THE ARAB REPUBLIC OF EGYPT

FEASIBILITY REPORT ON THE CAIRO-ALEXANDRIA LINE ELECTRIFICATION FOR EGYPTIAN RAILWAYS

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DECEMBER, 1979

JAPAN INTERNATIONAL COOPERATION AGENCY
(JICA)

PREFACE

By mutual agreement with the Government of the Arab Republic of Egypt, the Government of Japan had decided to undertake a pre-feasibility study for modernization of the Egyptian railways, and the study was executed by the Japan International Cooperation Agency (JICA).

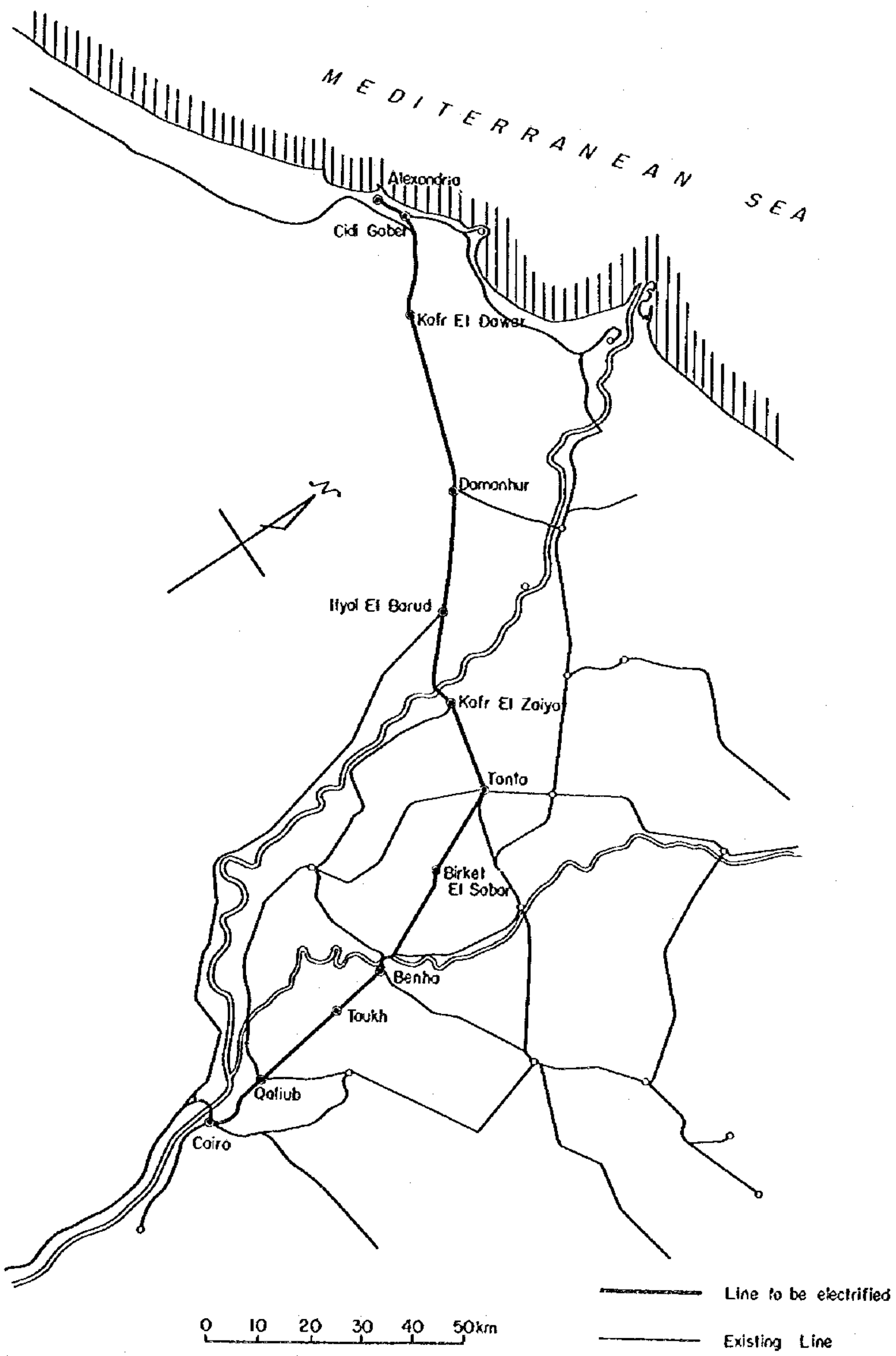
In view of importance of the said Project, JICA proceeded with its survey work in October 1978 after engaged in the preliminary survey starting from July in the same year and committed its survey team to hold a discussion meeting in March 1979 for briefing of the draft final report upon its presentation to the officials concerned. Submitted herewith is the final presentation of the report finalised by completion of the whole domestic work portion, after further briefing in September 1979 with some revisions made to the draft report in response to the request for JICA's views and comments in full particular with regard to the technical standard for railway electrification. Indeed, it will be the greatest pleasure to us all, if this presentation of the report can help furtherance of the Project toward its earliest implementation and development and, besides, contribute much to closer friendship and goodwill between the Arab Republic of Egypt and Japan.

In closing of the remarks as the President, I wish to express my heartfelt thanks to all the persons concerned who extended kindest cooperation and assistance during the full period of our committment in this study.

December 1979

Shinsaku HOGEN
President
Japan International Cooperation Agency
Tokyo, Japan

THE ELECTRIFICATION PROJECT OF THE CAIRO — ALEXANDRIA LINE



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AND
SURVEY TEAM FOR THE CAIRO-ALEXANDRIA LINE
ELECTRIFICATION IN EGYPTIAN RAILWAYS

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SUPPLEMENTAL STUDY ON A FORMULA FOR ELECTRIFYING LINE SECTIONS ON THE EGYPTIAN RAILWAYS

INTRODUCTION

1. INTRODUCTION

1.1 BACKGROUND

The Arab Republic of Egypt covers a total area of 1 million square kilometers, 95 percent of which is, however, a large expansion of desert. Almost all of the 38 million total population dwell in the limited zones such as the Nile delta and its green belt zone.

Accordingly, the whole network of the national railway is composed of the trunk line leading to Aswan all the way alongside the Nile and the railway network covering the Nile delta and the Suez district, both of which amount to about 4,500 km in total length.

Of all those railways, the Cairo-Alexandria Line is the trunk line of utmost importance, the 208 km double-track line starting from the 8.5 million populated metropolitan area of Cairo and, via the rural cities such as Benha and Tanta, finally leading to Alexandria with 2.5 million population. In the recent years, the number of passengers utilising the said main line has been on a steady increase and most of the running trains are packed to full capacity. To cope with this situation, the Government proposes the electrification project for modernisation of the existing line.

1.2 PURPOSE AND SCOPE OF SURVEY

The purpose of this survey is to make a feasibility study of the electrification project, from technical and economic standpoints, of the Cairo-Alexandria Line (208 km) as a part of the railway modernisation scheme now being planned by the Government of Egypt.

Main services rendered to achieve the above purpose include each of the following items.

1) Traffic demand forecast
   Collection of data pertaining to traffic demand forecast,
   Demand forecast on railway passengers.

2) Technical studies

Work plan for electrification, rolling stock design plan and technical reviews from the aspects of operation and maintenance.

3) Financial analysis

Analysis on the basis of carriage charges, railway passengers, estimated construction costs and operating expenses.

4) Economic evaluation

Evaluation by the proposed electrification

1.3 OUTLINE OF SURVEY SCHEDULE

Oct. 17th '78	(Tue.)	Arrival in Cairo Call to Cairo Office of JICA Call to E.R. Office to discuss survey items and schedule by reference to Inception Report.
18th	(Wed.)	Discussion with E.R.'s experts at E.R. Office on the specific subjects by technical divisions.
19th	(thur.)	Electric power division: Discussion with representatives from EEA. Other divisions: Discussion by technical divisions.
21st	(Sat.)	Discussion by technical divisions.
22nd	(Sun)	Main operation and rolling stock divisions: Joint discussion meeting. Other divisions: Site survey between Cairo and Tanta.
23rd	(Mon)	Traffic demand, economic and finance divisions: Joint meeting. Other divisions: Site survey with station yard of Cairo .

Oct. 24th	(Tue.)	Internal meeting among survey team members.
25th ∿28th	(Wed.) (Sat.)	Site observation between Cairo and Alexandria (Wayside, car depot, station yard and bridge).
29th	(Sun)	Operation and rolling stock divisions: Survey at Fraz depot and passenger car depot. Other divisions: Discussion meeting by technical divisions.
30th	(Mon)	Electric power division: Discussion with representatives from EEA. Traffic demand, economic and finance division: Discussion with representative from Central Agency For Public Mobilization and Statistics. Other divisions: Discussion by technical divisions.
31st	(Tue.)	Electric power division: Discussion with Ministry of Transportation officials. Other divisions: Discussion by technical divisions.
Nov. 1st	(wed.)	Electric power & civil engineering division: Survey on Helwon Line. Other divisions: Discussion by technical divisions.
2nd	(Thur.)	Signal & telecommunication division: Discussion with ARETO Other divisions: Discussion by technical divisions.
5th	(Sun)	Final discussion by technical divisions.

Nov.	6th	(Mon)	Discussion with Chairman of E.R. Board and other executive officers.
	7th	(Tue.)	Briefing to Chief Representative of JICA Cairo Office about the draft on Progress Report. Submission of Progress report to E.R.
	8th	(Wed.)	Report to His Excellency Minister of Transportation.
	9th	(Thur.)	Explanation of Progress Report to Japanese Embassy in Cairo.
	11th	(Sat.)	Departure from Cairo.

SUMMARY AND CONCLUSION

2. SUMMARY AND CONCLUSION

2.1 TRAFFIC DEMAND FORECAST

As the result of analysis made on the traffic volume of passengers by use of the economic factor, population and time requirement for travelling, it is predictable that the traffic volume will be on the steady increase on the strength of future economic growth and larger increase of the population along the railway. After completion of electrification, it is further expected that the total number of passengers will increase, being stimulated by the reduced time length for travelling between the stations, by about 18 percent in terms of passenger - km and by about 9 percent in number of passengers.

Table 2-1 Future Traffic Volume in Cairo-Alexandria Line

Item \ Fiscal Year	1976 (actual)	1984	1989	1994	1999	2004
No.of passengers (Unit: 100 thousand)	383	691 (635)	883 (811)	1,127 (1,035)	1,439 (1,321)	1,837 (1,686)
No. of Passengers-km (Unit: 1 million)	1,671	3,015 (2,541)	3,693 (3,113)	4,527 (3,814)	5,543 (4,672)	6,790 (5,724)

Indicated in the parenthesis is the estimated demand in case where the railway is not electrified.

Note: The economic factor (GNP) is estimated herein on the assumed basis that it would continue its growth at an annual average rate of 12 percent up to and including 1982 and 10 percent in and after 1983.

Table 2-2 Future Traffic Volume by Main Sections

Distance \ Fiscal Year		1984	1994	2004
CAIRO ∿ SHUBRA	Not electrified	295	472	756
	Electrified	328	525	843
QAHA ∿ TOUKH	Not electrified	206	335	547
	Electrified	240	391	636
NIFYA ∿ TANTA	Not electrified	172	281	457
	Electrified	202	329	536
TANTA ∿ SHOUBRA EL NAMLA	Not electrified	175	285	464
	Electrified	204	333	543
DAMANHUR ∿ EL BATAL SHLAH SALEM	Not electrified	175	284	463
	Electrified	205	334	544

(No. of passengers at daily average) (100 persons per single way)

2.2 TRAIN OPERATION PLAN

In accordance with the result to be obtained from the foregoing demand forecast, required transport capacity will be made for the traffic volume between the main stations, with due reference to the current pattern of transportation by the express train going into the branch line. Taking account of the remakably large flow of passengers, as is observed today, between the large cities and taking one of the main aims for electrified improvement at speed increase of a train, the scheduled operation diagram will be set up, on condition that the 12-car EMU (Electric Multiple Unit) limited express train would be put into operation on a basis of more than one train each hour. The planned maximum speed of the EMU train will be rated at 145 km per hour.

Speed increase is planned also for the EL (Electric locomotive)-

hauled express and semi-express trains. The constitution of the train diagram will be simple and clear by unification of the stations for train stoppage and the time of arrival and departure by use of the standardized operation schedule.

Table 2-3 Superior-class Direct Train of Cairo-Alexandria Line

Class	No. of trains	Time Interval	Makeup	Seat Capacity	Improved travelling time	Current travelling time	Reducible time (Reducible rate)	Station for stoppage
'A' Limited Express	7	1/2 hrs.	12	660	1°37'	2°23'	46' (32%)	
'B' Limited Express	12	1/1 hr.	12	660	1°50'	2°32'	41' (27%)	Benha, Tanta, Damanhur
Express	7	1/2 hrs.	8	700	2°15'	2°32'	17' (11%)	
Semi-express	12	1/1 hr.	8	700	3°5'∿ 3°18'	4°13'	60' (24%)	Shubra and other 14

Note: Travelling time corresponds to the section between Cairo and Sidi Gaber.

The effect in speed increase of a train as the result of electrification will be an improvement from the present rate of about 60 km per hour to about 80 km per hour at an average of all trains, which means reduction of travelling time by about 25 percent at average. The required number of cars after such improvement are estimated as follows:

EMU	(12-car makeup) 14 unit	168 cars	564 km/day·car (Train - km/car in makeup)
EL		48 locos	356 km/day·car (Train - km/car in makeup)

Thus, a very high operating efficiency can be expected from short-time shuttling at the platform of Cairo and Alexandria as well as from the planned speed increase of the train.

2.3 ROLLING STOCK PLAN

For selection of the optimum train type, comparative study has been made on the following alternatives.

(1) Locomotive-hauled train

(2) Push-pull system

(3) EMU system with the motive power units coupled to both ends only

(4) Power-dispersed EMU system

After such comparative study it is recommended that the power-dispersed EMU system should be adopted for the limited express train to be operated in the proposed railway line, because of its merits as enumerated below, although it may involve somewhat difficulty in maintenance of the rolling stock.

Namely, (1) Easy operation in shuttling, (2) availability of as much driving power as required, (3) small impact onto the track because of light axle load and (4) larger space for more seats.
The express, semi-express and local trains to be operated at a relatively low speed will be hauled by the electric locomotive, utilizing the conventional type passenger cars as they are.

Table 2-4 Rolling Stock Performance

Type of Trains	Limited express	Express, Semi-express and local trains
Train makeup	Power-dispersed EMU 12-car makeup (4 motorcars + 8 trailers)	Bo-Bo type EL-hauled (Hauling 8 cars)
Output (KW)	3,600	2,800
Max. allowable speed (km/H)	160	125
Planned maximum speed (km/H)	145	110

2.4 POWER INSTALLATION PLAN

The electrification system will be designed at AC 25 kV, 50 Hz system which is most suitable for a large capacity operation at high speed. Electric power will be received from five (5) substation sites connected with the 220 kV super high voltage network available in abundance along the railway.

Since super-high voltage network is available for power supply to the railway, any possible voltage unbalance and voltage fluctuation can be restrained within the preset limit even in the worst operating condition at each substation.

All electrical facilities at each of those five substations will be of single unit system. However, they will be fully capable of feeding by extension to the neighbouring substation, with less effect from any trouble of the generating plant or the transmission line.

Those substations will be operated by centralized remote supervisory control from their control center. The safeguard system for protection will be provided so as to improve the system reliability.

The overhead catenary system will be designed for compound catenary system as correspondable to the maximum allowable speed of 160 km per hour designed for the train. The hinged cantilevers will be generally used for supporting a catenary system. The domestic-made shaped steel will be used for fabrication of the support structure.

The movable bridges over the Nile and canals will be of such construction that the specially designed rigid suspension system will be used to meet the operating movable bridges.

2.5 SIGNAL INSTALLATION PLAN

It is important for AC electrification that the signal system to be used should be fully stabilized against any possible interference to arise from electric car current and its induced current.

The Egyptian Railways are going ahead toward improvement of the signalling system for the section between Qaliub and Alexandria, on the precondition that the existing line should be finally improved by AC 50 Hz electrification. After completion of the signal improvement project, the AC electric train operation can be finally realized at the planned maximum speed of 145 km per hour.

In the meantime, in the Cairo - Qaliub section where the signalling system has already been converted into the automatic signalling, the track circuit may be affected directly by such interference as aforesaid because it is designed at AC 50 Hz. Therefore, it is necessary that the said circuit should be improved to such a system as may be adaptable to the AC 50 Hz electrification system. It is advisable that the track circuit for this section should be of same system as being proposed for the aforesaid improvement project, in view of the unity in operation and maintenance of the equipment.

In future, it will be necessary to shorten the length of the block section between Benha and Alexandria, because the line capacity for that section will become tight.

2.6 TELECOMMUNICATION SYSTEM PLAN

Today, the Egyptian Railways are pushing forward various improvement projects aiming at modernisation of the telecommunication system. The completion of those projects is a 'must' in the field of telecommunication system to support the successful completion of the railway electrification project.

Meanwhile, the overhead bare wire now existing along the railway has been so far serving as the transmission line. After completion of the AC electrification system, however, the existing wire will not be serviceable due to inductive interference to arise from AC traction. To cope with such future change it must be replaced with aluminum-sheathed cable having high screening effect against inductive interference.

2.7 ROLLING STOCK DEPOT AND WORKSHOP

The maintenance work to be required for the electric rolling stock is classified into overhaul, principal equipment overhaul, bogie overhaul (for locomotive only), monthly inspection and daily inspection. At Cairo and Alexandria a depot will be provided respectively for daily inspection of electric locomotives. At Qaliub a large rolling stock center with an area of 273,000 m^2 expansion will be constructed to go through the consistent process of rolling stock maintenance from daily inspection to overhaul as well as their storage.

2.8 TRACK AND CIVIL WORK CONSTRUCTION

At present, the strengthening work of the existing track is being carried out by the Egyptian Railways toward the target completion by 1981. The track will be of such rigid construction with strength adequate enough to accept the proposed increase of train speed when the ongoing project will have been completed.

The new structure gauge will be determined as the result of addition of the current collecting unit to the train.

The structures to be considered as obstruction to the structure gauge may be an overhead foot bridge and a highway bridge. In reality, however, they would not be any big obstacles because any such difficulty can be overcome by lowering of the subgrade or remodelling of the existing structure. The existing railway has eight (8) movable bridges, most of which must be designed for special overhead catenary construction since the movable portion should secure certain clearance so as to permit navigation of vessels.

In order to cope with the need for increase in total number of trains and their smoothful operation exactly as scheduled, new installation of refuge and EL storage tracks and extension of the effective length of the arrival and departure tracks at Alexandria Station will be required.

2.9 CONSTRUCTION PLAN

2.9.1 Cost Estimation

Cost estimation is based upon the following conditions:

(1) The ordinary equipment and material will be procured in Egypt as much as available while the rolling stock, electrical equipment, car inspection instruments and rail will be off-share purchased.

(2) The engineers and workmen to be required for the construction work will be locally employed to the possible extent. The wage level for those local workers has been set at the local prevailing standard.

(3) The off-shore purchased equipment and material are priced on the CIF basis in 1979.

(4) The cost is indicated in Egyptian Pound (L.E.) at the exchange rate of 1 US$ = 0.70 L.E = 200 yens. (As of beginning of 1979)

(5) The off-shore purchase price includes duties and taxes.

The initial investment cost as calculated on the above conditions is as estimated in Table 2-5.

Table 2-5 Cost Estimation

(Unit: Million LE)

Item	Sum	Remarks
Land acquisition	9.7	Car depot, Substation
Civil work	16.0 (3.3)	Car depot--(subgrade, track, inspection and repair shed, building) refuge and EL storage tracks, betterment of Alex. Sta.
Substation	33.3 (32.2)	5 Substations 6 Sectioning posts
Trolley line	78.8 (46.1)	208km between Cairo and Alex., car depot
Signal & telecommunication	12.4 (11.5)	Improvement of telecommunication line between Cairo and Alex., improvement of signal track circuit between Cairo and Qaliub., facilities for depot
Mechanical	18.2 (17.7)	Inspection and repair instruments at depot
Rolling stock	138.5 (131.0)	EMU 14 units EL 48 cars PC
Design & supervision	13.1 (9.4)	
Total	320.0 (251.2)	

( ): Requoted foreign currency portion

Table 2-6 Additional Investment after Commencement of Commercial Operation

(Unit : Million LE)

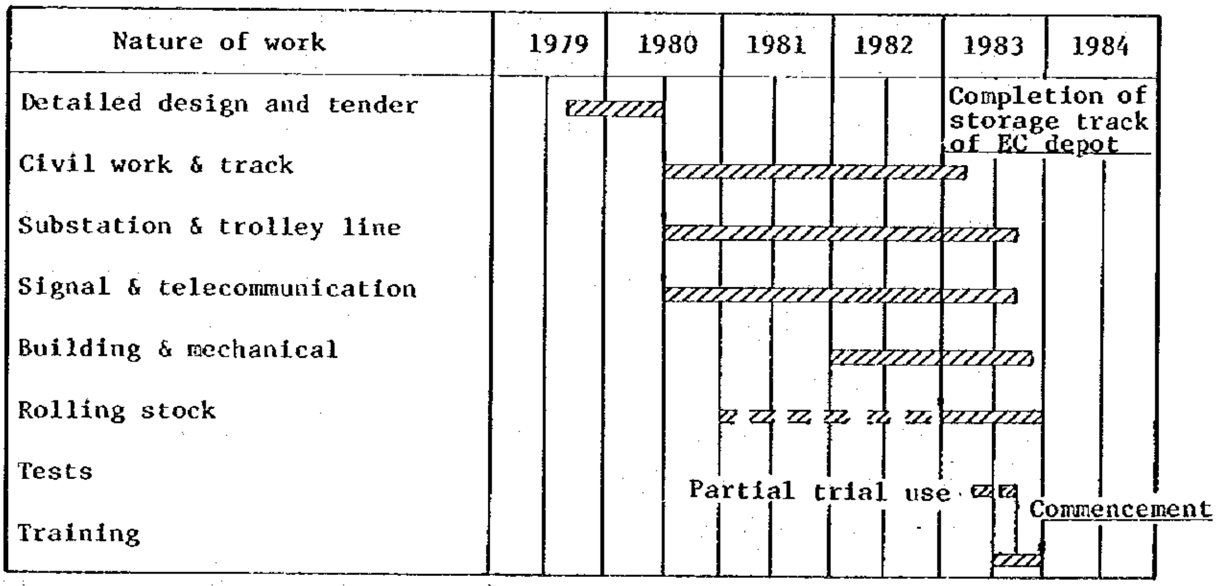
	1984～1988		1989～1993		1994～2003	
Civil work	0.5	Extension of relief tracks	8.5	Extension of relief tracks, Reinforcement of rolling stock basis, Extension of effective length for Cairo Station	11.1	Quadrupling of tracks in the Cairo-Qaliub section, Extension of relief tracks
Electrical	1.3	Installation of automatic signals in the Abis-Alex. section	4.2	Constructions associated with civil works	24.0	Installation of automatic signals in the Benha-Abis section
Mechanical	-		2.9	Constructions associated with civil works	-	
Rolling stock	18.8	EMU 12 EL 2 PC 205	77.6	EMU 30 EC 120 PC 15	96.0	EMU 70 PC 218 EC 60 EL 20
Design & supervision	0.2		1.5		3.2	
Land acquisition	-		1.6		4.2	
Total	20.8		96.3		138.5	

The additional investment includes the costs for expansion of car depot with further increase in the total number of trains, improvement by automatic control conversion of signals, conversion of the partial section into 4-track line system and rolling stock purchase, which may be broken down as estimated in Table 2-6.

2.9.2 Construction Schedule

In principle, the electrification project is planned on assumption that all the Cairo - Alexandria line could be put into commercial operation at the same time. In reality, however, the construction schedule has been formulated on the basis of the earlier completion of a partial section as the attempt to put it into trial running for the training purpose of the crew and the maintenance personnel.

Table 2-7 Construction Schedule



2.10 ECONOMIC EVALUATION

2.10.1 Purpose and Method

Generally, determination of the effect from the investment for the public service sector like the railway enterprise may often lead to an inappropriate conclusion if it is determined only from the viewpoint of managerial economics when the real purpose of the said sector is considered properly. Therefore, the effect on the aspect of the benefit must be determined at the same time. It is for this reason that the method of cost-benefit analysis as normally used has applied to the proposed project. And analysis has been made on a separate item-by-item basis with full care in mind to avoid duplication.

2.10.2 Benefits

The following items are the major benefits to be expected from implementation of the proposed project.

1) Reduction of the train operating cost as the result of change-over from diesel to electric operation.

2) Increase in traffic utility by shortening of the travelling time length as the result of improvement in the running speed.

3) Expectancy in saving of resources because of demend transfer from the other means of transpart to the railway.

4) Mitigation of capital investment by reuse of the rolling stock to be taken out of service after electrification for any other railway divisions.

5) Contribution toward improvement of the rolling stock operation efficiency and also easier maintenanceability for the electric cars and locomotives than for the diesel cars.

6) Contribution toward solution of road congestion, reduction of polluting emission and decrease of traffic accidents in conjunction with the foregoing 3).

7) Expected increase in the number of foreign sightseers due mainly to reducible travelling time and increased riding comfortability.

8) Expected large external effect by reduced noise level as the result of electrification.

2.10.3 Costs

It is forecasted that the traffic volume in the project section will continue further its increasing tendency, which should require some investment even if the railway is not electrified. Therefore, it can be said that the investment sum as may be required corresponding to aforestated benefits will be the differential sum of the investment between the two cases of 'Electrified' and 'Not electrified'. Such differential sum is indicated in Table 2-8.

Table 2-8 Difference in Investment Sums

(Million LE)

	Ground fasilities	Rolling stock	Total
1979 ∿ 1983	135.5	70.3	205.8
1984 ∿ 1988	Δ 6.5	Δ 55.1	Δ 61.6
1989 ∿ 1993	Δ 43.2	25.8	Δ 17.4
1994 ∿ 2003	Δ 12.5	Δ 17.9	Δ 30.4

The ground facilities cost includes the land acquisition cost.

2.10.4 Result of Analysis

The internal rate of return has been calculated at 7.5 percent on the basis of the foregoing preconditions. The benefits in the coverage of calculation are limited only to those measurable ones and there still remain some other intangible benefits besides those calculated ones. Furthermore, when the multiplied effect from utilisation of hydro electric power is taken into consideration in addition to possible saving of crude oil of scarcity value in recent years, it can be concluded that this project will be economically feasible in view of the result from the economic analysis.

2.11 FINANCIAL ANALYSIS

2.11.1 Financing Plan

The result of cost-benefit analysis reveals that the benefit which the project will bring about upon completion will be tremendous. On the other hand, however, the result predicts that in view of the project being planned on an unprecedented large scale the initial investment will reach a vast sum.

Such being the case, if the rate of fare or charge is increased only to cover the possible upward tendency of prices, it may be impossible to insure profitable business operation for each single fiscal year, not to mention of inability to secure a fair return from the investment.

For this reason, the rate increase was calculated on such alternative assumptions that primarily the rate should be increased at a rate of 20 percent every 3 years (Calculated Example I) to cover the increase rate of commodity prices assumed as 6 percent annually and, besides, that the increased rate of fare or charge should naturally reflect possibility of a certain return to be expected, more or less, from the invested capital in addition to full coverage of the commodity price increase (Calculated Examples II and III).

For financial analysis, the required sum of investment for execution of the project and the financing source from which loan will become available in case of need to cover any possible shortage of fund are not defined specifically herein. Thus, analysis has been made on the basis of two different terms of interest rate; the one as suggested by the ER authorities and the other at about 7 percent average for both of foreign and domestic currency portions of the loan fund.

2.11.2 Analysis Result

The analysis result reveals that much financial difficulty would continue without strong back-up of the government to solve the problems involved in borrowing of the short-term loan in vast amounts and also in dissolution of the commulative total loss which would otherwise last long, if the fare rate is increased only to cover the price increase alone (Calculated Example I) on the basis of the interest rate as suggested by the ER authorities.

However, if the rate is increased to such an extent that a certain return can be expected more or less from the invested capital, in addition to full coverage of commodity price increase, there would be certain amount of surplus to be yielded from both of the two different financing sources, which could in turn be used as part of the additional investment or help shortening the total period of repayment. Furthermore, it may be possible to reduce the increased rate of fare/charge if and when it is deemed necessary to do so.

2.12 SECURITY OF SAFETY

The proposed electrification project includes use of the 25 kV super-high voltage current into the receiving equipment at the substation and the overhead catenary system. Therefore, security of safety must be fully assured by limiting off all outsides from the premises of the substation, installation of the fence to keep them out and provision of the safeguard to limit the height of the loaded vehicles at the crossing.

Measures for safety protection at the crossing must also be taken as the train speed increases by electrification.

2.13 EDUCATIONAL TRAINING PROGRAME

Since the proposed project is the first conversion into AC electrification of the long-distance main line in the Egyptian Railways, the educational training programme suitably formulated for handling of many AC electric cars and other variously changed jobs as the result of electrification will be required.

As the procedural step in this direction, the personnel at a foreman's level will have to be trained first of all, in subsequence of which a lot of the average workers will also have to be educated.

In this connection, it is also necessary for on-the-job training purpose of those average workers that a part of the electrified section should be put into trial use about 6 months in advance of the scheduled final completion of the whole project.

2.14 CONCLUSION

As commonly said 'Egypt is Nile and vice versa'. Not exaggerated to say so, the Nile is the main artery of the Arab Republic of Egypt. The Nile delta serves as the pivot for almost all the nation's socio-economic activities.

The existing traffic route running along the Nile between Cairo, the 8.5 million populated largest capital in Egypt, and Alexandria, the second largest city well-known as the world prominent resort area and also as the top-ranking trade port, is of vital importance in the nation's economic and social activities. Therefore, the number of railway passengers continue the ever-increasing trend year after year with increase of the wayside population and growth of the nation's economy, as the result of which it has become necessary to modernise the railway with the view to strengthening its carrying capacity.

Meanwhile, in 1970 Aswan High Dam on the world largest scale as a rockfill dam was completed in the middle stream of the Nile and put into service for hydro power generation. In this connection, the project now being planned by the Egyptian Railways to convert the train operation system for the section with such brisk traffic demand from diesel operation consuming much oil as precious resources into electrical operation by utilisation of abundantly generated electricity can really be appraised as the pertinent scheme to the current energy situation when viewed from effective utilization of natural resources.

The electrification project for the said railway section should naturally require vast investment for installation of various ground facilities and also for purchase of new rolling stock. In fact, however, even in such a case that the railway would not be electrified, it is still anticipated that the traffic demand would increase at an annual rate of 4 or 5 percent, which would also eventually require additional investments of various kinds. In the other words, in order to meet the increasing demand additional investment would be required for additional provision of rolling stock such as the Diesel Multiple unit and the Diesel Locomotive, expansion of the car depot facilities and improvement of station building and signalling and telecommunication systems. Furthermore, it would also become necessary to start replacement of the presently operated Diesel Multiple unit and Diesel locomotive, when assessed from their durable service life, with new units in a few years to come. Furthermore, in view of the current situation that the track strengthening work for high-speed operation and the signal improvement work aiming at AC electrification are already going on, and that electrification work needs 4 years, it is advisable that the electrification work of the railway should start from now to be well-coordinated with those works now underway so as to achieve the overall improvement of the whole railway line.

Upon completion of electrification, the railway will be serviceable for high-speed, mass transit, so that the time distance between the cities will be reduced significantly. As the result, it may be possible that the socio-economic activities densely concentrated in and around Cairo will be dispersed widely into other surrounding cities. This will help relieve the densely settled inhabitants in and around Cairo and will also serve as the artery to stimulate well-balanced growth of all local cities.

The electrification project as referred to herein has been planned after expert discussions between the Egyptian Railways and the Japanese Survey Team. This project envisages 25 kV AC electrification which is of worldwide tendency and standard pattern. The technology upon which the project is based has been taken from the most up-to-date engineering feat being practically utilised by Japanese National Railways with its profound knowledge and experience. We are fully confident that this technology will equally be made full use of in Egypt as well as in Japan.

Meanwhile, the results of economic and financial analyses also fully assure, as referred to in each related Chapter, that the project will be feasible economically and paid off financially if the fare are increased on moderate basis in addition to the basic increase in escalation and the financing arrangements can be made efficiently.

In closing of the statement, we wish to express our deepest appreciation for cooperation and assistance which were extended by the Government of the Arab Republic of Egypt and the authorities concerned of the Egyptian Railways. It is also hoped sincerely that this project will be realized at the earliest possible date to serve for the benefit of the people, proving its result worthy of their dependability.

DETAIL

3. TRAFFIC DEMAND FORECAST

3.1 BACKGROUND SITUATION

The passenger traffic volume of Egyptian Railways has been on the continuing increase, as shown in Table 3-1, in terms of the total number of passengers and passenger - Km.

The main reasons to be considered on such tendency may be because the most population is concentrated into such a limited area as the Nile delta, notwithstanding the fact that Egypt has its territory of wide expansion, and also because the popularization rate of private cars still remains at a low level. Especially, the Cairo-Alexandria Line enjoys its most optimum conditions as a railway because it is running through the most densely populated zone with a moderate railway length of about 208 km.

Under such background situation it is expected that the traffic volume on this line will further continue its steady growth being backed up by future economic growth and population increase.

Table 3-1 Total Traffic Volume of ER.

Item \ Fiscal year	'70	'71	'72	'73	'74	'75	'76
No.of passengers (in 100 thousand)	2212	2359	2475	2822	2935	3053	2936
No.of passenger-Km (in million)	6772	7217	7364	8258	8671	8831	8748

3.2 METHOD OF TRAFFIC DEMAND FORECAST

Traffic demand will be forecasted on the basis of the basic data available, such as 'total traffic volume of ER', 'OD table between stations of this line in 1976', 'Population' and 'GNP'. Consideration will be given also to the induced demand effect (Time-reducing effect) which may be ascribed to the reduced running time length between the stations as the result of electrification.

To further explain the above, analysis will be made for demand forecast of the railway without electrification by use of the correlationship of the total traffic volume versus the GNP. In parallel with such analysis, on the basis of OD table between stations of this line in 1976, as shown in Table 3-2, further analysis will be made by use of two such factors as population and time-distance (required time) in order to determine the time-reducing effect quantitatively and sum it up.

The flow chart covering the procedural steps for demand forecasting is shown in Fig. 3-1.

Table 3-2 OD Table between Stations of Cairo–Alexandria Line

	Cairo	Shubra	Mit Halfa	Qalyub	Qal'ama	Sindyoun	Qaha	Toukh	Sandanhour	Benha	Arab El Raml	Quesena	Tukh Tanbisha	Birket El Sabe	Abu Mashour	Defra	Nafya	Tanta
Cairo		1,096,912	1,129	2,659,354	2,507	9,411	2,803	25,225	5,441	295,507	402	47,209	30	56,841	12	294	176	502,057
Shubra	247,681		0	191,364	3,731	9,463	5,848	7,413	8,656	13,855	26	6,563	0	6,219	0	51	1,963	30,419
Mit Halfa	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Qalyub	979,152	35,862	0		19,941	57,321	5,888	11,161	895	25,751	0	1,662	0	846	0	0	0	19,769
Qal'ama	7,400	14,001	0	19,678		979	756	1,562	230	2,945	0	181	0	105	0	0	0	369
Sindyoun	7,151	8,380	0	54,286	577		9,428	4,825	0	39,845	1	47	129	191	0	0	0	549
Qaha	15,151	9,289	0	2,824	2,294	44,006		23,384	445	9,697	55	355	277	62	0	0	0	456
Toukh	41,958	12,947	0	4,635	644	14,772	0		4,076	33,385	62	1,490	0	440	92	0	0	4,774
Sandanhour	19,451	9,965	0	2,121	536	0	17,511	10,846		12,481	0	606	11	98	0	0	0	630
Benha	1,754,243	74,657	0	22,282	1,349	22,215	1,271	35,572	22,564		29,751	27,135	4,837	23,814	594	325	0	140,861
Arab El Raml	30,551	5,541	0	0	730	0	15,079	164	1,369	0		5,546	0	1,030	0	0	0	6,558
Quesena	65,212	4,865	72	843	0	0	0	1,994	0	46,462	10,478		6,612	24,016	1,361	415	26	40,428
Tukh Tanbisha	7,102	555	0	0	192	0	0	0	413	4,013	0	0		1,858	0	0	0	3,654
Birket El Sabe	63,830	9,351	87	752	0	0	81	357	0	35,200	14,945	14,945	4,787		1,874	623	642	64,891
Abu Mashour	11,411	1,160	0	0	115	70	0	0	0	1,764	1,143	1,143	0	99		0	0	3,876
Defra	2,135	0	0	0	0	0	0	0	0	566	196	198	37	507	843		850	100,243
Nafya	278	0	0	0	0	0	0	0	0	199	249	249	503	699	964	1,576		60,837
Tanta	1,147,001	1,101	698	2,562	5,351	404	458	3,321	395	294,346	15,206	23,381	8,047	66,925	13,395	47,655	64,085	
Shoubra El Namla	1,323	25	0	40	0	0	0	0	0	9	0	0	0	0	0	0	0	41,099
Kafr Diama	2,248	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4,028
Kafr El Zayat	177,534	0	0	0	0	0	0	145	17	12,235	0	603	36	648	0	0	0	55,699
El Tawfiqiya	3,576	0	0	0	0	0	0	0	0	349	0	0	0	0	0	0	624	7,470
Ityai El Barud	44,024	0	0	0	0	0	0	0	0	11,555	567	379	52	411	0	0	0	39,579
Kafr Messid	0	0	0	0	0	0	0	0	0	577	0	45	0	31	0	0	0	1,191
Saft El Horiya	147	0	0	0	0	0	55	0	0	0	0	0	0	0	0	0	0	452
Dinshal	102	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	556
Ommdinar	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Damanhur	255,267	859	0	303	0	0	0	308	0	68,760	0	1,657	0	1,272	0	0	0	102,155
El Batal Salah Salem	0	0	0	0	0	0	0	0	0	385	0	0	0	0	0	0	0	225
Ezbet Bulad	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Abu Hummus	113,032	0	0	0	0	0	0	0	0	1,906	0	0	0	55	0	0	0	3,925
Desounes	985	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	922
Mamal El Quiras	4,808	0	0	6	0	0	0	0	0	369	0	98	0	275	0	0	0	2,277
Kafr El Dawar	53,553	0	0	280	0	0	0	1,338	0	9,919	568	1,290	0	2,114	0	0	0	34,943
El Beida	1,807	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	161
Ezbet Khurshid	238	0	0	0	0	0	0	0	0	0	0	50	0	0	0	0	0	27
Abis	2	5,571	53	1,348	0	0	0	0	0	0	0	9	0	4	0	0	0	90
Sidi Gaber	632,431	2,224	0	154	0	0	69	5	0	84,873	458	9,163	0	4,023	2	19	0	277,773
El Hadra	1,664	8	0	19	0	0	0	56	27	57	26	89	0	372	0	2	0	776
Alexandria	1,154,504	164	6	1,211	0	0	108,338	2,266	0	34,543	0	9,691	0	11,937	0	0	0	508,453

	Shoubra El Namla	Kafr Diama	Kafr El Zayat	El Tawfiqiya	Ityai El Barud	Kafr Messid	Saft El Horiya	Dinshal	Ommdinar	Damanhur	El Batal Salah Salem	Ezbet Bulad	Abu Hummus	Desounes	Mamal El Quiras	Kafr El Dawar	El Beida	Ezbet Khurshid	Abis	Sidi Gaber	El Hadra	Alexandria
Cairo	59	11	57,638	3,865	43,051	0	0	10	0	199,356	6,194	0	3,287	44	0	49,951	2,137	0	92	433,425	355	585,374
Shubra	0	0	1,586	320	1,058	0	0	0	0	3,504	66	0	254	0	0	532	0	0	0	1,411	0	11,754
Mit Halfa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Qalyub	0	0	285	156	2,743	0	0	0	0	12,312	0	0	0	0	0	2,454	0	0	0	51,660	0	64,517
Qal'ama	0	0	21	0	18	0	0	0	0	75	0	0	212	0	0	55	0	0	0	16	0	144
Sindyoun	0	0	1	0	0	0	0	0	0	17	0	0	0	0	0	0	0	0	0	0	0	25
Qaha	0	0	39	0	72	0	0	0	0	46	1	0	0	0	0	0	0	0	0	10	0	194
Toukh	0	49	451	0	165	0	0	0	0	420	0	0	5	0	0	90	0	0	0	4	0	1,380
Sandanhour	0	0	12	0	0	0	0	0	0	73	0	0	0	0	0	62	0	0	0	0	0	213
Benha	0	55	14,845	319	9,339	0	2,273	0	0	27,857	0	0	172	0	0	7,151	1,300	0	0	29,989	4,828	199,513
Arab El Raml	0	0	311	0	468	0	0	0	0	2,124	0	0	7	0	0	648	0	0	0	3,018	0	7,192
Quesena	0	0	827	36	291	0	0	0	0	2,724	0	0	0	0	0	1,536	0	22	12	7,348	0	56,389
Tukh Tanbisha	0	0	90	0	46	0	0	0	0	310	0	0	0	0	0	198	0	0	0	928	0	3,893
Birket El Sabe	0	0	443	27	506	0	0	0	0	1,109	0	0	0	0	0	1,886	0	0	0	15,605	0	10,419
Abu Mashour	0	0	0	0	55	0	0	0	0	144	0	0	0	0	0	253	0	0	0	1,025	0	3,936
Defra	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	61
Nafya	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
Tanta	27,682	8,026	172,442	73,727	262,417	54	445	570	0	105,175	220	0	11,351	0	0	44,804	161	427	0	182,667	604	553,296
Shoubra El Namla		12	602	72	32	52	59	36	17	420	0	0	0	0	0	252	0	0	0	306	0	30,954
Kafr Diama	338		17,570	215	207	0	0	0	37	345	0	0	0	0	0	249	0	0	0	0	0	571
Kafr El Zayat	1,358	3,551		34,458	23,817	457	441	385	0	27,970	0	35	525	0	0	15,060	0	0	0	46,357	61	74,824
El Tawfiqiya	10	36	42,138		8,874	0	1,140	370	0	7,175	0	0	0	0	0	1,048	0	0	0	1,140	0	10,555
Ityai El Barud	56	76	15,475	1,352		7,474	6,601	1,765	105	74,995	0	0	509	0	0	14,654	0	0	0	38,617	499	49,298
Kafr Messid	35	1	1,015	0	314		17	10	0	72	0	0	0	0	0	0	0	0	0	0	0	0
Saft El Horiya	86	0	110	163	2,955	2,003		502	192	4,985	0	0	0	0	5	492	0	0	0	103	0	88
Dinshal	0	0	22	100	811	332	925		3,797	7,415	0	0	1	0	0	42	0	4	0	52	0	97
Ommdinar	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0
Damanhur	77	45	37,867	4,697	154,130	8,597	5,106	39,814	44,125		65,569	10,852	51,868	2,785	1,338	84,416	390	753	7,872	212,471	514	245,163
El Batal Salah Salem	0	0	0	0	105	0	275	0	0	39,773		319	3,038	0	1,130	6,470	0	562	270	2,510	293	3,557
Ezbet Bulad	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0
Abu Hummus	0	0	1,919	1,669	2,986	0	5,240	0	0	23,278	0	2,961		319	310	8,445	0	451	2,218	13,898	155	18,638
Desounes	0	0	0	0	0	0	0	0	0	3,394	218	113	6,329		559	6,731	279	675	542	3,989	3,343	2,987
Mamal El Quiras	5	0	0	0	0	0	0	0	0	1,533	88	7,349	3,491	11,961		4,588	1,013	6,900	841	3,849	2,187	4,054
Kafr El Dawar	0	0	12,633	3,643	18,569	0	0	0	0	102,218	794	6,324	5,687	14,058	18,936		16,408	2,181	1,583	84,695	1,796	202,333
El Beida	0	0	0	0	0	0	0	0	0	893	0	15	254	0	968	15,211		602	625	2,622	133	2,784
Ezbet Khurshid	0	0	14	1	45	76	0	0	0	943	142	0	186	357	276	1,753	443		509	1,901	703	1,687
Abis	1	0	40	12	0	0	0	0	0	5,253	189	0	1,762	564	345	331	87	1,123		62	352	1,443
Sidi Gaber	0	0	26,501	8,661	32,252	0	0	0	0	166,513	1,618	0	14,811	4,464	2,310	51,966	2,378	2,127	7,093		62,502	629,162
El Hadra	2	0	475	68	567	0	0	0	0	2,234	216	0	1,835	2,713	425	6,140	2,893	1,452	5,827	194,274		1,607,982
Alexandria	16	40	60,016	13,801	100,415	0	0	18	0	504,921	5,942	0	20,152	2,035	1,274	152,543	32,981	11,694	19,358	3,075,082	1,607,982	

Note; This OD Table covers the number of passengers on board the train counted from the number of tickets sold at stations, not including the number of passengers by the tickets sold on the train.

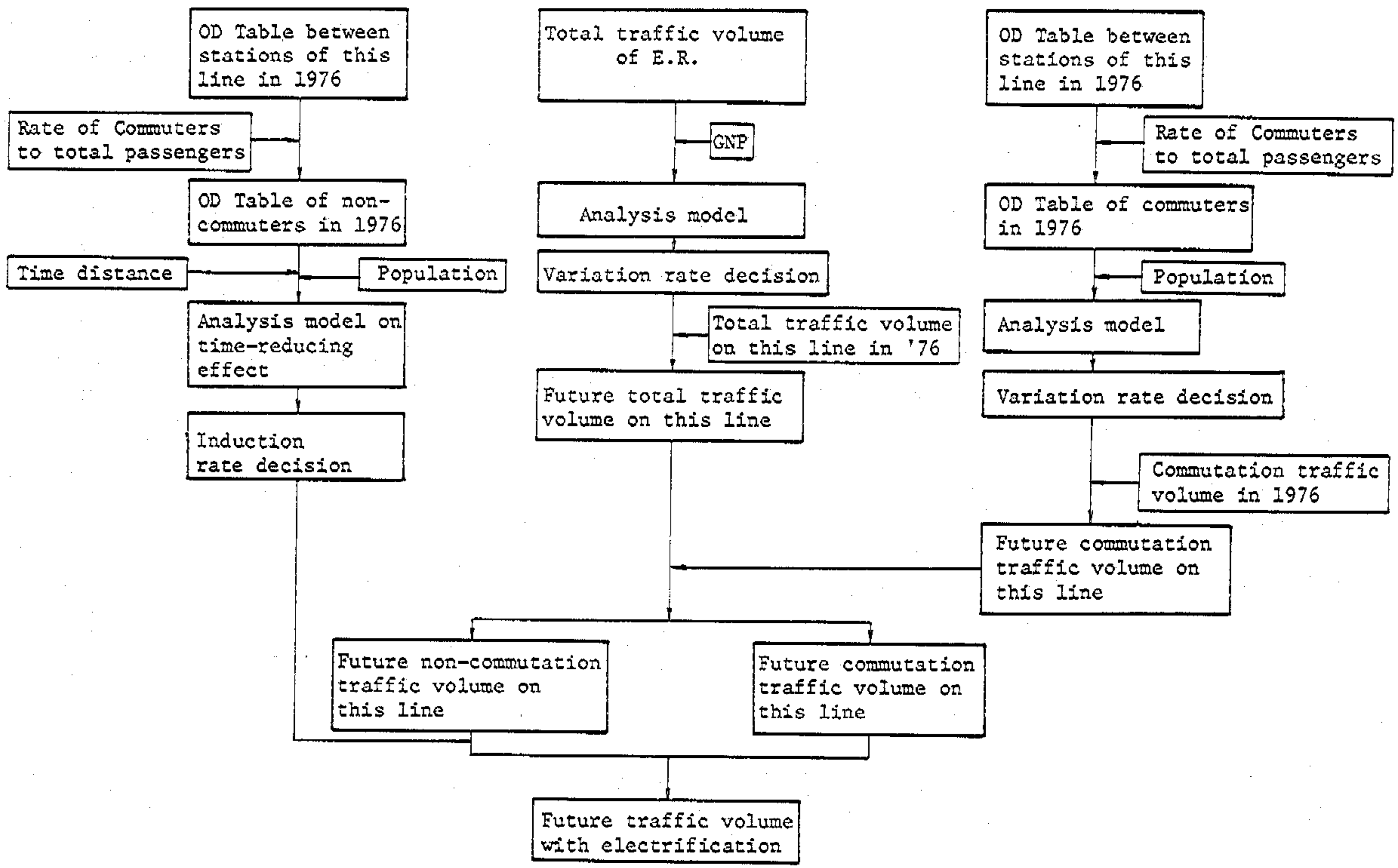


Fig. 3-1 Demand Forecast Flow Chart

3.3 FORECASTED RESULTS ON TRAFFIC DEMAND

3.3.1 Target Year for Demand Forecast

Demand forecast covers five (5) target fiscal years such as 1984, 1989, 1994, 1999 and 2004.

3.3.2 Traffic Demand

According to the actual operating record in 1976, the annual total of traffic volume on this line amounts to 383×10^5 in the number of passengers and $1,671 \times 10^6$ in the number of passenger - Km.
In the initial year of commercial operation with the electrified railway (1984), it is forecasted that the traffic volume will reach 635×10^5 in the number of passengers and $2,541 \times 10^6$ in the number of passenger - Km. Taking account of the time-reducing effect from electrification, it is expected that the traffic volume in the case of the railway being electrified will increase by 8.9 percent in the total number of passengers and by 18.7 percent in the number of passenger - Km, as compared with the case where otherwise the railway will not be electrified. It is further forecasted that the traffic volume after electrification of the railway will increase, in terms of the total number of passengers, at an annual rate of about 5 percent as shown in Table 3-3.

Table 3-3 Future Traffic Volume in Cairo-Alexandria Line

Item	Fiscal year	1984	1989	1994	1999	2004
No.of passengers (in 100 thousand)	Without electrification	635	811	1035	1321	1686
	With electrification	691	883	1127	1439	1837
No.of passenger-Km (in million)	Without electrification	2541	3113	3814	4672	5724
	With electrification	3015	3693	4527	5543	6790

(Note) The GNP is estimated at an annual average increase rate of 12 percent each year up to and including 1982 and 10 percent each year in and after 1983.

3.3.3 Traffic Demand by Main Sections

In the planned year of initial commercial operation with electrification the traffic volume by main sections of this line is expected to reach 295 × 10^2 passengers per day on one way in the Cairo-Shubra section and 172 × 10^2 passengers per day on one way in the Nifya-Tanta section in the case where the railway will not be electrified. If the railway is electrified, the traffic volume is expected to further increase by 11.1 percent between Cairo and Shubra and by 17.3 percent between Nifya and Tanta. The future traffic volume by main sections is shown in Table 3-4.

Table 3-4 Future Traffic Volume by Main Sections

Section	Fiscal year	1984	1989	1994	1999	2004
CAIRO ~ SHUBRA	Without electrification	295	373	472	597	756
	With electrification	328	415	525	665	843
QAHA ~ TOUKH	Without electrification	206	263	335	428	547
	With electrification	240	306	391	498	636
NIFYA ~ TANTA	Without electrification	172	220	281	358	457
	With electrification	202	258	329	420	536
TANTA ~ SHOUBRA EL NAMLA	Without electrification	175	223	285	363	464
	With electrification	204	261	333	425	543
DAMANHUR ~ EL BATAL SHLAH SALEM	Without electrification	175	223	284	363	463
	With electrification	205	262	334	427	544

(Number of passengers per day, one way in hundred)

4. TRAIN OPERATION PLAN

4.1 BASIC CONCEPTION

4.1.1 Present Status of Transportation

There are two main characteristic features as stated below in the present status of passenger transportation.

(a) The suburban traffic volume near Cairo and Alexandria is very sizable.

(b) As recorded on the passenger flow in 1976, the inflow and outflow of passengers to and from large cities take a much greater weight. The flow of passengers, for example, near Tanta is shown in Table 4-1 below.

Table 4-1 Flow of Passengers between Birket El Sabar-Tanta in 1976 (By return trip in annual total)

Flowing section	Passing passengers	Share rate (%)
Between Cairo ∿ Sidi Gaber, Alexandria	3,087,653	41
Between Cairo, Benha ∿ Tanta, Damanhur, Sidi Gaber, Alexandria	3,028,788	40
Between main intermediate stations, such as Briket El Sabar ∿ Main intermediate stations, such as Kafr El Zaiyat	644,957	9
Between all the remaining small stations	791,542	10

In view of the present status as above, it is essential that the main force for future improvement of the transportation should be oriented toward expansion of the high-speed train railway network between large cities and strengthening of the suburban transport capacity.

4.1.2 Transport Plan for Electrification

One of the key points involved in the transport plan for future electrification is speed-up of train operation. To comply with this requirement, the limited express train will have to be consist of EMU (Electric Multiple Unit) operated at a higher speed to its maximum possible extent. The highest-speed train will shorten the running time between Cairo and Sidi Gaber by 46 minutes, from the present time length of 2 hours and 23 minutes to 1 hour and 37 minutes. All other express and semi-express trains will be designed for EL (Electric Locomotive) traction with an aim to reducing each required running time length to the possible minimum. Futhermore, in order to demonstrate the efficiency by electrification to its utmost extent, any train to be driven into the branch line will be operated by traction of the electric locomotive, in so far it is possible, up to the branch-off station.

At present, stopping stations of express and semi-express trains are diversified into various patterns, which will be unified and simplified into one same pattern per each train classification after electrification of the railway. The working timetable schedule will be set up by introduction of the standardized train operation schedule, aiming at simple and clear constitution of the whole diagram.

4.2 ROLLING STOCK PERFORMANCE CHARACTER AND STANDARD OPERATING TIME OF TRAINS

Although the rolling stock characteristics are detailed in Chapter 5 "Rolling Stock", major factors used for formulation of the train operation plan are shown hereunder.

4.2.1 Rolling Stock Performance Character

o EMU

Train make-up:	12-car make-up
Train length:	23m × 12 = 276m
Weight:	720t
Capacity:	660 persons
Gross output:	3,600 kW
Acceleration:	0.57 km/h/sec. (Average rate up to a speed of 100 km per hour)
Deceleration:	2 km/h/sec. (Average rate at station stop)

o El-hauled train

No. of tractive cars:		8 cars
Train length:		18m + 23m × 8 = 202m
Weight:	Locomotive weight	88t
	Tractive weight	70t × 8 = 560t
	Total	648t
Capacity:		700 persons
Locomotive output:		2,800 kW
Acceleration:		0.45km/h/sec. (Average rate up to 76km per hour)
Deceleration:		2km/h/sec. (Average rate at station stop)

4.2.2 Speed

(1) Planned Maximum Speed

EMU train	145km/h
EL-hauled train	110km/h

(2) Speed Restrictions

Running times were calculated on the basis of a result of thorough discussions and reviews with the ER side on the status quo of speed-restricted sections along with the improvement programs for the future.

4.2.3. Standard Running Time

The following procedural steps will be taken to seek the operating characteristic curves for each different type of both EMU and EL-hauled trains, thereby calculating the required standard running time (at an unit of 15 seconds) for running between the stations.

(App. Table 1)

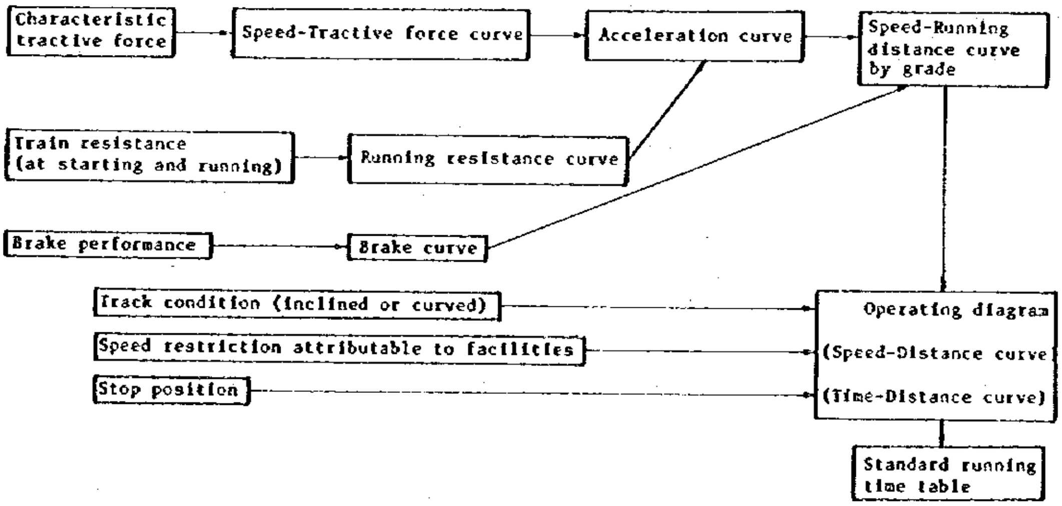


Fig. 4-1 Procedural Steps for Calculation of Standard Running Time of Trains

4.3 TRANSPORT PLAN

4.3.1 Speed Increase and Train Classification

Certainly, one of the great advantages involved in the electrification project is the possibility of the epoc-making speed increase of a train by employment of the EMU (Electric Multiple Unit).

With this as the main object, the drastic measures will be taken to improve the existing transport system. In view of the fact, as aforementioned, that the marked flow of passengers between the large cities accounts for 80 percent of the total passengers flow, the limited express train will be put newly into operation with the aim to reduce the current transit time of an express train significantly. The limited express train will be classified into the two categories; the one ('A' Limited Express) which will only require 1 hour and 37 minutes for travelling between Cairo and Sidi Gaber and the other one ('B' Limited Express) which will take 1 hour and 50 minutes for the same Cairo-Sidi Gaber section after stopping at the three intermediate stations such as Benha, Tanta and Damanhur. The car class for passengers will be graded into 1st and 2nd, same as being applied to present express at present.

Besides the above, speed increase is also contemplated to the possible extent for the EL-hauled express and semi-express trains.

Table 4-2 Comparison of Schedule Time for Train Running between Cairo and Sidi Gaber

Electrified train classification	Time (hour)	Train classification in pre-electrification	Time (hour)	Reducible time (Reducible rate)	Station for stoppage
'A' Limited Express	1/37	Express	2/23	46 minutes (32%)	
'B' Limited Express	1/50	Express	2/32	41 minutes (27%)	Banha, Tanta, Damanhur
Express	2/15	Express	2/32	17 minutes (11%)	
Semi-Express	3/05 ∿ 3/18	Semi-Express	4/13	about 60 minutes (24%)	Shoubra and other 14 stations

As the result of electrification, the average schedule speed of all the trains will be improved from the present level of about 60 km per hour, as roughly estimated, to about 80 km per hour. (Average reduction rate: 25%)

4.3.2 Stations for Train Stoppage

As present, there are express and semi-express trains being operated by various ways of scheduling for stoppage; for instance some trains pass through Benha, Tanta and Damanhur Stations as non-stop trains, some stop at one or three of those main stations and some stop at some other stations in addition to those aforestated. The revised timetable schedule after completion of electrificaiton will be simplified for the purposes of:

(a) mainly serving for convenience of general passengers, together with an attempt to standardize the timetable diagram as stated in the latter part, with a view to putting the timetable into their easy remembrance

(b) and promoting speed increase of all the trains.

Table 4-3 Stations for Train Stoppage

Station	'A' Limited Express	'B' Limited Express	Express	Semi-express	Local
Cairo	o	o	o	o	All the existing 38 stations between Cairo and Alexandria
Shubra				o	
Qaliub				o	
Qaha				o	
Toukh				o	
Benha		o	o	o	
Quwesna				o	
Birket El Sabar				o	
Tanta		o	o	o	
Kafr El Zaiyat				o	
El Taufiqiya				o	
Ityal El Barud				o	
Damanhur		o	o	o	
Abu Hummus				o	
Kafr El Dawar				o	
Sidi Gaber	o	o	o	o	
Alexandria	o	o	o	o	

4.3.3 Make-up Length of Train

Considering of the platform length of Cairo and Alexandria stations the planned make-up for an EMU limited express train will consist of 12 cars, on the precondition that the platform length at Alexandria should be further extended as a partial addition. For the EL-hauled train the 8-car make-up is planned.

Table 4-4 Effective Length of Platforms at Cairo and Alexandria

Cairo station		Alexandria station			Remark
Track No.	Effective length	Track No.	Effective length Existing	Effective length Improved	
1	335	1	283		
2	294	2	330		
3	274	3	270		
4	309	4	270		
5	244	5	240	300	
6	194	6	240	350	To provide for future EMU train make-up of 14 cars (322m in train length)
		7	205	350	
		8	205	350	

(Note) (1) EMU train 12-car make-up Train length 276m
Required effective length 296m

(2) EL train El-hauled 8-car make-up Train length 202m
Required effective length 242m
(To provide for additional length for another locomotive to the rear of the train after arrival at the platform)

4.3.4 Determination in Number of Trains

The number of trains to be set up for each classification of trains will be determined with due regard to the following points.

(a) For the express trains going into the branch lines (express trains from Cairo or Alexandria to Suez or Damietta), the number of such trains will be determined as may be required for the estimated increase in traffic volume.

(b) Since the make-up for any limited express train does not include the 3rd-class passenger car, the 3rd-class passengers should be adequately absorbed by capacity of both express and semi-express trains. In order to improve the boarding chance the present frequency of train operation must be increase (19 return trip operations by express and semi-express trains).

(c) Direct through train between Cairo and Alexandria

'A' Limited Express	1 train every 2 hours
'B' Limited Express	1 train every hour
Express	1 train every 2 hours
Semi-express	1 train every hour
Local	1 train every 2 hour

The above target standard of direct train operation has been incorporated into the determined number of trains.

Table 4-5 Determination Table for Passenger Trains (one-way/day) at Initial Commercial Operation by Electrication

Section / Train	Cairo ∿ Qaliub	Qaliub ∿ Benha	Benha ∿ Tanta	Tanta ∿ Damanhur	Damanhur ∿ Sidi Gaber
Estimated traffic volume for operation by electrification	(persons/day) 32,762	(persons/day) 23,969	(persons/day) 20,210	(persons/day) 20,450	(persons/day) 20,542
'A' Limited Express	7	7	7	7	7
'B' Limited Express	12	12	12	12	12
Total	19	19	19	19	19
Direct express	7	7	7	7	7
Direct semi-express	12	12	12	12	12
Total	19	19	19	19	19
Local train on main line (EL-hauled)	10	10	8	8	8
Express train going into branch line (EL-hauled)	31	31	7	8	11
Local train going into branch line (DL-hauled)	58				
Total	99	41	15	16	19
Grand total	137	79	53	54	57

Table 4-6 System Chart for Passenger Trains (one-way operation) at Initial Commercial Operation by Electrification (1984)

	Cairo – Qaliub 14' km	Qaliub – Barha 30.9 km	Barha – Tanto 41.4 km	Tanto – Ityal El Barud 35.6 km	Ityal El Barud – Damanhur 25.2 km	Damanhur – Abis 51.1 km	Abis – Alexandria 9.6 km
EMU train							
'A' Limited Express	7	7	7	7	7	7	7
'B' Limited Express	12	12	12	12	12	12	12
EL-hauled train							
Express 1 train/2 hours	7	7	7	7	7	7	7
1 train/2 hours	7	7	7				
1 train/1 hours	24	24					
1 train/2 hours						3	3
				8	8	8	8
Semi-express 1 train/1 hour	12	12	12	12	12	12	12
Local 1 train/2 hours	10	10	8	8	8	8	8
DL-hauled train							
Semi-express	4						
Local	54						
EMU Limited express train	19	19	19	19	19	19	19
EL-hauled express train	38	38	14	15	15	18	18
El-hauled semi express train	12	12	12	12	12	12	12
EL-hauled local train	10	10	8	8	8	8	8
DL-hauled train	58						
Total	137	79	53	54	54	57	57

4.3.5 Formation of Operating Diagram

(1) The Pre-requisite to Formation of Operating Diagram

The following conditions are given as pre-requisite to formation of the train operating diagram, with due consideration to enable all the trains to reach their destinations as quickest as possible.

(a) The minimum unit time for the operating time shall be 15 seconds with a view to setting up the train running schedule with higher precision as a whole. Necessary time allowance shall be included in the operating time length.

(b) Time to be required for blocking of the signal shall be as follows:

- Automatic blocking system - 15 seconds
- Controlled manual block system - 1 min. & 30 seconds

(c) The following rule shall apply to determination of train stoppage time at stations

- Stations exclusively for stoppage of local and semi-express trains

  30 sec. to 1 min.

- Stations for stoppage of limited express and express express trains

  2 min.

- Shift of train crew at such stations as cited above

  3 min.

(d) Time to be required for shuttling of limited express and express trains at Cairo and Alexandria stations:

More than 25 min.

Time for shutting of any other trains at same stations:

More than 15 min.

(2) Standardized Train Operation Schedule

The method of setting up the standardized train operation schedule is to formulate the timetable by regular repetition in the operation frequency of the same-class trains at a cycling time interval of

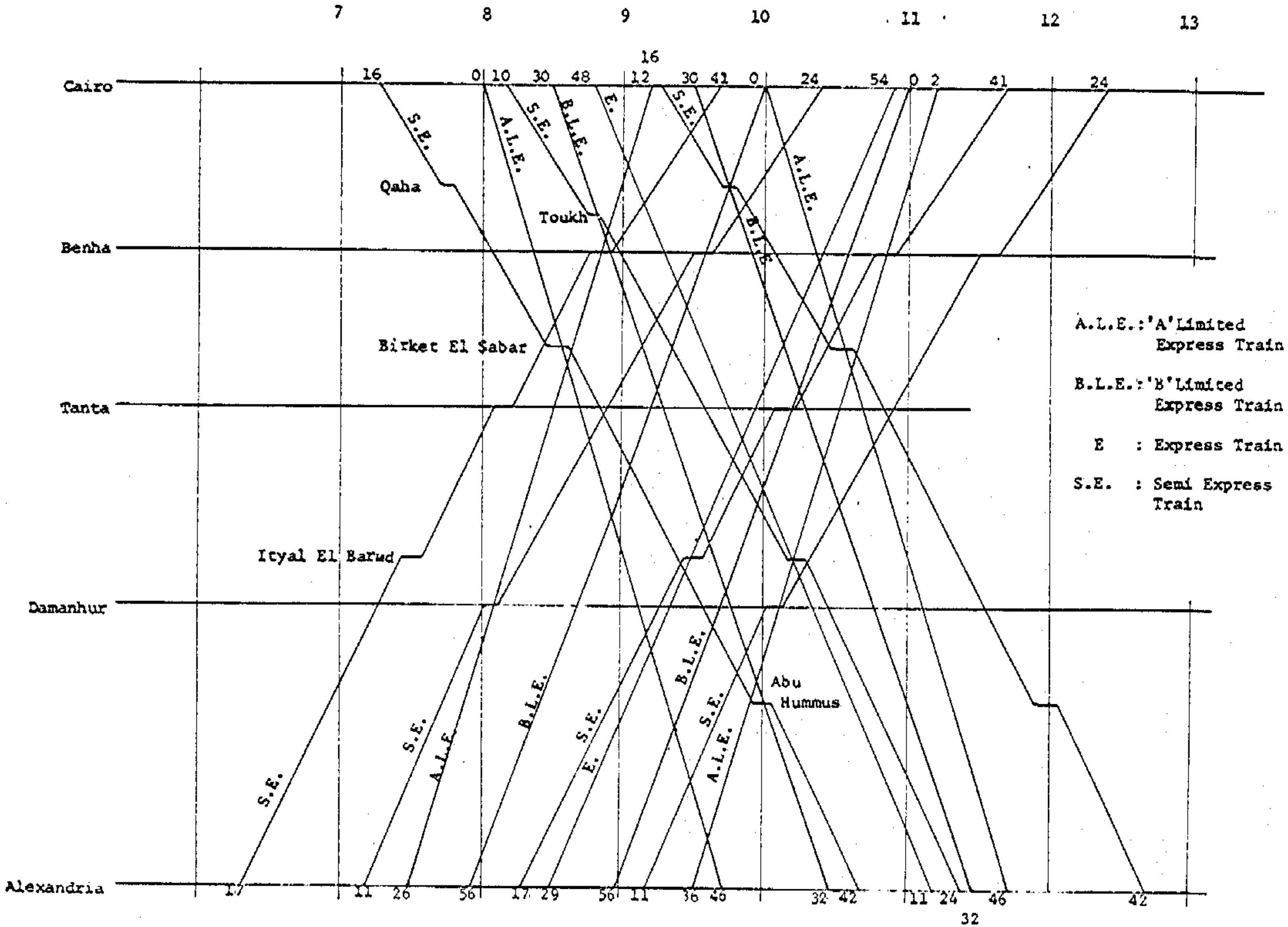


Fig. 4-2 Standardized Diagram for Electrified Railway Operation in Cairo-Alexandria Line in 1984

one hour or two. Fig. 4-2 shows a standard pattern of operation schedule set up in this manner.

The standardized train operation schedule has the following features:

(a) The time schedule can provide great convenience for passengers in choosing any train which may be easily identifiable to them, since the trains in so far as they are classified into same category are due to arrive at and depart from the station at a regular time interval of one hour or two.

(b) The averaged transport capacity can be easily provided irrespective of any time zone.

(c) The arrival and departure track at the terminal station, the yard track and the refuge track at the intermediate station can be handled by repeated operating practice of the same pattern. Therefore, adjustment can be made easily for normalisation of the scheduled operation even in the case where any dislocation may arise on the train operation schedule.

(3) Setting of Time Schedule

The operating time schedule for each train will be set up at any time zone between 0600 and 2400 of daily hours in accordance with the standardized train operation schedule. For express and semi-express trains running into the branch lines the time schedule will be set up nearly same as the existing schedule, and all of them will be EL-hauled trains so as to reduce the transit time. The locomotive for each of those trains will be shifted at the boundary station between the main and branch lines. For peak time operation any extra trains can be mobilized as additions up to about 15 percent of the total number of trains without any addition of rolling stock.

It is noted, however, that this train operation schedule is based upon such prerequisites, besides electrification of the whole railway system, as extension in effective length of Alexandria Station and new installation of the car depots and the storage tracks, conversion of the existing signalling system into automatic signal in the Cairo-Benha section, and new installation of the passenger refuge tracks at the stations of Ityal El Barud and Abu Hummus. (App. Fig 3)

4.3.6 Future Transport Improvement Plan

The improvement plan to meet the possible increase of the traffic volume after completion of electrification will include, in general, the following requirements.

(a) In and around the 5th year from commencement of the electric operation the number of trains will have to be increased under the original time schedule standardized at the initial stage of electrified railway operation. With the increase in the number of trains near Alexandria, automatic control conversion of signals in the Abis-Alexandria section will be required, and additional installation of refuge tracks will be also required.

(b) In and around the 10th year the transport capacity of the track between Cairo and Qaliub will get tight as the result of increase in the number of trains. To cope with such demand increase all the local trains will be converted into the electric cars by electrification of the railway line branched off at Qaliub.

In parallel with that, the effective platform length at Cairo Station will have to be extended to provide for the additional makeup of a train; 14-car makeup for the limited express train and 10-car makeup for the express and semi-express trains for the purpose of reducing the total number of running trains.

(c) In and around the 15th year, further improvement will be made by quadrupling of track between Cairo and Qaliub and by automatic control conversion of signals and additional installation of refuge tracks for the whole line. Then, one train for each of 'A' & 'B' limited express, express and semi-express trains will be operated respectively per each one hour.

(d) In and around the 20th year the number of trains will have to be increased by the same pattern of operating schedule as aforestated in (c).

4.4 OPERATION AND REQUIRED NUMBER OF ROLLING STOCK

4.4.1 EMU Limited Express Train

By making best use of the characteristic feature as the EMU train, the limited express train of this type will be operated for shuttling from and to the platforms of Cairo and Alexandria for the possible shortest time, so that the platform can be utilized effectively and the rolling stock can be operated more efficiently.

EMU 11 Trains for actual operation
3 trains for standby
Total 14 trains with 168 cars in total
Total running km 7,896.4 km/day
Average km per 1 train makeup 564 km/day

4.4.2 EL-Hauled Train

In order to relieve the tight demand in the platform capacity and mitigate the workload in the yard of Cairo and Alexandria Stations, the passenger cars will be operated, to the possible extent, by shuttling to and from the platform of both terminal stations. Those trains to be shuttled in a relatively short time (30 to 70 minutes) after arrival will start back by being coupled with a new locomotive to its opposite end, leaving the other one used for arrival of the train at the end of the platform. All the passenger trains between Cairo and Alexandria, except limited express trains and those going into the branch line from Qaliub and leaving Alexandria for Marsa Matruh via Abis, will be of El-hauled system. The trains going in and out of the branch lines at Benha or any other places will have to exchange EL for DL at any station where the line is branched off from the main line.

Electric Locomotives 40 for actual operation
8 for standby
Total 48
Total running km Approx. 17,088 km/day
Average km per locomotive 356 km/day

5. ROLLING STOCK PLAN

5.1 TYPE OF TRAIN

Generally, the factors involved in train operation, traffic capacity and rolling stock maintenance facilities may vary depending upon whether the selected type of train will be designed for locomotive-hauled system or electric multiple unit system. Therefore, it is first of all necessary to determine the optimum train type.

The train of power dispersed system, namely the electric multiple unit train may supercedes the locomotive-hauled train with the following advantages:

(a) Because the unit output per weight of the train can be increased readily, even the long makeup train can be provided with sufficient horse-power easily for high speed conversion.

(b) Since the adhesive weight takes a larger share in the total train weight, the schedule speed can be increased with improved performance of acceleration.

(c) Because of anticipated easiness in performance of the train shuttling work, the work at the terminal station may be simplified with resultant mitigation of workload for shunting of the train in the yard. This means that a large number of trains can be put into their operating schedule even though there are only a few number of tracks within the station yard. Also, the operating efficiency of rolling stock can be improved significantly.

(d) Since any train will be characterized by equal performance regardless of whether long or short in its makeup, the parallel operation diagram can be set up, thus serving for relieving the track capacity from its anticipated tightness. Besides the above, the proper transportation service will become available by use of the train made up with suitable length as may be adaptable to the need of the specific service area or time zone.

(e) The train can be operated at its highest speed without difficulty, in view of the required strength for tracks and bridges, because of its lighter axle load. This may result in saving of the maintenance cost of tracks.

On the other hand, there are some disadvantages as follows:

(f) The power dispersed system should require a greater number of motive power units to be operated which may result in some difficulty of rolling stock maintenance.

(g) The riding comfort for the passengers may be deteriorated by vibration and noise easily transmissible from the driving unit to their seats.

In this proposal, comparative study is made on various types of train, especially by taking up the limited express train as the main player in the railway transport between Cairo and Alexandria. Fig. 5-1 shows a comparative example of train makeup on such various types as explained hereunder:

(A) Locomotive-hauled train in general use

(B) Push-pull type with locomotives coupled to both ends of a train

(C) EMU (Electric Multiple Unit) with the motive power units coupled to both ends only

(D) EMU of power dispersed system

Table 5-1 makes comparison of those different types by their own advantages or disadvantages. In the Table, each type of train is compared with the others on an equal basis of 12-car makeup including the locomotive. As revealed in the column of "Comprehensive evaluation", the following conclusions have been reached after comparative studies:

Case (A) : There is no easy way of train operation for shuttling at the terminal station. Particularly, in case of this project where both Cairo and Alexandria are situated at stub stations, the

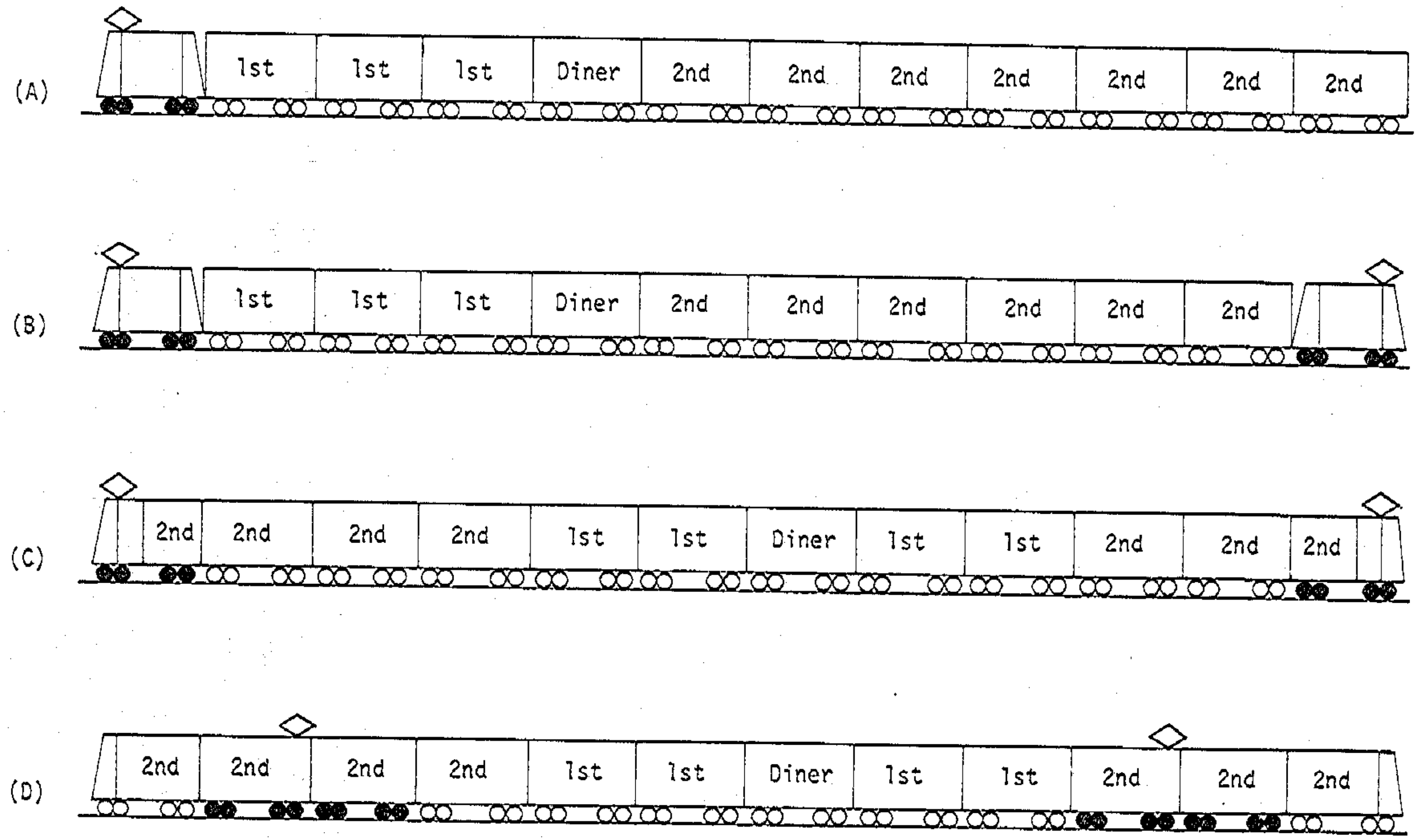


Fig. 5-1 Examples of Train Make-up

rolling stock can not be operated so efficiently and the track may be affected unfavourably by its heavier axle load.

Case (B) : This system requires double coupling with two (2) locomotives, which will eventually reduce the total number of passenger cars in the train makeup (as occupied by an additional locomotive). This will result in a relatively high cost of a rolling stock per each passenger's seat. And the track may be affected unfavourably same as in case (A).

Case (C) : This is the EMU train of same system as the Diesel Multiple Unit now being operated between Cairo and Alexandria. However, if the powered vehicle is partly shared by the passenger cabin, it will naturally place a limit upon the capacity of the traction motor, which will not be able to meet output requirement for train operation at a high speed of 160 km per hour. Obviously, this EMU system does not satisfy the requirement of this project.

Case (D) : This system requires an increased number of motor coaches as it is operated by dispersion of driving power. Although this may produce some maintenance disadvantage, it is rather acceptable to the proposed project in all such respects as performance character, impact to the track and rolling stock operation. Since all the space over the floor can be utilized wholly as the passenger cabin, the rolling stock cost per each seat is relatively lower.

After such comparative study as mentioned above, it has been decided that the limited express train will be planned on a basis of the EMU comprising four (4) motor coaches and (8) trailers.

The ordinary express, semi-express and local trains, which will be operated at relatively low speed, will be hauled by electric locomotives, and make full use of those passenger cars as conventionally used.

The commuter train will be operated by same diesel car as conventionally used for the time being after completion of electrification. In the future thereafter, however, the EMU sufficiently capable for mass transportation with relatively short makeup will be used for commuters. The car body will be designed specifically to serve for transportation of commuters with its improved performance character to ensure low speed and high tractive effort by changing the gear ratio of the motor unit. All the rest portion of the coaches will be so designed as to be able to utilize any interchangeable parts with those of the limited express train.

Table 5-1 Comparison of Limited Express Train Make-up System

Classification	(A) Locomotive-Hauled	(B) Push-Pull	(C) Power-Concentrated EMU	(D) Power-Dispersed EMU
Makeup	1 Loco 11 Coaches	2 Locos 10 Coaches	2 Motor coaches 10 Trailers	4 Motor coaches 8 Trailers
Weight (ton)	132+45×11 =627	88×2+45×10 =626	65×2+45×10 =580	55×4+45×8 =580
Output (kw)	3,600	1,800×2	1,000×2 (Shortage in output)	900×4
Acceleration restricted by adhesion (m/s/s)	0.42	0.56	0.45	0.75
Easiness in shuttling operation	×	o	o	o
Axle load	Large	Large	Medium	Small
Impact on track	Δ	Δ	Δ	o
Easiness of rolling stock maintenance	1	2	3	4
Price ratio of maintenance cost	80	90	92	100
Price ratio per train	85	94	94	100
Price ratio per seat	94	114	103	100
Comprehensive evaluation	No easy operation for shuttling, low efficiency in rolling stock operation	High cost per seat	Output shortage	Most recommendable in all such respects as seat cost and performance, though not equal in rolling stock maintenanceability to (C)

5.2 ROLLING STOCK PERFORMANCE

5.2.1 Performance of Limited Express Train

At present, the express trains are operated by DMU in such three categories as non-stop, one-stop and 3-stop between Cairo and Alexandria. Hereunder, calculation is made to seek required performance of the rolling stock for conversion of those currently operated trains into the EMU trains. The conditions are given as follows for estimation of the required performance.

(a) Time to be required for non-stop train operation shall be about one (1) hour and half between Cairo and Sidi Gaber. The speed limit sections in this instance shall exist near Cairo and Benha.

(b) The highest speed scheduled on the timetable shall be rated at 145 km per hour while the allowable speed on the track shall be rated at 160 km per hour. Accordingly, the rolling stock shall be so designed as to be able to secure the balanced speed over 160 km per hour on the flat level track.

(c) Since the whole track line includes only very gentle grade all the way, calculation for rough estimation shall be based on the assumption that the total track line would be laid on the exactly flat level. For formulation of the operation diagram correction taking account of some grade shall be incorporated into the preliminary estimation.

(d) A train shall consist of 12 cars in its makeup with estimated weight of 640 tons in normal operating condition. However, estimation shall be made on such assumption that the total weight would increase up to 720 tons when the train will be packed to its full capacity.

(e) The special express train scheduled to stop at very few stations may not necessarily require so large acceleration at its starting time. However, a certain degree of acceleration shall be required for that train because the carrying capacity will be reduced to the small if the acceleration falls far down below that of the commuter train. The value of the optimum acceleration is set at 0.2 m/s/s (0.72 km/h/s).

Fig. 5-3 shows the characteristic curve of the rolling stock which is assumed to be used for this project. This Chart also includes the characteristic curves in case of changing the optimum speed from 120 km/h to 160 km/h.

The calculated result is as shown in Fig. 5-4. As identifiable from the Chart, time to be required for travelling from Cairo to Sidi Gaber will be just one hour and half if the operating speed is 145 km/h at maximum.

Since this project makes it a precondition for the train to recover the lost time, in so far as the track condition may permit, the rolling stock is planned at the highest speed of 160 km per hour and at the rated output of 3,600 kW. On this basis, calculation has been made for the total travelling time excluding the stoppage time, the power consumption at an efficiency of 70 percent and the load factor of the traction motors for each one of non-stop and 3-stop trains in the case where such trains are operated by limiting the highest speed down to the normal operating speed, that is, 145 km per hour. The calculated result is as shown in Table 5-2.

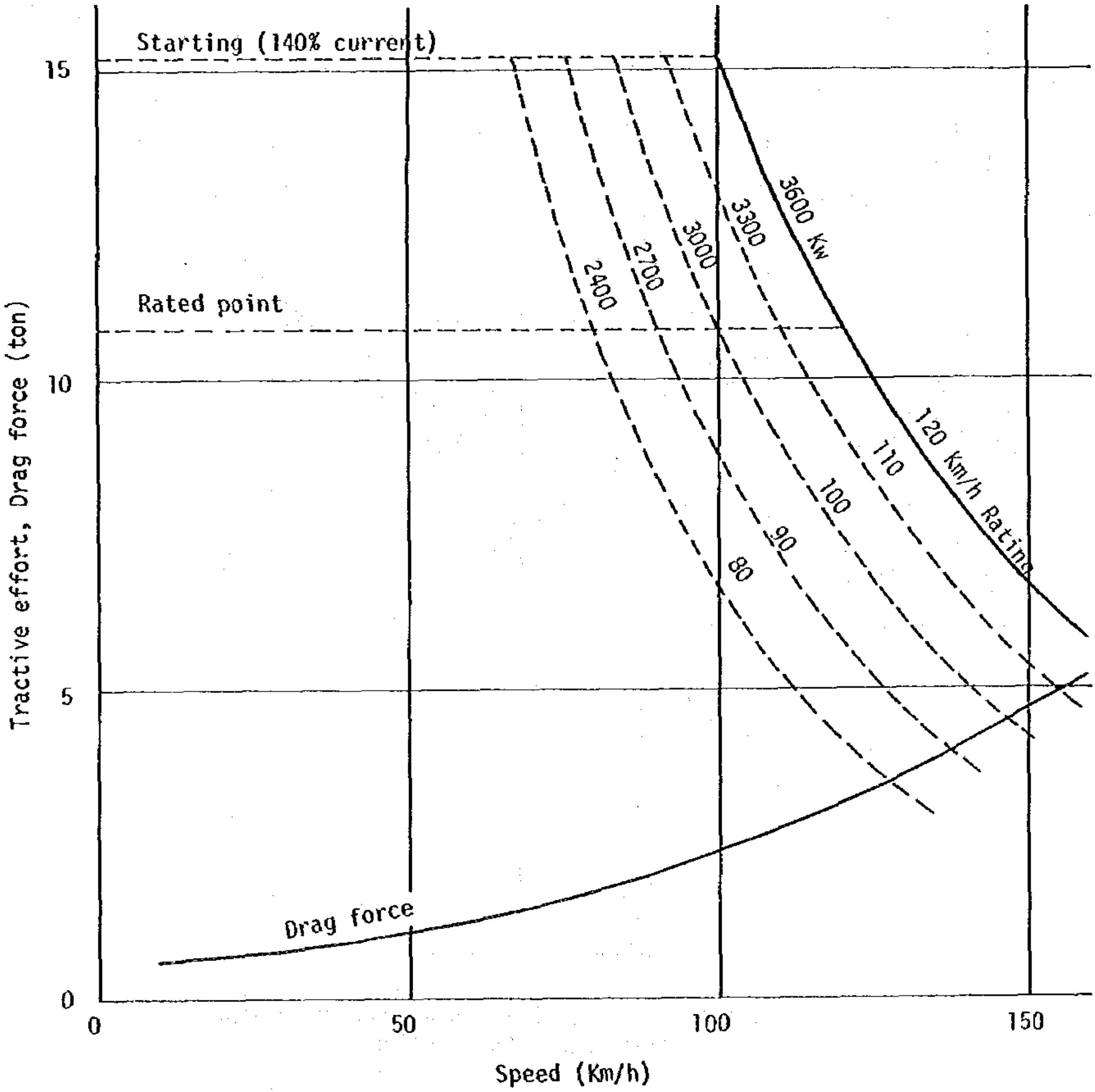


Fig. 5-2 Characteristic Curves of Limited Express Train

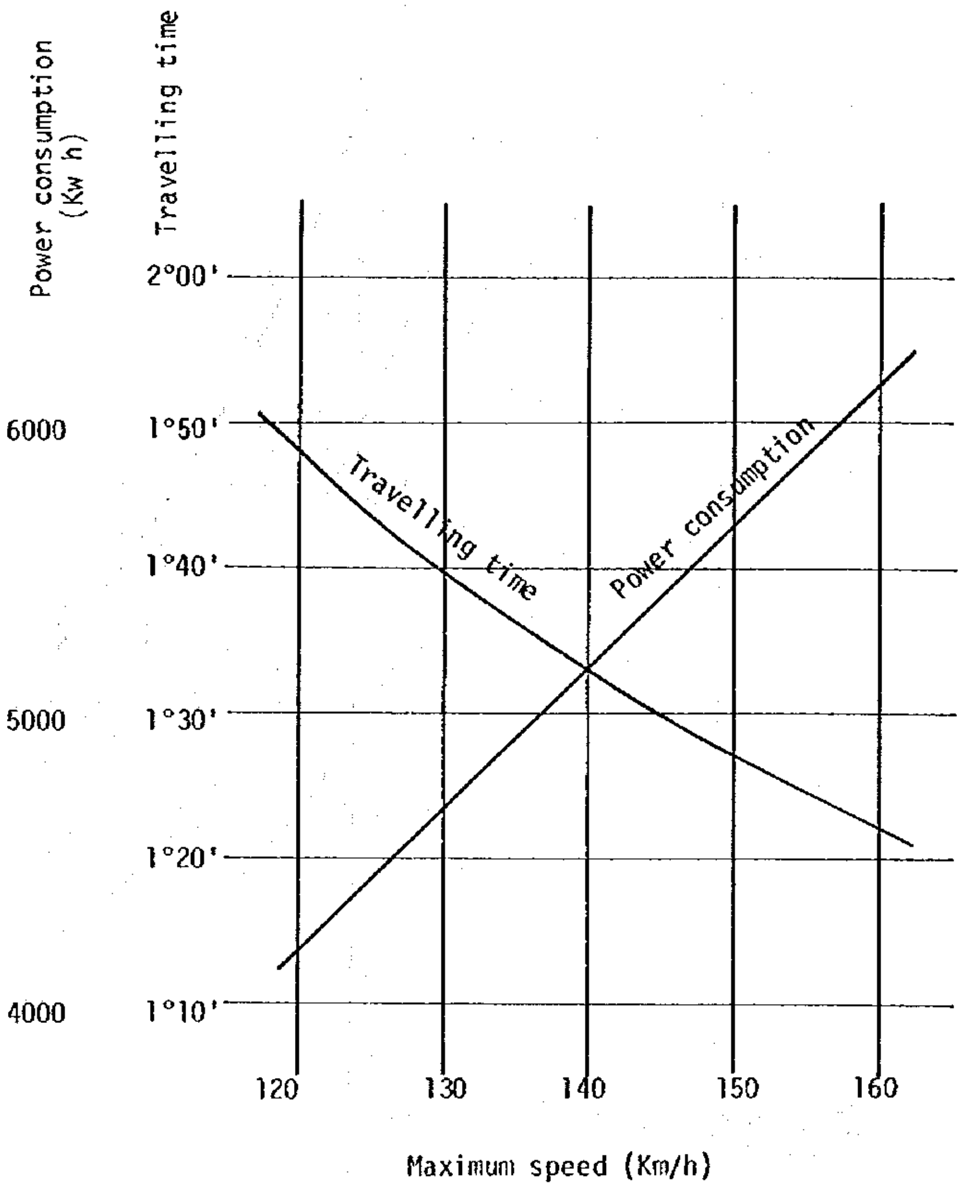


Fig. 5-3 Curves on Max. Speed and Travelling Time, Power Consumption

Table 5-2 Travelling Time of Each Train

Rolling stock		E M U		Loco + Carriage	
Rated power		3,600 kW		2,800 kW	
Planned max. speed		145 km/h		110 km/h	
Total weight		720 ton		650 ton	
Station	km	non-stop	3-stop	3-stop	15-stop
Cairo	0.0	0. 0. 0	0. 0. 0	0. 0. 0	0. 0. 0
Shubra	7.3				0. 07. 47
Qaliub	14.1				0. 14. 26
Qaha	25.7				0. 23. 42
Toukh	33.1				0. 30. 41
Benha	45.0		0. 23. 18	0. 28. 19	0. 40. 07
Quwesna	56.6				0. 50. 14
Birket El Sabar	68.0				0. 59. 24
Tanta	86.4		0. 44. 48	0. 54. 41	1. 12. 23
Kafr El Zaiyat	104.2				1. 25. 02
El Taufigiya	110.8				1. 31. 34
Ityal El Barud	122.0				1. 40. 37
Damanhur	147.2		1. 13. 44	1. 30. 46	1. 57. 18
Abu Hummus	163.6				2. 09. 11
Kafr El Dawar	181.6				2. 21. 57
Sidi Gaber	203.1	1. 30. 48	1. 40. 38	2. 04. 11	2. 36. 37
Alexandria	207.9	1. 38. 09	1. 47. 59	2. 11. 28	2. 43. 54
Power consumption (kWh)		5,410	5,630	4,150	4,980
Load factor of motors (%)		65.7	72.5	48.2	65.9

Note: (1) Time of train stoppage is not included.

(2) Acceleration corresponds to 140 percent of the rated current.

(3) Deceleration is constant at a fixed rate of 2 km/h/s.

(4) Power efficiency is rated at 70 percent.

5.2.2 Performance of Electric Locomotive

Estimation is made herein to define the required performance for a locomotive on assumption that the diesel locomotive now being used for hauling the train would be shifted over to the electric locomotive. The plan is based upon such a condition that a passenger train of 1,000 tons in weight can be operated at a speed exceeding 110 km/h. The characteristic curve is shown in Fig. 5-5.

In order to obtain the operating performance as specified above, a locomotive of four (4) driving axles, if so planned, would be weighed at 22 tons, or 88 tons in gross weight, to the maximum designed track capacity. In case of the locomotive of six (6) driving axles being put into operation, the gross weight would increase up to 108 tons though the axle load could be reduced down to some 18 tons. Now, let it be assumed that the coefficient of adhesion would be 20 percent, it is estimated that the starting acceleration as against a 1,000-ton train would be 0.15 m/s/s (0.54 km/h/s) for the 4 driving-axle locomotive and 0.18 m/s/s (0.66 km/h/s) for the 6 driving-axle locomotive. Thus, by use of the 6 driving-axle locomotive time could be shortened by about 25 seconds at one stoppage of the train.

On the other hand, however, because the total sum of purchase price and maintenance cost for the 6 driving-axle locomotive is estimated at about 1.3 time as much as that for the 4 driving-axle locomotive, this Project is planned on the basis of the 4 driving-axle locomotive which will surely be able to satisfy the designed requirement for operating performance.

The travelling time, the power consumption and the load factor of the traction motors for each train of 3 stops and 15 stops, in the case where the locomotive as estimated above would be used to haul the 8-car makeup train of 560 tons, are as shown in Table 5-2.

5.2.3 Performance of Commuter Train

The plan is based primarily upon such condition that the conventional diesel train will be utilized for the time being after completion of electrification. However, in anticipation of future demand for the

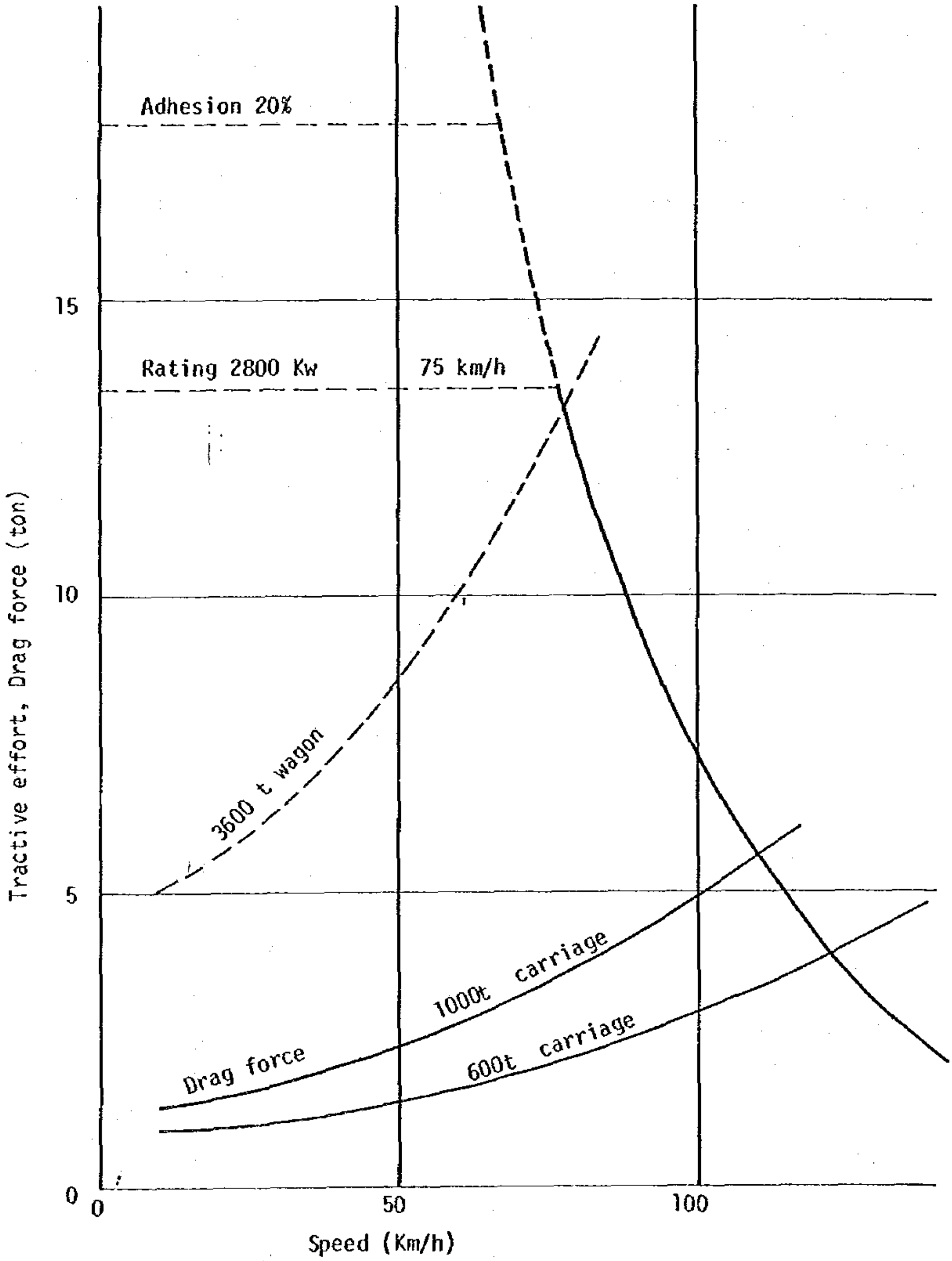


Fig. 5-4 Characteristic Curves of Locomotive

acceleration secured at least up to 0.29 m/s/s (1.0 km/h/s) even when the train is packed to its full capacity. Table 5-3 refers to the relationship between load and acceleration of the train and Fig. 5-6 shows the characteristic curves.

commuter's electric train, estimation is made to define the required performance character for that train. It is also planned that most of electrical and mechanical parts to be used for the commuter train will be same as are used for the limited express train.

The train will consist of six (6) coaches in makeup. The number of motor coaches will be half as many as the limited express train has, which means that the output will be reduced by half down to 1,800 kW. If the reduction gear is made at a large gear ratio and the rated speed is set about 75 km/h, the train can be operated at a speed of 110 km/h with

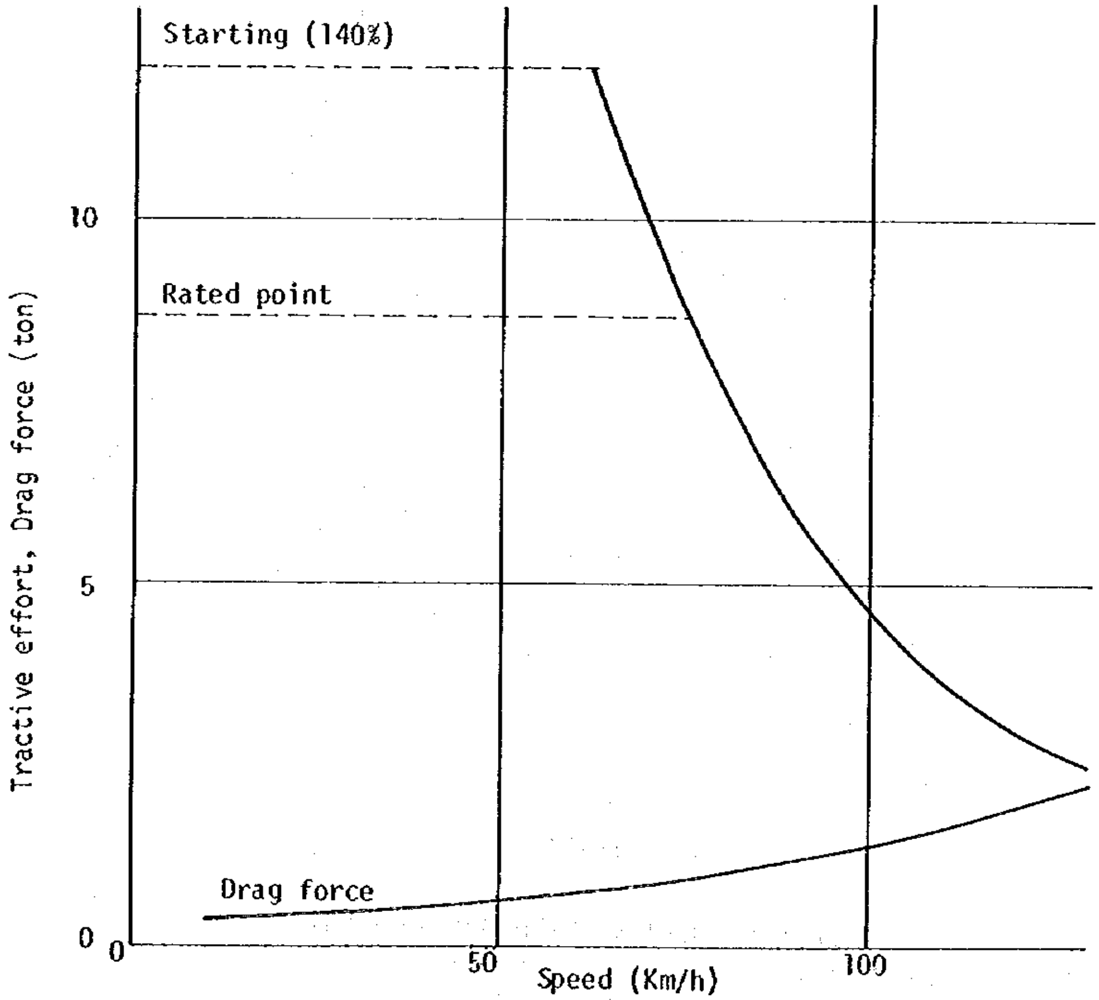


Fig. 5-5 Characteristic Curves of Commuter Train

Table 5-3 Accelerating Characteristics of Commuter Train

Train make-up			6 coaches	
Rated power			1,800 kW	
Rated speed			75 km/h	
Weight (ton)			Acceleration	
Tare	Load	Total	m/s/s	km/h/s
280	40	320	0.36	1.27
280	80	360	0.32	1.13
280	120	400	0.29	1.04

5.3 ROLLING STOCK CONSTRUCTION

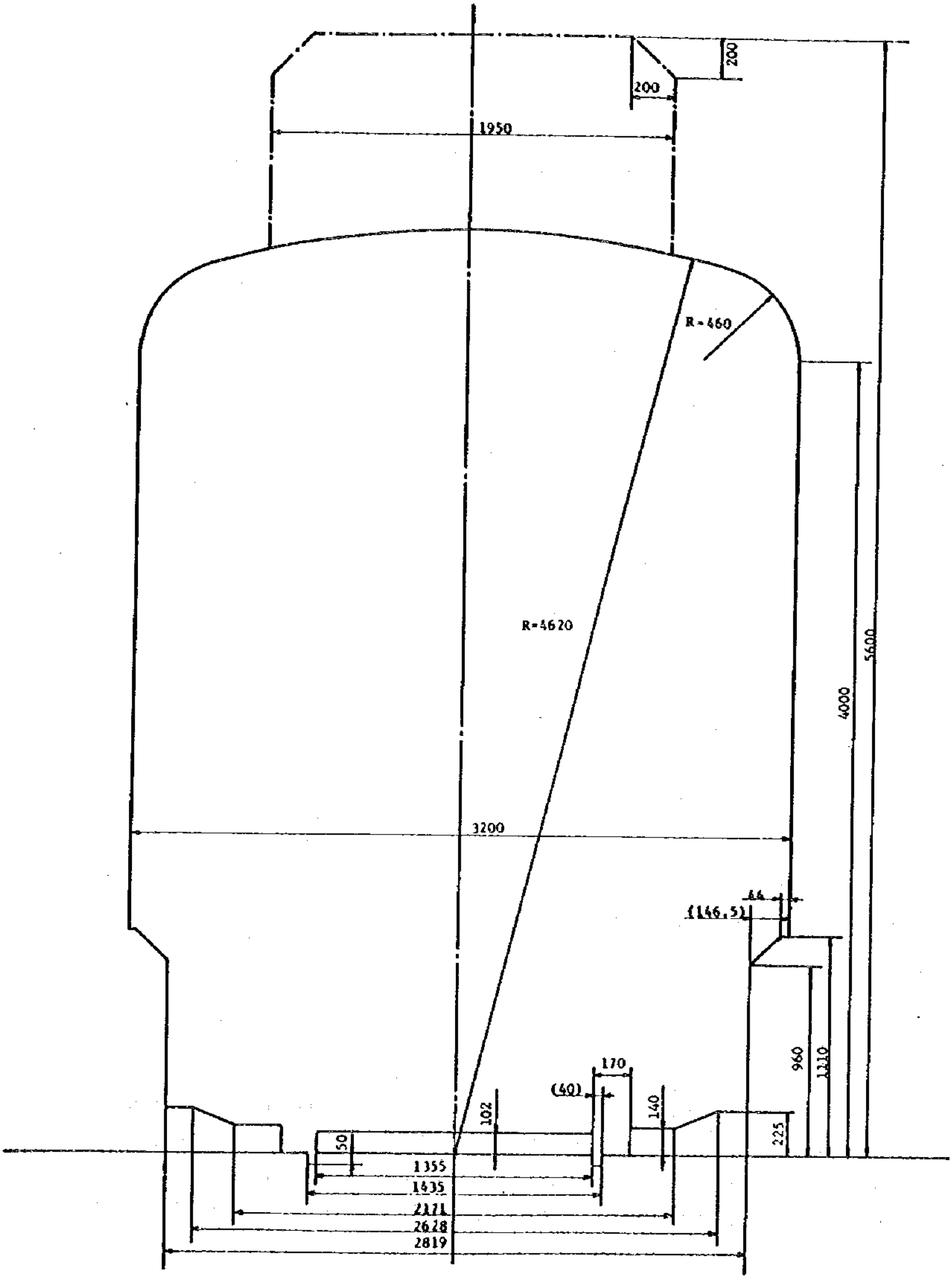
5.3.1 Vehicle Gauge

The vehicle gauge for electric powered rolling stock includes as addition the clearance to the pantograph with due reference to Drawing SM 3100B provided by the Egyptian Railways.

The supplemental portion provides a marginal allowance up to the maximum width of 1,950 mm as specified by the UIC Code as shown in Fig. 5-7.

The UIC Code provides that the overhead contact wire should be maintained at a height of 5,050 mm at minimum. On this basis, the proposed height of the contact wire should be 5,150 ± 100 mm so as to insure the least reconstruction of the existing structure. By so doing the train designed by UIC Codes can be operated.

The profile of the rolling stock shall be within the basic vehicle gauge at the down position of its pantograph.



—— Maximum dimensions for rolling stock when pantograph lowered
–·–· Maximum dimensions for pantograph

Fig. 5-6 Loading Gauge with Pantograph Clearance

5.3.2 Body Size of EMU Coach

The maximum width of vehicle gauge is set at 3,200 mm, the requirement for which should be satisfied on the straight track and the curved track of 200 meter radius. Therefore, the relationship between length and width of the car body may be as shown in Table 5-4, on assumption that the center-to-center distance of the bogies would have been selected most suitably.

Table 5-4 Car Length and Its Maximum Allowable Width

Distance between coupling faces (m)	20.0	23.0	25.0
Car body length (m)	19.5	22.5	24.5
Center-to-center distance of bogies (m)	14.0	16.0	17.0
Protrusion out of 200 radius (m)	0.125	0.16	0.20
Max. allowable car width (m)	2.95	2.88	2.80

Then, the planned size of a coach will be 22.5 m in length and 2.85 m in width with due regard to the riding comfort inside the carriage. The gap between the coupled coaches will be allowed at 0.5 m by use of the automatic tight coupler.

5.3.3 Normal Accommodation Capacity

A preliminary estimation must be made to determine the normal accommodation capacity as it is required for estimation of the transport capacity.

In case of the special express train, the total number of seats are regarded as the normal accommodating capacity. The seats for the 1st -class carriage are arranged in 3 lines at a pitch of 1,240 mm and those for the 2nd-class carriage are in 4 lines at a pitch of 990 mm. By properly arranging the driver's cabs, decks and toilets, the total accommodating capacity for 12-car makeup of a train can be estimated at 660 persons, excluding the accommodating capacity in the dining coach.

5.4 MAIN FEATURES OF ROLLING STOCK

5.4.1 EMU for Limited Express Train

Electric system: Single phase AC, 25 kV, 50 Hz
Overhead current collecting system

Kinds	Number of Seats	Tare Weight (ton)	Total Weight (ton)
2nd-class control coach (T_C)	60	50	
2nd-class interim motor coach (M)	76	55	
2nd-class interim motor coach (M')	72	55	
2nd-class trailer (T)	76	45	
1st-class trailer (T_S)	42	45	
Dining car (T_D)		50	
12-car makeup train	660	590	640 *

Composition of train makeup : T_C M M' T_S T_S T_D T_S T_S T M M' T_C

Car size		
	Coupling face-to-face length	23,000 mm
	Car body length	22,500 mm
	Car body width	2,850 mm
	Height	3,700 mm

Note: * Performance character of rolling stock is estimated on the basis of 720 tons.

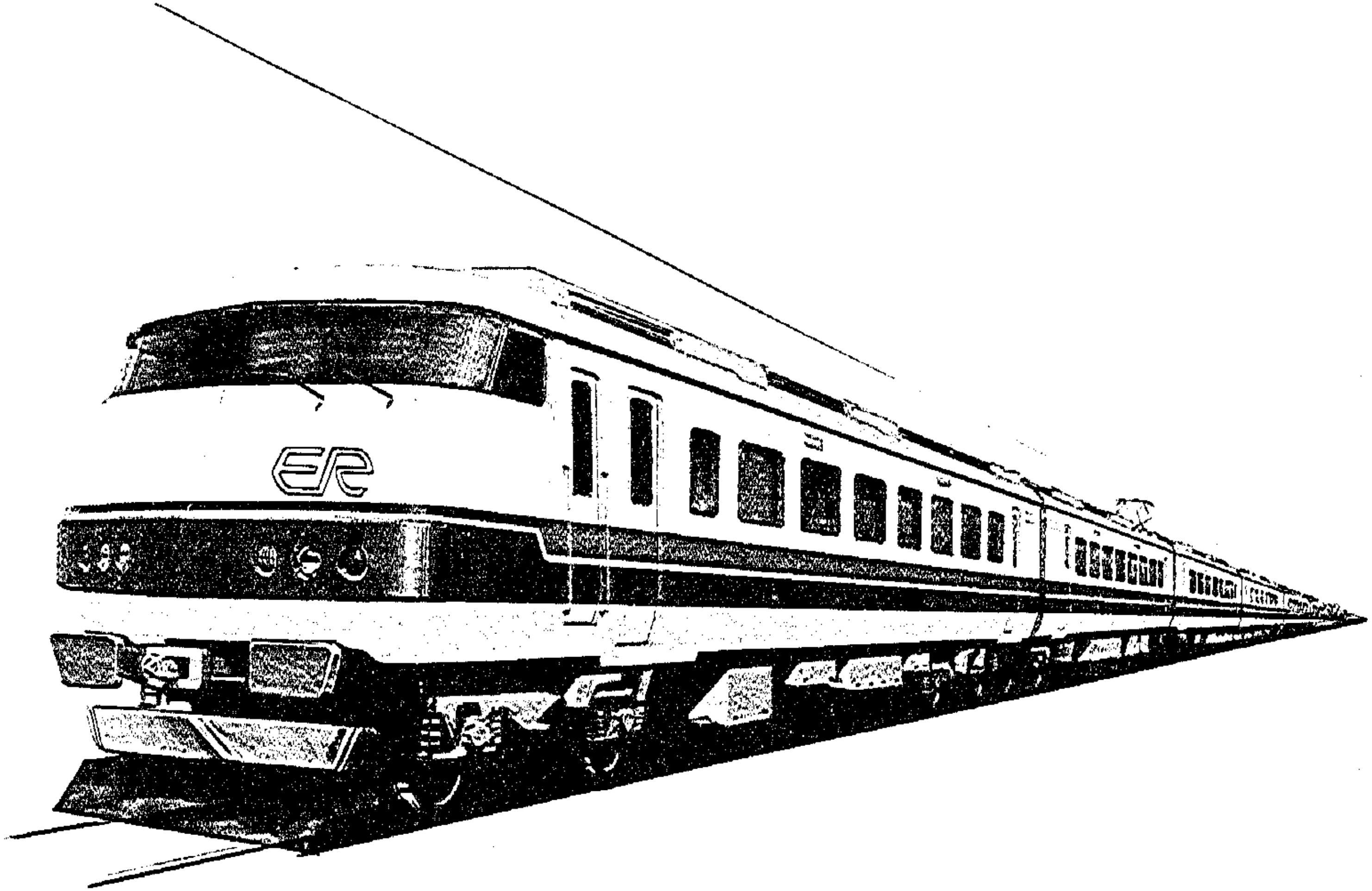
Rating of a train	Power output	3,600 kW
	Speed	120 km/h
	Tractive effort	10.8 ton
Max. allowable speed		160 km/h
Traction motor	Pulsating current series motor	
	Output	225 kW
	4-series, 2 circuit parallel, 2 units	
Power control	Continuous phase control with thyrister	
Brake system	Electromagnetic straight air brake	
Outfit	Automatic tight coupler	
	Air conditioner	

5.4.2 Electric Locomotive

Electric system	Single phase AC, 25 kV, 50 Hz
	Overhead current collecting system
Operating weight	88 ton
Axle arrangement	$B_o - B_o$
Body length	18,200 mm
Rated output	2,800 kW
Rated speed	75 km/h
Rated tractive effort	13.5 ton
Max. allowable speed	125 km/h
Power control	Continuous phase control with thyrister
Brake control	Automatic air brake

5.4.3 Commuter Train

Makeup of one train	6 coaches
Tare weight	280 ton
Number of seats	512
Total weight	400 ton
Rated output	1,800 kW
Rated speed	75 km/h
Rated tractive effort	8.6 ton
Max. allowable speed	125 km/h



Electric Multiple Unit for Cairo Alexandria Line

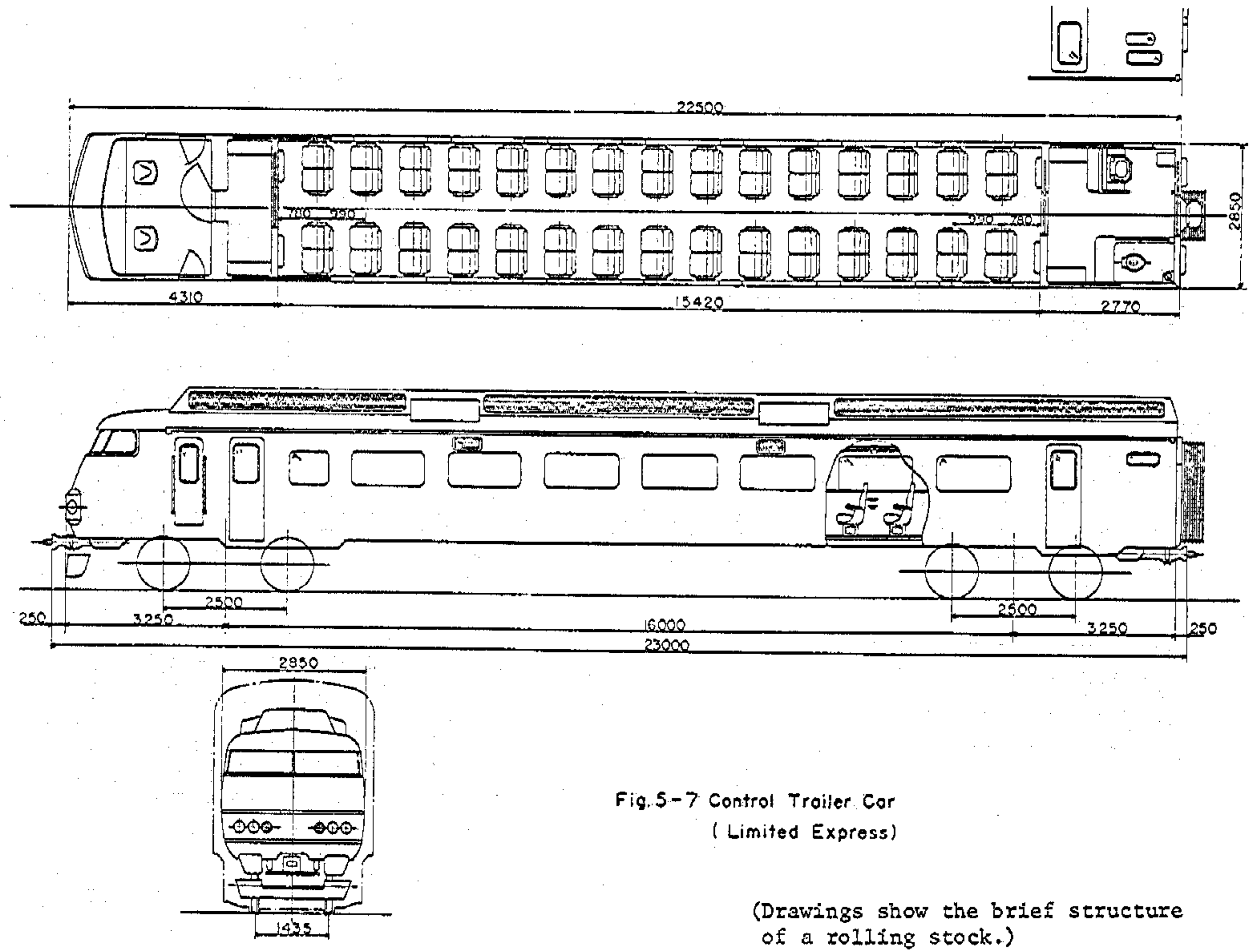


Fig. 5-7 Control Trailer Car
(Limited Express)

(Drawings show the brief structure
of a rolling stock.)

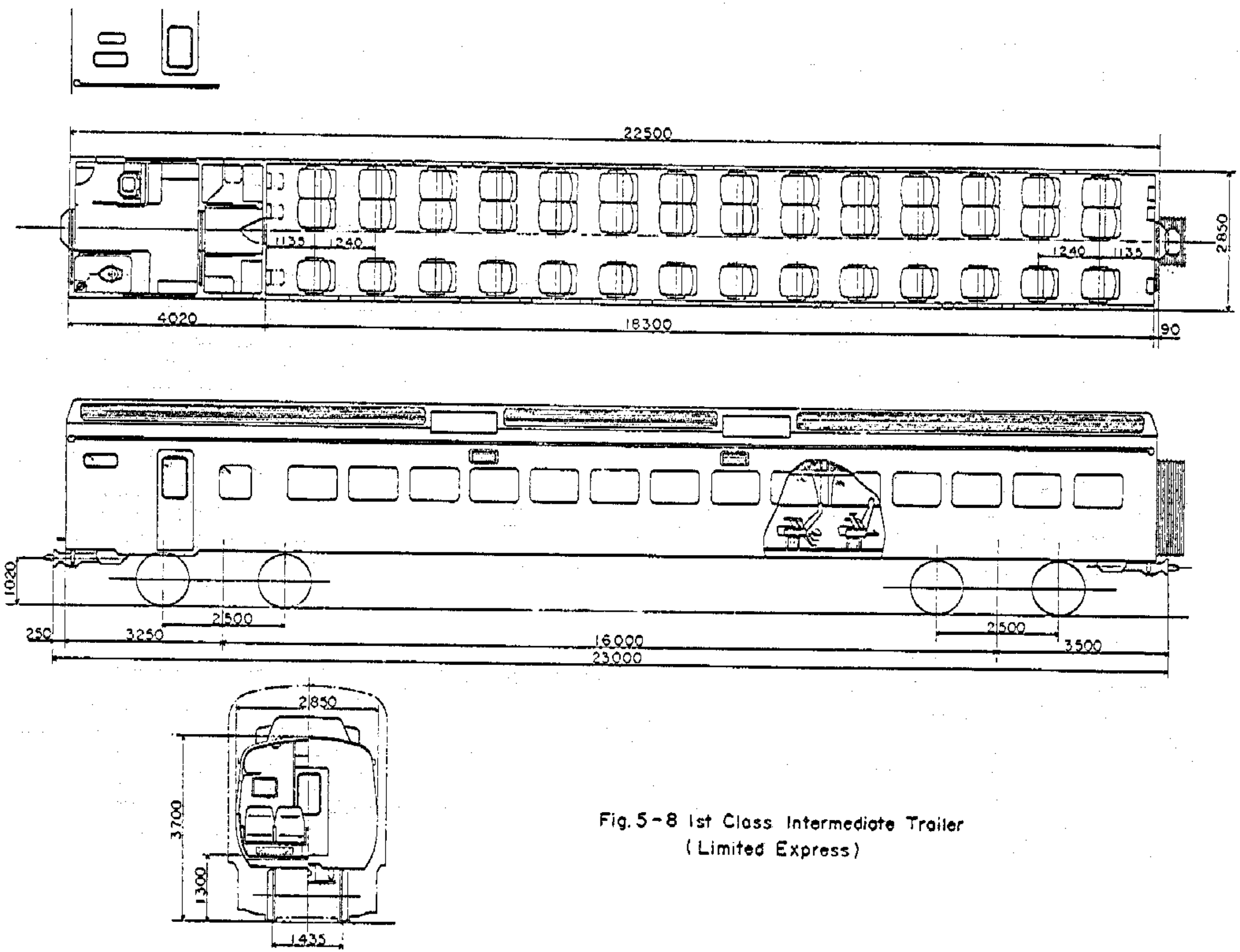


Fig. 5-8 1st Class Intermediate Trailer
(Limited Express)

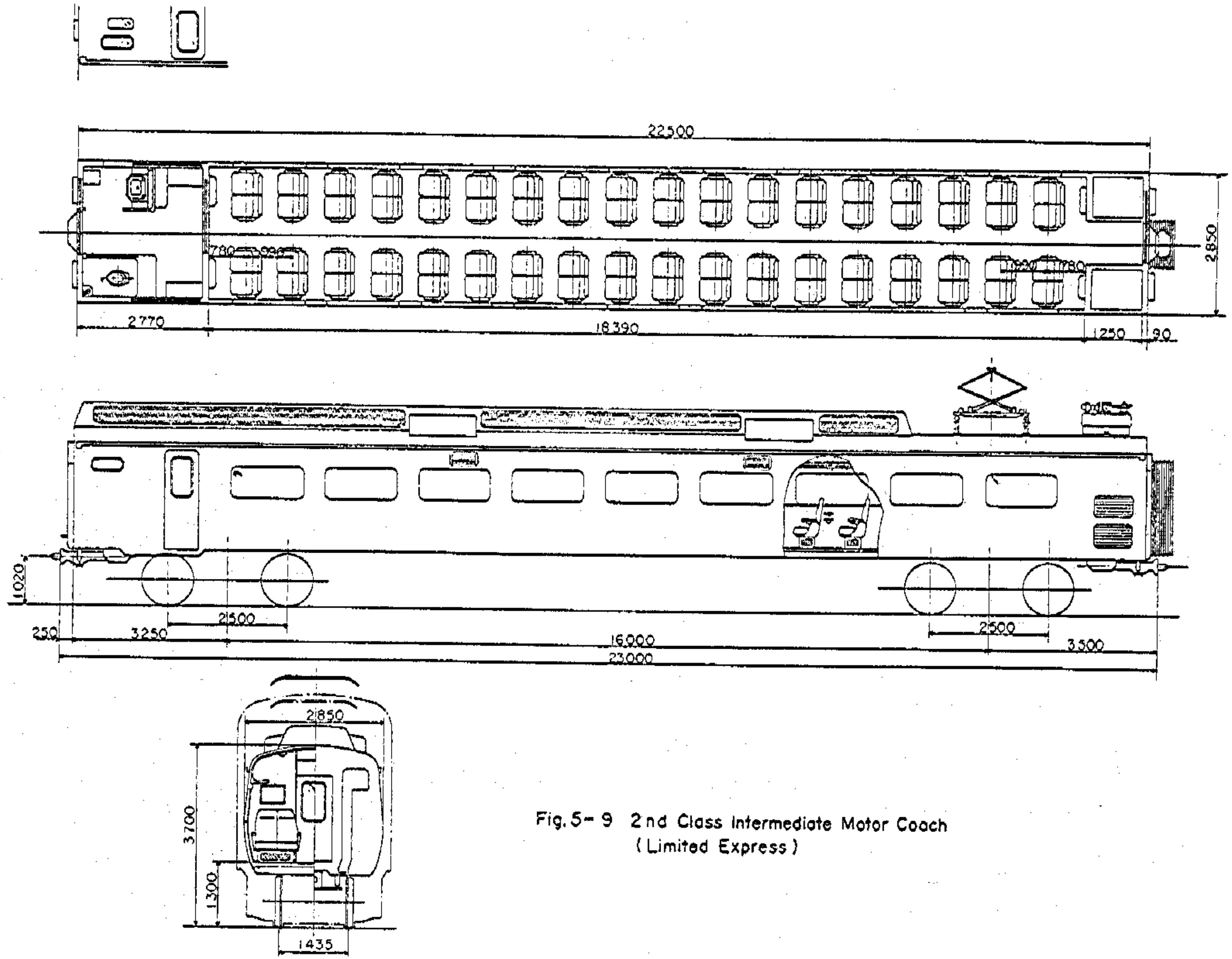


Fig. 5-9 2nd Class Intermediate Motor Coach
(Limited Express)

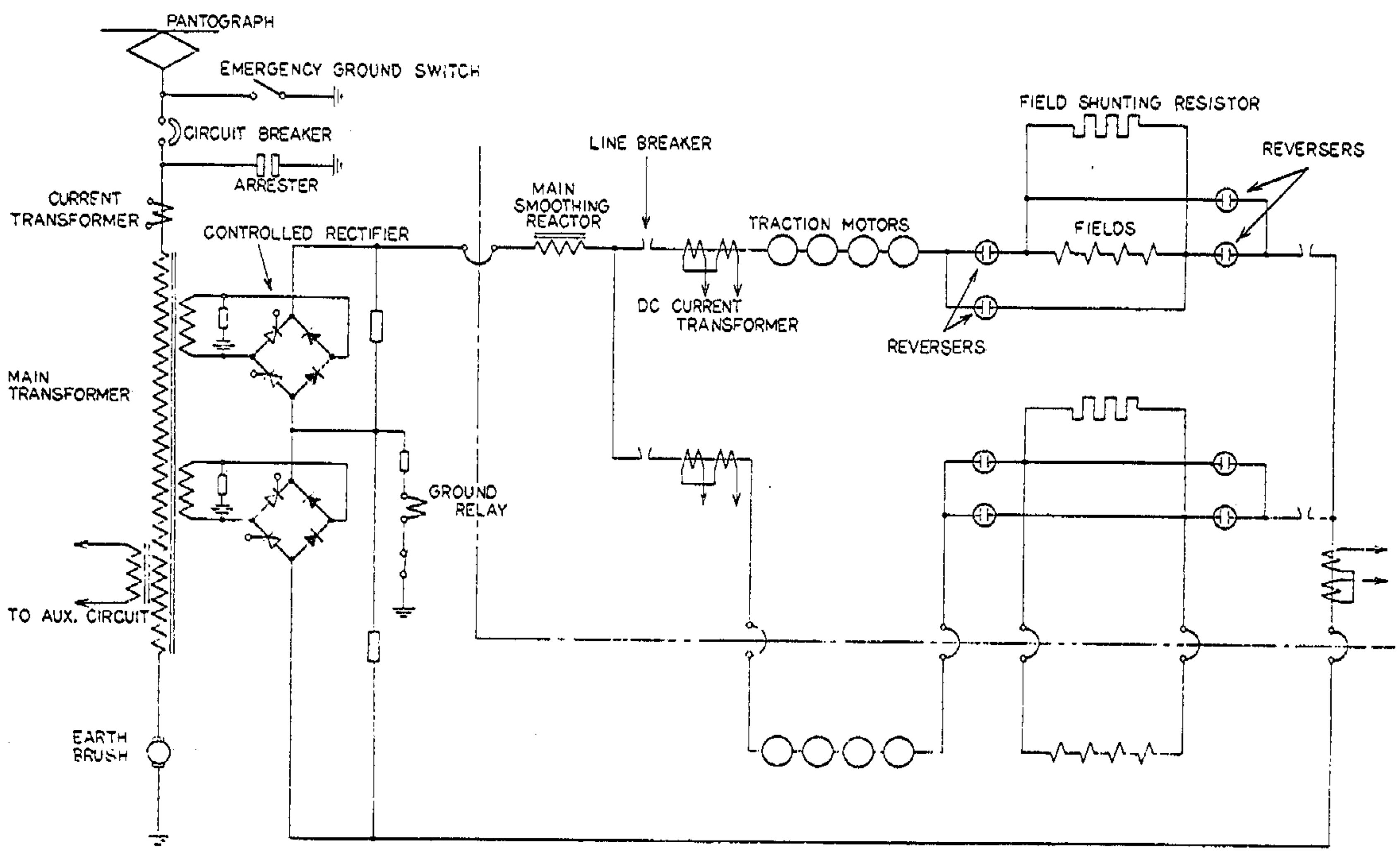
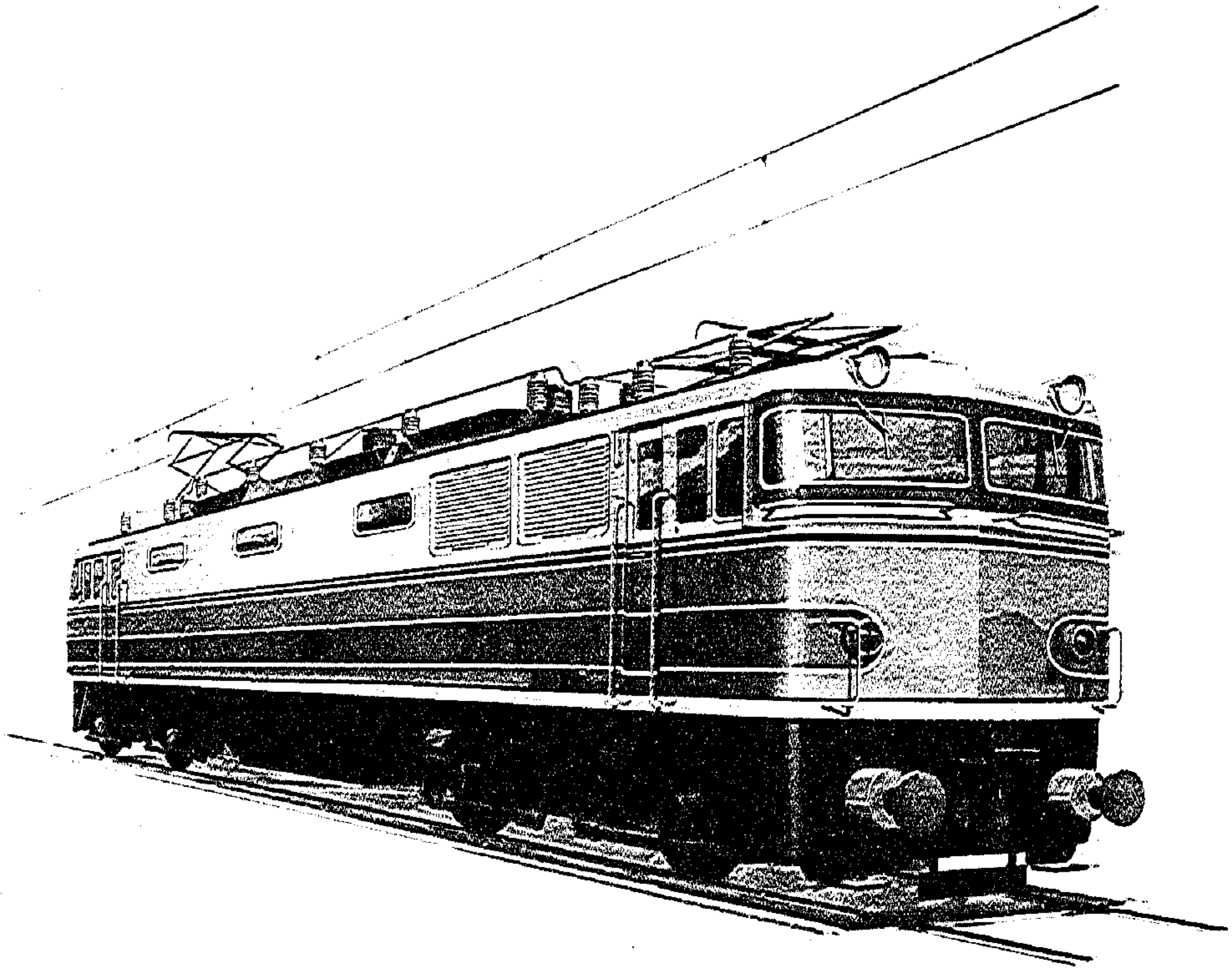


Fig. 5—10 Schematic Diagram of Traction Circuit
(Electric Motor Coach)



Electric Locomotive for Cairo Alexandria Line

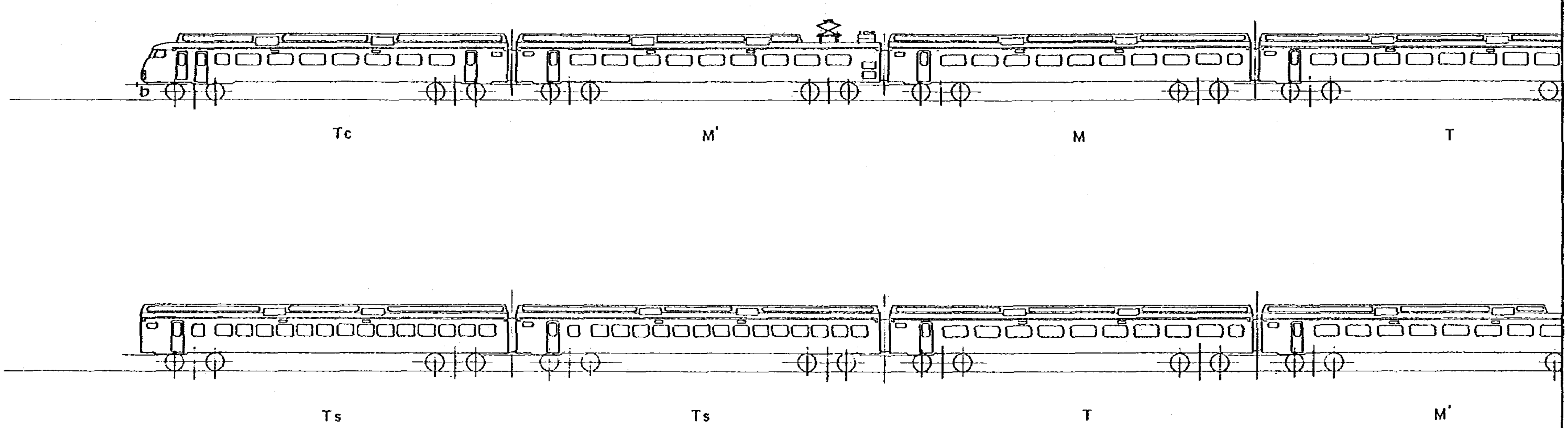


Fig. 5 - 11 12 - Car Electric Multiple - Unit Set
(Limited Express Train)

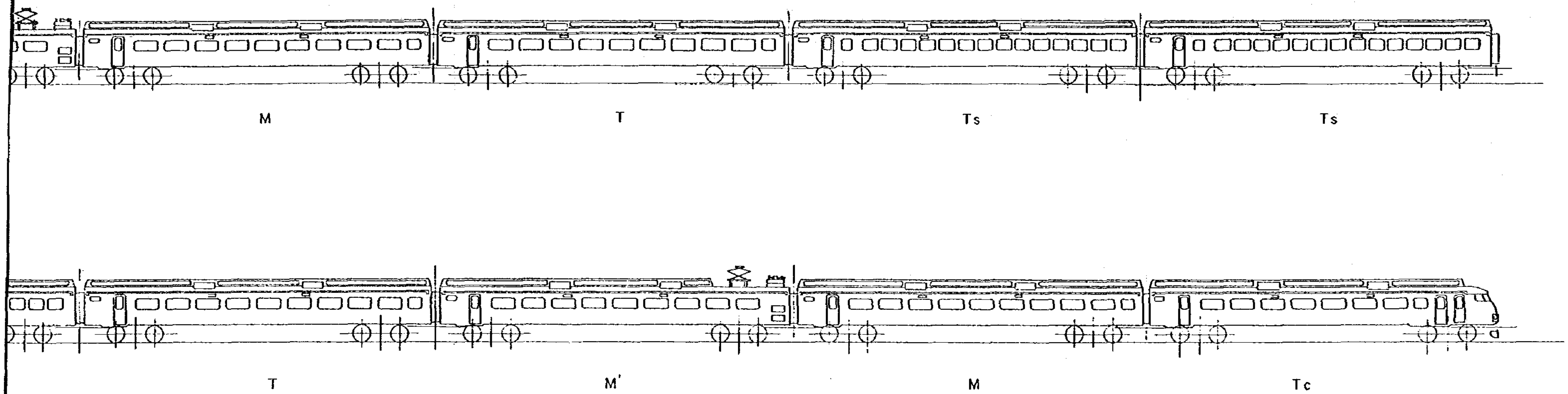


Fig. 5 - 11 12 - Car Electric Multiple - Unit Set
(Limited Express Train)

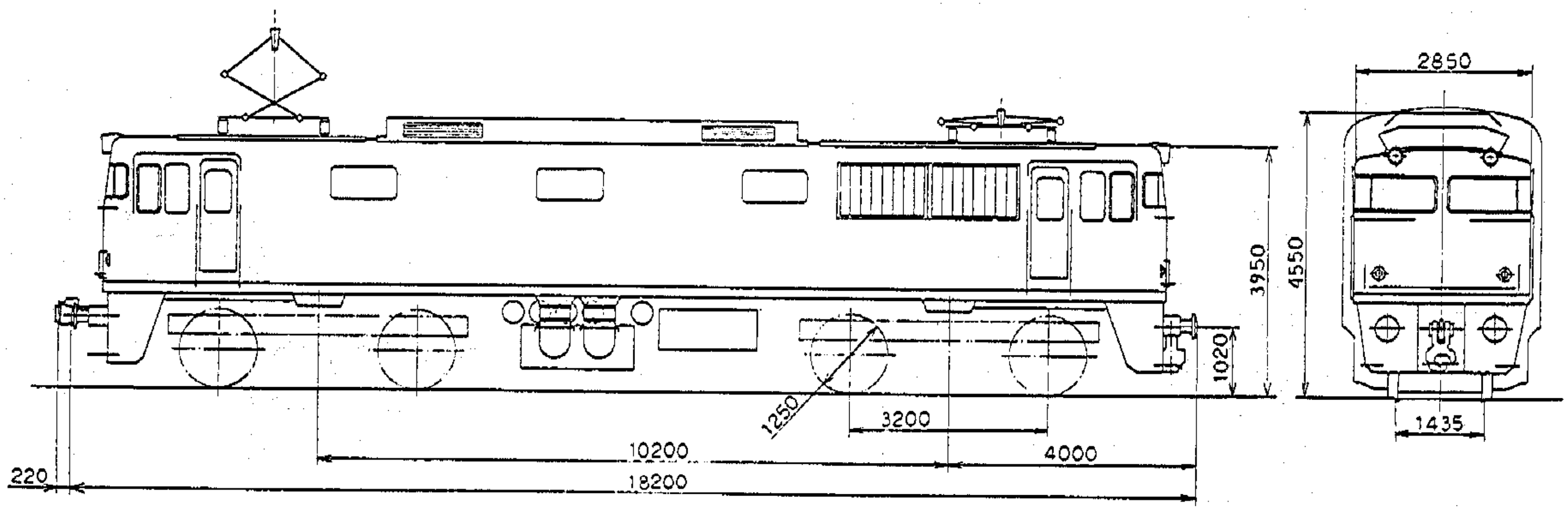


Fig. 5 -12 Electric Locomotive

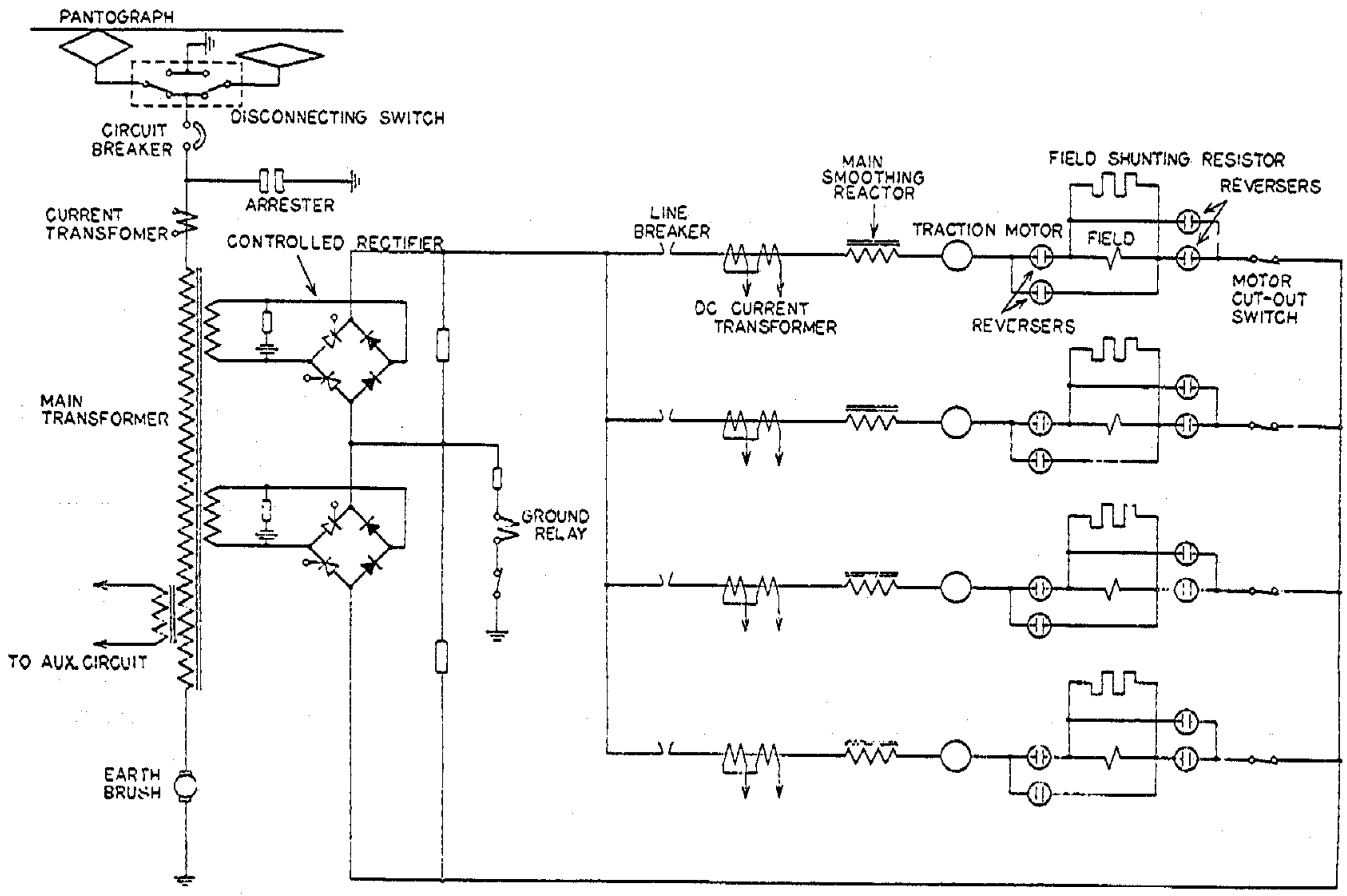


Fig. 5-13 Schematic Diagram of Traction Circuit
(Electric Locomotive)

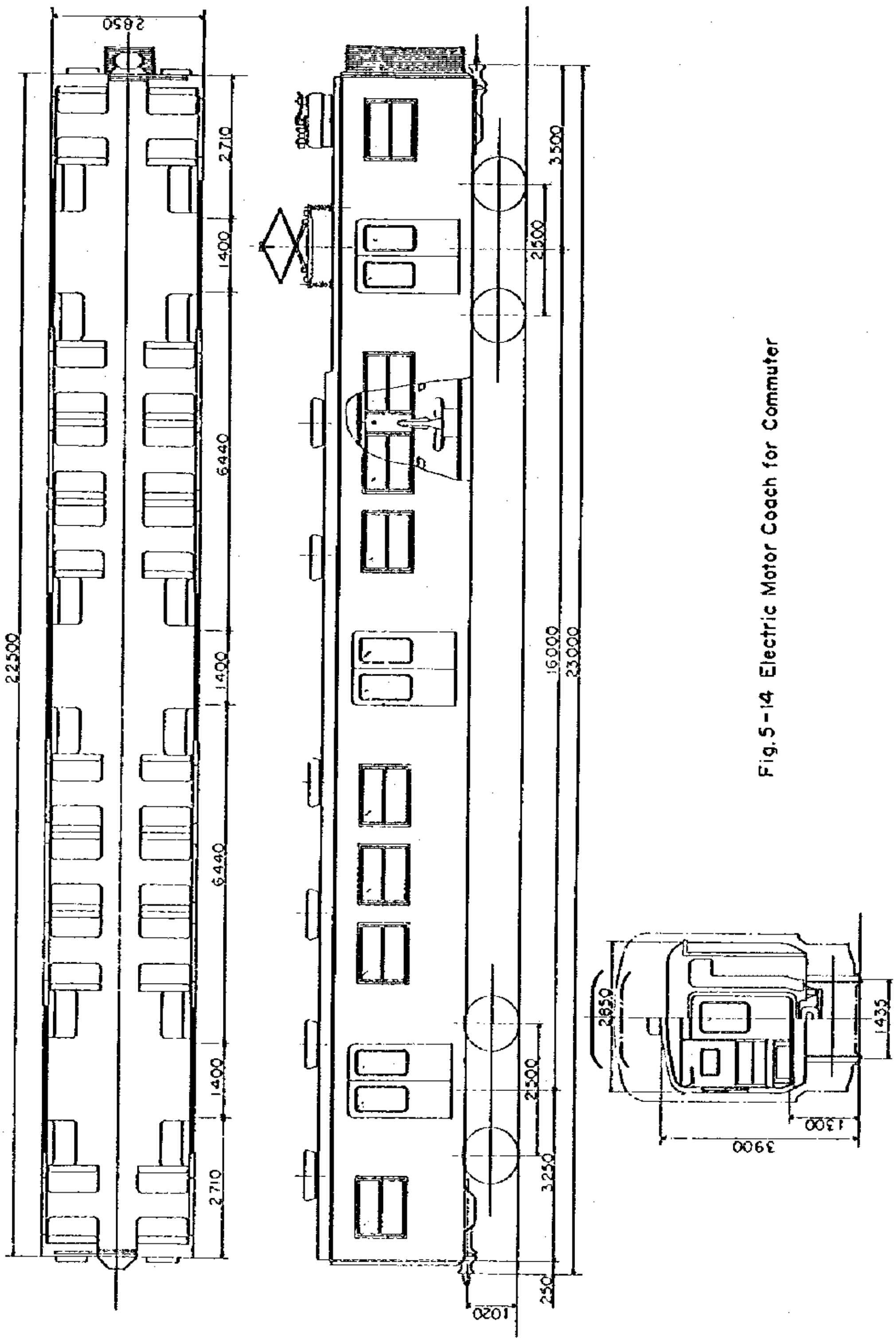


Fig. 5-14 Electric Motor Coach for Commuter

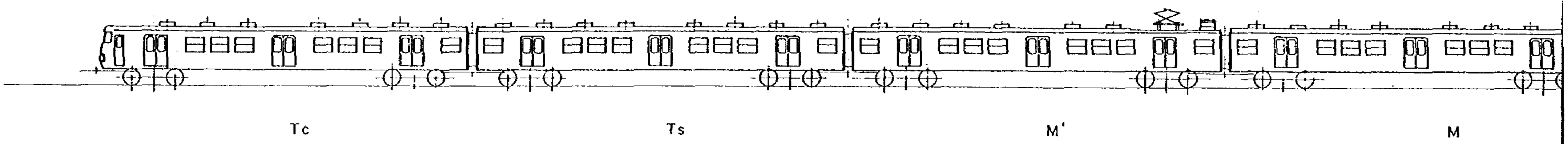


Fig. 5-15 6-Car Electric Multiple-Unit Set
(Commuter Train)

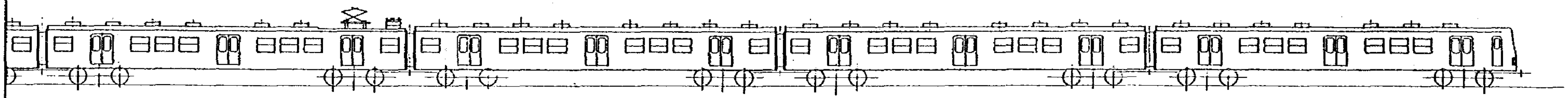


Fig. 5-15 6-Car Electric Multiple-Unit Set
(Commuter Train)

6. POWER INSTALLATION PLAN

6.1 MASTER PLAN

6.1.1 Electrification System

The electrification system for the railway includes the following systems now being in practical use:

1) Direct current electrification 1,500 V or 3,000 V
2) Alternating current electrification 15 kV 16 2/3 Hz or
20∿25 kV 50(60) Hz

Since the Cairo - Alexandria line has very few obstacles like tunnels and rather complete installation of the power supply network, the AC electrification system of 25 kV, 50 Hz, which is suitably conditioned for high speed, and may require low cost ground installation of high maintenance-free nature, has been adopted.

The overhead catenary system will be composed of compound catenary for the high speed operation section and simple catenary for the auxiliary main track within the station yard and for the track in the depot. For the bridge portion on the Nile, the special catenary system using the rigid suspension structure will be adopted.

6.1.2 Electric Operation Plan

For the time being after electrification, electric operation will apply mainly to the passenger trains of direct travelling between Cairo and Alexandria. The substations are provided with the feeding capacities adequate enough to require no operational restriction in the least even when the two neighboured substations may get into trouble. Therefore, the electric system will be of one line system without any standby system.

For the system of touching part of different power source, the dead section system which does not require any use of the changeover circuit breaker will be adopted. Travelling time will hardly be affected even by use of this system.

The number of the current collecting device (pantograph) of an electric train will be one or two per each train. It is expected in this connection that maintenance care for possible worn-out of contact wire and frequency of mutually related troubles between catenary system and pantograph should be reduced to a great extent.

6.1.3 Feeding System

The feeding will be of AT feeding system using the auto-transformer (A.T.) being separated in four (4) systems by the directions of the track and by up and down tracks. The feeding can be also separated or extended at the sectioning post in an intermediate point between the substations. Explanation drawing of AT feeding system and fundamental feeding system diagram are as shown in Figs. 6-1 (1) and (2). Within the station yard of Cairo and Alexandria a subsectioning post will be provided for convenience of system operation and maintenance work.

The total structure of the feeding system is as shown in Fig. 6-2. Feeding voltage should be maintained below each of the following levels:

Normal voltage of overhead calenary system	25 kV (100 %)
Minimum voltage of overhead catenary system	20 kV (80 %)
Normal voltage of substation	27.5kV(110 %)

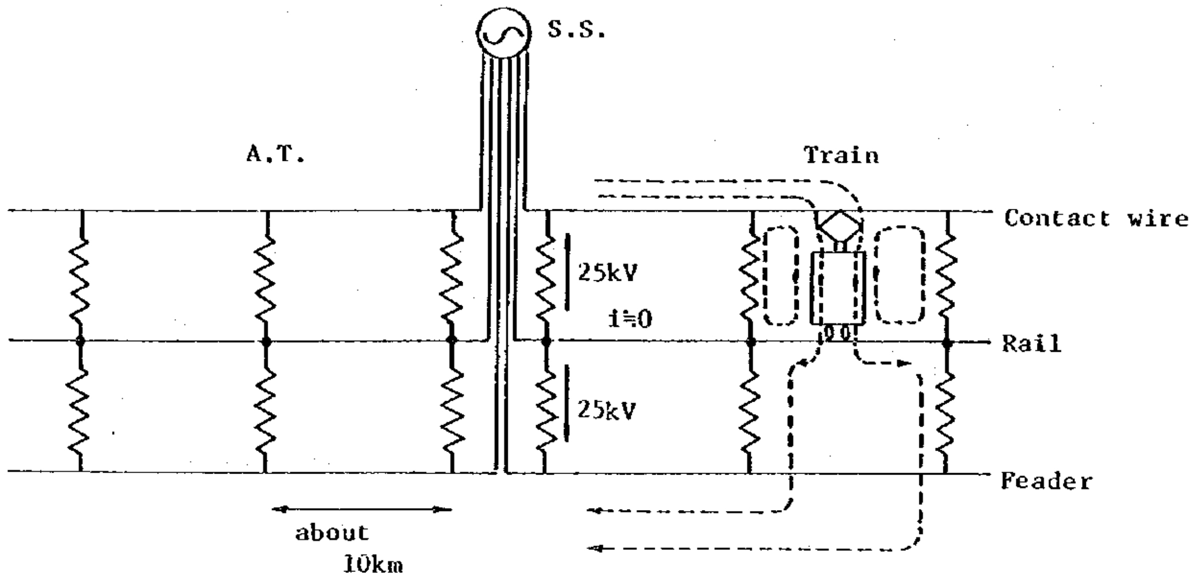
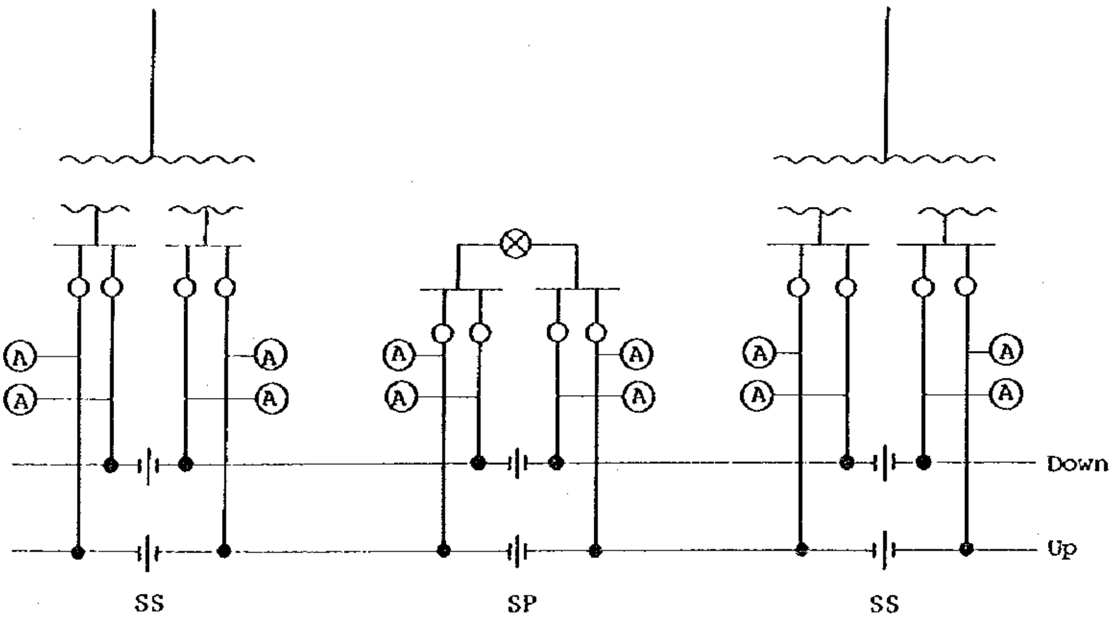


Fig. 6-1-(1) Rough-Sketch of AT Feeding System



─┤├─	Dead Section Insulator
○	Circuit Breaker (Normally closed)
⊗	Disconnecting Switch (Normally open)
Ⓐ	Auto-transformer

Fig. 6-1-(2) Fundamental System Drawing

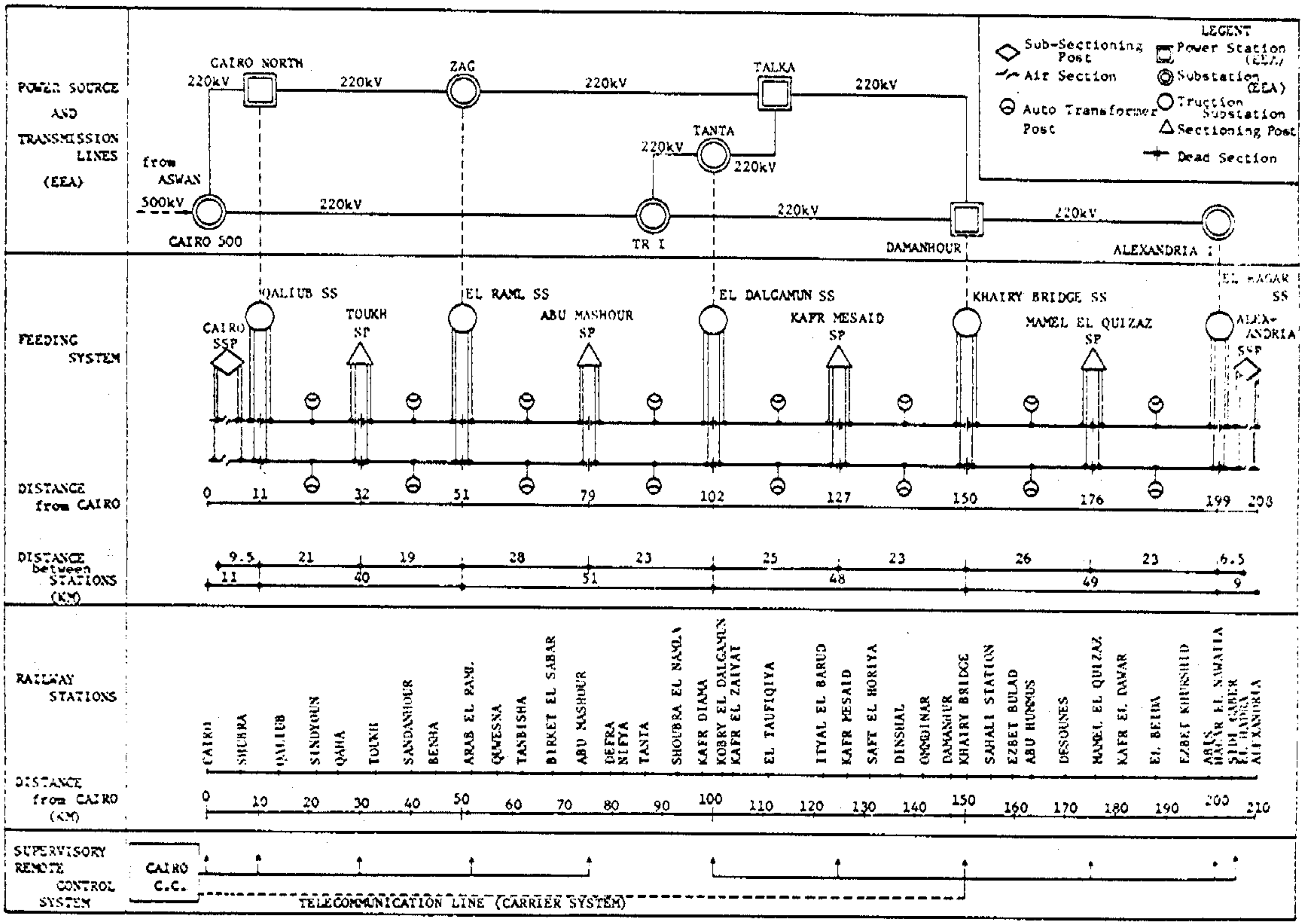


Fig. 6-2 Power Distribution & Feeding System for Cairo-Alexandria Line

6.2 POWER SOURCE PLAN

6.2.1 Requirement for Power Source

Voltage fluctuation as provided by the Egypt Electric Authority (E.E.A.) for the customers is stipulated at 5 percent normally and 10 percent in case of emergency. Besides that, since the voltage unbalance rate must also be restrained below 1 percent by all possible means, the short-circuit capacity of the power supply network must be determined after careful review with the above requirement in mind. In view of the fact that the short-circuit capacity of the 220 KV transmission network, from which power is to be received, reaches 2,000 MVA at least, such restrictive conditions as stated above can be satisfied if power is received from the existing 220 KV network.

When forecast is made from the aspect of power demand and supply, it is expected that power demand under this project will be covered adequately by the existing supply capability since power generation in Egypt exceeds power consumption in any even of the long-range power supply programme.

6.2.2 Power Receiving Plan

Basically, power will be received at five (5) points directly through the exclusive lead-in transmission line, which will be constructed by E.E.A., from the power station or the substation of the complete 220 KV network system now existing in and around the major cities alongside the railway, in order to satisfy the following requirements as stated in the preceding item.
Namely,

1) The power receiving facilities should be of large total capacity.

2) Large marginal tolerance should be incorporated into the capacity of either power station or substation.

3) The system should be protected with completeness.

Table 6-1 includes the list of installed capacity of power station or substation candidated for power receiving.

Table 6-1 Installed Capacity for Candidated Power Receiving Facilities

Plant	Units Size	Total Cap.
(Generating Stations)		
1. Cairo North	2 × 10 (MW)	100 (MW)
	1 × 20	
	2 × 30	
2. Talka	3 × 12.5	127.5
	3 × 30	
3. Damanhur	2 × 15	225
	3 × 65	
4. Bieuf	2 × 26.5	113
	2 × 30	
5. Max	2 × 14	28
6. Kormeuz	4 × 16	64
(Substations)		Breaker Cap.
7. Tanta	2 × 40 (MVA)	5,000 (MVA)
8. Damanhur	2 × 50	5,000
9. Alexandria II	2 × 125	10,000
" I	2 × 75	5,000