example of repair line in Fig. 12.

The standard work schedules of engine repair, overhaul repair and principal parts inspection are shown in separate table.

Table 1. Type and Main Features of Typical Diesel Railcars

Item \ Type		For general use			For commuter use			For suburban train use				
		KIHA 20	KIHA 25	KIHA 22	KIHA 30	KIHA 35	KIHA 36	KIHA 23	KIHA 24	KIHA 45	KIHA 46	KIHA 53
Class		2nd			2nd			2nd				
Power transmission		Hydro-mechanical			Hydro-mechanical			Hydro-mechanical				
Main dimension	Length between coupling faces mm	20,000			20,000			21,300				
	Width of car body mm	2,928			2,929			2,928				
	Max. height above rail level mm	3,925			3,945	3,955	3,945	3,925				
	Truck wheel base mm	2,100			2,100			2,100				
	Center to center distance of trucks mm	13,800			13,800			14,400				
Deadweight tons		32.2	30.5	32.9	32.4	31.2	31.1	34.2	34.5	33.0	33.2	39.7
Seating and standing capacity	Seating	70	76	71	56	58	62	76	77	84	85	73
	Standing	12	12	10	72	74	74	40	25	40	22	41
	Total	82	88	81	128	132	136	116	102	124	107	114
Motorman's cab		both ends	one end	both ends	both ends	one end		both ends		one end		both ends
Toilet		with			without	with	without	with				
Side entrance		2			3			2				
Engine	Number of engine	1			1			1				2
	Type	DMH 17 H			DMH 17 H			DMH 17 H				
	Number of cylinder-diameter x stroke	8 - 130 x 160			8 - 130 x 160			8 - 130 x 160				
	Output/No. of revolution (cont. rating) P.S/r.p.m	180/1,500			180/1,500			180/1,500				
Torque converter	Number	1			1			1				2
	Type	TC 2 or DF 115 A			TC 2 A or DF 115 A			TC 2 A or DF 115 A				TC 2 or DF 115 A
Gear ratio		2,976			2,976			2,976				
Max. speed km/h		95			95			95				
Fuel capacity lit.		550			550			550				550 x 2
The first year of manufacturer		1963	1957	1963	1962	1961	1962	1966	1967	1966		1957

Item \ Type		For express train use							For limited express train use				
		KIHA 23	KIRO 28	KIHA 27	KIHA 55	KIHA 56	KIHA 91	KISARO 90	KIHA 81	KIHA 82	KIHA 80	KIRO 80	KISASHI 80
Class		2nd	1st	2nd				1st & 2nd	2nd			1st	Dining
Power transmission		Hydro-mechanical							Hydro-mechanical				
Main dimension	Length between coupling faces mm	21,300							21,300	21,100			
	Width of car body mm	2,944					2,950		2,903				
	Max. height above rail level mm	3,925					4,008		3,910			4,060	3,910
	Truck wheel base mm	2,100							2,100				
	Center to center distance of trucks mm	14,400							14,400				
Deadweight tons		33.1	34.3 - 36.5	33.8	38.9	38.0	35.6	31.0	42.2	43.5 - 44.1	41.2	41.6	38.2
Seating and standing capacity	Seating	84	52	84				52	40	52	72	48	40
	Standing	-	-	-				-	-	-	-	-	-
	Total	84	52	84				52	40	52	72	48	40
Motorman's cab		one end	without	one end				without	one end		without		
Toilet		with							with				without
Side entrance		2							1				-
Engine	Number of engine	1			2		1	-	1		2		-
	Type	DMH 17 H					DML 30 HBS	-	DMH 17 H				-
	Number of cylinder-diameter x stroke	8 - 130 x 160						-	8 - 130 x 160				-
	Output/No. of revolution (cont. rating) P.S/r.p.m	180/1,500					500/1,600		180/1,500				-
Torque converter	Number	1			2		1	-	1		2		-
	Type	TC 2 A or DF 115 A					DW 4 B	-	TC 2 A or DF 115 A				-
Gear ratio		2,976					2,314	-	2,613				-
Max. speed km/h		95					120		110				
Fuel capacity lit.		800			550 x 2		1,300	-	550		550 x 2	550	-
The first year of manufacturer		1961					1966	1957	1960	1961			

Note: KIHA 22 is equipped with facilities necessary for the cold-climate district.
DF 115 - Niigata-Twin disc., TC-2 - Shinko - S. R. M.

TABLE 8. OUTLINE OF INSPECTION & REPAIR

Major Category	Classification	Regular inspection (B)	Principal inspection	Overhaul inspection
Limit of running kilometerage	New Type	125,000	250,000	500,000
	Old Type	80,000	160,000	320,000
Car body	Painting	Coating of damaged part	Coating of body exterior	Repainting
	Interior	Inspection without removing	Repairing of defective parts	Removing dismantling & inspection
	Door engine	Performance test	Removing important part & their function oiling	Removing dismantling & inspection
Track & running gear	Wheel assembly	Measuring dimensions ultrasonic flow detection.	Removing dismantling, Ultrasonic flaw	detection, wheel lathing
	Axle box	Inspection of box interior, renewal of grease.	Removing, dismantling &	inspection
	Roller bearing	Outside view inspection.	Removing, dismantling &	inspection
	Spring	Outside view inspection.	Removing, dismantling &	inspection
Brake rigging	Air compressor	Dismantling & inspection of key parts (main)	Removing, dismantling &	inspection
	Air brake valve	Performance test	Removing, dismantling &	inspection
	Governor, Oil separator reducing valve, etc.	Adjusting	Removing, dismantling &	inspection
	Strainer, Oil separator	Cleaning	Removing, dismantling &	inspection
	Foundation brake rigging	Outside view & performance inspection	Removing, dismantling &	inspection
Power trans-mission	Torque converter	Outside view & inspection clearance adjusting of TC-2 servomotor	Removing, dismantling &	inspection
	Reverser	Dismantling & inspection of key parts	Removing, dismantling &	inspection
	Propeller shaft	Outside view inspection, oiling	Removing, dismantling &	inspection
	Universal joint	Outside view inspection, oiling	Removing, dismantling &	inspection
Electric apparatus	Contractor	Performance test contact cleaning		Dismantling & inspection
	Relay	Performance test contact cleaning		Dismantling & inspection
	Master controller	Performance test contact cleaning		Removing, dismantling & inspection
	Rotary machine	Replacement with one finished inspection	Removing, dismantling &	inspection
	Wiring	Insulation resistance test		Insulation resistance test, pictec-tric test
Engine & it's ac-cessories	Cylinder head	Outside view inspection	Removing, dismantling &	inspection
	Crank case	Outside view inspection, Renewal of grease	Removing, dismantling &	inspection
	Charging generator	Replacement with one finished inspection	Removing, dismantling &	inspection
	Fuel injection pump	Outside view inspection	Removing, dismantling &	inspection
	Blower	Dismantling & inspection of key parts		Removing, dismantling & inspection
Coupler	Coupler	Dismantling & inspection of key parts	Removing, dismantling &	inspection
Meter	Tachometer	Outside view inspection	Removing, dismantling &	inspection
	Voltmeter	Outside view inspection	Removing, dismantling &	inspection
	Ammeter	Outside view inspection	Removing, dismantling &	inspection
	Speedmeter	Outside view inspection	Removing, dismantling &	inspection

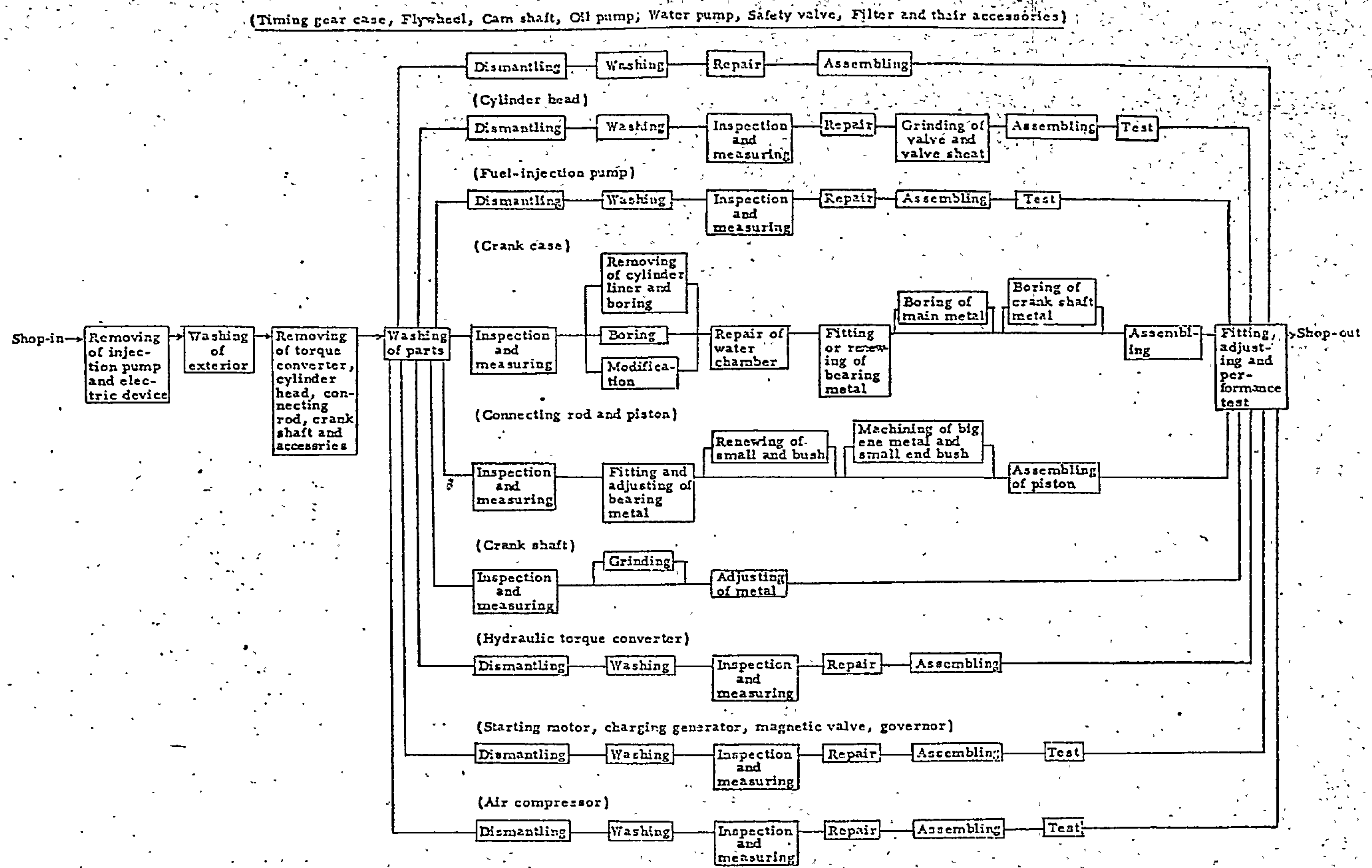


Fig. 7. Block Diagram of Engine Repairing

5. Repair Facilities of Diesel Railcars.

5.1 Outline

Along with the modernization of motive power, the rolling stock have made a conspicuous change in respect of the speed and other performances. On the other hand, to cope with the transportation demand, the number of cars has sharply increased. Especially the diesel railcar taking place of the conventional passenger cars, contributes a great deal toward the improvement in the interurban transportation on non-electrified lines. However, most workshops which should take charge of the maintenance of these cars are equipped with the facilities mainly for passenger cars, and there is a big difference in the contents of inspection and repair of the diesel-motored railcar as against passenger cars. As a result there are many unfavorable conditions in the repair works from the stand point of the efficiency of work and the inspection and repair process. Considering the increase of modern cars, it is necessary to qualitatively change the workshop facilities and equipments and increase the repair capacity. Therefore, augmentation and modernization of repair facilities for diesel railcars are being carried forward.

To this end, the layout of the diesel railcar repair workshop is being improved for the mechanization and automatization of work and the flow line work system, b6th in the first process facilities provided for the inspection and repair of car body, including the assembling and disassembling, car body painting and shop-in inspection, and in the second process facilities provided for the inspection and repair of trucks, wheel sets, engine, etc. In this way efforts are being made to make a big reduction of repair cost and shorten the length of time of repair.

5.2 Kinds of inspection and repair in workshop

Overhaul inspection

Intermediate inspection (B)

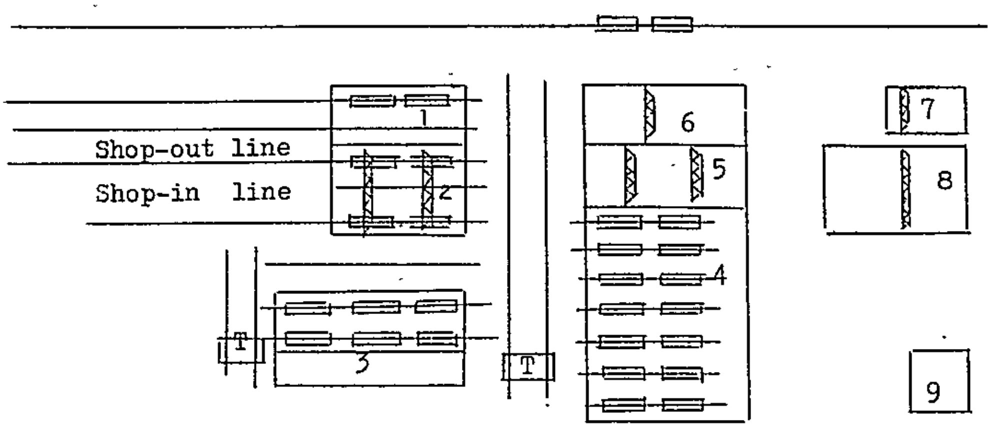
5.3 Repair workshop for diesel railcar

Out of the total of 26 repair workshops of JNR throughout the system, 20 are repairing diesel railcars, conducting overhaul inspection and intermediate inspection (B). But, inasmuch as the concentration of engine repair produces good economy, certain workshops are specified for the repair of engines investment is being made in those particular workshops for modernized facilities.

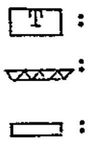
5.4 Layout of diesel engine inspection and repair workshop

The overhaul inspection and the intermediate inspection (B) of diesel railcar is conducted in the order of shop-in inspection, disassembling, inspection, repair, the painting, equipping, final inspection, trial run and deadheading and the standard schedule is 7 days for the overhaul inspection and 6 days for the intermediate inspection (B).

(See separate Tables)



1. Diesel railcar servicing room
2. Disassembling and assembling shop
3. Car body painting and parts repair shop
4. Car body repair shop
5. Truck repair shop
6. Wheel and axle repair shop
7. Engine performance testing room
8. Engine repair shop
9. Electric apparatus and measuring instrument control room



: Traverser

: Overhead travelling crane

: Rolling stock

Fig. Layout of Diesel Railcar Workshop

5.5 Principal shops in the workshop

(1) Shop-in inspection, shop-out servicing shop.

(2) Disassembling and equipping shop

(3) Car body repair shop

(4) Car body and parts painting shop.

(5) Bogie repair shop.

(6) Wheel set repair shop

(7) Engine and engine accessories repair shop

(8) Weak current electrical equipment and measuring instrument control shop.

5.6 Inspection and repair facilities in principal shops

(1) Shop-in inspection, shop-out servicing shop

In these shops, the car is inspected, tested and adjusted in its working order, and also undergoes adjustment and minor fixing in preparation for the test run and deadhead movement, ascertaining the completion of the inspection and repair, and oiling and watering. Particularly noteworthy is the fact that an overall testing machine to make a sequence-control of the test of the general wiring, circuit, air brake, etc. has been developed as a countermeasure against the degradation of efficiency and the delay of work caused by the complication of control equipment due to the modernization of rolling stock.

The principal facilities are:

Lifting jack (60 tons);

Inspection pit (double type);

Deadheading facilities (oiling and watering);

Withstand voltage tester (3 KVA, 5 KVA);

Systematic circuit tester (semi-automatic); and

Simple operation device (for non-controller car).

(2) Disassembling and equipping shop

The diesel railcar brought to the workshop is broken up into the main components such as car body, bogie and engine, and the interior fillings, brakes, the door engines etc. are detached for inspection and repair. Reversely, those parts are attached and all the components are assembled. The car body is carried into and out of the car body disassembling and equipping shop by temporary trucks.

The principal facilities are:

Overhead traveling crane (Main hoist, 20 tons; auxiliary, 3 tons);

Inspection pit (double type);

Lift for mounting and dismounting the engine;

Working platform with crane;

Fork lift with reach (Battery car);

Parts transporting car; and

Car tractor (tractive force, 1 ton)

(3) Car body repair shop

The outside plate, interior, wiring and equipments of the car body stripped of the principal parts such as engine and bogie are adjusted and repaired.

The principal facilities are:

Battery car with work bench;

Device for mounting and dismounting automatic coupler;

Wiring tester;

Brake testing machine; and

Traverser (25 m long, loading capacity 45 tons).

(4) Car body painting shop

The car body painting work requires a pretty long time, from the adjustment of base to the inside and outside washing, polishing painting and then to drying. Moreover, the diesel railcar is painted all in 2 colors, so the exterior painting, in particular, takes much time. In the JNR workshop, mechanical devices for outside plate painting, such as automatic washing machine, polishing machine, simultaneous two-color painting machine, hot-air drier, etc. developed by JNR's own staff have been introduced. Thus each arranged as a tactic unit, the works, are mechanized and automatized on a flow line system, so that the work efficiency will be raised and the work process shortened, thereby improving the working rate of the workshop.

The principal facilities are:

Automatic washing and polishing machine for the outside plate of car body;

Two-color simultaneous painting equipment; and

Hot air car body drier.

(5) Bogie repair shop

The bogie is taken apart into wheel sets (with spur gears), bogie frame, swing bolster, brake and springs. The wheel sets are transferred to wheel repair shop, but other parts are inspected and repaired in this shop, where the bogie assembling work, the last step of bogie repair, is also done.

The principal facilities are:

Overhead traveling cran (12 tons);

Automatic bogie washing machine;

Automatic bogie painting machine;

Brake parts washing equipment;

Shot blast for brake parts; and

Electromagnetic flow detector for brake parts;

Reverser running-in device;

Reverser washing machine;

Reverser disassembling and assembling device;

Axle box washing machine; and

Roller bearing washing machine.

(6) Wheel repair shop

The inspection and repair of wheels and axle hold an important part in the car safety. Therefore, wheel sets are thoroughly inspected and repaired, when they are shopped in, so that cars will always keep the best condition offering comfortable trip can be enjoyed.

The sizes of the wheel shops more or less differs, depending on the work volume and the kind of the wheels and axle, but the equipment for inspection and repair and the work are all standardized. The main works carried out in the wheel repair shop are the flaw detection, the trueing of wheel tread and the replacement of wheels and axles whose wear and tear has reached the allowable limit.

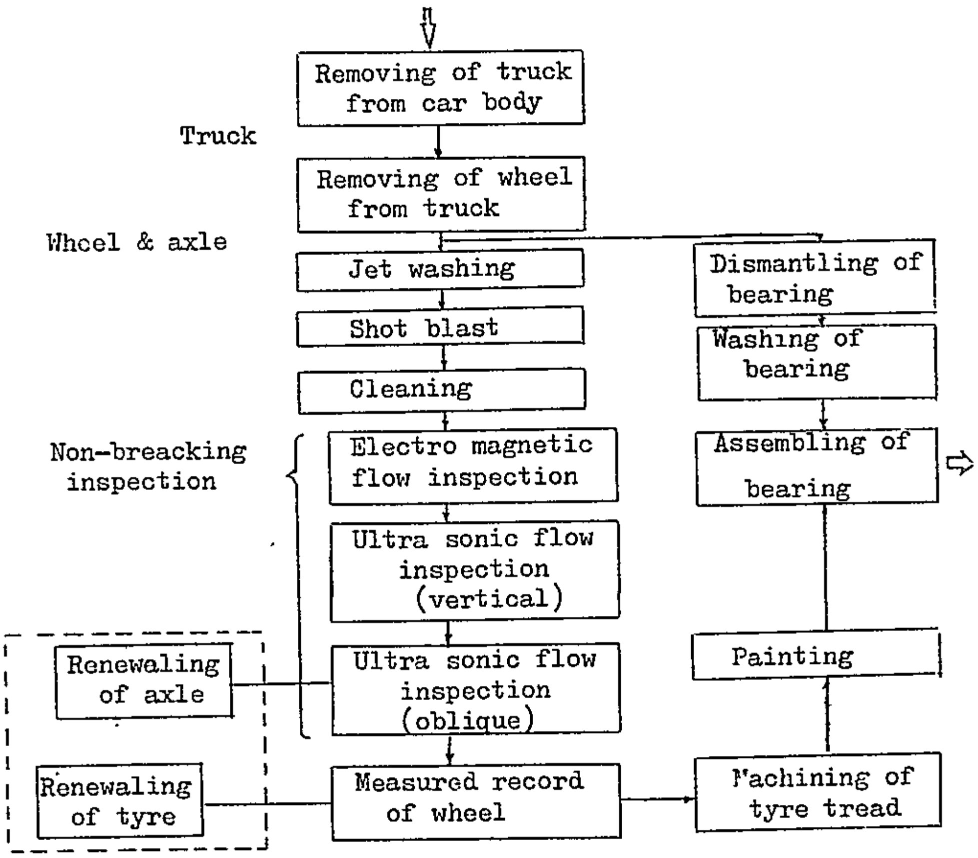


Fig. 2. Flow Chart of Inspection and Repair of Wheel Set.

The principal facilities are:

a) Ordinary facilities for inspection and repair

Automatic jet washing machine for wheels and axle;

Shot blast;

Electromagnetic flow detector;

Ultra-sonic flow detector (vertical and oblique);

Automatic wheel lathe;

Automatic wheels and axle painting device:

Wheels and axle hauling device; and

Roller bearing washing machine.

b) General repair machine

Tyre boring machine;

Solid wheel boring machine;

Wheel center lathe;

Axle lathe;

Hydraulic press for wheels and axle;

Tyre colking machine;

Tyre shrinkage fit machine;

Overhead traveling crane, 2 tons;

Jib crane, 1 ton; and

Wheel sets storing rock.

(7) Engine and accessories repair shop

The repair of the engine has a large weight in the car maintenance cost, and the reduction of repair manhours and the number of days of repair is pushed forward by mechanizing and automatizing the work, using, among others, automatic washing machines, disassembling and assembling device, and automatic cylinder boring machine (4 cylinders are simultaneously re-turned, automatically measuring the dimensions) and the automatic performance testing machine, and by putting the whole process on a flow line work system.

The shop is divided into engine repair shop equipped with a flow line work system mainly for engine repair, sound-proof engine performance test room and dustproof injection pump repair shop. Besides, there are repair shops for auxiliary rotary machine, compressor, etc.

a) Engine repair shop

The principal facilities are:

Oil flushing equipment;

Acid washing machine;

Engine exterior washing machine;

Engine disassembling device;

Parts washing machine (Cylinder block, torque converter, cylinder head, etc.);

Soft blast;

Parts disassembling and assembling devices (converter, cylinder head, etc.);

Hydraulic press (cylinder liner, etc.);

Automatic cylinder boring machine (dimension measuring and simultaneous working on 4 cylinders);

Valve and valve seat grinding machine;

Gear chambering machine;

Two-axle boring machine for piston rod;

Electromagnetic powder flow detector (crankshaft);

Crankshaft grinder;

Lapping machine;

Overhead traveling crane, 3 tons;

Jib crane;

Floor conveyer and roller conveyer for transporting parts.

b) Engine performance test room

The engine performance test, including the running-in operation and adjustment, is conducted on the same test table for a long time. As a result, a number of testing machines is required. Therefore, the test is automatized to enable unattended overnight operation, and thus to reduce the number of machines and staff members, and shorten the time required.

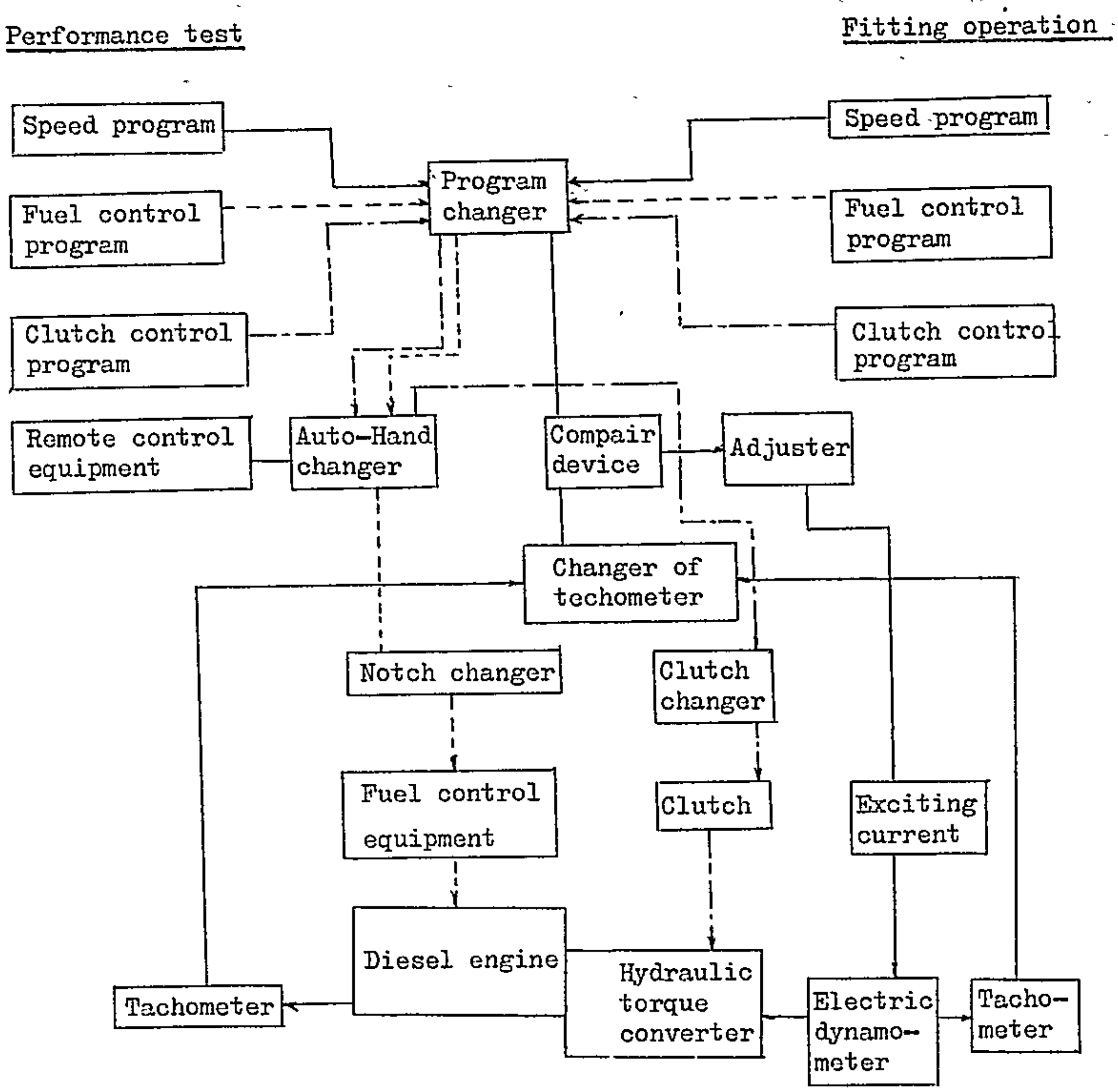


Fig. 3 Diagram of automatic operation system of engine performance test

c) Injection pump repair shop

The injection pump repair shop is airconditioned and the main facilities there are:

Automatic injection pump washing machine (ultrasonic washing); and

Injection pump testing machine.

d) Auxiliary rotary machine and air compressor repair shop

The main facilities are:

Starting motor testing machine;

Charging generator testing machine;

Commutator groove cutting machine; and

Thermal switch tester.

(8) Weak current equipment and measuring instrument control shop

Along with the modernization of rolling stock, electronic techniques have been introduced into the controlling equipments. As a result, it is necessary to make a particular control of the equipment of this kind. The shop is provided with dust-proof facilities and the equipment for the temperature control. It is equipped also with standard measuring instruments necessary for the supervision of the instruments used, calibrator and vibrating device, etc.

The principal facilities are:

Testing device for the ATS-S type cab equipment for automatic train stop system;

Semiconductors testing device;

Public announcement telephone testing device;

Vibration testing device; and

Standard measuring instruments and calibrator (frequency, current, voltage, etc.)

Table 9. Standard Process of Diesel Railcar (Overhaul Inspection)

Item			1st day (10, 12, 13, 15)	2nd day (10, 12, 13, 15)	3rd day (10, 12, 13, 15)	4th day (10, 12, 13, 15)	5th day (10, 12, 13, 15)	6th day (10, 12, 13, 15)	7th day (10, 12, 13, 15)
Body	Body parts	Car body	Repair						
		Roof board	Repair						
		Sash	Removing	Repair			Fixing sash		
		Seat	Removing	Repair			Fixing		
		Water supply system	Removing	Repair					
		Door engine	Removing	Repair			Fixing and adjusting		
		Vestibule diaphragm, Toilet room, etc.	Removing	Repair			Fixing		
	Automatic coupler		Removing	Repair		Fixing			
	Train and running gear	Truck	Washing Dis-mantling	Repair	Painting	Assembling	Fixing truck to body		
		Wheel and Axle	Washing & inspection	Machining and repair					
		Reverser	Removing & dismantling	Repair and assembling		Assembling and adjusting			
		Foundation brake rigging	Removing	Repair	Repair and fixing		Brake test		
		Air brake valve	Removing						
	Painting	Body exterior	Scraping Undercoating	Rubbing	Painting		Making		
		Body interior	Cleaning	Rubbing; Painting of roof	Painting				
		Train and running gear		Cleaning	Painting				
		Parts			Painting				
	Electric device	Lamp apparatus	Removing		Repair of parts		Fixing		
		Electric apparatus	Removing		Repair of parts		Fixing and adjusting		
		Wiring		Repair			Wiring	Test	
		Broadcasting device	Removing	Repair			Fixing		
		A. T. S. device	Removing	Repair and adjusting			Fixing	Test	
	Air-conditioning unit		Removing	Repair of piping and parts		Fixing of heater	Fixing of preheater test		
	Speed meter, etc.		Removing	Repair			Fixing		
Engine and its Accessories	Engine		Removing				Fixing	Adjusting of starting	
	Cooling device	Cooling water tank	Removing	Repair and test			Fixing		
		Radiator element	Removing				Fixing		
		Radiator fan	Removing		Repair		Fixing		
	Fuel device		Removing	Repair			Fixing		
	Propeller shaft		Removing	Repair			Fixing		
Inspection	Inspection		Shop-in inspection	Intermediate inspection			Stop-out inspection		Sending to shed
	Trial run							Trial run in yard	Trial run on line

Table 10. Standard Process of Diesel Railcar (Intermediate Inspection B)

Item			1st day (10, 12-13, 15)	2nd day (10, 12-13, 15)	3rd day (10, 12-13, 15)	4th day (10, 12-13, 15)	5th day (10, 12-13, 15)	6th day (10, 12-13, 15)
Body	Body parts	Car body	Repair					
		Roof board	Repair					
		Sash	Repair					
		Seat	Repair					
		Water supply system	Repair				Adjusting	
		Door engine	Repair				Adjusting	
		Vestibule diaphram, Toilet	Repair					
	Automatic coupler		Removing	Repair	Fixing			
	Train and running gear	Truck	Removing, Dismantling	Repair, Painting	Assembling	Fixing of wheel to truck		
		Wheel and axle	Removing of wheel, Cleaning, inspection, machining	Cleaning, inspection, machining				
		Reverser	Removing & dismantling	Repair and assembling				
		Foundation brake rigging	Removing	Repair	Fixing		Brake test	
		Air brake valve	Removing	Repair	Fixing			
	Painting	Body exterior	Scraping, Surfacing coat	Rubbing, Painting		Making		
		Body interior	Cleaning		Repair			
		Train and running gear			Repair			
		Parts			Repair			
	Electric device	Lamp apparatus	Removing	Repair		Fixing	Test	
		Electric apparatus		Repair		Wiring	Test	
		Wiring		Repair				
		Broadcasting device		Repair				
		A. T. S. device		Repair			Test	
	(Cooling device)		Removing	Repair		Fixing	Test	
	(Heating device)		Removing			Fixing and test		
	Speed meter		Removing, Repair			Fixing		
Engine and its Accessories	Engine		Removing			Fixing	Adjusting	
	Cooling device	Cooling water tank	Repair			Fixing		
		Radiator element	Removing			Fixing		
		Radiator fan	Removing, Repair					
	Fuel device		Removing, Repair			Fixing		
	Propeller shaft		Removing	Repair		Fixing		
Inspection	Inspection		Shop-in inspection		Intermediate inspection		Shop-out inspection	
	Trial run						Trial run in yard	Trial run on line, Sending to shed

Table 11. Standard Process of Engine Repair

Parts \ Date	1st day	2nd day	3rd day	4th day
Engine	Dismantling, washing and inspection; Replacing of liners and boring if necessary	Replacing of liners and boring if necessary	Fitting of piston; Fixing of parts	
Crank		Grinding of crank shaft if necessary; Machining and fitting of bearing	Assembling of piston	
Metals		Fitting of bearing; Boring; Assembling of bearing		
Cylinder head	Dismantling and repair	Grinding of valve and valve seats, assembling		
Valve		Repair and assembling of valve		
Injection pump	Dismantling and inspection	Replacing of parts, assembling and test		
Nozzle	Dismantling	Assembling and test		
Water pump	Dismantling	Repair and assembling		
Lubricating oil pump	Dismantling	Repair and assembling		
Others	Dismantling	Repair and assembling		
Starting motor, Charging generator	Dismantling and inspection	Repair of parts, assembling and test		
Electrical equipment	Dismantling and inspection	Repair, assembling and test		
Hydraulic converter	Dismantling and inspection	Repair of parts; Assembling		
Cluch	Dismantling and inspection; Replacing and repair of parts	Replacing and repair of parts	Assembling; Fixing	
Performance test				Fitting of engine; Adjustment, performance test