REPORT

BY

DIESEL RAILCAR SURVEY TEAM

IN INDONESIA

(PROJECT NO. I-22 RAIL BUS)

I

NOVEMBER 1971

OVERSEAS TECHNICAL COOPERATION AGENCY
JAPAN

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DATE		VISITED	FOR	DISCUSSED WITH
1971 Nov.	23 Tue.	Tokyo – Djakarta		
"	24 Wed.	Embassy of Japan Ministry of Land Commenication	Notice Notice & Asking requests for survey	 Director General Mr. Sumpono, Mr. Darmawan, Mr. Suerono, Mr. Soeprapto.
"	25 Thu.			
"	26 Fri.	Ministry of L.C. Embassy of Japan Djakarta Stations	Advance discussion – " – Inspection (3)	Mr. Sumpomo, Mr. Sucrono.
"	27 Sat.	Manggarai Work Shop Djakarta Depots	Inspection (3) Inspection (3)	Mr. Marjono, others
"	28 Sun.	Djakarta – Bandung	Moving	
"	29 Mon.	P.N.K.A.H. Office	Notice & Asking for co-operation Free Talking.	Mr. Sumali, Mr. Soenarno, Mr. Patrtosiswojo, Mr. Dedijowono, Mr. Fiakanto.
"	30 Tue.	– " –	Discussion for car structure, and Air Brake, Explanation of Data.	Mr. Patrtosiswojo.
Dec.	1 Wed.	– " –	Luncheon Party Asking for data.	Mr. Sumali, Mr. Soenarno, Mr. Rohaeli, others.
"	2 Thu.	Bandung T.University Bandung Station Bandung D.L.Depot.	Making Report	
"	3 Fri.	Bandung – Jogjakarta	Moving.	
"	4 Sat.	Jogjakarta Workshop Railway Training Centre.	Inspection	Mr. Sanjorjo, others.
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"	7 Tue.	Surabaja E.R.Office Depot.	Discussion	Mr. Moehaedy.

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Dec.	8 Wed.	Surabaja - Semarang Semarang Workshop Semarang C. R. Office	Inspection Discussion	Mr. Soedarno, Mr. Latief.
"	9 Thu.	Train Control Office.	Inspection.	
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"	11 Sat.	Djakarta W.R. Office	Discussion	Mr. Pantiarso.
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"	14 Tue.		Making Report.	
"	15 Wed.	Land Communication	Notice.	Mr. Faudi
"	16 Thu.		Making Report.	
"	17 Fri.	Djakarta - Banding P. N. K. A.	Reported (Temporary)	Mr. Patrtosiswojo Mr. Budijowono Mr. Rohaeli.
"	18 Sat.	P.N.K.A. Djakarta	Making Report	Mr. Patrtosiswojo
"	19 Sun.	Bandung. Djakarta	Making Report	
"	20 Mon.	P.N.K.A. Bandung - Djakarta.	Moving Making Report	Mr. Sumali Mr. Patrtosiswojo
"	21 Tue.	Embassy of Japan	Discussion & Report	
"	22 Wed.	Land Communication	Final Report	Mr. Sumpono, Mr. Faudi
"	23 Thu.	Djakarta - Tokyo, Japan.		Mr. Soeprapto, Mr. Suerono. Mr. Darmawan.

Formation of Survey Team

Leader: Shinichiro Yoshihara,
Authority of Rail Transportation
Ministry of Transport.

Member:	Toyohiro Matsumoto,	Railway Operating Engineer.
	Yaichi Kobayashi,	Transport Economist.
	Noribumi Achiwa,	Rolling Stock Engineer.
	Shinya Nakajima,	Rolling Stock Engineer.
	Masakaru Shigehisa,	Rolling Stock Engineer.

I FOREWORD

We are pleased to introduce ourselves that we, as a team of 6 members have been sent by the Japanese Government at the request of the Indonesian Government to make an inspection from various viewpoints for use of diesel railcars, drawing up a list of feasible lines for their operation, feasibility study on those lines, and so on in the Indonesian State Railways.

Regarding diesel railcars herein mentioned, it was once taken up as Project Aid No. F-22 for Rail Buses in connection with one of the project aids in 1971 for the Indonesian Government from Japan, and an inspection was already made at its beginning.

However, thereafter, a change was made by the Indonesian Government on its original project, namely the use of Rail Buses was switched from on the feeder lines to the truck lines. Hence a new inspection and also a further one to concrete the project became necessary.

It should, therefore, be understood that diesel railcars are not for a quite different project, but for the revised project of previous Rail Buses in connection with the above mentioned project aid in 1971.

From the viewpoints mentioned above, the inspection was carried out, bearing in mind that it was for one of the economic project aids for Indonesia under the cooperation of the Japanese Government.

The detailed process of the inspection is as shown in the attached list.

We hereunder state particulars on which we believed an inspection should be sincerely based;

1. We adopted as they are and correctly the data available today. We also obtained as much data as possible by actual local inspection and survey regarding matters of which data we understood not available in papers.
2. The inspection carried out is based upon a view of Dieselization covering the entire Java Island, but it does not mean to cover any other districts or Islands of Indonesia. Though we tried to make an inspection suitable for a long term project, the result became that of comparatively short term owing to the limitation of inspectiong hours and items and also to the difficulty of obtaining required data. Therefore, it is considered that the amendment or modification should become necessary within a few years in accordance with the change of Govermental Policy or social circumstances.
3. Regarding a standard for selection of feasible lines for diesel railcars, we adopted the data such as transportation density, transportation/ton.Kms., transportation/person.Kms. etc., most of which were suggested or provided by the Indonesian Government.
4. In the process of collecting inspection results and of completing this report, we did not consider at all those which were considered as national policies or projects of the Indonesian Government or other provincial public organizations such as regional developing project, economical growth project, industrial promotion policy, social policy, population policy, etc.
5. Regarding the economic calculation to search after the suitability of introduction of diesel railcars into certain lines, it was made from a viewpoint of feasibility only, and any other

conditions such as that mentioned in Para. 4 above were not considered.

6. In connection with each feasible line, the rolling stock design regarding the rolling stock to be used, and the number of rolling stock to be used by each applied line, the operational diagram, rolling-stock training facilities (including workshop and depot) and the time for carrying out maintenance and repair, are studied in considerable details as the working design and working plan and described in Annex I (Case study on diesel railcar Operation & Maintenance), but these are presented as only one example out of many. It is, therefore, natural that they are not final. Concerning these working designs and plans the Indonesian Government must carefully establish suitable plans and render the final decision.

This report is made on the basis of the above-mentioned points of view, therefore, when this project is taken up by the Indonesian Government as one of its projects, the other factors, if any, should also be concidered at the time of performance.

We hereby would like to express out sincere gratitude to officials of the Indonesian Government, especially Mr. Sumpono, Director General of Ministry of Land communication, Gentlemen of P.N.K.A. and Embassy of Japan in Indonesia who all kindly offered us their full cooperation in carrying out our inspection this time.

II MODERNIZATION OF TRACTION POWER

1. Constitutional Betterment of P.N.K.A. :

In considering the transportation industry, as one of the biggest factors which support the economy of a nation, the transportation field is to be attached with importance.

It is said that the railways in European countries and in U.S.A. and in Japan lost their previous brilliant status, and the problems of Governmental Subsidy and increase of fare are being dicussed; recently it is also reported that the governmental subsidy bas been decided to be given to the railways.

This is to show that the railways are going to loose their monopolistic status by the increase of Air craft and Automobile traffic.

In spite of this situation, the reason why nations must adopt policies to subsidize railways is that its necessity is duly appreciated for large quantity and long distance transportation.

It may be said that even P.N.K.A. can not stand outside of this problem.

Therefore, in order to keep the railway industries forever as a foundation of Indonesian industries, it is inevitably necessary for the Indonesian Government to correctly appreciate the importance of the future transportation field, and to take fundamental measures to meet the betterment of constitution of P.N.K.A. for the normalization of railway management.

For the Railways which must take charge of long-distance mass-transportation, carrying great volume of measuring cargoes and an overwhelming number of commutors, and must also bear the huge assets and their maintenance, it order to find the only way left for their independence, it is essential to improve the efficiency of production and to reduce the relative cost of operation.

In other words, the available way to establish a stable foundation in competition with road transport is to modernize the transportation system, to reduce the cost of traction, to improve the operating efficiency of powered railcar, and to modernize and rationalize management of transportation.

When you look into railways in European countries, U.S.A. and Japan, you may be aware that dieselization is almost completed in U.S.A., while in France, Italy, Holland, West Germany and Japan, dieselization and electrification are in process, which show that the modernization of traction power is playing an impoftant role in the betterment of Railway management.

In the case of British Railways, the management is in a critical situation. However, as far as the dieselized or electrified sections are concerned, managements are operating in black, and some sections of them are positively contributing to gaining profit.

Considering the above-mentioned aspects, it is urgently necessary to positively promote the modernization of traction power, and making this as a backbone, to promote the modernization of transportation system and finally, to promote the betterment of constitution of P.N.K.A.

Though we realize that the project of introducing diesel railcars this time is really pertinent, it is considered most important for P.N.K.A. to establish a general long term project, while looking over the above mentioned respects.

2. Effects :

The most distinguished effects of modernization and its performance of traction power are an effective use of energy and a betterment of management of P.N.K.A., but regarding the later, it is mainly considered from the viewpoint of reducing the managing costs.

However, attention should be called to the fact that the improvement of service quality is surely expected along with the modernization of transportation system, especially in respect of passenger transportation, the field of electric car and diesel railcar is expected to expand in big scale, hence an epoch-making improvement is expected.

The modernization of traction power is expected to provide passengers with new type of services, and this in turn will lead to more passenger, hence resulting in the increase of profit.
At the same time, the present operation plan of trains hauled by the present traction power car should be replaced with a new operation plan which is to be made on the basis of market research, etc. from new points of view.

Our inspection process and analysing method this time are also based upon the theory herein mentioned.

Regarding the efficiency of energy, needless to say it can be greatly improved from the 5% in steam locomotives run by coal; i.e., in the case of electric operation (supplied by steam power electric generation) efficiency is approx. 30%, and 20% even in diesel operation.

3. <u>Henceforward</u> :

1. To promote the modernization of transportation system simultaneously.
2. To carry out a general rationalizing project in parallel with the modernization of traction power.
3. To get a satisfactory effect by priority investments.
4. To make an appropriate plan by re-training and transposition of staff.
5. By watching the change of circumstances such as improvement of technique, to revise long term projects at appropriate time, to keep the project constantly developing in the best conditions.

It will become one of the important plans for P.N.K.A. how to incorporate the modernization of traction power into a long term general plan in the future.

III Diesel Railcar Train

1. Effect of Diesel-Railcar-ization

In regards to the dieselizing plan of non-electrified railway sections, it will be necessary to make studies separately for diesel locomotives and diesel railcars, taking into consideration the railway section, train composition, train schedule, etc., based on the transportation demand and transportation form.

Generally, by dieselization, not only can a sharp curtailment be made in personnel expenses, power expenses and repairing expenses but also improvements in Services to passengers can be made through the rationalization of power utilization and rolling stock maintenance as well as through the adoption of a oneman crew operation of the traction power.

The effects of diesel railcar usage are as follows:

(1). In case of a railway section where the transportation demand produces a stepped difference, usage efficiency of rolling stocks can be promoted by efficiently employing the advantage to partition and to combine, which is the meritorious characteristic of the diesel railcar.

(2). In case of a transportation form which branches into many lines from a single line, since the transfer points for customers can be minimized by partition and annexation of the diesel railcar into a number matching the transportation demand, services can be promoted.

(3). In comparison with steam and diesel locomotives, speed up is possible on non-electrified railway sections.

(4). In comparison with locomotives, the axle load is lighter, so the track maintenance fee proves to be cheaper.

(5). Since it is possible to perform passenger transports in small units, frequent services can be provided.

However, when comparing electrification with dieselization, it necessarily cannot be said that dieselization is more advantageous, so a comparative study has been made on both (In accordance with the actual results of the Japanese National Railways for 1970) and their results are as follows:

(1). Rolling stock expenses

The rolling stock expenses for each limited express train with an equal number of vehicle composition is about 54.4% of that of the diesel railcar (181 type, 65 type) for the electric train (113 type, 103 type) and shows that it is much cheaper for the electric train.

Note; 113 type: DC electric train, suburban type
103 type: DC electric train, commuting type
Kiha 65 type: Diesel railcar train, express type
Kiha 181 type: Diesel railcar train,limited expfess type

(2). Facility expenses

The facility expenses for double track electrification is about 1.8 times that of sigle track electrification and moreover, in case of dieselization refueling facilities, etc., become necessary, but their cost of construction only amounts to about 20% of the facility expenses for electrifying a single track line.

(3). Power cost

When the power cost per traffic volume for electric cars and diesel railcars and indicated by an exponent, with that of the electric car as 100, it will become about 146 for a diesel railcar train, and about 130 for a diesel locomotive, versus and electric locomotive.

(4). Rolling Stock maintenance expenses

When the rolling stock maintenance expenses per kilometer for an electric train is indicated by an exponent of 100, it will be about 200 for a diesel railcar.

(5). Usage efficiency

Usage efficiency will vary according to the usage condition and usage railway section, however, it is about the same (450 kms/per car) for both the electric and diesel railcar. In addition, that of the diesel railcar is higher and about 2 times that of a diesel locomotive. In concluding the above, electrification will be more advantageous on a rilway section where the traffic volume is great.

2. Operation of diesel railcars

Each diesel railcar is provided with its own engine, transmission, reverser and braking system, so not only can a multiple unit control on several diesel railcars be made at one place but also since partition and annexation is facilitated, and mobility can be demonstrated. However, from the point that electricity, water and oil are used for power generation, matters which must be observed in operational handling are greater in comparison with other types of vehicles. Those matters to which special attention must be provided in operational handling in comparison with other types of vehicles, will be as follows:

1. Since diesel railcars use oil as the power source and a great amount of oil is also used in the power transmission system, etc., special attention must be given to emittion smokes and offensive smells origination in the underfloor vicinity during operation so the train fires will not occur.

2. Since it can be considered that conditions will occur where the engine will be overheated and stopped by temperature rise due to shortage of engine cooling water, etc., so it will become necessary to suitably supply water at turn-back points, etc.

3. Since it is customary that the number of driving wheels of a diesel railcar is structurally small against the entire number of axles of a train, when the adhesion coefficient is small depending upon weather and rail conditions, idling occurs in case the train resistance is large as in starting and ascending, and not only does operation become impossible but it becomes a cause for damaging the vehicles. Therefore, particular considerations become necessary in the provision of a sanding device and in operational handling.

4. When high notch operation is continued in case of operation on a continuous sharp gradient railway section, a rise in the temperature of the engine cooling water is often incurred and may lead to operational impossibility due to the engine being placed in a stopped condition. Therefore, when

operation on such a railway section, it becomes necessary to suitably control the continuous high notch operation.

5. Each pilot lamp positioned in front of the operator's seat notifies any abnormality on the vehicles to the driver during operations, so constant attention should be placed on these pilot lamps for immediately grasping the existence of any abnormality. In addition, it is necessary to pay attention to any abnormal noise that may originate under the floor.

6. Attentions during operation preparations

   Prior to starting the operation, in order to check whether or not fuel oil and engine cooling water are loaded and whether or not the engine, transmission, reverser, etc., are normally working, handle the equipment at the driver's stand (Master control handle, reverser handle, speed change handle, etc.) and together with checking that the pilot lamps (Engine, reverser, transmission, direct coupling, etc.) are normally lit, check the accumulating condition of the main reservoir pressure by a pressure gauge and, at the same time, check the brake action. Furthermore, check the conditions of the steam whistle, buzzer, lamp system, etc.

7. Attentions during operation commencement

   (1). Transfer the reverser handle to "Forward" position and check whether or not the pilot lamp is lit.
   Then, move the transmission handle to "Transmission" position.

   (2). After checking that the doors of each vahicle are closed, release the brake by the starting signal from the conductor or others and insert the master control handle. In this case, confirm that the transmission pilot lamp is lit and accelerate the speed. Sudden accelerations, however, should be avoided.

(3). When operation is commenced from a place where the gradient is steep, loosen the brake after raising the noch suitably so as to avoid rolling.

8. Attentions during operation

(1). The change-over from speed change to direct coupling is performed when a fixed speed is attained after the operation is started, so that the engine rotation and the propeller shaft rotation balance (Change over speed will differ according to the wheel diameter).

(2). Change-over from direct coupling to speed change. When transferring from direct coupling operation to speed change operation, return the master control handle to "1-2" notch when a fixed speed is attained, (The speed when change-over is made from speed change to direct coupling) and move the transmission handle to "Transmission" position and after checking that the transmission pilot lamp is lit, place it at an optional notch.

(3). Handling when transferring from powered operation to coasting. When transferring from powered operation be coasting, after placing the master control handle to notch "1", return it to "OFF" notch and after confirming that the neutral pilot lamp is lit, move the transmission handle to "Neutral" position.

(4). Handling when transferring from coasting to powered operation. When transferring from coasting to powered operation, move the transmission handle from "Neutral" to "Transmission" Position when a fixed speed is attained (The speed when changed-over from speed change to direct coupling) and after checking that the transmission pilot lamp lits, place it at an optional notch. When transferring from coasting to powered operation, position the transmission handle at "Transmission" and place the master control handle at notch "1" and after confirming that the transmission pilot lamp is lit, raise the notch suitably according to the speed at that time and while raising the engine revolution, place at "Direct coupling" position, and move to an optional notch after checking that the direct coupling pilot lamp is lit.

3. Inspections and repairs of Diesel railcars

The main points which we must consider in performing rolling stock inspection are to "Minimize troubles" and "Elevate the usage efficiency of rolling stocks". It is wise to perform an inspection which matches the transportation system in accordance with this principle and upon adopting a dependable theory in rolling stock maintenance and analyzing the data on the troubles and repair conditions for each vehicle part, inspections should be performed at a proper time under a proper method. In other words, it is essential that a dependable management is performed. In addition, for elevating the usage efficiency of rolling stocks, it is necessary that the suspension time of rolling stocks be minimized as much as possible. For this purpose, cases where certain types of inspections must be complеted during the interval between shuttle services will become necessary.

Presently, diesel railcars can be generally classified into 3 types of vehicles according to their applications, the hydraulic system limited express type, the hydraulic system express type and the hydraulic system ordinary type. For periodically inspecting the abrasion and deterioration conditions of these vehicles, they have been divided into groups of about 5 stages, from new model diesel railcars centered around limited express and express vehicles to ordinary old type diesel railcars for local use, mainly from the standpoint of vehicle structure, and an inspection set up matching each of these groups has been established. This is the actual situation which exists in countries which possess many diesel rail cars. Among these periodical inspections, there are the following inspections.

> Overall inspections and principal part inspections performed at the maintenance work shop, alternation inspections performed at stationing sections and operational inspections accompanyingly performed on dynamic conditions subh as acceleration, reduction, vibration, etc., during operation of the diesel railcar and on the overall actions and functions of each equipment and the performance inspection which decides the periodicity and inspection contents upon taling into consideration the condition of running stores such as brake block, etc., due to various condi-

tions such as usage railway sections vehicle type, etc., oil amount of various parts such as engine lubrication oil and elongation of piston stroke of the brake cylinder and which is performed at the optimum period and place upon considering the vehicle application aspect.

The alternation inspection is one which performs inspection in intact state on the conditions, actions and performances on the engine, engine auxiliary devices, power transmission system, control system, running equipment, brake equipment, coupling device, reception facilities within vehicles, etc., and also on the insulation resistance of electrical parts under a prescribed cycle in accordance with the usage condition of the diesel railcar and also is an inspection which adds necessary items for performing inspections on specific main parts.

The principal part inspection executed at the maintenance work shop is an inspection where detailed inspections are performed on the engine, engine accessory equipment, power transmission system, electric system, control system, running system, brake equipment gauges, coupling device, etc., upon removing or dismantling these principal parts.

The overall inspection makes a general inspection on detailed parts upon dismantling each portion.

Besides the above, contingent inspection which is occasionally performed when required such as in the case of vehicle trouble, etc., is performed either at the stationed section or at the work shop according to the degree of the trouble.

After completing principal part inspection and overall inspection, a trial run is performed by using the main line or a designated yard track and a functional confirmation is performed on the engine operation condition, the condition and the degree of output, vibration and oscillation of the driving part, the function of the control system, the actions of the brake equipment, temperature rise of principal parts, etc. Inspection is completed upon completing this functional confirmation. In all inspections, equipment which become causes to fail-out troubles, that is, troubles where derailment or no-brake conditions originate, for example, on a portion of the bogie driving system and the brake equipment, it is necessary that scrupulous inspection be made in these places as care-requiring position. The Diesel railcar periodical inspection performed by the Japanese National Railways is as shown in Table 1.

Table 1 - Diesel railcar periodical inspection

Group	Vehicle classification	Period			
		Alternation inspection (A)	Alternation inspection (B)	Principal Part inspection	overall inspection
A	Limited express new vehicle. Those that have completed necessary remodelling among B.C. and D groups	Within 60 days and 30,000km	Within 12 months and 125,000km	Within 24 months and 250,000km	Within 48 months and 500,000km
B	Initial period vehicle of limited express	Within 60 days and 30,000km	Within 9 months and 108,000km	Within 18 months and 216,000km	Within 36 months and 432,000km
C	Express type vehicle	Within 60 days and 30,000km	Within 9 months and 96,000km	Within 18 months and 192,000km	Within 36 months and 384,000km
C	Ordinary type vehicle	Within 60 days and 30,000km	Within 9 months and 78,000km	Within 18 months and 156,000km	Within 36 months and 312,000km
E	Initial period vehicle of ordinary type vehicle	Within 60 days and 20,000km	Within 6 months and 78,000km	Within 12 months and 156,000km	Within 24 months and 312,000km

(Note): Among alternation inspections, alternation inspection (B) is one undertaken by adding necessary matters on specific principal parts and alternation inspection (A) refers to alternation inspection other than those for alternation inspection (B).

4. Fundamental Usage of diesel railcars

(1) Usage of diesel railcars can roughly be classified into the following four:

i) To be operated as High Speed Superior diesel railcar train; Utilizing characteristics of high speed operation of diesel railcar, high speed superior diesel railcar train, operated between main cities as mainly faster than semi-express and between main city and tourist resort, should more frequently be operated. Eventually, services to the passenger and income will aggressively be promoted. Increase of number of trains.

ii) Replacement for steam locomotive train in branch line:

To decrease operational costs and to rationlize the management, by means of replacing steam locomotive train with diesel railcar. This replacement should mainly be done for the purpose of rationalization of the management of branch lines. Of course, the combination of the increase of number of trains and replacement can simultaneously be executed. Moreover, it can be adopted for the lines which have been operated with diesel railcars for the purpose of the above.

iii) Reinforcement:

To reinforce transportation capacity following increase of traffic. Mainly for relief of high speed superior train which is suffering from heavy traffic.-Reinforcement.

iv) Re-newal:

To renew the old diesel railcar. It should be minimized except for supplementing abolished cars whose conditions are quite bad,

(2) Superior diesel railcar train;

Diesel railcars are suitable for high speed operations, achieving and nimble and faster operations.

No smoke, modern and fashionable design, conveniently-equipped interior and high speed will naturally be welcomed by the passengers. Diesel railcars can be freely operated on any lines, it is not necessary to interchange locomotives and to supply coal and water on the way, and the number of trains can easily be increased or decreased, according to the meeds of traffic and routing, which can not be done by the locomotive train and coaches. The efficiency of diesel railcar is remarkably high in comparison with that of the conventional ones.

(3) Promotion of Introduction of diesel railcar:

i) To decide the priority of introduction of diesel rail car, decrease of cost and expenses as well as profitability must be considered. In this case, particular conditions of the lines in question, such as traffic requirements, relations between cities, ratio of commuters and relations with the other transport facilites should carefully be studied.

ii) The efficiency of the supplemental diesel railcars which are added to meet the increase of commuter passengers, is usually quite low. The counter-measures for the above should be considered.

iii) The priority should be given to the lines between non-electrified cities and/or the lines between these cities and tourist resorts because these diesel railcars will be able to enjoy high efficiency and profitability, due to the development of advanced specifications and mobility of diesel railcars.

IV. Feasibility Evaluation of Diesel-Railcar-ization

1. Outline of passenger transportation

An outline of passenger transportation along the considered sections is shown in Figure (21) - (27) and Table (21).

The following facts should specially be mentioned.

(1) The competition between railway and highway bus is considerably server everywhere. Especially, between Djakarta and Bogor, Djakarta and Tjirebon, Semarang and Jogjakarta, Surabaja and Malang, the competition is very keen. In many cases, railway loses in the competition not because of its transport conditions, but because of its shortage of capacity.

(2) In the vicinity of Djakarta, the highway traffic is so dense that, in peak hour, the vehicle speed drops down to 10 - 20 Km/h. But the widening of the highways is almost impossible. Therefore, the congestion should be reduced by railway.

(3) More than 30% of the railway passengers do not pay their charges. Trains are often considerably late.
The passenger fares of both railway and highway bus are rather flexible according to the situation of competition. Because of these facts, it is very difficult to clarify the conditions of passenger transportation.

(4) The growth of passenger traffic is not so large, and is estimated generally at about 3% per year.

We selected the 10 following lines for the introduction of diesel railcars taking into account the railway traffic volume, motor-car traffic volume, urban population, and whether the railway line passed through important local cities.

1. Djakarta - Tjirebon
2. " - Bandung
3. " - Bogor
4. " - Merak
5. Surabaja - Malang
6. " - Banjuwangi
7. " - Madiun
8. Semarang - Surabaja
9. " - Tegal
10. " - Jogjakarta

The results of various calculations on these 10 lines are shown in Table (21), (22), and(24) below.

2. Evaluation and assumptions

The elements for evaluation are shown in Table (22), (23) and (24). These elements are nothing but a small parts of many elements to be considered in the evaluation of railway project.

These elements are estimated on the following assumptions.

(1) PNKA could collect perfectly the charge of Rp. 1.5 per passenger-Km of the diesel railcars.

(2) Induced traffic is not considered in this study, but, as a matter of fact, the volume of induced traffic would not be so small as to be neglected.

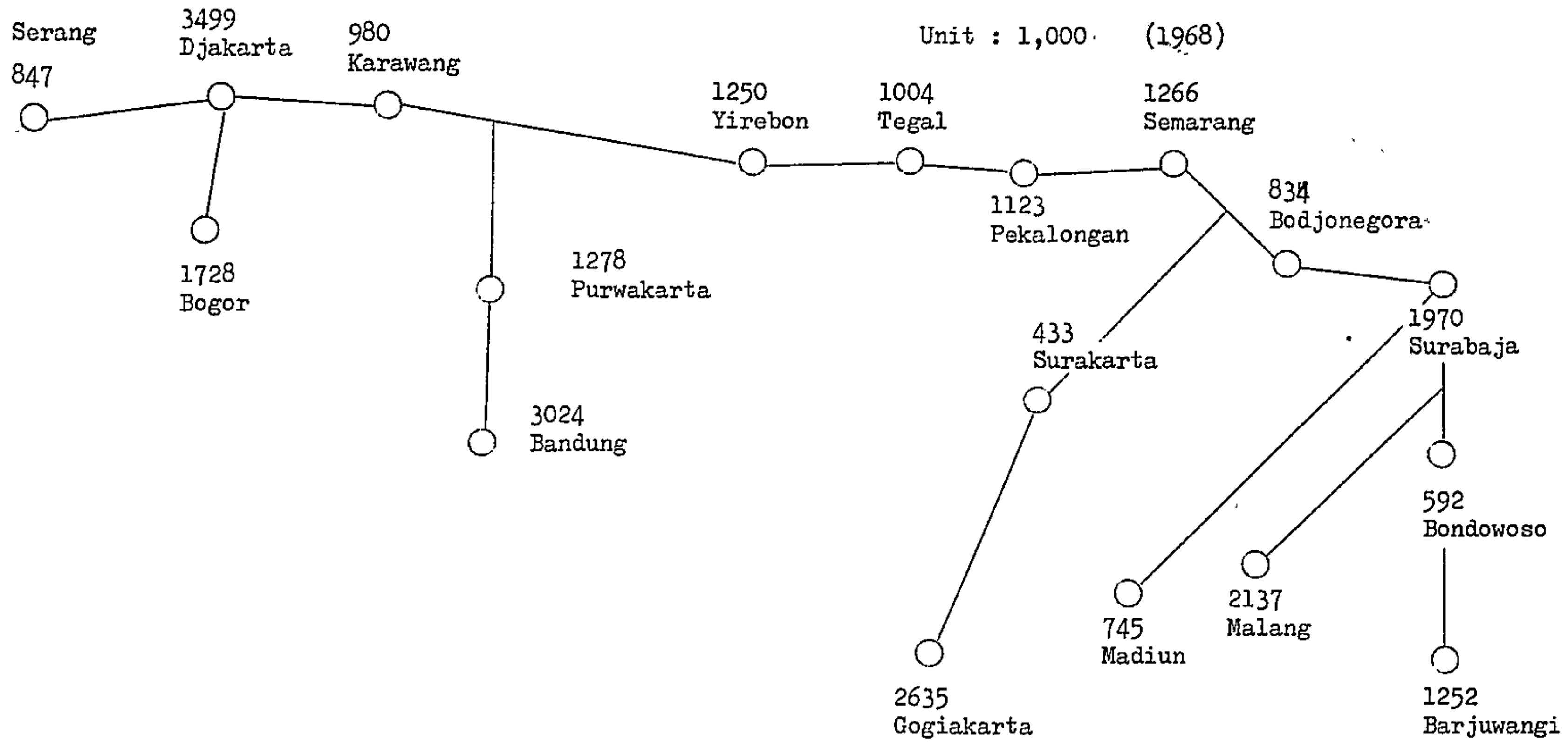
(3) It is possible to organize a diagram which assures the average riding efficiency of 70%.

(4) The track can maintain the running distance shown in Table (23). (VKU).

(5) Cost increase in track maintenance and general administration is so small as to be neglected.

Fig. (21) Population Along Considered Sections

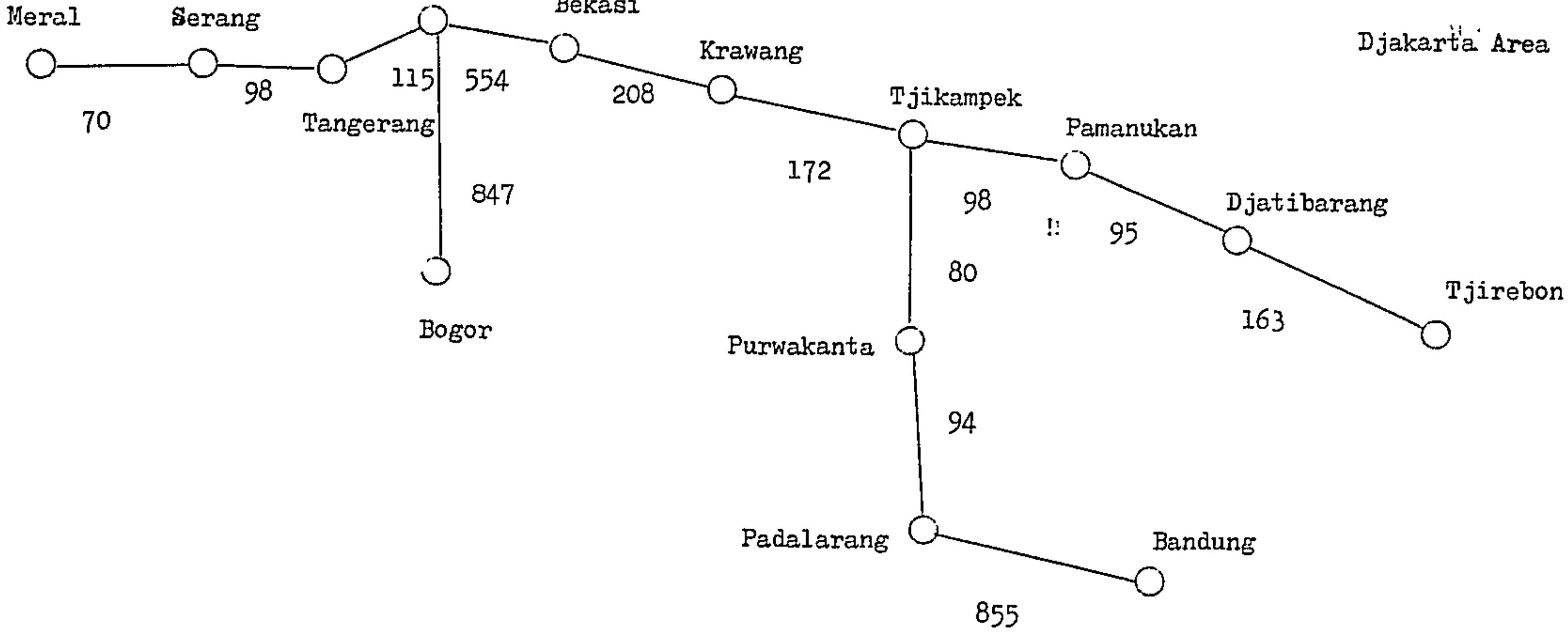
Unit : 1,000 (1968)



Source: Indonesia 1968 - 1970
Highway Service
Interim report
TABLE IR-403-T01

Fig. (22) Highway Bus Troffic in 1968

(Average Daily Traffic)

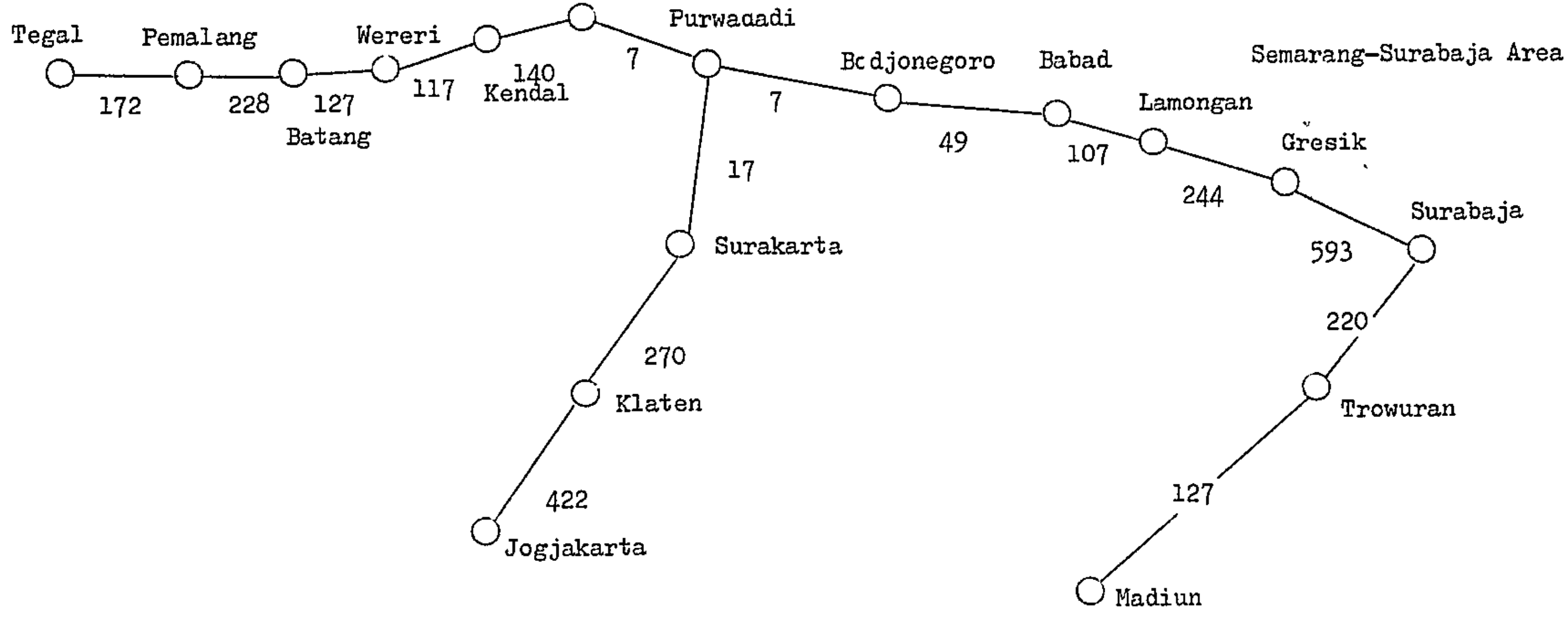


Source : Indonesia 1968 - 1970
Highway Service
Interim Report

Fig. (23) Highway Bus Troffic in 1968

(Average Daily Traffic)

Semarang–Surabaja Area

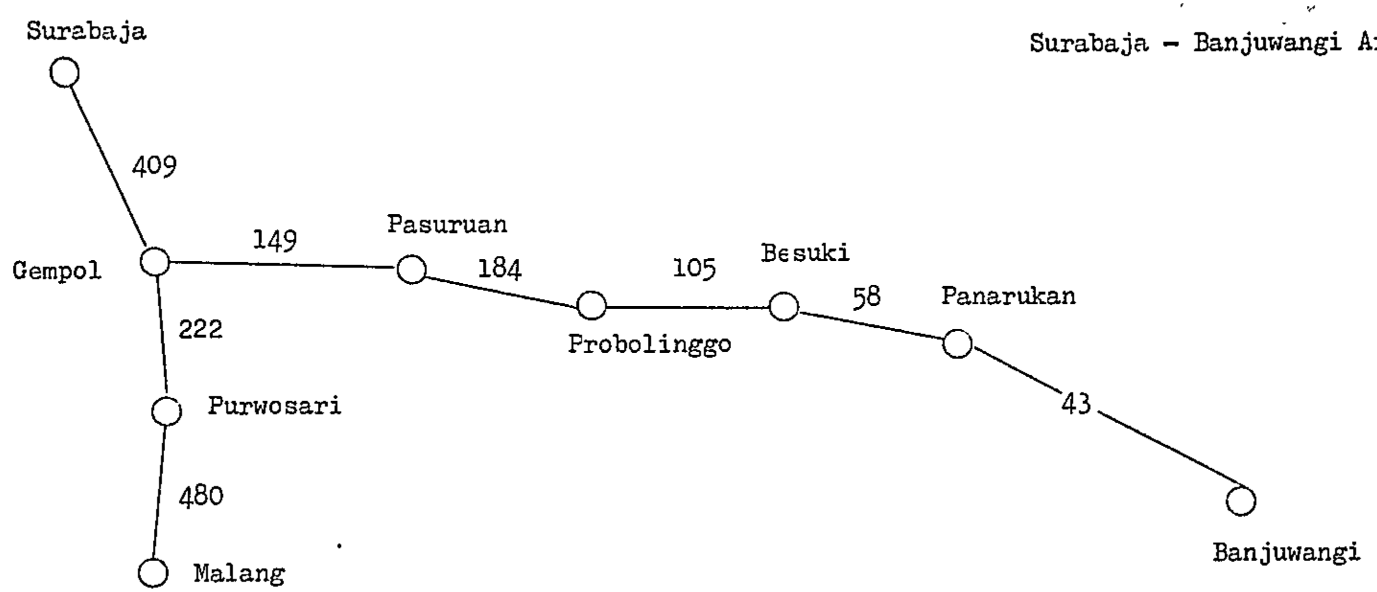


Source : Indonesia 1968 – 1970
Highway Service
Interim Report

Fig. (24) Highway Bus Traffic in 1968

(Average Daily Traffic)

Surabaja - Banjuwangi Area



Source : Indonesia 1968 - 1970

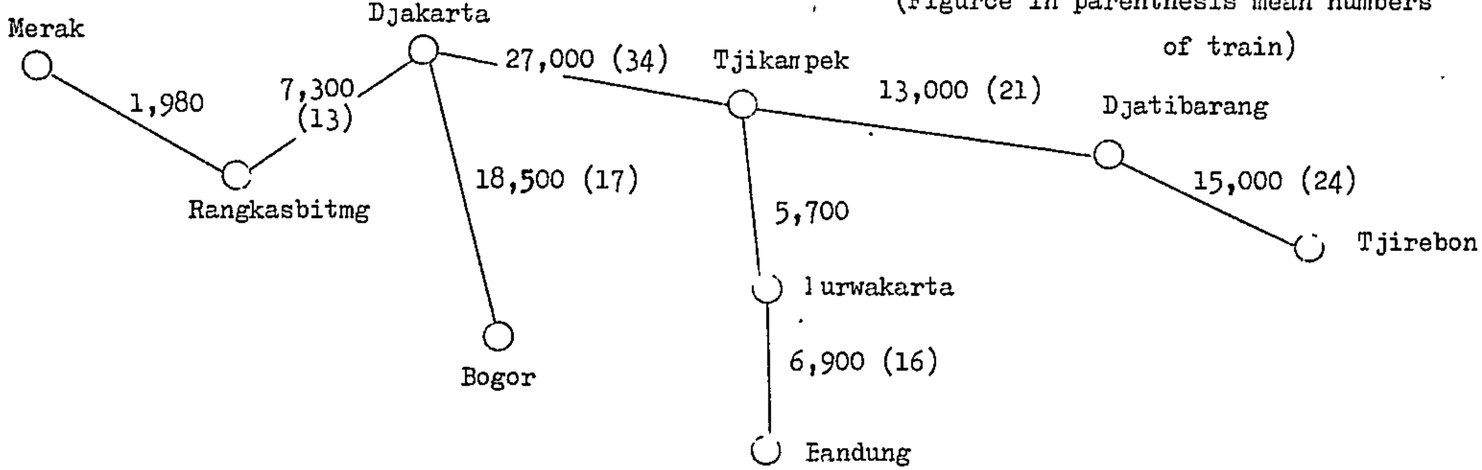
Highway Service

Interim Report

Fig. (25) Railway Passenger Traffic

in 1970 Djakarta Area

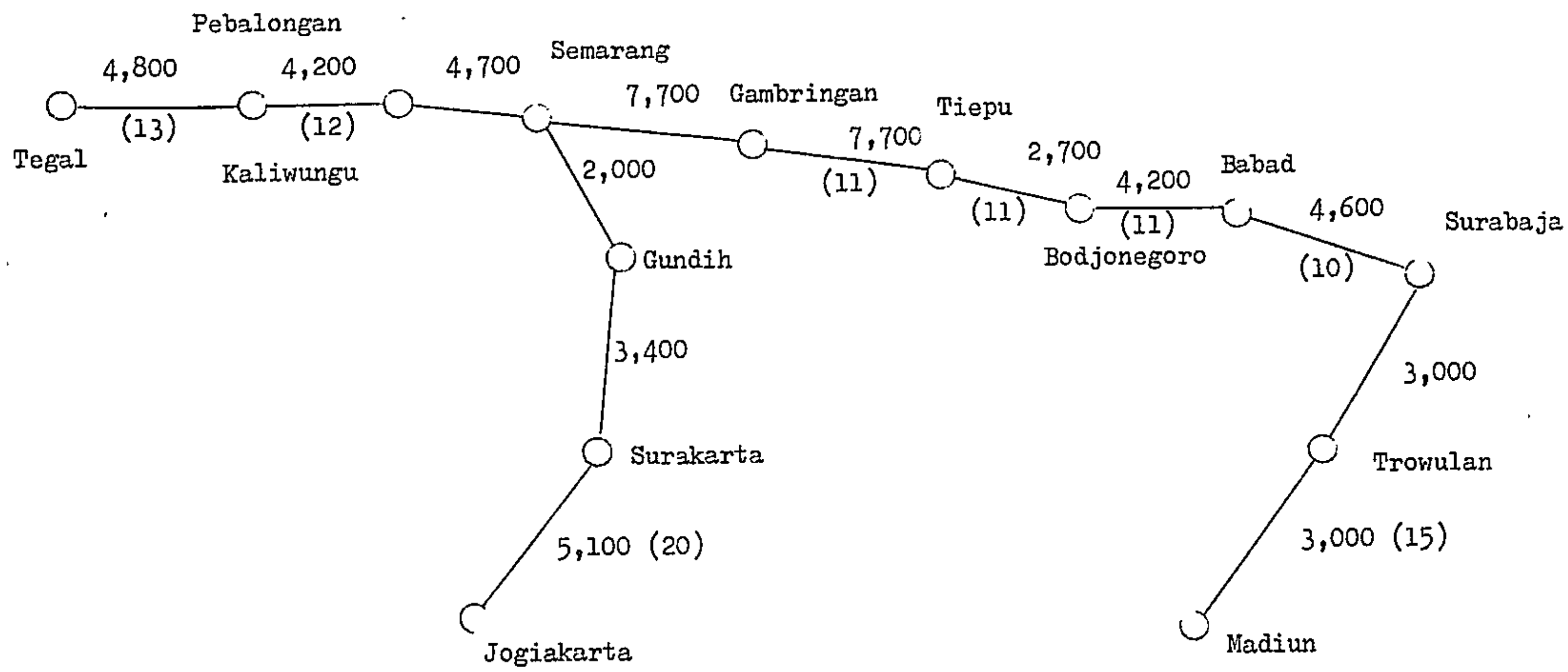
(Figurce in parenthesis mean numbers of train)



Source : Propocal to the Government of Federal German Republic from the Republic of Indonesia

Fig. (26) Railway Passenger Traffic in 1970

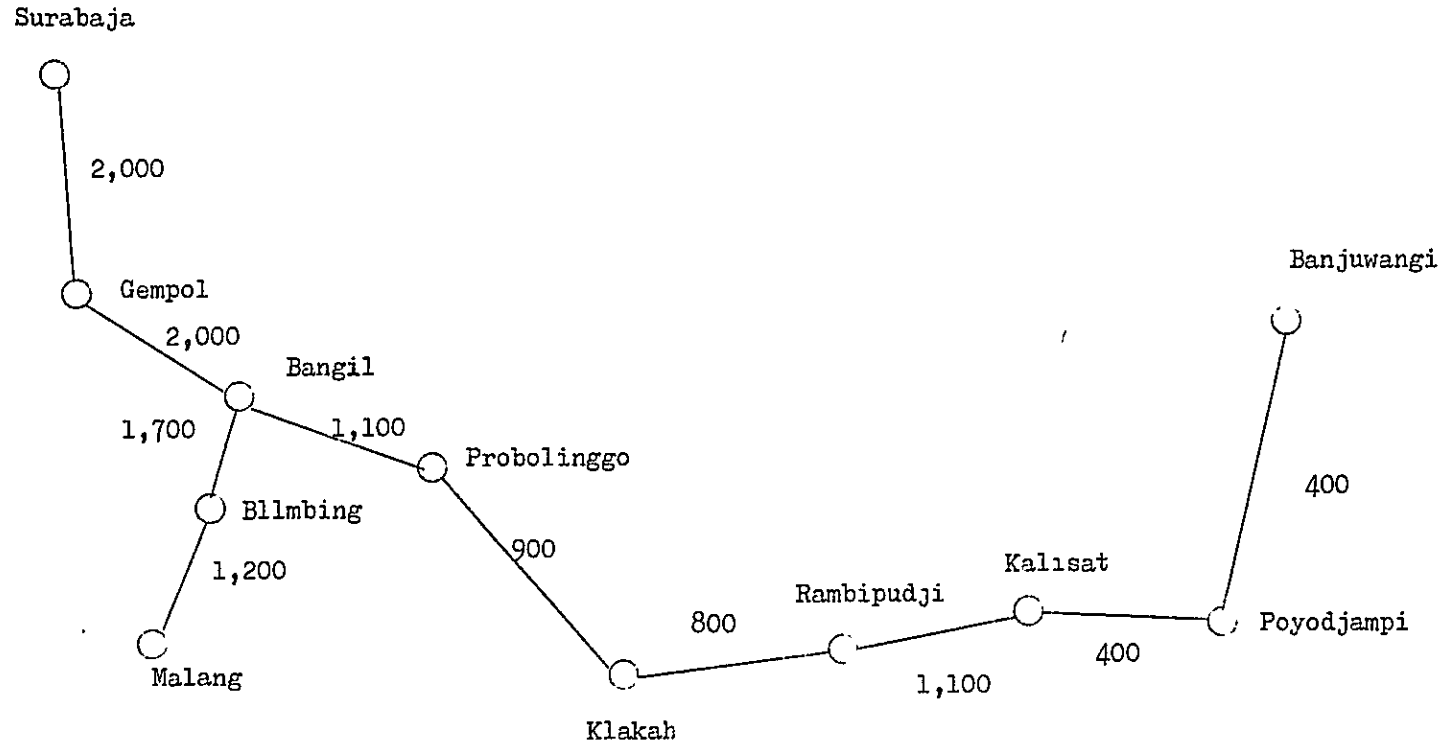
Semarang - Surabaja Area



Source : Proposal to the Goverment of Federcel German Republic from the Republic of Indonésia

Fig. (27) Railway Passenger Traffic in 1970

Surabaja - Banjuwangi Area



Source : Propocal to the Goverment of Fedcıal German Republıc from the Republic of Indonesıa

Table (21) Conditions of Passenger Transportation

Element / Explanation / Section	Distance (Km)		Hour		Charge (Rps)	
	Railway	Highway	Railway (unlimited economy)	Highway bus	Railway (unlimited economy)	Highway bus
Djakarta - Tjirebon	219	235	5.0	5.0	310	268
Djakarta - Bandung	170	160	4.0	4.0	250	250
Djakarta - Bogor	54	55	0.7	1.25	60	90
Djakarta - Merak	152	95	4.0	3.0	190	150
Surabaja - Malang	96	93	1.67	2.5	150	150
Surabaja - Banjuwangi	265	290	7.8	8.0	360	450
Surabaja - Madiun	176	180	3.3	4.0	200	300
Semarang - Surabaja	281	388	5.5	7.0	360	580
Semarang - Tegal	148	166	4.0	3.5	190	300
Semarang - Jogjakarta	167	118	3.5	3.5	250	150

Table (22) Elements for Deciding Priority

Notation / Equation Number / Unit / Explanation / Section		RR'	PW'	PR	PW	PDR	PDW	RD	P	KO.03	KO.08
Equation Number		(215)	(216)			(207)	(206)	(205)	(203)	(202)	(202
Unit		million passenger Kms	million passenger Kms	million passenger Kms	million passenger Kms	million pass. Kms	million pass Kms	million Kms	million Rps	million Rps	million Rps
Explanation		traffic in present trains (1970)	traffic in highway bus (1968)	traffic in present trains (1974) PR=PR'X 1.126 (3% increase)	traffic in highway bus (1974) PW= PW' X 1.194 (3% increase)	diverted traffic from present trains PDR=PRX0.07	diverted traffic from highway buses PDW=PWX0.09	traffic of diesel rail cars RD=PDR+PDW	profit of diesel rail cars	maximum possible investment at discount rate 0.03 KO.03=PX25.00	maximum possible investme at disco rate 0.08 KO.08=PX
Djakarta	Djakarta-Tjikampek	356	303	401	362	28	33	61	42	1048	629
	Tjikampek-Tjirebon	351	136	395	222	28	20	48	27	668	401
	Tjikampek-Bandung	141	196	159	234	11	21	32	26	660	396
	Djakarta-Bogor	170	475	191	567	13	51	64	63	1563	938
	Djakarta-Merak	134	143	151	171	11	15	26	20	488	293
	Total	1152	1303	1297	1556	91	140	231	177	4425	2655
Surabaja	Surabaja-Malang	44	234	50	279	4	25	29	30	758	455
	Surabaja-Banjuwangi	110	336	125	401	9	36	45	41	1023	614
	Surabaja-Madiun	164	243	185	296	13	27	40	33	833	500
	Total	318	818	358	977	25	88	113	105	2613	1568
Semarang	Semarang-Surabaja	252	189	284	276	20	20	40	27	663	398
	Semarang-Tegal	206	298	232	356	16	32	48	40	1000	600
	Semarang-Jogjakarta	157	245	177	293	12	26	39	33	825	495
	Total	615	732	692	874	48	79	127	100	2488	1493
Grand Total		2085	2853	2347	3407	164	307	471	381	9525	5715

Elements for Deciding Priority

PW	PDR	PDW	PD	P	KO.03	KO.08	KO.15	KO.20	VO.03	VO.08	VO.15	VO.
	(207)	(206)	(205)	(203)	(202)	(202)	(202)	(202)	(201)	(201)	(201)	(2
million passenger Kms	million pass. Kms	million pass. Kms	million Kms	million Rps	million Rps	million Rps	million Rps	million Rps	car	car	car	ca
traffic in highway bus (1974) PW= PW X 1.194 (increase)	diverted traffic from present trains PDR=PRX0.07	diverted traffic from highway buses PDW=PWX0.09	traffic of diesel rail cars PD=PDR+PDW	profit of diesel rail cars	maximum possible investment at discount rate 0.03 KO.03=PX25.00	maximum possible investment at discount rate 0.08 KO.08=PX14.995	maximum possible investment at discount rate 0.15 KO.15=P x 8.974	maximum possible investment at discount rate 0.20 KO.20=P x 6.906	maximum possible number of diesel rail cars at discount rate 0.03 VO.03=KO.03÷62	maximum possible number of diesel rail cars at discount rate 0.08 VO.08=KO.08÷62	maximum possible number of diesel rail cars at discount rate 0.15 VO.15=KO.15÷62	max pos num die cars dis 0.2 VO.
362	28	33	61	42	1048	629	377	293	17	10	6	
222	28	20	48	27	668	401	240	187	11	[illegible]	4	
234	11	21	32	26	660	396	238	185	11	[illegible]	4	
567	13	51	64	63	1563	938	563	438	25	15	9	
171	11	15	26	26	488	293	176	137	8	[illegible]	3	
1556	91	140	231	177	4425	2655	1,593	1,239	71	43	26	
279	4	25	29	30	758	455	273	212	12	[illegible]	4	
401	9	36	45	41	1023	614	368	286	16	10	6	
296	13	27	40	33	833	500	300	233	13	8	5	
977	25	88	113	105	2613	1568	941	732	42	25	15	
276	20	20	40	27	663	398	239	186	11	[illegible]	4	
356	16	32	48	40	1000	600	360	280	16	10	6	
293	12	26	39	33	825	495	297	231	13	8	5	
874	48	79	127	100	2488	1493	896	697	40	24	14	
3407	164	307	471	381	9525	5715	3,429	2,667	152	92	55	

This table shows the calculation process of the maximum possible
Method of calculation is shown in each column, but in connection
[illegible]

KO.08	KO.15	KO.20	VO.03	VO.08	VO.15	VO.20	KL	KU
(202	(202)	(202)	(201)	(201)	(201)	(201)		
million Rps	million Rps	million Rps.	car	car	car	car	kilometer	million Rps.
maximum possible investment at discount rate 0.08 KO.08=PX14,095	maximum possible investment at discount rate 0.15 KO.15 = P X 8.974	maximum possible investment at discount rate 0.20 KO.20 = P X 6.906	maximum possible number of diesel rail cars at discount rate 0.03 VO.03=KO.03÷62	maximum possible number of diesel rail cars at discount rate 0.08 VO.08=KO.08÷62	maximum possible number of diesel rail cars at discount rate 0.15 VO.15=KO.15÷62	maximum possible number of diesel rail cars at discount rate 0.20 VO.20=KO.20÷62	distance of the section	maximum possible investment per km at discount rate 0.03 KU = KO.03÷KL
629	377	293	17	10	6	5	84	[illegible]
401	240	187	11	6	4	3	219 (**)	7.8
396	238	155	11	6	4	3	170 (*)	10.0
938	563	438	25	15	9	7	54	28.9
293	176	137	8	5	3	2	152	3.2
2657	1,5[illegible]	1,239	71	43	26	20	511	8.7
455	273	212	12	7	4	3	96	7.9
614	368	286	16	10	6	5	265	3.9
500	300	233	13	8	5	4	176	4.7
1568	941	732	42	25	15	12	537	4.9
398	239	186	11	6	4	3	281	[illegible].4
600	360	280	16	10	6	5	148	[illegible].8
495	297	231	13	8	5	4	167	[illegible].9
1493	896	697	40	24	14	11	596	[illegible].2
5715	3,429	2,667	152	92	55	43	1,644	

(Note)
(*) Djakarta - Bandung
104.8 + 66.0 = 170.8

(**) Djakarta - Tjirebon
84 + 135 = 219

This table shows the calculation process of the maximum possible investment. Method of calculation is shown in each column, but in connection with the column having equation number, show the equation shown afterwards.

Table (23). Internal rate of return

notation	PD	R	VK	E	VK U	NV	K	i	B/C	
equation No.	(205)	(217)		(217)			(217)	(217)		
unit	million pass Kms	million Rps	thousand car Kms	million Rps	Km	car	million Rps			
explanation / section	traffic of diesel rail-cars	first year revenue of diesel rail cars PD. (FR - $\frac{PDR.FRP}{PD}$)	necessary diesel rail car Kms VK = PD ÷ (120 x 0.7)	operational and maintenance cost E = VK x 26 Rp	possible running distance per car per day by tentative diagram	necessary number of diesel rail cars NV = VK ÷ 365 ÷ VK U *)	original cost K = NV x 62	internal rate of return	cost benefit ratio at discount rate 0.15	*4 is the least unit number of diesel rail cars for a train set.
Djakarta (Tjirebon (Bandung	141	138	1679	44	569	8	496	0.28	1.54	
Djakarta - Bogor	64	82	762	20	491	6	372	0.37	1.44	
Djakarta - Merak	26	27	310	8	484	4	248	0.11	0.68	
Surabaja (Malang (Banjuwangi	74	93	381	23	714	4	248	0.31	2.04	
Surabaja - Madiun	40	45	476	12	510	4	248	0.19	1.20	
Semarang - Surabaja	40	39	476	12	414	4	248	0.17	1.04	
Semarang - Tegal	48	54	571	15	425	4	248	0.25	1.38	
Semarang - Jogjakarta	39	45	464	12	661	4	248	0.18	1.11	
Total	471	523	5607	146	534	38	2356	0.23	1.34	

This table shows the calculation process of the internal rate of return.

Method of calculation is shown in each column, but in connection with the column having equation number, see the equation shown afterwards.

Table (24) Important elements for evaluation

section \ elements	maximum possible investment at discount rate 20% (million Rps)	maximum possible investment per Km at discount rate 20% (million Rps)	internal rate of return	cost-benefit ratio at discount rate 0.15
Djakarta (Tjirebon (Bandung	665(185 + 187 + 293)	2.2	0.28	1.54
Djakarta - Bogor	438	8.1	0.27	1.44
Djakarta - Merak	137	0.9	0.11	0.68
Surabaja (Malang (Banjuwangi	498(286 + 212)	1.4	0.31	2.04
Surabaja - Madiun	233	1.3	0.19	1.20
Surabaja - Semarang	186	0.7	0.17	1.04
Semarang - Tegal	280	1.9	0.25	1.38
Semarang - Jogjakarta	231	1.4	0.18	1.11
Total	2667	1.6	0.23	1.34

What is immediately clear from Tables (22) and (24) is that in Table (24) the Djakarta – Merak line indicates a slightly inferior figure, dropping below 1 when the cost benefit ratio at discount rate is 0.15. In other lines, however, the value exceeds 1, demonstrating that they are all feasible lines. Even in the case of Djakarta – Merak line, in Table (22) when the maximum possible number of diesel railcars at discount rate is 0.20, a two-car operation is possible, so it can not be said to be always unfeasible. It is all the more so, since we have not considered the induced traffic in this case.

Regarding the contents and methods of calculation of Tables (22), (23) and (24), we are going to explain about them in Chapter 3.

3. Procedure of Estimation

(1) Possible number of diesel railcars.

The possible number of diesel railcars in each section is obtained from the following equation.

$$DC = \frac{K}{PDC} \quad \text{...........} \quad (201)$$

where

K : maximum possible investment

PDC : Price of one diesel railcar,

The price of diesel railcar rises year after year. @¥50,000,000.– (Rp. 62,000,000.–) is the estimated price as one in 1974, but subject to shipment at Japan by March of 1974.

(2) Maximum possible investment.

The maximum possible investment of each section is obtained from the following equation.

$$K = \sum_{y=1}^{n} \frac{(1 + r)^y}{(1 + i)^y} \cdot P \quad \ldots\ldots\ldots\ldots (202)$$

where

K : Maximum possible investment

n : Period (years) of evaluation (n = 25)

r : Growth rate per year of the diesel railcars profit (r = 0.03)

i : Discount rate

p : The first year profit of the diesel railcars.

i) Period of evaluation

For the period of evaluation, we adopted 25 years. This is rather too long as compared with other ordinary cases. But to compute the maximum possible investment, the period of evaluation must be equal to the life period of a considered equipment. And, the life period of diesel railcar is 25 years.

ii) Growth rate of the diesel railcars profit.

The growth rate of the diesel railcars profit is nothing but the growth rate of passenger traffic. In Indonesia, there are no data useful for estimation of the growth rate of passenger traffic. But the growth rate of population in Indonesia is known as 2.7% in general.

Therefore, the round figure of 3% is herein adopted as the growth rate.

iii) Discount rate.

Theoretically, the discount rate is equal to the interest rate of the loan available, i.e. 3% in this case. But, in recent years, to evaluate projects severely, hypothetical high discount rate, e.g. 15% or 20%, is often required for economic feasibility. Therefore, the maximum possible investment is herein computed at the discount rate of 3%, 8%, 15% and 20% respectively.

(3) First year profit.

The first year profit is computed as follows.

$$P = PD \cdot PU \quad \text{..................} \quad (203)$$

$$PU = FR - CD - \frac{PDR \cdot FRP}{PD} \quad \text{,.........} \quad (204)$$

where

P : first year profit

PD : first year passenger-Kms of the diesel railcars.

FR : passenger fare per Km of the diesel railcars (FR = Rp. 1.5)

CD : operational and maintenance expenses per passenger-Km in diesel railcar transportation (CD = Rp. 0.3)

PDR : diverted passenger-Kms from present trains

PU : profit per passenger-Km of diesel cars

FRP : passenger fare per Km of present trains (FRP = Rp. 1.1)

In equation (204) PDR. FRP means the railway revenue reduction caused by the diesel railcars.

i) Passenger fare of the diesel railcar.

For the estimation of diversion traffic and revenue of the diesel railcars, the fare level is the most important matter. In this study, Rp. 1.5 is assumed as the fare per passenger-Km of the diesel railcars, because, in the representative section from Djakarta to Bandung, the fare of unlimited economy is Rps. 250 for the distance of 170 Kms, i.e. Rp. 1.5 per Km.

ii) Operational and maintenance cost.

Between Djakarta and Tjirebon, the operational and maintenance cost of the hypothetical annual diesel rail-car traffic of 1,572,420 car-Kms is estimated as Rps. 40,634,836 (shown in Annex 1 repairing and operation cost) Therefore the cost per car-Km is

$$\text{cost per car-Km} = \frac{40,634,836}{1,572,420} = \text{Rps. } 26$$

$$\text{and, the cost per passenger-Km} = \frac{\text{Rps.}26}{\text{capacity X efficiency}}$$

$$= \frac{\text{Rps. } 26}{120 \times 0.7} = \text{Rps.} 0.3$$

Thus the figure of Rps. 0.3 is adopted as the maintenance and operating cost per pass-Km (CD in equation (204))

(4) Traffic diversion

The traffic of the diesel railcars is obtained from following equations.

PD = PDW + PDR .... (205)

where

PD : first year passenger-Kms of the diesel railcars

PDR : diverted pass.-Kms from present trains

PDW : diverted pass.-Kms from highway buses.

PDW = PW. RD .... (206)

Where

PW : pass.-Kms in highway buses

PD : diversion rate from highway buses (RD = 0.09)

PDR = PR. RDR .... (207)

where

PR : pass.-Kms in present trains

RDR : rate of diversion from present trains (PDR = 0.07)

$$RD = \int_L^{\infty} f(x)\,dx \quad .... \; (208)$$

where

f(x) : probability density function of time evaluation value

L : lower limit of the time evaluation value necessary for diversion from highway bus to diesel railcar (L = Rps. 62)

$$L = \frac{\Delta F}{\Delta T} \quad .... \; (209)$$

where

ΔF : difference between bus passenger fare and diesel railcar passenger fare (ΔF = Rps. 0.25)

$\triangle T$: difference between bus trip hours and diesel railcar trip hours ($\triangle T$ = 0.004 hours)

$$\triangle F = FR - FW \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (210)$$

where

FR : passenger fare per Km of diesel railcar.

FW : passenger fare per Km of highway bus

$$\triangle T = SW - SR \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (210.1)$$

where

SW : trip hours by bus

SR : trip hours by diesel railcar.

$$f(x) = \frac{1}{x \cdot \sigma \sqrt{2\pi}} \cdot \frac{1}{e - 2\sigma 2} \cdot (\log x - \mu)^2 \ldots (211)$$

where

μ : standard deviation of log x

σ : average of log x

$$\sigma = \sqrt{\log \left(\frac{S^2}{M^2} + 1 \right)} \quad \ldots\ldots\ldots \quad (212)$$

where

S : standard deviation of time evaluation value

(S = Rps. 34)

M : average of time evaluation value (M = Rps. 43)

$$\mu = \log M - \frac{2}{2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (212.1)$$

$$RDR = \int_{LR}^{\infty} f(x).dx \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (213)$$

where

LR : lower limit of time evaluation value necessary for diversion from present train to diesel railcar

(LR = Rps. 68)

$$LR = \frac{\Delta FR}{\Delta TR} \quad \cdots\cdots\cdots\cdots\cdots\cdots (214)$$

where

ΔFR : difference between present train passenger fare and diesel railcar passenger fare (FR = Rp. 0.4)

ΔTR : difference between present train trip hours and diesel railcar trip hours.(TR = 0.006 hours)

$$\Delta FR = FR - FRP \quad \cdots\cdots\cdots\cdots\cdots\cdots (215)$$

where

FRP : passenger fare per Km of present trains (FRP = Rps. 1.1)

i) Conditions of passenger transportation.

To estimate the diversion rate, the conditions of passenger transportation are supposed as follows.

	diesel railcar	highway bus	present train
Passenger fare per Km	(FR) Rps.1.5	(FW) 1.25	(FRP) 1.1
Hours per Km	(SR) 0.025 (40 Km/h)	(SW) 0.029 (35 Km/h)	(SRR) 0.031 (32 Km/h)

FR : The Djakarta – Bandung section is considered as representative. In this section, the fare of unlimited economy class is Rps. 250 for the distance of 170 Kms. Therefore, the fare per Km is Rp. 1.5

FW : In West Jawa, where the traffic is the densest, the prevailing bus passenger fare is Rp. 1.25 per Km.

FRP : About 30% of railway passengers do not pay fare. Therefore, Rp 1.5 x 0.7 = Rp. 1.1
This figure may be too large. According to the P.N.K.A. statistics, the revenue per pass.-Km is only Rp. 0.6 in 1970.

SR, SW AND SRR:

These figures include the waiting time and the stopping en route.

ii) Time evaluation.

The S in equation (212) was estimated as follows.

$$M = MJ. \frac{YI}{YJ}$$

MJ : average value of one hour of passengers in Japan. (MJ = \$1.08 in 1967)

YI : income per capita in Indonesia

YJ : income per capita in Japan.

and

$$\frac{YI}{YJ} = \frac{\$92}{\$921} = 0.1 \quad (1967)$$

Therefore, M = Rps. 43

As to the S in equation (12),

$$S = M. \frac{SJ}{MJ} = \text{Rps. } 34$$

SJ : standard deviation of time evaluation value in Japan (SJ = \$0.8)

The growth rate of the income per capita in Indonesia is only 0.8% per year. In this study, therefore, the shift of the probability density function in equation (211) was neglected.

iii) Basic Traffic.

Basic traffic (PR' and PW' in Table (22)) is obtained from a next equation.

$$PR' = ADPT.\ KM.\ 365 \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (215)$$

ADPT : average daily passenger traffic of the railway section (see Figure (25, (26) and (27))

KM : distance of the section.

$$PW' = ADBT.\ KM.\ AP.\ 365 \quad \ldots\ldots\ldots\ldots \quad (216)$$

ADBT : average daily bus traffic of the highway section (see Fig. (22), (23) and (24))

AP : average passengers on a bus (AP = 40 passengers).

(5) Internal rate of return.

Internal rate of return is obtained from the next equation.

$$\sum_{y=1}^{n} \frac{(1+r)y}{(1+i)y} \cdot PD \cdot \left(FR - \frac{PDR.\ FRP}{PD}\right)$$

$$= \sum_{y=1}^{n} \frac{1}{(1+i)y} \cdot (VK.CVK) + NV \cdot PDC \quad \ldots\ldots\ldots \quad (217)$$

$$NV = VK \div 365 \div VKU \quad \text{.....................} \quad (218)$$

where

r : see equation (202)

n : "

PD : see equation (203) and (204)

FR : "

PDR : "

FRP " "

VK : vehicle-Kms of diesel railcars hypothetically introduced.

CVK : operational and maintenance cost per car-Km.

NV : number of diesel railcars hypothetically introduced.

PDC : see equation (201)

VKU : possible running distance per car per day by tentative diagram which is shown in ANNEX - I (Case Study of Diesel Railcar Operation and Maintenance)

V. Rolling Stocks

1. Fundamental design.

(1) The investigation about the following items for the purpose of finding the most desirable diesel railcar design for Indonesian State Railways was executed by a Japanese Survey Team. Before the survey trip, preliminary discussion had been held at Bandung with P.N.K.A. technical engineers about the diesel railcars construction.

a. Railway track condition

b. Maintenance facility of Workshop, Depot and Station.

c. Climatic condition.

d. Actual riding condition.

(2) From the result of our investigation, fundamental design of diesel railcar shall be as follows:

a. 11 ton axle load, suitable for commuter service and inter-city service.

b. To give the comfortable riding quality.

c. To minimize the maintenance cost.

d. To enable an easy procurement of spare parts.

(3) From the above mentioned fundamental design policy, the special feature of diesel railcars shall be as follows:

i) Material: To use standard parts as much as possible for easy procurement of spare parts.
JRS & JIS Standard or equivalent are recommended.

ii) Principal Dimension:

Car body length	20,000 mm
" width	2,990 mm

Car body height	3,600 mm
Bogie center distance	14,000 mm
Wheel base	2,200 mm
Wheel diameter	774 mm
Floor height (about)	1,100 mm
Coupler height	775 mm + 10 mm / - 15 mm
Axle load	11 tons
Maximum speed at 0 /	90 Km/h
Maximum speed at 14 /	40 - 50 Km/h
Minimum curve radius	100 m
Passenger capacity	
seating	80
standing	40 Total 120
Loading capacity (about	10 tons
Fuel capacity	550 litres.

iii) Car body

Underframe	Anticorrosive steel plate of JRS Standard is recommended.
Super structure	Ordinary steel plate is to be used. It is advised that Stainless steel is worthy to be studied for outside sheathing.
Insulation	Fire pròof material is to be used.
Interior panelling	Aluminium base plastic decorative plate is to be used.
Doors	Steel plate doors are to be provided.

Foot step .... Three stages of foot step are to be provided for passengers convenience.

Windows .... Simple construction of window is recommended for an easy maintenance.

iv) Interior equipment

Passenger compartment.. The seat cushion and back are to be made of hardened plastic plate or other suitable material.

Toilet room .... Toilet room is to be provided for passengers' convenience.

v) Draw and buffer gear.

The coach shall be provided with bottom operated automatic couplers with knuckle contour AAR 10A. The draft gear capacity shall be of 30 tons.

vi) Bogie

To give a good riding quality, swing-link type of bogie is recommended.

vii) Braking equipment.

Diaphragm-operated type equipment is recommended to give the maintenance free service.

Detail descriptions are as follows;

a. Westinghouse type automatic electro-magnetic air brake equipment is to be used.

b. The continuous, graduated air brake is to be applied to each car.

c. The brake pipe pressure will be 5 Kg/cm^2, and the train pipe will be 1" size pipe to be used.

d. Air compressor: An engine-driven compressor will be provided at each engine, and a synchronizing circuit for each compressor is to be prepared.

e. Brake Valve: One brake valve for each car (single cab station.)

f. Control valve: Triple-pressure, diaphragm-operated type control valve will be used.

especially, for maintenance free services, easy repairs and long term services.

g. Brake cylinder: To be mounted on each bogie.

viii) Electrical equipment

110 volt system for lighting shall be used for easy procurement of a lamp bulb in Indonesia, Alkaline type battery will be used for easy maintenance.

Fluorescent light fitting will be provided for passengers' room.

ix) Power and transmission

The diesel engine shall be of well-known make, having long experience in railway field.

DMH17H series of JNR standard or equivalent is recommended.

According to the calculation of balancing speed at actual service line, minimum 180 PS output at continuous rating is to be required.

Simple driving system of radiator fan is recommended from a viewpoint of an easy maintenance.

2. Cost

Cost of diesel railcar in 1974: @¥50,000,000.-(=Rps.62,000,000.-)

Cost of diesel railcar is estimated under following conditions -

Description of diesel railcar (Cost Estimation)

1. Type and Train composition .... All motor cars with driving cab; generally two cars MC and MC.

2. Number to be purchased .... 12 cars.

3. Service operation .... Commuter and inter-city service.

4. Climatic conditions .... Max. 35^{o} C temperature.
   " 90% humidity
   " 500 m altitude

5. General specification.

   (1) Rolling Stock gauge .... P.N.K.A. Drawings.

   (2) Track gauge .... 1,067 mm

   (3) Min. Radius of Curvature ... 100 m

   (4) Max. Gradient .... 21 %

   (5) Axle load .... 11 tons

   (6) Wheel diameter .... 774 mm

   (7) Max. speed .... 90 Km/h

   (8) Speed at gradient .... 40 Km/h at 14 /
   (refer to attached drawing)

   (9) Passenger capacity .... 80 seating
   40 standing

   (10) Tare weight .... 34 tons

   (11) Length of car body ....20,000 mm

   (12) Width of car body .... 2,990 mm

   (13) Floor height .... 1,180 mm

(14) Roof height .... 3,600 mm

(15) Coupler's height .... $775^{+10\ mm}_{\ \ 15\ mm}$

6. General layout

(1) Drawing ....

(2) Driving control cab .... To be provided at one end at right side.

(3) Toilet room .... To be provided at one end.

(4) Gangway .... To be provided at both ends with rubber bellows.

7. General construction of body

(1) Underframe .... SS-41 and anticorrosive steel plate.

(2) Car body shell .... 1.6mm SPHC at outside sheathing, and 1.2mm SPHC at roof.

(3) Floor .... 1.2mm thick 13mm high keystone plate.

15mm thick water proof wooden plate.

3mm vinyl covering sheet

(4) Insulation .... 25mm thick glassfiber in each inside of keystone plate, 40mm thick glass fibre and wire net at under side of the keystone plate above the engine.

(5) Interior panel .... 1.6mm thick plastic coated alumminium plate.

(6) Seat .... For passenger: - fixed cross type.

Seat frame is to be of alumminium.
Seat cushion and back are to be made of hardended plastic plate.

(7) Doors .... All doors are to be of light weight construction made of 1.6mm steel plate.

(a) Side entrance .... Two double hinged-type

(b) Gangway .... The gangway door is to be of hinged type at driver's end and sliding type at tail end.

(c) Partition .... Hinged type

(d) Drivers .... Hinged type

(e) Lavatory .... Hinged type

(8) Foot step .... To be provided at each side entrance inside the car.
The steps consist of three stages.

(9) Vestibule bellows .... The end walls of the coach is to be provided with gangway plate and rubber bellows.

(10) Windows .... To consist of a fixed underpart and an upperpart to open upwards (sliding type); The windows to be provided with 5mm thick anti-sunglass.

(11) Parcel Rack .... Plastic coating pipe is to be provided along whole length of side wall.

(12) Hand strup .... Hanging type for side entrance, grip type for each cross seat.

8. Coupler and Draft gear.

(1) Coupler	Automatic coupler with knuckle contour AAR 10A is to be provided at both ends. Height of knuckle is to be made as 280mm.
(2) Draft gear	30 tons rubber type draft gear is to be provided.

9. Bogie	4 wheels, and all welded construction. Wheel is of solid retyrable disc of 774mm dia. Swing hanger type of bolster. Sanding device and brake cylinder are to be mounted onto the bogie frame. Clasp brake system is to be provided.

10. Brake equipment

(1) Brake system	As mentioned in chapter 1.
(2) Air compressor	Engine driven compressor is to be provided.
(3) Brake cylinder	Mounted on each bogie
(4) Slack adjuster	Mounted on each bogie,
(5) Brake rigging	To be arranged to apply equal pressure to the brake block
(6) Emergency brake	To be provided at suitable position.
(7) Hand brake	To apply the brake on the bogie under the driver's cab.

11. Electrical equipment

(1) Charging generator	110 volt D.C. output 2.5 KW engine

driven generator is to be provided.

(2) Battery .... Alkaline type battery of ample capacity suitable for 110 volt system is to be provided.

(3) Lighting .... All lightings of cars are to be of 110 volt. 20 Watt F.L. for passengers room and lavatory. 20 Watt or 15 Watt I.L. for other lighting. 200 Watt I.L. for Head light.

(4) Wiring .... All the wiring under the frame run in steel conduit pipes.

(5) Inter car coupler ...... To be provided on each end.

(6) Distribution panel ..... All panel shall be centralized and fitted in a cubicle inside the car.

12. Ventilation

(1) Fans .... 12" fixed ceiling fans are to be installed.

(2) Regulator .... All fans are to have centrally operated speed regulator.

(3) Toilet room .... 9" exhaust fan is to be provided.

13. Signalling

(1) Horns .... Two horns are to be provided.

(2) Signal disc .... Two swing out signal disc which are operated manually are to be provided.

(3) Signal lamp .... To be provided.

14. Power and Transmission

(1) Power unit mounting	Engine and Torque convertor are to be mounted onto the underframe. Power shall be transmitted through above-mentioned converter, propller shaft with universal joint and the reversing gear box.
(2) Diesel engine	J.N.R. type DMH17H 180ps/1500rpm x 1 (alternatively DMH17HS 250ps/ 1550 rpm x 1)
(3) Water cooling system ...	Underfloor mounted radiator system with belt-driven radiator fan.
(4) Torque converter	DF115 or T.C.2 (J.N.R. standard)
(5) Engine air suction system	From above-floor at ear side.
(6) Exhaust pipe system	From the roof
(7) Lubrication	Fully automatic oil pressure. lubrication device is to be provided.
(8) Fuel tank	To be of all-steel welded construction. 550 litres.

15 Control

(1) Control system	Remote and multiple unit control.
(2) Dead man's device	To be provided.
(3) Safety device	To be provided for too low oil, too high water temperature.
(4) Speed meter	Electric speed-meter is to be provided.

16. Equipment and instrument in the cab .... Followings are to be provided; master controller, brake valve, air pressure gauge, speed meter, indicator, water temperature gauge, light switch, warning horn valve, window wiper, fire extinguisher.

17. Painting and Lettering ..... Painting and lettering are to be as per P.N.K.A. requirement.

18. Spare parts .... 1 set of Bogie truck, Engine Converter, propeller shaft, and etc. for 12 cars.

3. Delivery

(1) On the assumption that 12 nos. of diesel railcars are assigned corresponding to the rail buses under the 1971 Project No. F-22, the delivery of the assigned 12 nos. of diesel railcars is estimated as follows.

i) 5 months for office procedures, designing of the rolling stocks and consultation (such as Loan Agreement between the Governments, Tendering, Evaluation, Contract, Drawing approval, etc.)

ii) 6 months for manufacturing of the rolling stocks.

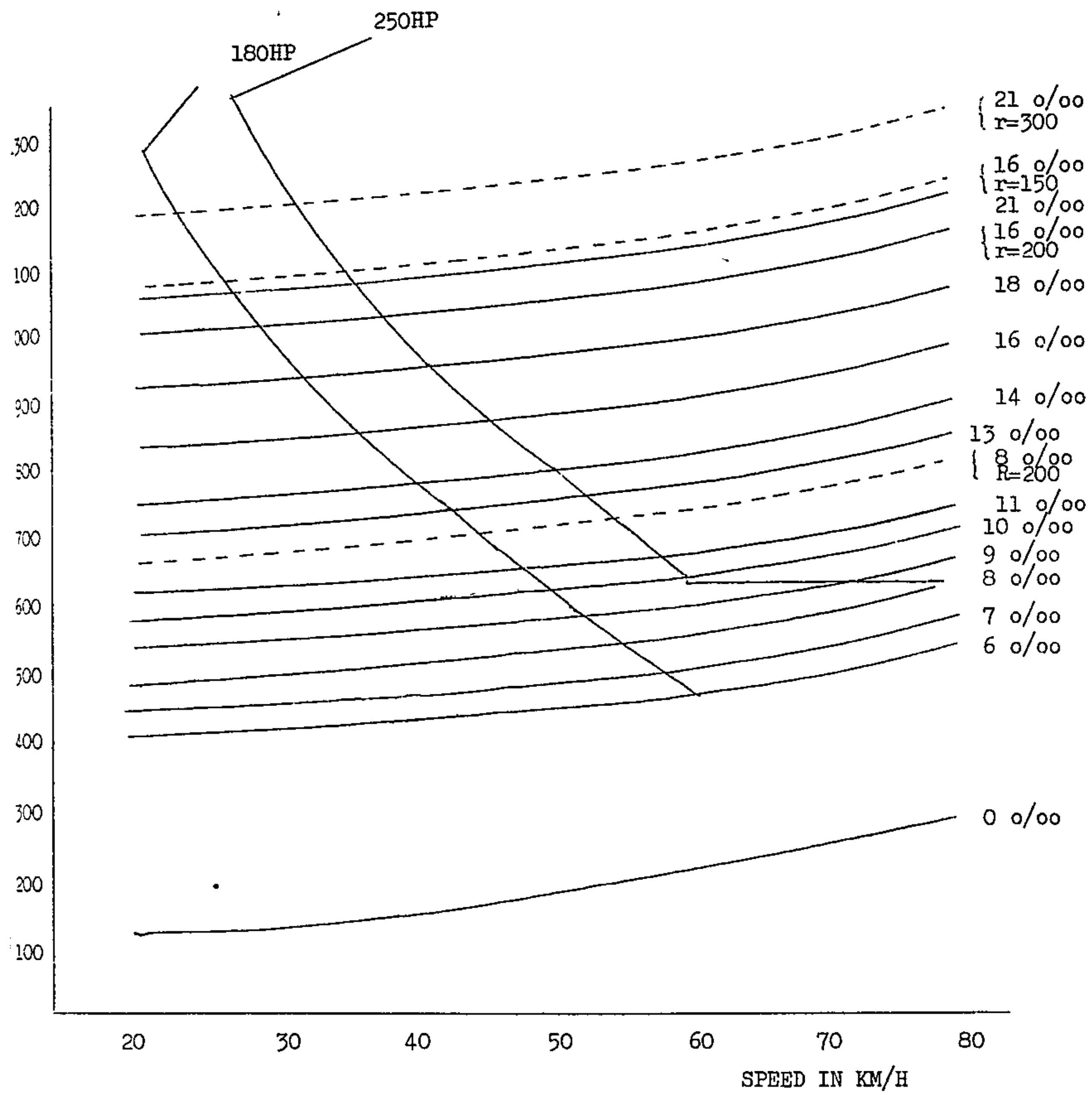
iii) 1 month for delivery.

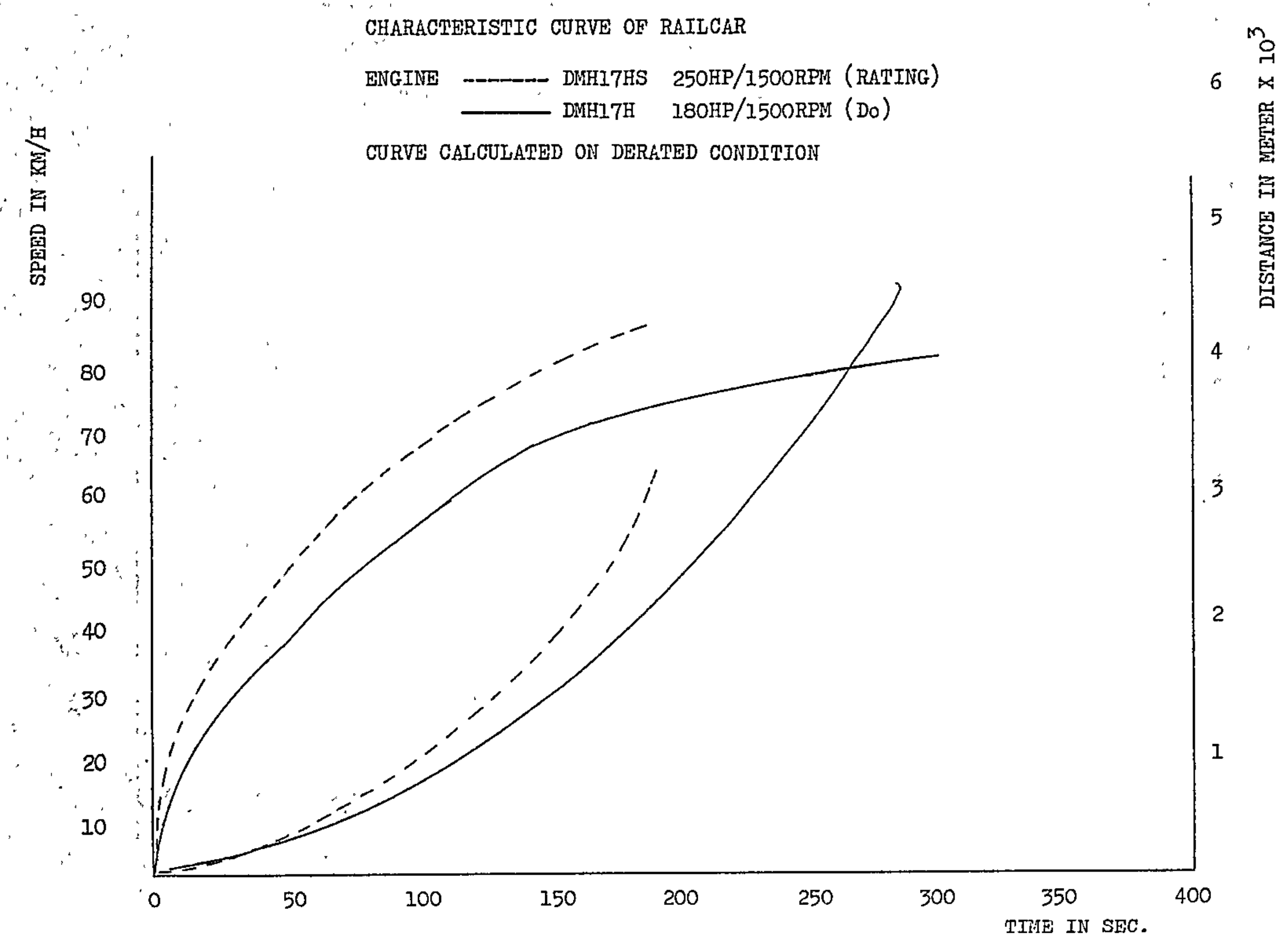
Therefore, a total of 12 months is estimated necessary at least.

(2) However, in the above case, it is advisable that both the Japanese and Indonesian governments will make earnest efforts to shorten as much as possible the periods mentioned in

paragraph (1) above, so that the diesel railcars will be delivered by March of 1973, the date desired by the Indonesian Government.

BALANCING SPEED ON GRADIENT LINE



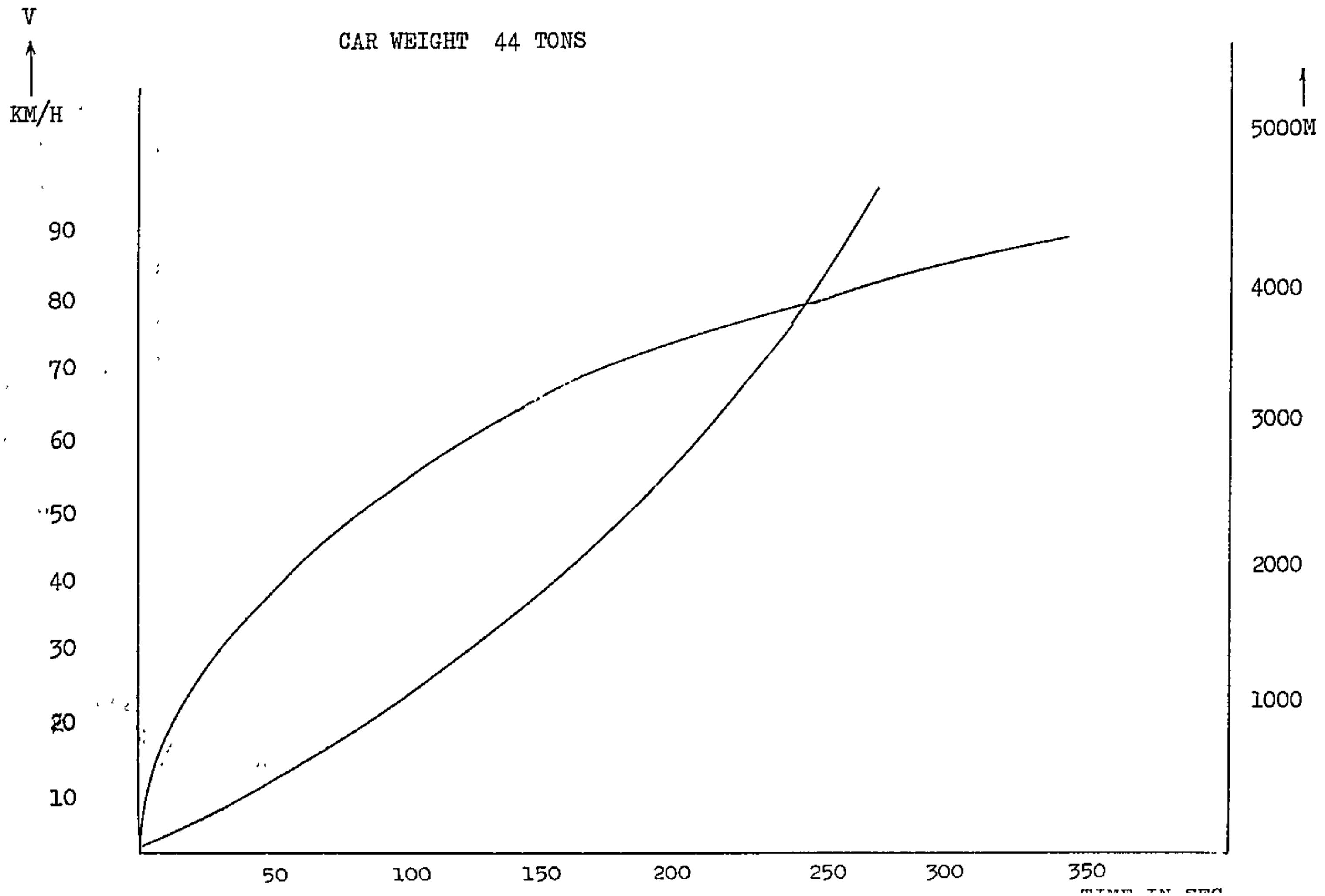

CHARACTERISTIC CURVE OF RAILCAR
ENGINE -------- DMH17HS 250HP/1500RPM (RATING)
———— DMH17H 180HP/1500RPM (Do)
CURVE CALCULATED ON DERATED CONDITION
SPEED IN KM/H
10
20
30
40
50
60
70
80
90
0
50
100
150
200
250
300
350
400
TIME IN SEC.
1
2
3
4
5
6
DISTANCE IN METER X 10^3

TIME-SPEED & TIME-DISTANCE CURVE

ENGINE DMH17H (180HP/1500RPM)

SITE CONDITION (450m 35°C 90%RH)

CAR WEIGHT 44 TONS

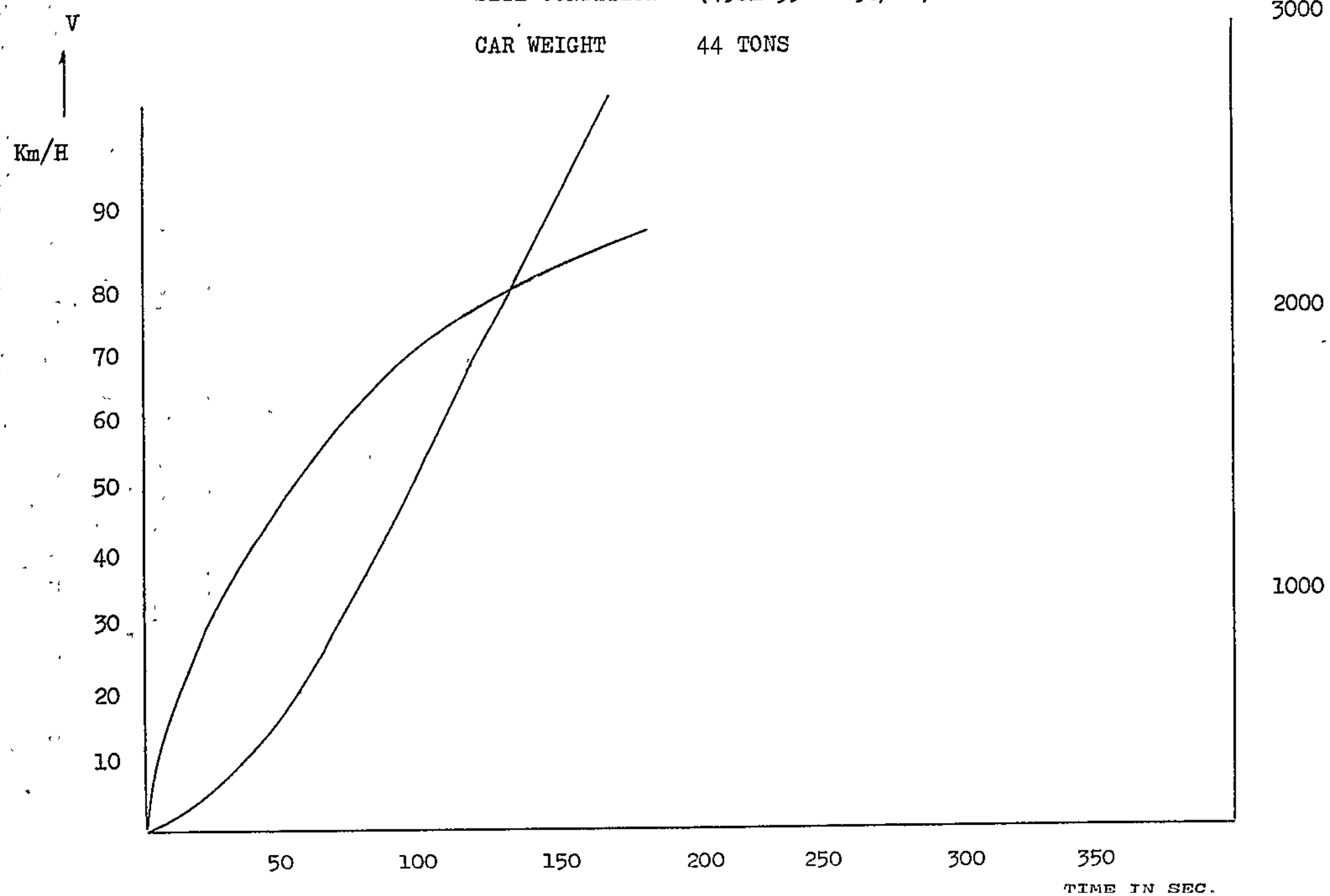


TIME-SPEED & TIME-DISTANCE CURVE

ENGINE DMH17HS (250HP/1500RPM)

SITE CONDITION (450m 35°C 90%RH)

CAR WEIGHT 44 TONS



Regarding Air Brake Equipment, various types of air brake equipment may be considered as one of the respects of car structure, however, it is considered most preferable that the Indonesian Government establish Indonesia's own Railways' Standards for air brake equipment.
Besides, it is considered necessary to establish a system or an order so that air brake equipment can be manufactured in Indonesia as a domestic product in the near future.

VI. CONCLUSION

1. It is understood necessary for the Indonesian Government to take up an Introduction of Diesel Railcars and their promotion as a semi-long term project for the coming 4 - 5 years.

2. Feasible quantity of diesel railcars to be introduced, calculated macrocosmically from the viewpoint of maximum possible investment, is as shown in Table (22) Element for deciding priority;

No. of diesel railcars	Discount rate per annum
152 nos.	at 3%
92 nos.	at 8%
55 nos.	at 15%
43 nos.	at 20%

On the contrary, as shown in Table (24) Important elements of evaluation which is calculated from the other side of this table (22), all the listed lines clearly show the feasibility considered from an internal rate of return of more than 0.15 and a cost benefit ratio at discount rate 0.15 of more than 1.

Please refer to the attached Table (24).

These figures shown above are ones simply calculated, based only upon a diverting rate of passengers from railways and road transportation.

Of course a considerable induced traffic volume can be expected as a benefit, such as frequent service, speed-up, shortening of travelling hours, increase of transport capacity, improvement of riding quality etc. to be provided by an operation of diesel railcars.

However, in this report, such expection was neglected so that the maximum feasibility could be obtained in the worst conditions. (For calculating this inducing effect by those benefits, it is necessary to make minute inspections or survey from various view-points over a rather long period, but to our regret, the given time and instruments were not enough to do it.)

Therefore, if the induced traffic volume could also be considered, then very considerable increase of passengers and hence great increase of the profit are expected.

3. To promote this project, the fully furnished facilities are inevitably necessary at workshop and depot for diesel railcars, however, the furnishing of facilities at workshop and depot is considered necessary to be taken up in 1972 or 1973 as a different project.

4. Regarding the lines and sections where diesel railcars are to be operated, it is considered to be performed by making yearly plans. However, as far as the above mentioned 10 lines are concerned, any of them is considered feasible.

5. We did not intend to restrict the feasibility for those 10 lines only.

   It can not be said that any of the other lines or sections is not feasible.

   In other words, the above mentioned feasibility is considered restricted for these 10 lines only, because time was not enough to inspect other lines, therefore, the introduction of diesel railcars should also be studied for the other lines with similar conditions to the 10 lines.

6. Regarding an operation of diesel railcars, when the spare parts, depot and its economy, etc. are considered together, for obtaining the best effect, it is most preferable to operate diesel railcars by a centralized operation method, therefore a distributed operation should not be adopted as far as possible.

7. For operating diesel railcars efficiently, attention should be drawn to the necessity of further facilities, especially of fully furnished operation control system and signalling and safety maintenance facilities.

8. Regarding the operation of railcars, as the municipal transportation among Djakarta City and also among the electrified section between Bogor, it is well understood and needless to say that the electriccar-ization is more appropriate than diesel-car-ization following the trend of the world.

   However, the following matters should be considered and be decided prudently.

   1) Base or depot
   2) Inspection and maintenance capacity for Electrical equipment. (Facilities and staffs)
   3) Securing of Electric power.
   4) Shortage of operating length. (Short length of track in service)
   5) Availability of cars to other lines and other purposes.
   6) Signalling and safety maintenance facilities.

9. For operation of diesel railcars, the followings should be carefully taken care of for efficient use.

   1) Test running
   2) Training of drivers
   3) Facilities of depot
   4) Maintenance, tune-up and repairing
   5) Planning of effective diagram
   6) Proper operation and maintenance
   7) Basic action for emergency
   8) Proper wiring of Station facilities.
   9) Signalling and safety guard

10. Regarding the operation by approx. 12 nos. of diesel railcars, it is considered possible without improving present facilities of P.N.K.A. Therefore, it is regarded that there will be no trouble for service operations.