Rigid cantilever arms will be installed on the main line in general; and in the depot and track transfer sections, truss beams will be adopted, to support the catenary lines. Ground wires will be installed to protect the system from lightning attacks. Standard assemblies of supporting structures will be as shown in Figure 3-7.4.

4) Power Distribution System

Overhead 13.2kV power distribution lines will be installed on the supporting structures for above contact lines to supply electricity to the signalling and telecommunication equipment on the wayside and also electrical utilization equipment of each station and the depot.

Power transformers and distribution panels will be provided at the two MRT substations (No.1 at Guasmo, No.5 at the car depot) for high voltage power distribution; a sectionning switch will be installed at a substation (No.3) which is located at midway of the line to isolate; and distribution and signalling transformers will also be provided for low voltage power services. Electric system of high and low voltage lines is:

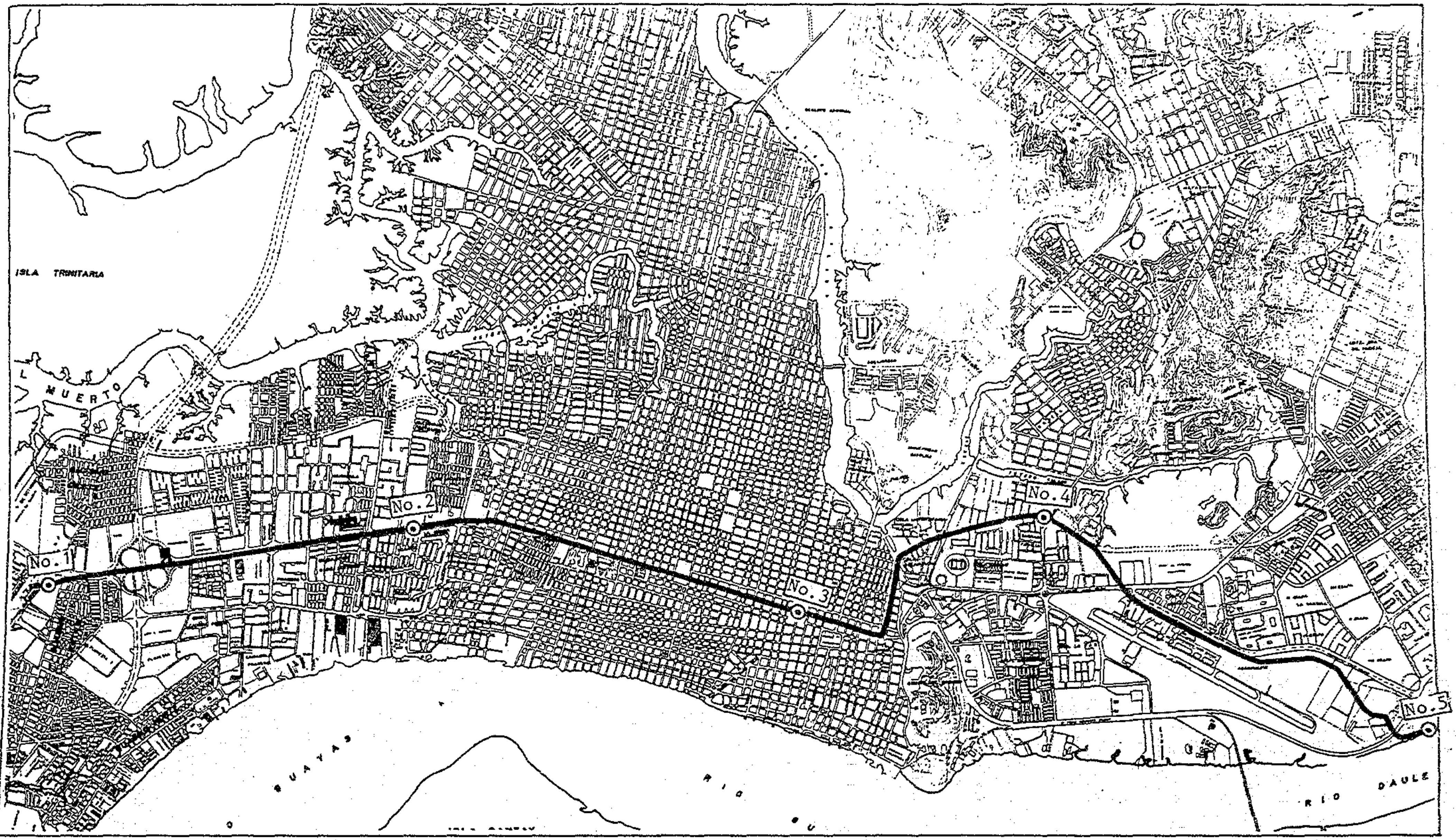
(1) High voltage lines: 60Hz, three-phase, three wires, 13.2kV

(2) Low voltage lines: 60Hz, three-phase, three wires, 208/120V-Y

60Hz, single-phase, three wires, 240/120V

Comparing with reception of a low voltage power service at each utilizing location from EMELEC, characteristics for installation of private high voltage distribution system/line is as follows:

(1) High reliability of system - electricity is supplied from the two MRT substations where the power is received from the separated transmission system



⊙ indicates location of substation (S/S)

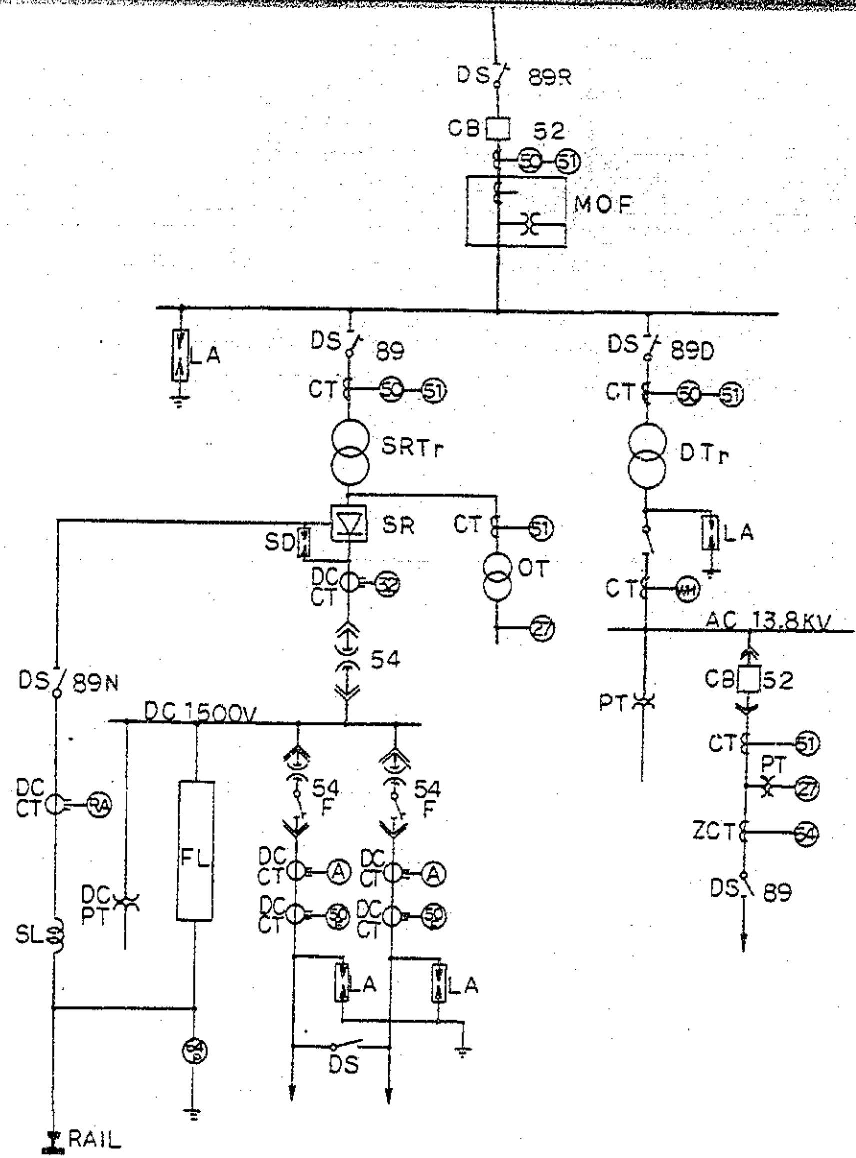
No.1 S/S: 0K000M
No.2 S/S: 3K200M
No.3 S/S: 7K000M
No.4 S/S: 10K800M
No.5 S/S: 15K300M (Depot)

THE FEASIBILITY STUDY ON GUAYAQUIL CITY URBAN TRANSPORTATION PLAN IN THE REPUBLIC OF ECUADOR

Figure 3-7.1 *LOCATION OF SUBSTATIONS*

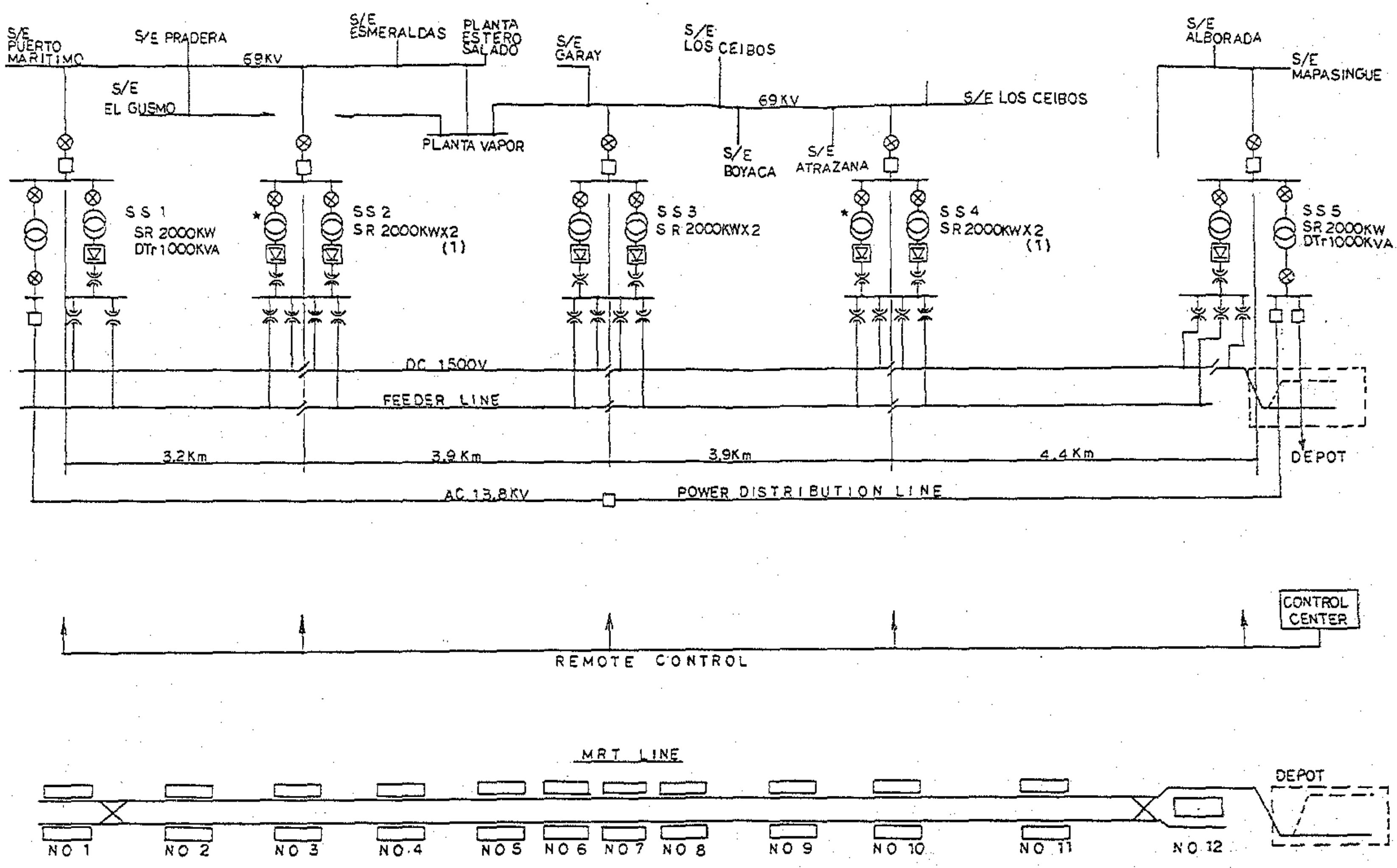
LEGEND:

SYMBOL	DESCRIPTION
A	AMMETER
CB	CIRCUIT BREAKER
CT (DCCT)	CURRENT TRANSFORMER (DC TYPE)
DS	DISCONNECTING SWITCH
DTr	DISTRIBUTION TRANSFORMER
FL	FILTER
LA	LIGHTNING ARRESTER
MOF	MEASURING OUT FIT
OT	OPERATION TRANSFORMER
PT (DCPT)	POTENTIAL TRANSFORMER (DC TYPE)
RA	RECORDING AMMETER
SD	SURGE DISCHARGER
SL	SERIES REACTOR
SR	SILICON RECTIFIER
SRTr	SILICON RECTIFIER TRANSFORMER
WH	WATT-HOUR METER
ZCT	ZERO PHASE CURRENT TRANSFORMER
27	UNDERVOLTAGE RELAY
32	DC REVERSE CURRENT RELAY
50 (50F)	SHORT-CIRCUIT SELECTING RELAY
51	OVERCURRENT RELAY
54 (54F)	DC HIGH SPEED CIRCUIT BREAKER (FEEDER)
64 (64P)	GROUND FAULT RELAY (DC TYPE)



Note: Diagram shows No.1 & No.5 substations, others exclude power distribution equipment.

THE FEASIBILITY STUDY ON GUAYAQUIL CITY URBAN TRANSPORTATION PLAN IN THE REPUBLIC OF ECUADOR	N
Figure 3-7.2 SUBSTATION MAIN CIRCUIT CONNECTION DIAGRAM	
JAPAN INTERNATIONAL COOPERATION AGENCY	



S/E : SUBSTATION OF EMELEC
SS : MRT SUBSTATION & NUMBER
SR : SILICON RECTIFIRE & TRANSFORMER
DTr : POWER TRANSFORMER FOR DISTRIBUTION

Note: Rectifire banks indicated with '*' will not be installed in 1990

-◎- : TRANSFORMER
⊠ : SILICON RECTIFIRE
-⊗- : DISCONNECTING SWITCH
-□- : CIRCUIT BREAKER
-)(- : HIGH SPEED CIRCUIT BREAKER
-/- : SECTION INSULATOR

THE FEASIBILITY STUDY ON GUAYAQUIL CITY URBAN TRANSPORTATION PLAN IN THE REPUBLIC OF ECUADOR

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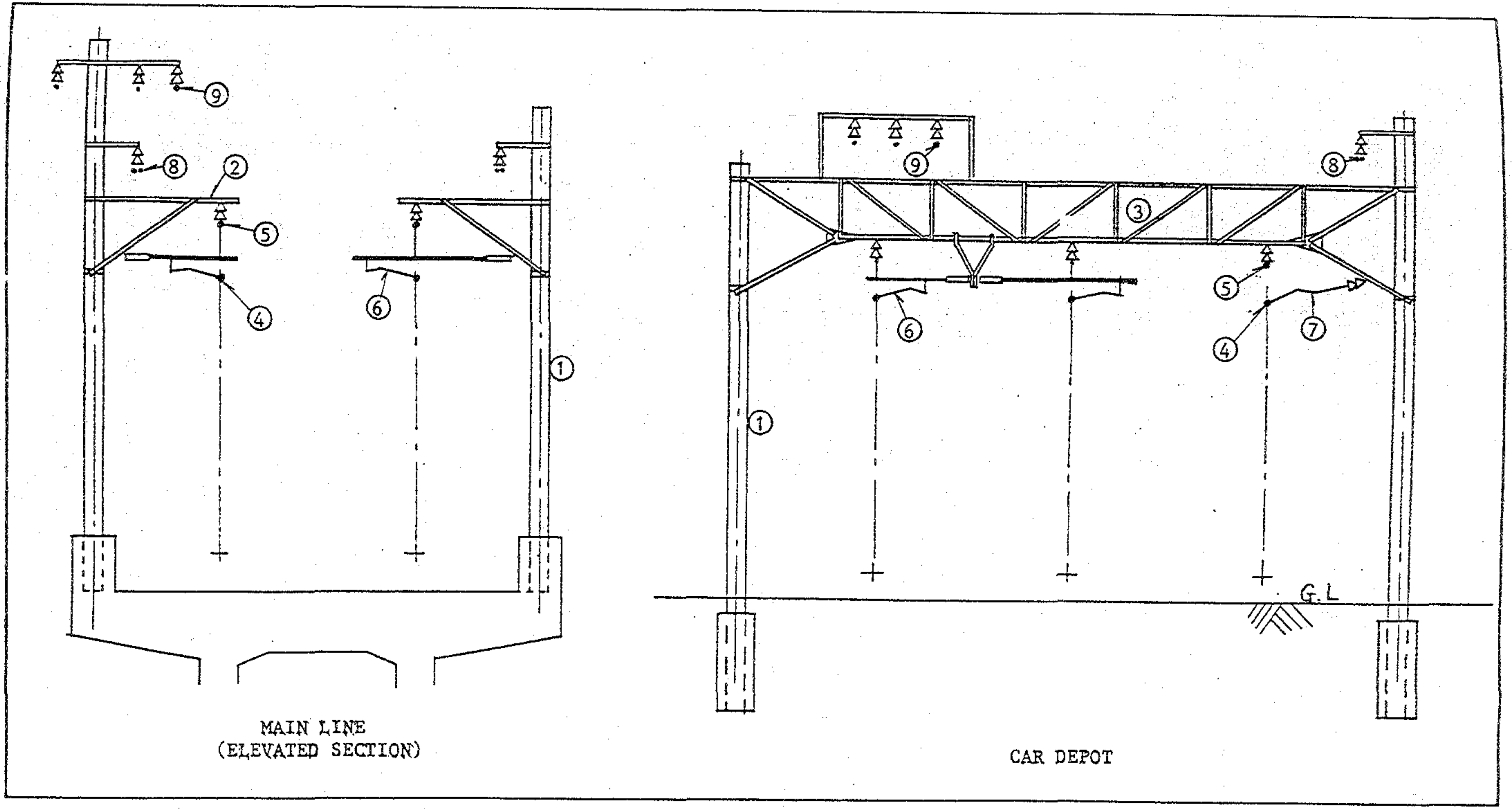
Figure 3-7.3 SCHEMATIC FEEDING DIAGRAM

JAPAN INTERNATIONAL COOPERATION AGENCY



① : Concrete Pole
② : Rigid Cantilever
③ : V-truss Beam
④ : Trolley Wire
⑤ : Messenger Wire
⑥ : Steady Device
⑦ : Pull-off Device
⑧ : Feeder Wire
⑨ : 13.2 kV Power Distribution Wire

THE FEASIBILITY STUDY ON GUAYAQUIL CITY URBAN TRANSPORTATION PLAN IN THE REPUBLIC OF ECUADOR

JAPAN INTERNATIONAL COOPERATION AGENCY

Figure 3-7.4 STANDARD ASSEMBLY FOR CONTACT LINE SYSTEM

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(2) Low probability of fault occurrences made by external cause - other customer's equipment is not connected with the system, and the line is installed within the property line

(3) Easy to make phase coordination - all power sources for the track circuits of the signalling system are rquired to be connected in phase

(4) Facility of interrelating power sources for the signalling system and train operation

3-8 Signalling System

Signalling system will be provided to ensure efficient control of high speed train operations. The system will include the following devices for signalling, train control and level crossing protection in such a pattern as designed to meet the operation characteristics of the urban transportation system. Schematic layout of the signalling equipment will be as shown in Figure 3-8.1 and 3-8.2.

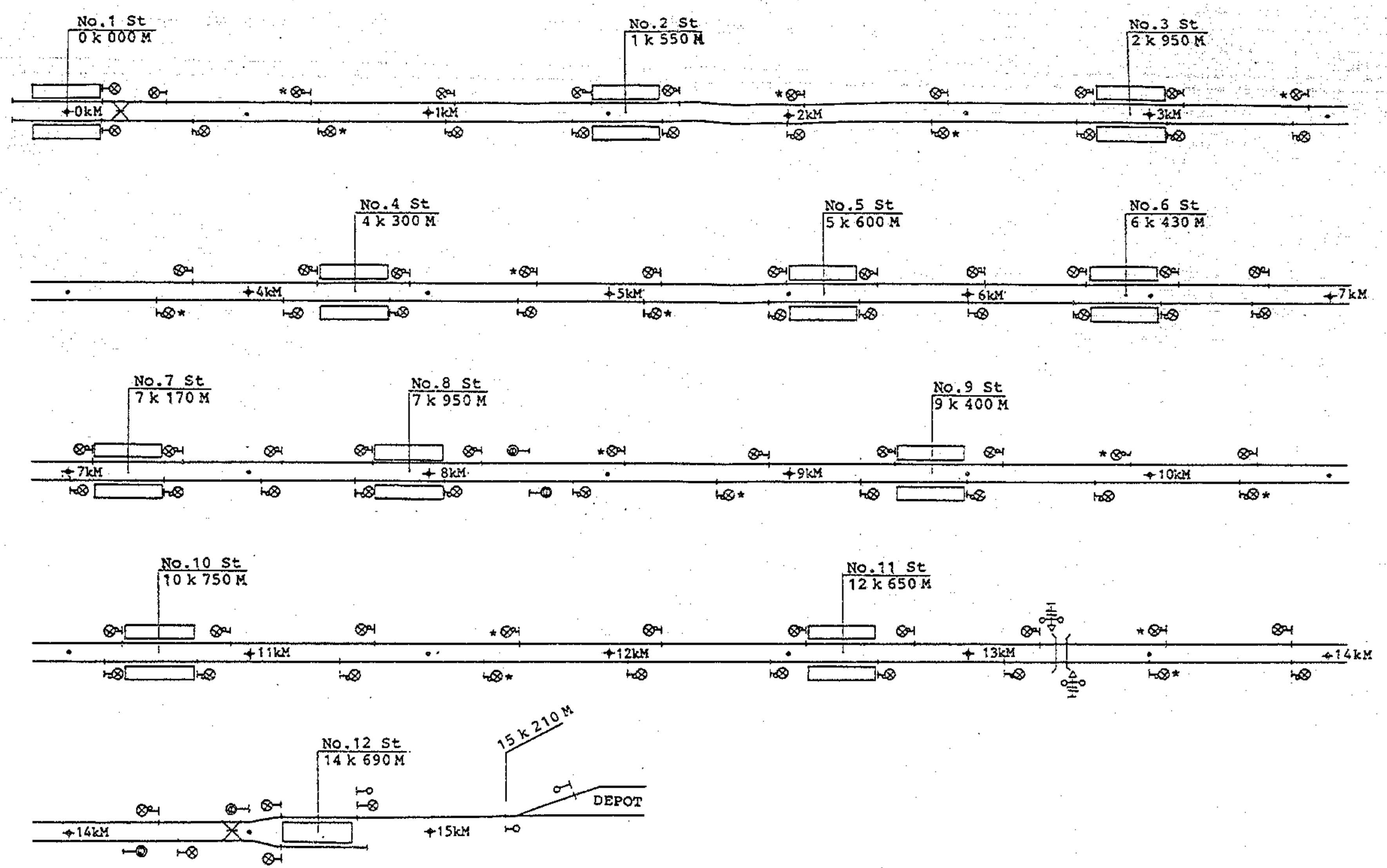
1) Signalling

Signalling is made by a combination of the signals, relay interlocking devices, electric switch machines and track circuits. Automatic block system will be adopted on the main line.

a. Signals

Color light signals will be adopted to indicate an instruction of the running condition or proceeding route clearance to a train driver. And the signals will be formed of either 2 or 3 aspects on each signal unit for separated color identification. The signals will be categorized as follows:

(1) Home signals, which will be installed at the entrances of stations to give instructions as to acceptability and unacceptability for approaching trains to the station.



: Home Signal
: Automatic Block Signal
: Shunting Signal
: Repeating Signal
: Insulated Rail Joint
: Level Crossing Equipment

Note: Block signals indicated with '*' will not be installed in 1990

THE FEASIBILITY STUDY ON GUAYAQUIL CITY URBAN TRANSPORTATION PLAN IN THE REPUBLIC OF ECUADOR

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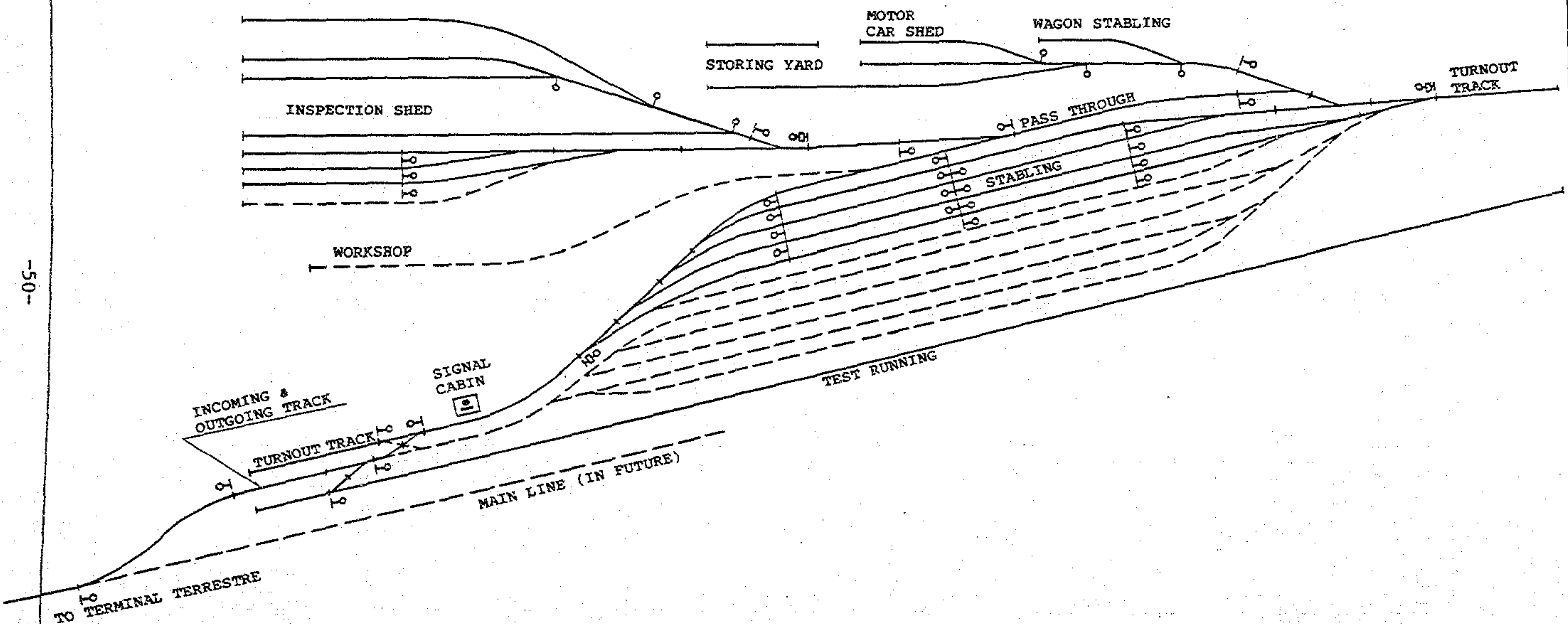
Figure 3-8.1 SCHEMATIC LAYOUT FOR SIGNALS (MAIN LINE)

JAPAN INTERNATIONAL COOPERATION AGENCY



INSULATED RAIL JOINT

HAND OPERATED SWITCH

SHUNTING SIGNAL

TURNOUT WITH NO SYMBOL IS OPERATED BY ELECTRICAL SWITCH MACHINE

THE FEASIBILITY STUDY ON GUAYAQUIL CITY URBAN TRANSPORTATION PLAN IN THE REPUBLIC OF ECUADOR

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Figure 3-8.2 SCHEMATIC LAYOUT FOR

(2) Starting signals, which will be installed at the departure tracks of stations to give an instruction of permission of departure to outgoing trains from the station.

(3) Repeating signals which will represent the signal indication appearing on the main signal, covering any shortage of the visual distance to home, starting and block signals.

(4) Shunting signals, which will be installed in the car depot to give an instruction of permission for shunting operation.

Home, starting and repeating signals will provide 3 aspects to indicate 'Proceed', 'Caution' and 'Stop'; and shunting signals will provide 2 aspects of 'Proceed' and 'Stop'. These indications are made by color lights: 'Green', 'Yellow' and 'Red'.

b. Relay Interlocking Device

Signals and electrical turnout switches will be installed to ensure safe and efficient operations for leaving, arriving and shunting of trains in the depot and terminus stations. To provide overall control of these equipment, the relay interlocking devices will be installed so as to make electrical interlocking relations among them. Relay interlocking devices will comprise control panel, and relay and instrument boards.

The control panel will provide the route indication lamps; several lamps among them are lit white to show a track clearance when the route is set up for arrival or departure of a train. The route setting will be made by depressing two push button switches at starting or entering point and arriving or existing point for a train. If the train enter the route, the indication lamp is turned to red by proceeding of the train. After the train passes through a section on the track, the lamp is switched off and returned to stanby position.

c. Electric Switch Machines

Electric switch machine will be provided to switch the turnout for desired direction as may be required to set up the cleared route for the train. Such switching will be made by the electric motor.

d. Track Circuits

Commercial frequency track circuits will be provided to detect the occupancy of trains for the automatic block system and Centralized Traffic Control System (CTC).

2) Train Control

a. Centralized Traffic Control System (CTC)

CTC will be introduced to control train operations and supervise operation conditions. The CTC Center will be located in the depot and provide operation and indication panels.

Operation panel will be provided to operate the turnout switch mahicnes on the main lines, installed with telecom equipment such as automatic and dispatch telephones, train radio and portable radio operation console. And the indication panel will schematically display faults of signalling devices and train occupancies in block sections and stations; the occupancy is indicated by white lamp(s).

Train dispatcher(s) supervises the operation conditions at the CTC Center in full time; If a train operation trouble may occur, the dispatcher will give prompt direction to a train driver, station master and/or maintenance division through the telecom system.

b. Automatic Train Stop System (ATS)

ATS will be provided to compensate a failure caused by a train driver. The ATS will automatically make warning sign to a train driver when the train is approaching a blocked section ahead; and after that, if the driver does not brake, the train will be automatically stopped by the ATS.

This system will consist of ground and on-board devices. The ground device is a wayside coil which instructs stop sign to pick-up coil on a railcar. The on-board device consists of pick-up coil, automatic brake control mechanism and warning devices.

3) Level Crossing Protection

Level crossing protection facilities will be installed for safety and protection of road vehicles and pedestrians from train operation, and for prevention of traffic accidents at the crossing. And they consist of the following devices:

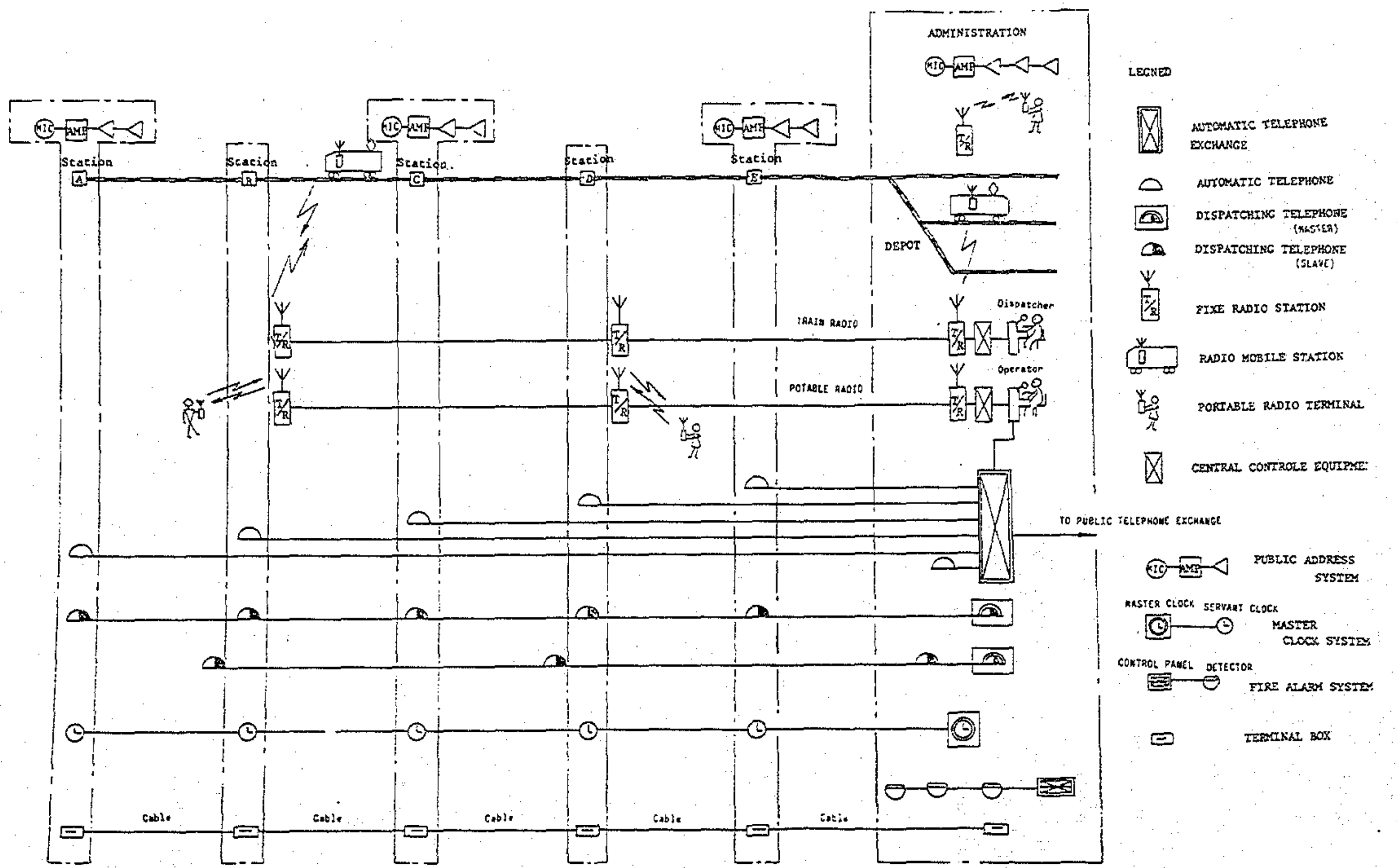
(1) Level crossing signals, which will be provided to warn vehicle drivers and pedestrians by means of alarm and red flash lights that a train is approaching the crossing.

(2) X-mark indicators will be provided as an annunciator for a train driver to confirm that the crossing signal has been completely performed.

(3) Train detectors will be provided to automatically detect an approaching train, and installed respectively at both points of alarm start and stop so that adequate time of alarming can be ensured at the crossing.

3-9 Telecommunication System

Telecommunication system will be provided to increase efficiency of administration and operation of the MRT system, and also installed to broadcast for emergency call when fire or under the urgent condition. Concept diagram of the telecom system will be as shown in Figure 3-9.1.



THE FEASIBILITY STUDY ON GUAYAQUIL CITY URBAN TRANSPORTATION PLAN IN THE REPUBLIC OF ECUADOR

Figure 3-9.1 SCHEMATIC DIAGRAM FOR TELECOMMUNICATION SYSTEM

JAPAN INTERNATIONAL COOPERATION AGENCY

1) Telephone System

a. Automatic telephones

Electronic Private Automatic Branch Exchange (EPABX) and telephones will be installed to make general communications of inter-offices and/or stations for administration, operation and maintenance of the MRT system.

The EPABX equipment will provide subscriber and extension lines for automatic telephones which will be connected with a subscriber of the IETEL network. The public telephone services will be given through the telephone exchange of IETEL Department.

Communications by extension telephone will be made as follows:

(1) Inter-office and/or station calls: directly connected by dial of extension telephones

(2) Outgoing call to a subscriber on the IETEL network: performed by dial of an extension telephone or through a telephone operator

(3) Incoming call from a subscriber on the IETEL network: carried out through a telephone operator.

The automatic telephones will be also connected with portable radio system through the telephone operator.

b. Dispatch Telephones

Train operation and electric power dispatch telephone system will be provided; for this system, the telephones will be of selective call type.

The train operation dispatch telephones will be installed at the key stations (No.1 at Guasmo, No.5 at Centro Civico, No.8 at 9 de Oct., No.12 at Terminal Terrestre) and the train dispatch center (CTC Center).

The power dispatch telephones will be installed at each substation and the power dispatch center.

2) Radio System

a. Train Radio

Train radio will be provided to communicate between a train driver and operation dispatcher when a train operation trouble or fault on signalling system may occur.

This radio system will consist of operation console at the dispatch center (CTC Center), transmitter-receivers in a cab of trains and base stations located along the MRT line.

b. Portable Radio

Portable radio will be provided for maintenance and operation of the MRT system instead of talk-back equipment and wayside telephones; and will be also used for train shunting in the depot. The radio system will be capable of communication not only in this system, but also with automatic telephone system through an operator. Operation consoles will be installed at the dispatch center (CTC Center) and signal cabin in the depot.

3) Master Clock System

Master clock system will be installed at the offices and shops in the depot and each station; and will be provided to secure accuracy of work time of the officers, laborers and to increase efficiency of their work, and also for passenger service.

The system will consist of a master equipment and slave clocks. The master equipment will be installed at the telecom equipment room of the administration building of the depot and slave clocks at each location. The master equipment will transmit 30 seconds clock pulses to drive slave clocks.

4) Public Address System

Public address system will be installed in the depot to make information announcement and emergency call or dispatch to laborers, officers and security guards from a janitor room of the administration building and/or security staff room; and will be capable of background music broadcast. And the system will be also provided at major stations for passenger services.

This system will consist of a master public address equipment, operation panels and local speakers. Broadcasting will cover separated several area, and each operation panel will be capable of selection of either overall announcement or individual selective announcement.

5) Fire Alarm System

Fire alarm equipment will be installed at the offices and shops in the depot to secure safety of officers and laborers and to minimize fire damage by early detection of the fire.

The fire alarm system will consist of a control panel, annunciators, combination boxes and detectors. The control panel will be installed at the janitor room of the administration building and/or security staff room and generate fire signal and alarm from each building and/or site of the depot. Annunciators will be installed at the security office, and indicate fire signs with alarm transferred from control panel. Combination boxes and detectors will be installed at each office, shop and site where staff and laborers are usually working; and will be provided with an alarm bell, manual transmitter, location lamp and telephone jack.

3-10 Car Depot and Maintenance Shops

1) General

This car depot will have responsibilities for daily check, inspection, repair and stabling of electric railcars. The headquaters of the MRT and the CTC (Centralized Traffic Control) center will be located in this depot and this depot will be a base for control and administration of the whole MRT system including drivers of the main line train operation.

The site of this depot was selected with emphasis on the following considerations:

(1) The loss of time in deadhead run of trains should be minimized.

(2) The car depot should permit further expansion in the future.

(3) The car depot should not conflict with the plans of future land development and road construction.

(4) The site should be wide enough to stable the cars and install facilities required.

For fulfilment of abovementioned consideration, a site having about 98,000 sq meter in area which is located on the north side of Terminal Terrestre in-between the River Daule and the intended bus highway will be most suitable for the car depot.

Furthermore the location of this depot will be the most suitable for incoming and outgoing trains between the depot and the terminal station.

The facilities to be constructed in this depot will be as follows:

(1) Headquarters for mass rapid transit system

(2) Centralized control and administration center for train operation and electric power

(3) Stabling tracks for the 5-car trains

(4) Following facilities for the inspection of electric railcars of 5-car train formation

   i. facilities for daily inspection, monthly inspection and temporary inspection
   ii. facilities for car washing, cleaning and sweeping
   iii facilities for wheel tread reprofiling

(5) Workshop facilities for general inspection and principal equipment inspection of electric railcars
(Open to work from the year 1993)

(6) Facilities for maintenance of track facilities

(7) Facilities for maintenance of equipment of electric power supply, telecommunication and signals

(8) Material store

(9) Train drivers office

The land of this depot has a triangle shape and the depot will be planned taking the following matters into consideration.

(1) Train operation in and out of the depot should be able to be conducted directly from and to the terminal station without switch-back operation.

(2) The stabling track group will be planned so as to stable two train formations on each track. And north and south ends of every stabling track should be lead to the turnout track laid north and south respectively so as to be able to carry out shunting operation of train formation from each stabling track without any extra shunting of other trains.

(3) The workshop and inspection shed should be planned so as to be built close each other taking the common use of facilities into consideration. Before the completion of the workshop, car repair should be able to be carried out in the temporary inspection shed.

(4) The headquarters office and centralized control center should be placed at the suitable position to allow easy access of the related persons from the outside of the depot.

The number of electric railcars and train formations at the planning stage for construction of the depot is shown on the following Table 3-10.1.

Table 3-10.1 NUMBER OF ELECTRIC RAILCARS AND TRAIN FORMATIONS

Item	Initial stage	Final stage
Number of cars	70	135
Number of train formations	14	27

2) Stabling Facilities for Train Formations and Track Arrangement inside the Car Depot

All train formation except the trains to be stabled at the station yard for the first trains in the morning will be stabled in the depot. These train formations will be stabled on the stabling tracks, inspection tracks and other tracks.

The train formation stabling capacity of this depot is shown on the Table 3-10.2.

Table 3-10.2 CAR STABLING CAPACITY

(Unit: Train formation)

Place	Initial Stage	Final Stage
Station yard	2	2
Stabling track	7	19
Monthly inspection track	1	1
Daily inspection track	1	2
Cleaning track	2	2
Workshop	1	1
Total	14	27

Each stabling track should be able to stable two 5-car trains.

Each end of the every stabling track will lead to the east and west turnout track respectively so as to carry out the shunting operation without any extra shunting operation of other trains. And track arrangement inside the depot should be planned so that the movement of train between the stabling track and the inspection shed will not affect the incoming and outgoing operation of trains between the depot and the station.

The track arrangement in the depot should be planned to adopt No. 6(1:6) turnout for siding track and No. 8(1:8) for branch point from the main line track, and 100 meter of minimum radius of curvature for tracks.

The layout of the depot is shown on the Figure 3-10.1.

3) Inspection System of Electric Railcar

a. Kinds, Intervals and Places of Inspection

The kinds and intervals of inspections was determined as shown in Table 3-10.3 in consideration with the performance, characteristics and function of car equipment and optimum car performance between inspections will be ensured and superfluity of maintenance service will be avoided.

The places in charge of inspection, on the other hand, are determined in consideration of required inspection time, train operation schedule and degree of parts dismantling of car for inspection.

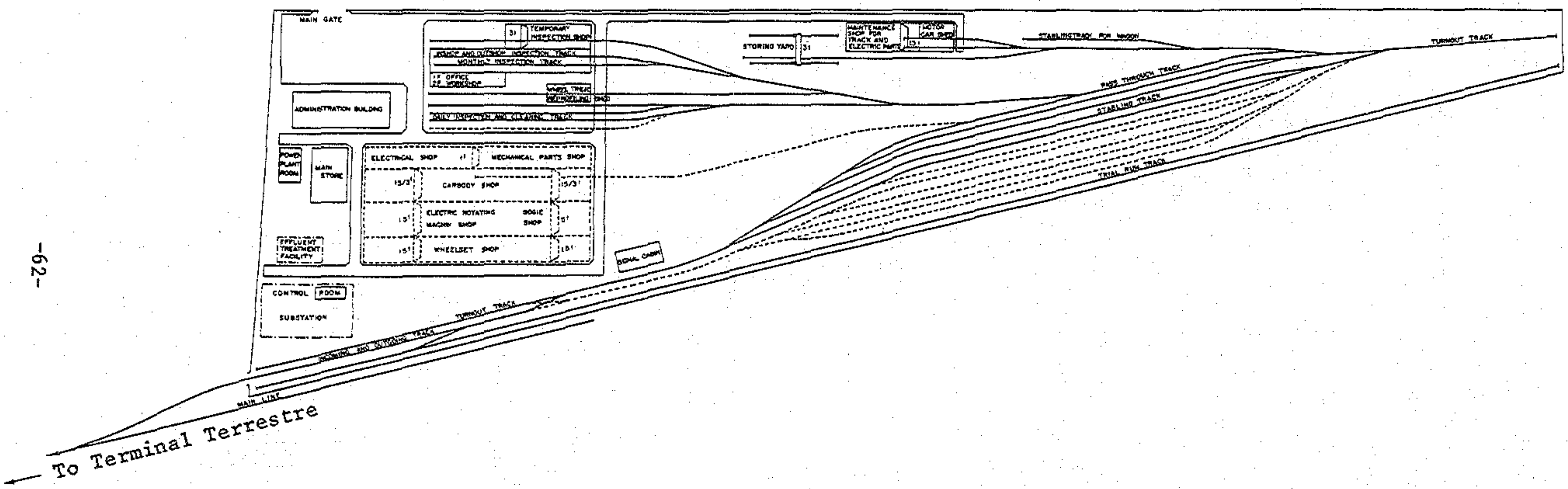


Figure 3-10.1 LAYOUT OF DEPOT

Note:
1. Workshop is constructed in the second stage and opens its operation in 1993.
2. Stabling tracks shown in dotted line are constructed in conformity with the increase of rolling stock.

Table 3-10.3 INTERVALS AND PLACES FOR INSPECTION

Type of Inspection	Procedure	Inspection Interval	Running Kilometerage	Inspection Place
General Inspection	Cars are completely dismantled of their equipment and all parts are completely inspected and repaired.	4 years or less	600,000km or less	Workshop
Principal Equipment Inspection	Principal equipment is dismantled, disassembled, inspected and repaired.	2 years or less	300,000km	Workshop
Monthly Inspection	Car equipment is inspected in the working order on its functions	60 days or less		Inspection Shed
Daily Inspection	Cars are inspected in the working order in the intervals of train operation.	48 hours or less		Inspection Shed
Termporary Inspection	Inspection is conducted whenever need arises from trouble of cars.	Inshop rate 0.1/year		Workshop or Inspection Shed

Note: 1. When an upper grade inspection on the table is executed, the inspections of lower grade are deemed to have been executed at the same time.

2. Inspection should be made according to described conditions of running kilometerage or intervals whichever become applicable first.

b. Classification of Car Cleaning

The train formations will be cleaned according to the following classifications as shown on Table 3-10.4.

Table 3-10.4 CLASSIFICATION OF CAR CLEANING

Type of Cleaning	Interval	Procedure		Place
Major Cleaning	30 days	Passenger Room	Floor, windows, doors, panel boards and other things in the room are cleaned and dis-infected.	Cleaning track
		Body	Car ends are cleaned	-ditto-
			Car sides are cleaned	-ditto
Medium Cleaning	6 days	Passenger-Room	Window, floor and seats are cleaned.	-ditto-
		Body	Car ends are cleaned	-ditto-
			Car sides are cleaned	-ditto
Sweeping	Everyday	Passenger Room	Floor and seats are sweeped	Stabling track

c. Methods of Inspection and Repair

c-1 Workshop

(1) Trains enter the workshop in 5-car formation for general inspection and principal equipment inspection, and they also leave the workshop in 5-car formation when inspection is finished.

(2) To keep the work load evenly, half the train is given general inspection and the other half is given principal equipment inspection.

(3) The major works to be carried out in the workshop are as follows.

i. The body and bogie of each car are separated and put together by overhead travelling cranes.

ii. The car is dismantled of its equipment on a fixed rest, using mechanical power to remove heavy parts.

iii. Car bodies are painted in an isolated shop.

iv. Car equipment are inspected and repaired in the exclusive shop for repair.

(4) Two kinds of trail run are necessary: one on the trial run track inside the depot yard; and the other on the main line. The trail run on the main line is to be carried out according to the timetable.

c-2 Inspection shed

(1) The monthly inspection is conducted during the daytime in a state of 5-car train formation in working condition.

(2) The daily inspection is also conducted during night and daytime in a state of 5-car train formation in working condition.

(3) Tread of wheels are reprofiled in the interval of train operations during the daytime in a state of 5-car train formation in working condition.

(4) Parts and consumables needing replacement are replaced in the shop.

(5) Cars are cleaned, sweeped and washed in the interval of train operations during the daytime in a state of 5-car train formation.

c-3 Annual working days of workshop and inspection shed

The annual working days of the workshop and inspection shed will be as follows:

Workshop	250 days
Inspection shed	
Monthly inspection	250 days
Daily inspection	365 days
Major cleaning	250 days
Medium cleaning	365 days
Sweeping	365 days
Wheel tread reprofiling	250 days

d. Inspectionwise Annual Number and Standard Required Days (Hours for Inspection)

The annual number of the inspection is calculated from the following formula:

$Im = N.a$

where,

Im number of inspection of car (train formations/year)

N total number of train formations

a cycle of inspection (times/year)

The cycle of the inspection is determined from the inspection intervals estqablished for each kind of inspection.

d-1 Number of car inspection

The annual number of train formations for each kind of inspection will be as shown on Table 3-10.5.

Table 3-10.5 INSPECTIONWISE ANNUAL NUMBER OF TRAIN FORMATIONS

Inspection	Initial Stage	Final Stage
General Inspection	3.5	7
Principal Equipment Inspection	3.5	7
Monthly Inspection	78	151
Daily Inspection	2,400	1,628
Major Cleaning	171	329
Medium Cleaning	680	1,312
Wheel Tread Reprofiling	14	27
Temporary Inspection	1.4	2.7

d-2 Inspectionwise required number of days (hours) excluding holidays

The inspectionwise required number of days (hours excluding holidays will be as shown on Table 3-10.6

Table 3-10.6 INSPECTIONWISE REQUIRED NUMBER OF DAYS (HOURS) EXCLUDING HOLIDAYS

Inspection	Number of Days (Hours)
General Inspection	22 days Principal
Principal Equipment Inspection	22 days
Monthly Inspection	1 day
Daily Inspection	2 hours
Major Cleaning	4 hours
Medium Cleaning	1 hour
Wheel Tread Reprofiling	2 cars/day
Temporary Inspection	5 days

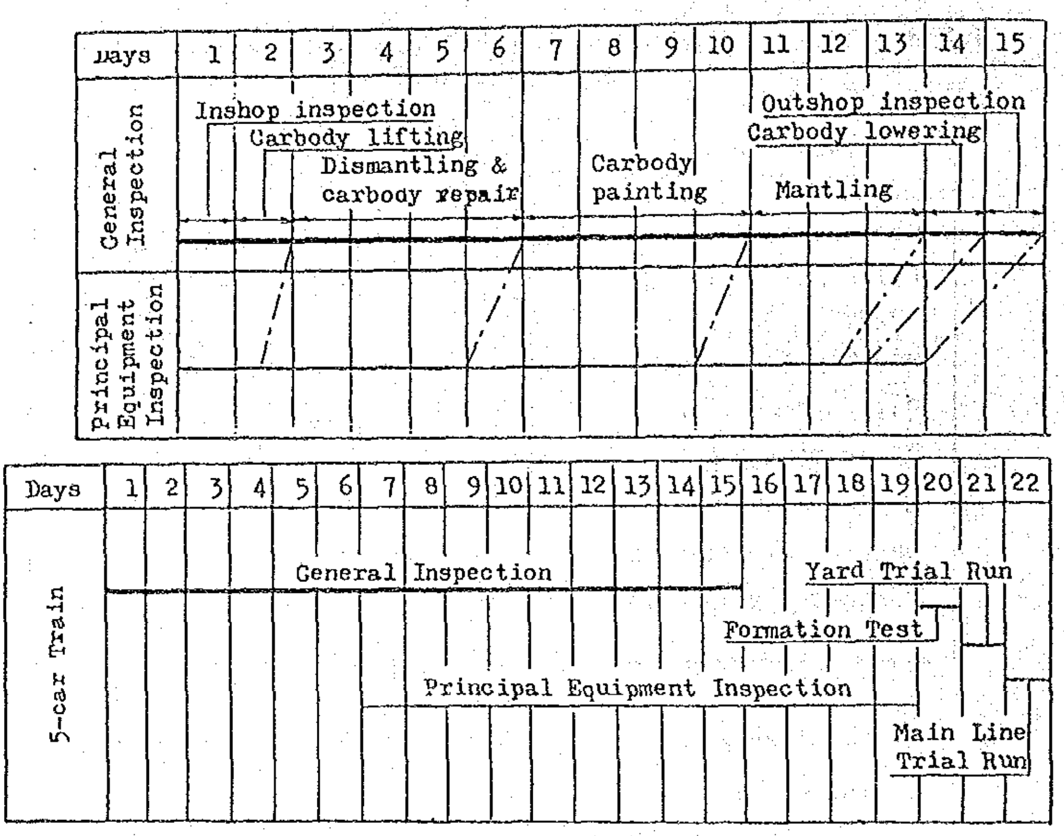
d-3 Standard schedule of general and principal equipment inspection

To unify the work load of repair works incidental to general inspection and principal equipment inspection, inshoped 5-car train formation will be divided into two groups as one is McMT and other is MMc, and for the half of the train formation the general inspection will be executed and the other half the principal equipment inspection will be performed.

The standard required days for combined inspection of train formation will be 22 days. The required number of days for the general inspection will be 15 days and for the principal equipment inspection will be 13 days. After completion of the inspection, one day for formation test and two days for yard trial run and main line trial run will be required.

The standard schedule of the general and principal equipment inspection will be as shown in Figure 3-10.2.

Figure 3-10.2 STANDARD SCHEDULE OF GENERAL AND PRINCIPAL EQUIPMENT INSPECTION



d-4 Number of train formations (cars) stayed simultaneously in workshop and inspected per day in inspection shed

The number of train formations(cars) stayed simulataneously in the workshop and inspected per day in the workshop will be as shown on the Table 3-10.7 and it is determined from Table 3-10.5, 3-10.6 and the Figure 3-10.2.

Table 3-10.7 NUMBER OF TRAIN FORMATIONS (CARS) STAYED PER DAY

Inspection		Initial Stage	Final Stage
Workshop (cars)	General Inspection	2	3
	Principal Equipment Inspection	2	
Inspec-tion shed (forma-tions)	Monthly Inspection	0.14	0.61
	Daily Inspection	6.58	12.68
	Major Cleaning	0.68	1.32
	Medium Cleaning	1.86	3.60
	Wheel Tread Reprofiling	0.28 cars	0.54 cars
	Temporary Inspection	0.03 cars	0.27 cars

4) Facility Plan of Workshop

a. General

The workshop shall have a such a scale that car dismantling, parts disassembling, repairs, tests, parts assembling, and fitting-out required for general inspection and principal inspection could be all accomplished within the prescribed period.

The workshop should be provided with the facilities in conformity with the method of car inspection and repair and the equipment layout should be rational to suit for the flow of inspection and repair work.

Moreover, the workshop should be so planned that the unexpected temporary inspection and repair of cars could be performed.

b. Scale of Facilities

The scale of facilities of the workshop should be determined as shown in Table 3-10.8 from the number of train formations (cars) stayed simultaneously shown in Table 3-10.7.

Table 3-10.8 SCALE OF REPAIR SHOP

Inspection	Initial Stage	Final Stage
Maximum number of cars stayed simultaneously in shop	5 cars	5 cars
Carbody repair shop	5 cars	5 cars
Carbody painting shop	2 cars	2 cars
In-shop & out-shop Inspection Shed	5 cars on one track	5 cars on one track
Temporary Inspection Shed	2 cars	2 cars

c. Plan of Shops and Its Arrangement

The workshop layout should be so planned that the carbody lifting (form the bogie), carbody dismantling, carbody repairs, bogie repairs and parts repairs could be performed in a systematic manner.

c-1 In-shop and out-shop inspection track

One inshop and outshop inspection track having inspection pit with side pit for general inspection and principal equipment inspection of 5-car train formation should be provided in the monthly inspection shed.

c-2 Carbody repair shop

Carbody lifting, dismantling, carbody repair, fitting-out and carbody mounting should be performed in the same carbody repair shop. The car holding capacity will be so planned that it hold 5 cars in the initial stage and also in the final stage.

Cars will be moved from place to place by two overhead travelling cranes in this shop.

c-3 Carbody painting shop

The carbody painting shop which can hold 2 cars will be arranged in the inner part of the carbody repair shop. In consideration of air pollution by painting, the painting shop will be isolated from other shops.

c-4 Repair shops of bogies, wheelsets and electric rotating machine

A shop for bogie disassembling and reassembling will be arranged at the next bay to the carbody repair shop, and repair shops of bogies, wheelsets and electric rotating machine will be arranged around the shop for bogie disassembling and reassembling to perform the repair work in a systematic manner and save time in transport. In planning the wheelset shop work flow will be taken into account such as the relationship between the rolling direction of wheelsets and the machine layout.

c-5 Parts repair shop

The repair shop of electric parts and brake equipment will be concentrated according to the type of repair work apart from the shops for car repair, such as bogie, wheelsets and electric rotating machine repair and painting.

c-6 Yard trial run track

A track for running test of repaired cars will be located along the east boundary inside the depot so that the yard trial run may not be restricted by any shunting operations inside the depot and incoming and outgoing operations between the depot and the terminal station.

c-7 Temporary inspection shop

The shop for repair of temporarily inshoped cars which could hold two cars will be planned jointly with the monthly inspection shed.

d. Mechanical Equipment

The followings are the main considerations in the planning of mechanical equipment.

d-1 Assurance of required car performance and function

Electrical and mechanical testing machines and machine tools which are required to ensure optimum performance of car equipment will be planned.

d-2 Safety and saving of manpower in heavy parts transport

Carbody will be lifted and lowered by overhead travelling cranes. Necessary transportations will also be provided to ensure the safety of workers and to avoid the use of manpower in the transport of heavy parts.

d-3 Maintenance of working environment

Proper mechanical equipment for air blasting, cleaning and painting will be provided to maintain a good environment for the workers.

5) Facility Plan of Inspection Shed

a. General

The facilities for monthly inspection and auxiliary works will be concentrated in one building. And daily inspection, car cleaning and wheel tread reprofiling will be performed on one and the same track group to facilitate the administration of inspection works.

A turnout track will be provided, because one switch back operation of train formation will be required to move it from the inspection tracks to the stabling track on account of land restraints.

b. Scale of Facilities

The scale of inspection facilities will be determined as shown in Table 3-10.9 from the number of train formations(cars) stayed simultaneously shown in Table 3-10.7.

Table 3-10.9 SCALE OF INSPECTION SHED

Track	Initial Stage	Final Stage
Monthly Inspection Shed	1 track	1 track
Daily Inspection Track	1 track	2 track
Cleaning Track	1 track	2 track
Wheel Tread Reprofiling Track	1 track	1 track

Note: Each track will be able to hold one 5-car train formation.

c. Layout of Inspection Facilities

c-1 Monthly inspection shed

Two inspection tracks each of which has inspection pit for monthly inspection and in-shop and out-shop inspection will be installed in this shed building.

c-2 Auxiliary shop

A two storied auxiliary shop building for the repair work of car parts, holding an office for car inspectors and material store will be planned annexed to the monthly inspection shed building.

c-3 Daily inspection, car cleaning and wheel tread reprofiling tracks

Three tracks for daily inspection and cleaning each of which can hold one 5-car train formation will be arranged in parallel with the monthly inspection shed building.

A wheel tread reprofiling track will be planned between the car cleaning track and the monthly inspection shed building. This track could hold one 5-car train formation each before and behind the wheel tread reprofiling machine installed at the middle of the track which can be used without disturbing the use of other tracks.

c-4 Turnout track

A turnout track for shunting of 5-car train formations between the stabling tracks and the track group of inspection shed and workshop will be laid at extended portion which is diverged to the end of the stabling track group.

d. Mechanical Equipment

The works in the inspection shed will include the following:

i. Checking the operating condition of car equipment from the outside in the working condition of train formation.

ii. Replacement of consumables

iii. Maintenance of normal wheel tread profile for safety operation of car and for comfortable riding for passengers.

iv. Car cleaning

The inspection shed will therefore be provided with simple testing equipment and wheel tread reprofiling machine.

6) Maintenance Facilities for Track, Electric Power and Signalling

Track maintenance shop should be so equipped that turnouts needing repair could be disassembled, repaired and assembled. And shop for maintenance of facilities of electric power and signals will be provided in the same shop building.

A motor car shed for stabling and daily check of motor car will be planned so as to connect with the track maintenance shop building.

A material stock yard which have one gantry crane will be planned near this building for storing rails, cable drums and other heavy track materials.

7) Administration Building and Other Buildings

a. Administration Building

The administration building will be placed at a suitable place to allow eacy access of related persons from the outside the depot.

The headquarters of the MRT, the CTC control center and the drivers office will be planned in this building.

And this building will be the multi-storied structure with centralized airconditioning facilities.

b. Main Store

The main store for stocking materials for maintenance of cars, track facilities, and electrical facilities will be planned at the south of the workshop building.

c. Signal Cabin

A signal cabin will be placed near the neck portion of the stabling track group to the incoming and outgoing track for convenience of observation of movement of incoming and outgoing cars in and from the depot and of shunting operation inside the depot.

d. Substation

The substation will be planned at a suitable place.

(The Major machines, mechanical facilities and instruments will be as Appendix 1-8.)

4. Construction Method and Schedule

4-1 Outline

In order to construct big structures in an urban area it is absolutely necessary, in the first place, to adopt measures for making road traffic smooth, securing safety and eliminating impediments due to construction (noise, vibration, obstacles, etc.), and second to construct economically and efficiently.

Since there are a large traffic volume and obstacles in the construction section along the MRT, it is necessary to carry out detailed preliminary survey in the stage of execution including traffic flow survey.

4-2 Construction Methods for Main Structures

In construction, its methods vary depending on the location and space of each working site. As this construction plan includes to construct viaducts within the road sites, it is important to secure the working sites.

The working sites and construction methods are as follows:

(1) For Av. 25 de Julio and Av. San Jorge, the existing median strip is used as the working site.

(2) For Av. Quito, a working site 7.0 m wide is secured in the central zone of the street.

(3) In executing the substructure construction for grade-separated crossing with 2 to 3 spans (portal piers), the road traffic is regulated so as to keep one side traffic. As for the other substructures, their construction is carried out within the abovementioned working site and no special methods are required.

(4) In erecting the superstructures, the most suitable erection method is employed to meet the conditions of each working site and traffic regulation (traffic suspension) is practiced within the intersecting area temporarily. Figure 4-2.1 shows typical erection methods applicable to this project.

Regulation on the road traffic is required for executing both substructure and superstructure constructions. Since most of the structures are reinforced concrete made, on-site execution is possible but foreign expert engineering assistants are required for track construction, electrification, etc.

4-3 Construction Schedule

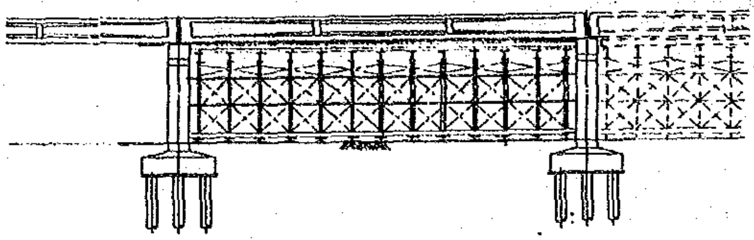
Figure 4-3.1 shows the construction schedule made based on following conditions:

(1) The MRT commences its service on January, 1990.

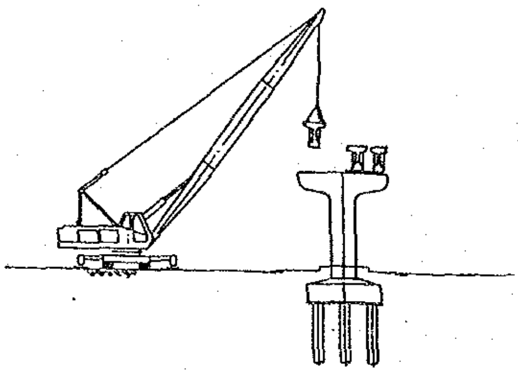
(2) To make total construction period shorter, construction is carried out on full turn-key contract which includes survey and detailed design.

(3) Workshop in the depot is excluded in the schedule and it is constructed within 3 years after opening of service.

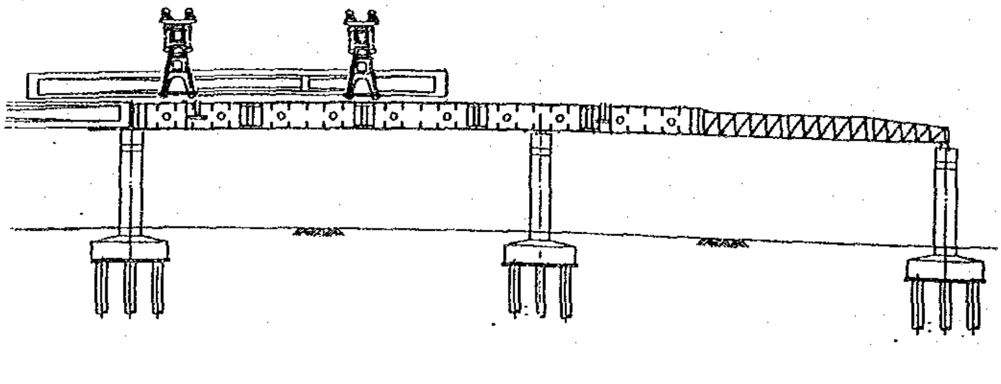
Figure 4-2.1 ERECTION METHODS



Staging Erection

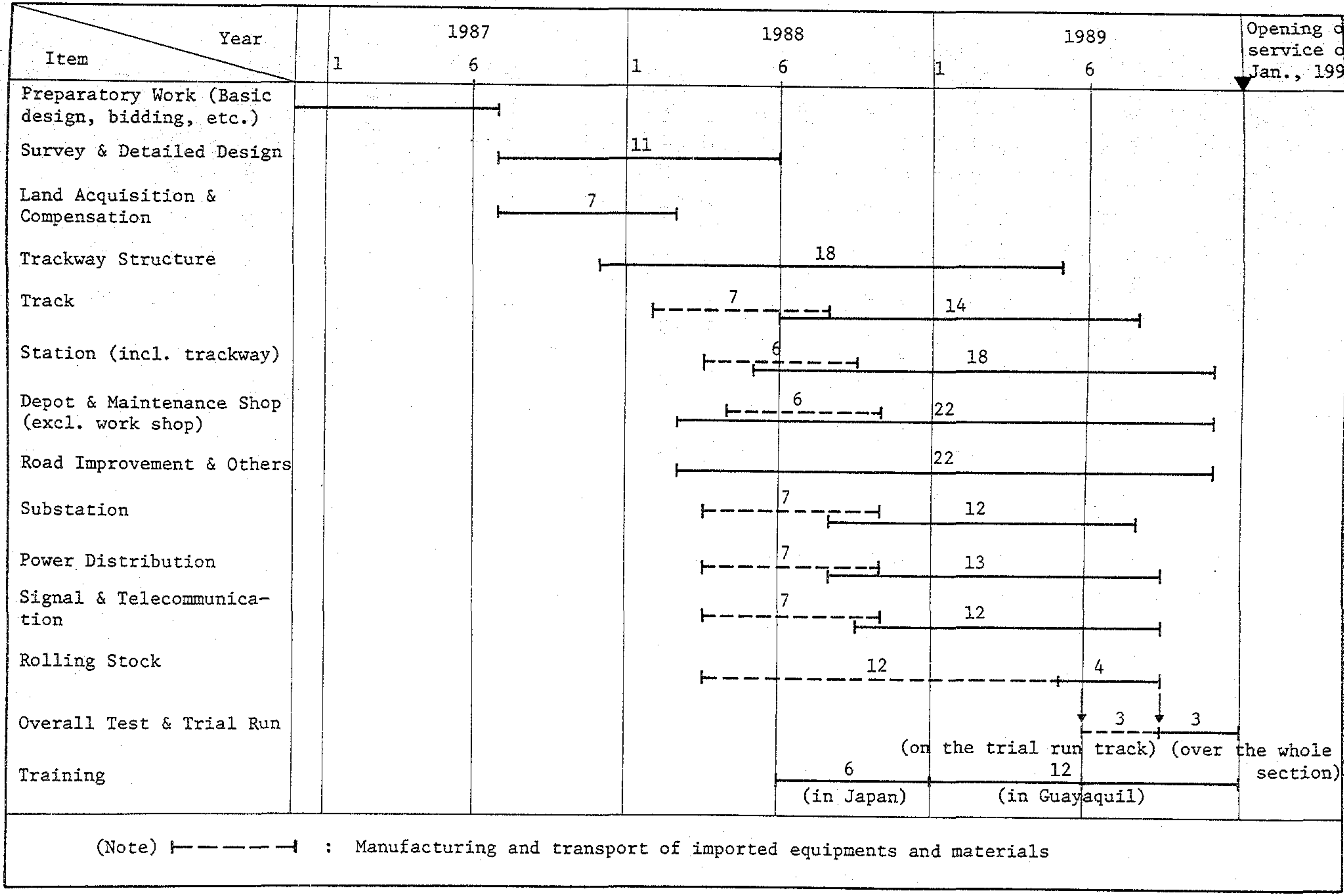


Erection by Crane



Launching Erection

Figure 4-3.1 CONSTRUCTION SCHEDULE



5. Project Cost Estimation

5-1 Premises

(1) Project cost estimates are to be carried out based on the prices on commercial base (not economic price) as of October 1985, giving no consideration to inflation.

(2) It should be assumed that all imported materials and equipments are free of import tax. (However, in estimating the hire of the machinery for construction works which can be used widely for various purposes, consideration should be given to tax.)

(3) Cost estimates are to be split into foreign currency and local currency.

(Prices to be estimated on the foreign currency basis)

- Cost for purchasing imported materials and equipments (FOB)
- Costs of marine freight of the imported materials and equipments as well as insurance premium
- Personnel expenses of the foreigners engaged in design and supervision, and management overhead

(Prices to be estimated on the local currency basis)

- Cost for purchasing local materials (Prices including the 6% commodity tax should be used.)
- Local transportation cost
- Labor expenses for local laborers (Management expenses of local companies should be included therein.)
- Cost of purchase or rent of machinery locally supplied.

(4) Basic unit costs used for the estimation are the prices as of October 1985 and they are shown in Table 5-1.1, 5-1.2 and 5-1.3.

(5) Project cost is to be presented in the local currency (Sucres).

The exchange rate should be 1US$ = 120 Sucre = 210 Japanese yen and 1 Sucre = 1.75 yen (as of October 1985).

5-2 Project Cost

The project cost estimated based on the premises in the former section 5-1 is shown in Table 5-2.1.

As shown in the table, the project cost is estimated divided into 5 staged years (1990, 1993, 1996, 2000 and 2010). Of these staged costs, the cost in 1990 is the initial cost for opening of service and the costs in other 4 staged years are the additional costs to increase transport capacity in conformity with estimated demand, and in addition, cost of the workshop is added in 1993.

Further details of cost estimation are shown in Appendix 1-9.

Table 5-1.1 UNIT COSTS OF CONSTRUCTION MATERIALS

(Prices in 1985)

Item	Unit	Unit Cost (sucres)	Remarks
Cement	bag	300	in bag (50 kg/bag)
Sand	m^3	675	
Gravel	m^3	750	
Crushed stone	m^3	350	
Ready-mixed concrete	m^3	5510 ~ 6980	FC = 210 kg/cm^2 ~ 380 kg/cm^2
Steel-bar	t	41,880	deformed bar (ϕ8 – 32 mm)
Shape steel	t	45,000 ~ 62,500	angle, channel, etc.
Plywood	m^2	390 ~ 540	12 m/m ~ 18 m/m.
Paint	liter	180	
Concrete pipe	m	1,760	ϕ = 525 m/m (plain concrete)
	m	13,700	ϕ = 1050 m/m (reinforced concrete)
Concrete pole	m	950 ~ 1240	ϕ = 350 ~ 700 m/m
Vinyl chloride pipe	m	110 ~ 630	ϕ = 50 ~ 150 m/m
Slate	m^2	1,100	
Concrete block	m^2	460	for floor
Electric wire	roll	1,360	(100 m)
Transformer	ea	15,100	50 KVA

Source: CAMARA DE LA CONSTRUCCION DE GUAYAQUIL and statements from private contractors in Guayaquil.

Table 5-1.2 LABOR WAGES

(Wages in 1985)

Kind of Labor	Minimum Wages (sucres/month)
Legal minimum wages	8,500
Laborer	8,800
Laborer master	9,000
Craftsman	9,250
Skilled workman	9,700
Assistant foreman	10,450
Foreman	11,350
Heavy machine operator	16,200
Assistant operator	9,600
Mechanic	17,400
Assistant mechanic	9,600
Welder, Electrician	14,400
Driver	12,000

Source: CAMARA DE LA CONSTRUCTION DE GUAYAQUIL.

Table 5-1.3 LAND AND COMPENSATION COST

(Costs in 1985)

Item \ Cost	Cost (sures/m^2)	
Land Cost	300 - 7,800	(based on the valuation by IESS*)
Compensation Cost (by material of buildings)	Bamboo	5,000
	Mix of bamboo and concrete	15,000
	Concrete	25,000

*IESS = Instituto Ecuatoriano de Seguridad Social
(Ecuadorian Institute of Social Security)

Table 5-2.1 PROJECT COST (SUMMARY)

CASE: Basic Case

(Unit: Million Sucres in 1985 Prices)

	Item / Year / Currency		1990 L.C	1990 F.C	1990 Total	1993 L.C	1993 F.C	1993 Total	1996 L.C	1996 F.C	1996 Total	2000 L.C	2000 F.C	2000 Total	2010 L.C	2010 F.C	2010 Total	TOTAL L.C	TOTAL F.C	TOTAL Total
Civil Work	Track	(A.1)	687	484	1,181	-	-	-	-	-	-	-	-	-	-	-	-	687	494	1,181
Civil Work	Structure of Way	(A.2)	4,502	5,167	9,669	-	-	-	-	-	-	-	-	-	-	-	-	4,502	5,167	9,669
Civil Work	Station	(A.3)	792	1,435	2,227	-	-	-	-	-	-	-	-	-	-	-	-	792	1,435	2,227
Civil Work	Depot & Maintenance Shop	(A.4)	588	838	1,436	324	678	1,002	36	46	82	-	-	-	23	42	65	971	1,604	2,575
Civil Work	Miscellaneous	(A.5)	455	201	656	-	-	-	-	-	-	-	-	-	-	-	-	455	201	656
Civil Work	Sub-total	(A)	7,024	8,135	15,159	324	678	1,002	36	46	82	-	-	-	23	42	65	7,407	8,901	16,308
Electrical Facilities	Substation	(B.1)	175	963	1,138	4	55	59	-	-	-	8	110	118	-	-	-	187	1,128	1,315
Electrical Facilities	Power Distribution	(B.2)	180	385	565	-	-	-	-	-	-	1	0	1	-	-	-	181	385	566
Electrical Facilities	Signal & Telecommunication	(B.3)	60	338	398	-	-	-	-	-	-	2	15	17	-	-	-	62	353	415
Electrical Facilities	Others	(B.4)	31	0	31	-	-	-	-	-	-	-	-	-	-	-	-	31	0	31
Electrical Facilities	Sub-total	(B)	446	1,686	2,132	4	55	59	-	-	-	11	125	136	-	-	-	461	1,866	2,327
Rolling Stock (Number of rolling stocks)		(C)	28	5,327	5,355 (70)	4	761	765 (10)	8	1,522	1,530 (20)	2	381	383 (5)	12	2,283	2,295 (30)	54	10,274	10,328 (135)
Land	Land Acquisition	(D.1)	145	0	145	-	-	-	-	-	-	-	-	-	-	-	-	145	0	145
Land	Compensation	(D.2)	117	0	117	-	-	-	-	-	-	-	-	-	-	-	-	117	0	117
Land	Sub-total	(D)	262	0	262	-	-	-	-	-	-	-	-	-	-	-	-	262	0	262
Engineering Services (Survey, Design, Supervision)		(E)	367	718	1,085	-	-	-	-	-	-	-	-	-	-	-	-	367	718	1,085
Contingency		(F)	452	456	908	16	34	50	2	2	4	0	0	0	1	2	3	471	494	965
Project Cost		(G)	8,579	16,322	24,901	348	1,528	1,876	46	1,570	1,616	13	506	519	36	2,327	2,363	9,022	22,253	31,275

(Note)
1. L.C = Local Currency Portion
   F.C = Foreign Currency Portion
2. Exchange Rate
   1 US$ = 120 Sucres = 210 Yens
3. A.3 incl. structure of way
   A.4 incl. track, mechanical and electrical facilities
   A.5 incl. road improvement, obstacles elimination, etc.
   A.4 = costs for EMELEC and IETEL
4. F = 5% of (Σ(A.1 – A.4) + B.2) + 20% of (A.5 + D.2)
5. G = Σ (A – F)
6. Opening year and operating kilometerage in 1990, 14.7 km

6. Management Plan

6-1 General

1) Establishment of Management Body

The urban transportation system proposed in this report is the first electric railroad in Ecuador. This means that it is necessary to establish a new managerial body of the system. In planning this body, there are some alternatives from the standpoint of management/control of the system.

Generally, there are the following three types of undertakings.

Type A --- Private enterprise. This is most strong in a spirit of pursuing profits and in an efficient management.

Type B --- Government organ or public corporation. This is good in obtaining subsidy from governmental budget.

Type C --- Combination of Types A and B. The body itself is a private enterprise and the spirit of its management is close to Type A. In some cases, the relating governmental organ controls the system indirectly through its share holding.

2) Circumstances for the MRT System in Guayaquil

There is no private enterprise in Guayaquil which is capable of maintaining/repairing rolling stock, signalling, tracks and other facilities of speciality in electric railroad. It is very natural that there is no proper undertaking where there is no need.

As for automobiles, there are many private works to carry out their maintenance because there are a lot of needs for such maintenance in this age of motorization. However as for railroads, especially in Ecuador, it is not expected to have a large need of their maintenance which is enough to keep a private business in a good profit.

From this point of view, the management body of the MRT system will be chosen between Types B and C in the previous section of 1), because the MRT system will have to carry out the maintenance of rolling stock and facilities by itself and accordingly employ a fairly large number of technical staff for maintaining the system in good order. This will perhaps not be borne by a private undertakings.

3) Location of Management Office

The site of the management office is proposed to be in the premises of the rolling stock workshop and running depot to be built at the northern end of the proposed MRT route.

The building of the management office is proposed to be a consolidated one in which major accomodations for office workers as well as for other field staff will be included. This is for reducing the area of land acquisition to the minimum and for the convenience of all MRT staff to have a good communications working in the same building.

4) Employment and Preparatory Education of Technical Staff

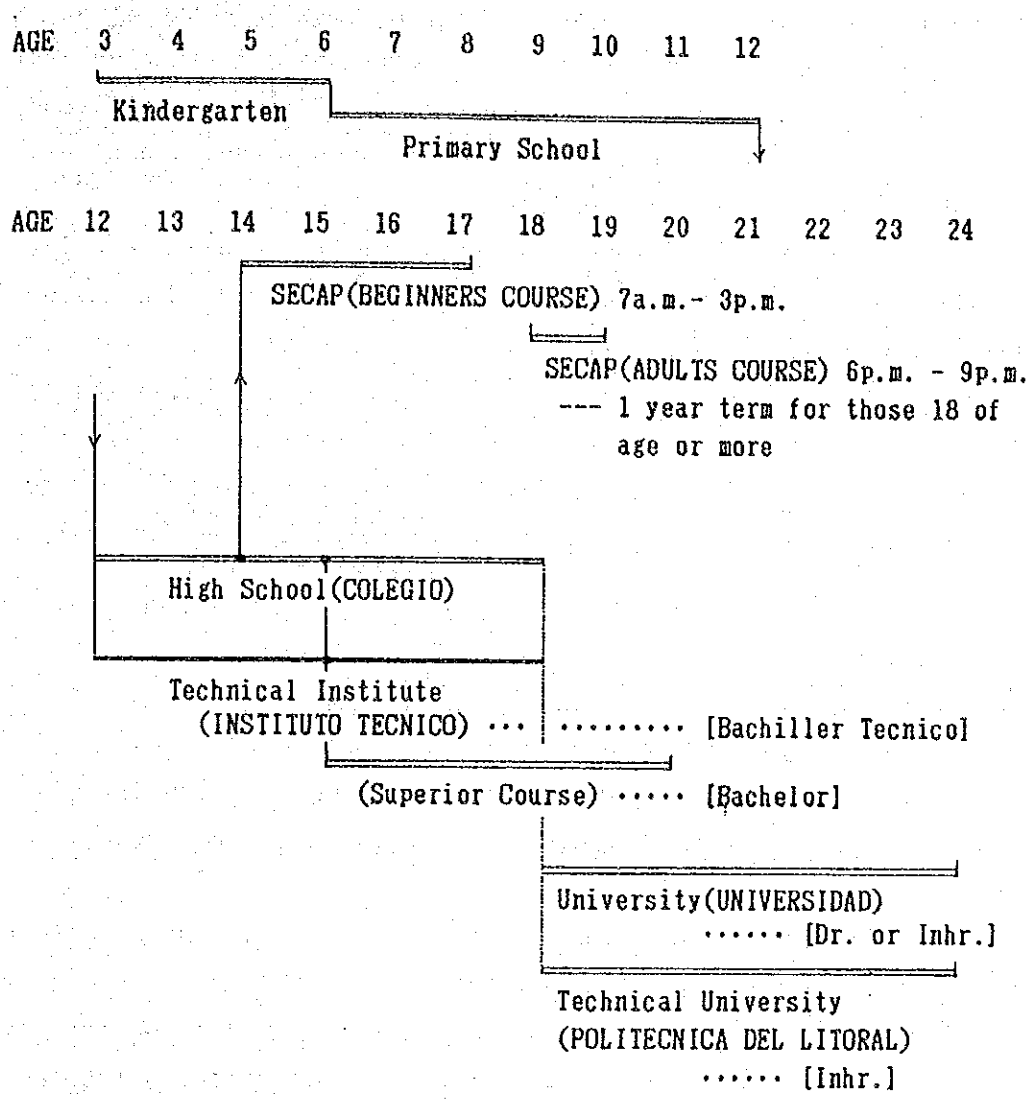
Some high class engineers and a fairly large number of technical staff will have to be employed for the MRT system before the system commences its services and they are required to receive preparatory education of electric railroads in due course. This is because no knowledge will be given them in school education.

High class engineers are required to be the graduates of university (UNIVERSIDAD) or technical university (POLITECNICA DEL LITORAL) and field technical staff will be graduates of other schools (COLEGIO/ITSSB*/SECAP**). For reference, Ecuadorian schooling system is shown in Table 6-1.1.

Note: * --- Instituto Tecnico Superior Simon Boliver
** --- Servicio Ecuatoriano de Capacitacion Profesional

Ecuadorian instructors for the preparatory education must be raised first in the place where electric railroads are

Table 6-1.1 SCHOOL TERM IN ECUADOR



COURSES IN SCHOOL		
COLEGIO	SECAP	INSTITUTO TECNICO
1) Mathematics & Physics (for Engineer) 2) Chemistry & Biology (for Doctor) 3) Phirosophy & Social Science (for Lawyer)	1) Lathing 2) Welding 3) Milling 4) Drilling 5) Electricity 6) Heavy Truck Tractor 7) Automobile	Basic curriculum = Mathematic & Physics 1) Electricity 2) Electronics 3) Radio/TV 4) Industrial Mechanical Engineering 5) Automobile 6) Refrigeration

already in existence. This means that in Ecuador there is no proper site for this education. Therefore, some designated staff must go out of Ecuador to study the system of electric railroad, the way of maintaining the system and other relevant items for keeping the system in good order.

As the preparatory education is what will be planned prior to the opening of MRT services, it will be implemented consecutively in Ecuador. So, foreign instructors will have to be sent to Ecuador for assisting Ecuadorian instructors, because the limited period of their study in foreign countries will cause some difficulties in implementing by themselves the preparatory education for other technical staff who receive education only in Ecuador.

5) On-the-Job Training

After the commencement of services, all technical staff are still required to receive on-the-job training occasionally so that they are accustomed well to the system and can meet any troubles to happen.

Curriculum in the on-the-job training will become complicated especially for beginners, because the aim of this training is in getting all field workers accustomed to the method of operation, understand the structure of the system so that they can respond to any kind of happenings on the system.

6) Securement of Skilled Workers

Another serious problem, among others, that must be kept in mind is the dispersion of skilled workers to the organ outside the MRT system after they got well-trained. So often, social circumstances instigate skilled workers to change their job to that of higher income. In order to avoid this, a certain measures must be established to get them work long in the system, otherwise the system will have to repeat training for technical staff in vain.

This is a problem of labor management or wage system and much depends on the social system in Ecuador. Therefore, it is recommended to study this matter further upon actual implementation.

7) Ticket and Fare System

It is required to establish a reasonable fare system to make MRT system attractive for the public to ride. On the other hand, however, it must be a profitable rate to keep the system's independence in financial aspect as far as possible so as to cover the running cost of the system mostly by user's expense.

Two staged fare system is proposed in this Report, in which a cheap rate would be applied to passengers to ride a short distance of less than 5 km or less than the section of three stations, for example and a higher rate to the majority of passengers. It is generally contradict that the complete acceptance of the cheap rate on the side of users is unacceptable by the system in order to establish its stable finance.

It is also recommended to introduce a commutation ticket, which passengers can buy at designated places outside the MRT stations and some discount rate will be applied for saving passengers' expense and also for railways convenience in mitigating congestion at booking windows. Because in peak hours it is necessary for MRT system to handle a large number of passengers quickly and without applying commutation ticket system, all commuters have to go and buy their ticket at booking windows. This will result in the more assignment of staff for ticket vending.

6-2 Organization

1) Body in Charge of Management

The following four cases are considered for the would-be body that controls the MRT system in Guayaquil. Their comparison is described hereunder and summarized in item e of this section.

For either case, what the attention would have to be paid is the adverse possibility caused by total budget, if MRT budget would be a part of it which would be insufficient in general.

a. The case Guayaquil Municipal Authority controls MRT system

a-1 Preparatory process

(1) A department or a section which takes charge of management/control of MRT system have to be additionally established in the organization of Guayaquil Municipal Authority.

(2) The Municipal Authority have to employ engineers and technical staff for the MRT system and give them necessary education before the commencement of MRT services.

(3) If possible, the independent budget system for MRT management is recommended which is managed under separate account from the municipal general budget.

a-2 Advantage

(1) MRT is an urban transport system for Guayaquil and it must function best coping with the city development plan. In this sense, if the city authority directly touches with the planning, management and control of the MRT system, the system design will have a good coordination with the aim of the city authority.

(2) It is easy to get subsidy from the municipal budget when MRT runs in deficit.

b. The case ENFE controls MRT system

b-1 Preparatory process

(1) It is preferable for ENFE to establish its regional office in Guayaquil that would solely engage in the management/control of MRT system. This is because the MRT system is completely separated system from the present ENFE network and a completely different electric system.

(2) Additional employment of engineers and technical staff for MRT operation is necessary and preparatory education have to be planned for them, too.

b-2 Advantage

(1) Education of the general knowledge on railroad will be easy as compared with other cases of management, because the basic process of train operation is common. Therefore if some of the present ENFE staff be transferred to MRT system, they can be educated simply more of the particular curriculum on modern technology of electric railroad.

(2) It is good to receive subsidy from the national budget when MRT runs in deficit because ENFE is a government-controlled body and supported by the national budget already.

c. The case CTG controls MRT system

c-1 Preparatory process

(1) Establishment of a particular department or section for the management/control of MRT system will be required. This is because the job charactor of MRT operation is completely different from those presently handled by CTG.

(2) Employment of engineers and technical staff for MRT operation is necessary and preparatory education have to be planned for them, too.

c-2 Advantage

(1) CTG presently controls all bus routes in Guayaquil area and it is very convenient to establish a coordinated system of MRT and road transportation in the area. Where there are different controlling bodies for each system and they are left for free competition, a strong body sometimes eats a weak one. This kind of competition is not preferable for urban transportation system, because a rapid transit system is generally planned for easing congestion in road traffic.

d. The case New Body controls MRT system

d-1 Preparatory process

(1) It is recommended to establish a certain committee at an earliest possible time designated for studying/deciding the charactor or the structure of MRT management body. Following the study in the committee, actual establishment of the new MRT body should also be implemented at an earliest possible time.

(2) It is recommended for the new MRT management body to be a semipublic corporation. The body itself is a private enterprise but receives indirect control of the relevant governmental bodies through their share holdings.

d-2 Advantage

(1) It is thought good for the system to be managed in a sprit of private enterprise that is usually most strong in pursuing profit under efficient management.

(2) It is also convenient for the system to be supported by governmental subsidy, if necessary.

(3) As the body is independent and its accounting is completely separated from other organ's, there is expected no fear for the system to be pulled backward due to weak budget of other organ's.

e. Summarized comparison of features by management bodies

Features expected by the selection of the would-be management body is summarized in Table 6-2.1.

The Study Team proposes to establish a new body because it is thought best to implement independent management to some extent.

Table 6-2.1 COMPARISON OF MANAGEMENT BODY

Management Body of MRT System			
Guayaquil Municipal Authority	ENFE	CTG	New Body
1) Necessity of establishing a joint committee to promote MRT project			
Necessary	Depending on needs	Necessary	Necessary
2) Employment of staff/ their education and training			
Newly required	Partly required	Newly required	Newly required
3) Convenience in receiving govermental subsidy			
Good	Good	Good	New law required
4) Restraint by total budget			
Probably	Probably	Probably	None
5) Efficient management			
——	——	——	Good
6) Fare control			
——	——	Good	——
7) Coodination with city development plan			
Good	——	——	——
8) Coodination with bus service			
——	——	Good	——

2) Office Organization

Office organization will be simplified as proposed in Table 6-2.2 so as to keep office members to the minimum. Office members will work for all matters releting to the planning of items concerned and the supervision of its implementation.

There will be four departments in the office. They are Administration Dept., Transportation Dept., Rolling Stock Dept. and Civil & Electrical Dept. The function of each departments is clarified in Table 6-2.2, too.

Managers of the last two departments will concurrently take the top post of relevant field organs, of which explanation is also made in Table 6-2.2. This is a problem of Equadorian's choice, but the reason why the Study Team recommends this system is for avoiding unnecessary communication within the management side. For the time being, MRT system will be not a large one, only operating ten more kilometer length of route and consequently, the management work will not become complicated.

Rolling Stock Department will hold the responsibility of maintaining all machineries in the MRT system. Rolling stock designers won't be assigned. Such design will be passed to contractors, if necessary.

Maintenance of track, other civil structures, buildings and electrical facility/apparatus will be managed by Civil & Electrical Dept. all together.

The required number of office member is;

General Manager and his direct independent staff ---	7
Staff in Administration Dept. ----------------------	24
Staff in Transportation Dept. ----------------------	20
Staff in Rolling Stock Dept. -----------------------	12
Staff in Civil & Electrical Dept. ------------------	15
Total ----	78

Table 6-2.2 OFFICE ORGANIZATION

```
General Manager (1)
 |   Vice Manager (1)
 |      Secretary (1)
 |   Auditor (1)
 |   Inspecting Engineers (3) --- One each for Rolling Stock,
 |                                for Track,Civil Structures & Architecture,
 |                                for Electrical Engineering,
 |
 |--[ Administration Department ]
 |    Manager (1), Secretary (1), Staff (22)
 |      Chief 1, General affairs 1, Document & Public relations 1,
 |               Personnel affairs 1, Security Guards 6, Reserved Guards 3
 |      Chief 1, Asset control & Budget 1, Accounting 2, Casher 1
 |      Chief 1, Material procurement 1, Purchase contract 1,
 |               Procurement inspection 1
 |
 |--[ Transportation Department ]
 |    Manager (1), Secretary (1), Staff (18)
 |      Chief 1, Regurations control 1, Fare system & Market research 1,
 |               Traffic & operation statistics 1
 |      Chief 1, Timetable & Train diagram control 1, Operating bulletin 1,
 |               Utilization of rolling stock & Control of crew's shift 1,
 |               Operating instructor 1
 |      Chief 1, Train & traffic dispatchers 3, Reserved 2
 |               Dispatchers for civil & electrical engineering 3
 |
 |--[ Rolling Stock Department ]
 |    Manager (1), Secretary (1), Staff (10)
 |      Chief 1, Regurations control 1 --- for Rolling stock & Machinery
 |               Asset control 1 -- for Planning of procurement & replacement,
 |                                  Keeping of drawings, specifications, etc.
 |      Chief 1, Rolling stock maintenance control 2
 |                                -- including maintenance recording
 |               Technical instructor 1
 |      Chief 1, Maintenance materials control 2
 |                                -- including storage control
 |
```

[Civil & Electrical Department]
Manager (1), Secretary (1), Staff (13)
Chief 1, Regurations control 2
-- for Track, Electric facilities and Structure & architecture
Chief 1, Asset control 2 -- for Planning of procurement & replacement, Keeping of drawings, specifications, etc. For Track, Electric facilities and Structure & architecture
Chief 1, Facilities maintenance control 3
-- including maintenance recording. One each for Track, Electric facilities and Structure & architecture
Technical instruction and maintenance materials control 3
-- including storage control. One each for Track, Electric facilities and Structure & architecture

Notes: 1. Board members are General Manager, Vice manager, Auditor, and Department Managers.
2. Each department manager concurrently takes the top position of the relevant field organ.
3. Three shift system is planned only for security guards and dispatchers. Other office members are daytime workers.
4. Upon purchase inspections in charge of the Administration Department, cooperation will be given by technical members of the other department concerned.

3) Field Organization

a. Stations

It is proposed to have 12 stations, of which four are main ones and remaining eight are small ones. Main stations will have a stationmaster each. The stationmaster of each main station hold the responsibility of controlling small stations designated to come under his control.

Train operation will also be controlled at main stations and small stations will only work for passenger services. One assistant master will work all the time at each small station to watch train operation but he has no obligation to control train movement in normal routine operation. Rather he watches safety in passenger handling with trains.

Occasional operating instructions will be given to train drivers directly through train radio by train dispatchers in the control center. Necessary informations are passed to the stationmaster, too. So, there is no need for stationmasters to transmit such instructions to train drivers. Therefore, stationmasters are only required to keep train running on time.

b. Railcar Depot

Workshop for maintenance of rolling stock and running depot for train operations will be consolidated into a single field organ so as to have a good coordination between maintenance staff and driving staff.

One diesel-powered motorcar is assigned to this organ for the maintenance of track and other facilities and this organ takes charge of maintaining it in good order. Drivers of this motorcar are not assigned to this organ.

c. Civil Maintenance Depot

This organ is in charge of the maintenance of track, civil structures and buildings. Track maintenance will be carried out directly by the members in this depot in normal conditions. For a large scale maintenance like a replacement of turnouts and for recovery work from disasters or accidents which usually require a large manpower, additional forces will be put into under the contracts.

Motorcar drivers are assigned to this depot who are required to work for the maintenance of electrical facilities if required so by the Electrical Maintenance Depot.

d. Electrical Maintenance Depot

This depot takes charge of the maintenance of all electric facilities. For facilities of railway speciality like signalling apparatus and catenary system, some repairmen are assigned for their maintenance, but for communications and power supply system the assignment of repairmen is limited to the minimum extent for implementing minor repair.

For a large scope of maintenance to require more manpower, additional forces will be put into under due contracts.

e. Required Number of Field Members

Required number of field members is:

Station staff	292
Staff in Railcar Depot	179
Staff in Civil Maintenance Dept.	22
Staff in Electrical Maintenance Depot	22
Total	515

Detailed breakdown of the above figures are clarified in Table 6-2.3.

Table 6-2.3 **FIELD ORGANIZATION**

(1) Stations [Total of station staff = 292]

Main stations --- 4 stations [14 x 4 = 56]
Stationmaster (1)
Assistant Masters (4) - 1 for general affairs & traffic business
3 for train operations (1 x 3 shift)
Staff (9) -------------- 1 for general affairs and traffic business
4 for ticket vending (1 x 2 shift) + 2
4 for ticket inspection (1 x 2 shift) + 2

Small stations -- 8 stations [16 x 8 = 128]
Assistant Masters (3) - for train operations (1 x 3 shift)
Staff (13) ------------- 1 for general affairs & traffic business
6 for ticket vending (2 x 2 shift) + 2
6 for ticket inspection(2 x 2 shift) + 2

Reserved staff for all stations [24 + 84 = 108]
Assistant Masters (24) -- (4 x 4 + 3 x 8) x 0.6
Staff (84) --------------- (9 x 4 + 13 x 8) x 0.6

Remarks: 1. Stationmasters of the main stations control the staff of small stations.
2. Determination of the rate of staff in reserve is explained in the section (5) of this table.

(2) Railcar Depot [Total of depot staff = 179]
Depot Master (Manager of Rolling Stock Dept. takes this post concurrently)
Assistant Master (7) -- 3 for crew control (1 x 3 shift)
1 for railcar movement control in depotyard
2 in reserve for the above two items
1 for railcar maintenance
Drivers [In-Depot service] (5) -- (1 x 3 shift) + 2
Drivers [Line service] (53) ----- details in Appendix -- 1-10
Conductors (53) ----------------- ditto.
Technician (1) for daily planning of the work in depot
Signalmen (5) --------- 3 as signal cabin attendant (1 x 3 shift)
2 in reserve

Switchmen (5) --------- 3 for switching turnouts in the depot-yard and for communication with signal cabin (1 x 3 shift)
2 in reserve

```
Railcar Inspectors --- 12 for daily inspection.
          (22)            (3 inspectors x 2 groups x 2 shift)
                        3 for all other inspections
                        7 in reserve for daily inspection
Railcar Repairmen -----  5 for carbody and brake gears
                                   -- (2 x 2 shift on holidays)
          (25)          5 for electrical parts
                                   -- (2 x 2 shift on holidays)
                        5 for running gears
                                   -- (2 x 2 shift on holidays)
                        4 for machining & welding
                                   -- (2 x 2 shift on holidays)
                        6 for assembling & disassembling as well as
                          crane and jack handling (0 on holidays)
Storekeepers (3) -----  2                  -- (1 x 2 shift)
                        1 for reserve
```

Remarks: 1. Car cleaning is entrusted to contractors. No mechanical cleaning is planned.
2. Machinery maintenance is entrusted to contractors, but oiling to the machinery is in charge of users.
3. On Saturdays, Sundays and holidays, only daily inspection and car cleaning are planned.

(3) Civil Maintenance Depot [Total of depot staff = 22]

```
Depot Master (Manager of Civil & Electrical Dept. takes this post
              concurrently)
Assistant Master (1)
Inspectors (6) --------  3 for tracks
                         3 for civil structures and buildings
Track gangmen (8) ----   8 for track maintenance
                                   (4 member x 2 groups)
Repairmen (2) ---------  2 for minor repair of structures
                           and buildings
Motorcar driver (2)      2 including reserved one
Storekeepers (3) -----   2                 -- (1 x 2 shift)
                         1 in reserve
```

Remarks: 1. Major repair excepting track maintenance is entrusted to contractors.
2. No routine work is scheduled on Saturdays, Sundays and holidays.
3. Routine work is planned for night hours after the last train.

(4) Electrical Maintenance Depot [Total of depot staff = 22]

Depot Master (Manager of Civil & Electrical Dept. takes this post concurrently)

Assistant Master (1)

Inspectors (8) -------- 2 for signalling system
2 for catenery system
2 for communications system
2 for power supply & substation system

Repairmen (10) -------- 3 for signal maintenance
3 for catenery maintenance
2 for minor repair of communications system
2 for minor repair of power supply system

Storekeepers (3) ------ 2 -- (1 x 2 shift)
1 for reserve

Remarks:
1. Major repair of communication and power supply system is entrusted to contractors.
2. No routine work is scheduled on Sundays and holidays.
3. Routine work is planned for night hours after the last train.

(5) Rate of staff in reserve

Rate of staff in reserve = 0.6 for staff to work every days

The above rate is determined through the following figures.

Days of a year	365 days	----- (a)
Saturdays/Sundays = (365/7) x 2	104 days	----- (b)
National holidays	15 days	----- (c)
Paid holidays	15 days	----- (d)

Rate = a/(a-b-c-d)-1 = 0.580

6-3 Preparatory Education

1) Education for Ecuadorian Instructors

Ecuadorian instructors will at first have to be educated in a foreign country where an electric railroad is presently on service and from where rolling stock or other electrical apparatus is to be procured. This is because no electric operation is implemented in Ecuador now and subsequently no instructors can be found in Ecuador.

It is proposed to raise at first the following nine Ecuadorian instructors in the above method. They are;

three --- for rolling stock structure and its maintenance
(Mechanical parts/ Electrical parts/ Wiring & Control system)

three --- for track and civil structure and their maintenance
(Track & Turnout/ Structure/ Building & Station)

three --- for electrical apparatus and its maintenance
(Signalling/ Telecommunication/ Catenery & Transmission)

2) Dispatch of Foreign Instructors

Even though the above nine Ecuadorian instructors will be raised, they will face with the difficulties in giving sufficient instructions to other Ecuadorian technical staff for MRT operation because of their limited period of education in foreign countries.

Therefore, they will have to be helped by foreign instructors sent to Ecuador. Preparatory education implemented in Ecuador will be carried out basically by Ecuadorian instructors so that Ecuadorians can stand on their own foot for future maintenance of MRT system by themselves. In this sense, foreign instructors will work supplementally when Ecuadorian instructors would find some difficulties in their instructions.

Foreign instructors to be sent to Ecuador will be the following specialists who are well-experienced in maintaining each system and have ample knowledge of the structural mechanism of the system. They are;

One train operation engineer
One rolling stock engineer
One track engineer
One signal engineer

Preparatory education on the train operation will be carried out only in Ecuador by foreign instructors. This is because the driving technique of trains can be well transferred to Ecuadorians by training them on the actual line in Guayaquil. Ecuadorian instructing drivers will be raised first and they will continue further training of other drivers. Therefore, the staying period of foreign instructor on train operation will be shorter than other foreign instructors.

3) Curriculum for Preparatory Education

The curriculum to be planned in the preparatory education is given in Table 6-3.1. As for structure and system mechanism as well as functions of each item, general lesson will be given, but for their maintenance, features of troubles that will come frequently and the method of their inspection or maintenance will be given in each depending on courses.

Table 6-3.1 ITEMS IN PREPARATORY EDUCATION

1. For Rolling Stock Engineering	
[On mechanical parts]	1. Body structure 4. Brake mechanism 2. Pantograph 5. Door mechanism 3. Coupler/ buffer 6. Bogie/ wheelset
[On electrical parts]	1. Motor 5. Air conditioner 2. Pantograph 6. Electromagnetic valve 3. Resistor 7. Lightening arrestor 4. Relay/ switch/ breaker
[On wiring & control system]	1. Traction circuit 4. Auxiliary circuit 2. Control circuit 5. Master controller 3. Control cam apparatus 6. Reverser
2. For Track & Civil Engineering	
[On track & turnout]	1. Rail/ sleeper/ fastening 2. Ballast/ roadbed 5. Gauge/ curve 3. Turnout 6. Tracklaying 4. Adjustment of track irregularity
[On structure]	1. Concrete viaduct 3. Drainage 2. Bridge & girder
[On building & station]	1. Workshop layout 3. Office building 2. Station building/ platform
3. For Electrical Engineering	
[On signalling]	1. Automatic signal 4. Relay interlocking 2. CTC system/ control panel 3. Level crossing apparatus
[On communications]	1. Train radio 3. Portable radio 2. Railway telephone system
[On catenary & power supply]	1. Catenary structure 2. Substation control

6-4 On-the-job Training

1) Retraining of Staff

After commencement of MRT services, technical staff are still required to be accustomed to the technologies of MRT operation and maintenance in order that the system can always offer good services and can instantly respond to unexpected troubles, if any.

Technical staff will receive in this on-the-job training the basic knowledge of the system structure in general and the applied knowledge of the possible cause of the system failure and resultant phenomena thereby.

Instructors to engage in the on-the-job training will be Ecuadorians who are to receive basic knowledge in their preparatory educations beforehand.

2) Training for Recovery on Emergency

The training for recovery on emergency is strongly required for the system because long time suspension of the services will bring some inconvenience to customers or, in the worst, confusion of traffic.

If some trouble or accident occurs, the prompt information of the case must be passed to the nearby stationmaster so that he can suspend operation of the following or approaching train. Then, the case must be advised to the train dispatcher who can instruct the proper action to all the operating staff concerned.

In order to recover the trouble or accident and bring the system back to the normal operation in the minimum possible time, the method of rescue work must be studied occasionally on how to organize the temporary rescue gang, how to use tools and other rescue materials and how to control passengers in such case.

In anticipation of the case when MRT track cannot be used for recovering the trouble or accident, it is preferable to prepare always rescue automobile with rescue tools/materials mounted beforehand so that it can reach the site through road as soon as possible.

It is good for the system to hold from time to time a joint meeting with bus companies, police authority, fire stations, hospitals and schools so that they can take proper action when MRT goes out of order. It is also recommended for the system to make campaign occasionally of traffic safety for automobile drivers and pedestrians.

Technical staff, especially operating staff of MRT itself, must have a knowledge enough to meet a light trouble of the system that can be repaired simply by them, not by asking for other staff to come and help in remedying it. Such is the case of fuse breakage, for example.

3) Curriculum for On-the-job Training

The curriculum for on-the-job training is as shown in Table 6-4.1.

Table 6-4.1 CURRICULUM IN ON-THE-JOB TRAINING

(On train operation) Driving technique of trains/ Signalling system Technique of CTC control and blocking Light maintenance of rolling stock Responding process on emergency
(On rolling stock maintenance) Rolling stock mechanism & structure/ Inspection method Disassembling & assembling of parts Responding process on emergency
(On maintenance of track & structure) Measurement of track irregularity/ Inspection method Rail fastening/ Tie tamping Responding process on emergency
(On maintenance of electric facilities) Signal & power control system/ Inspection method Replacement of catenery Responding process on emergency

6-5 Importance of Maintenance

After commencement of MRT services, it is most important on the technical side to establish a well-organized maintenance system for rolling stock and other facilities. In order to eliminate the adverse effect caused by insufficient maintenance, proper preparation is required to meet the following cases.

Case 1 --- Temporary suspension of MRT services due to the failure of rolling stock on service. Even though the preventive inspection system is applied to the maintenance of rolling stock, this kind of trouble sometimes happen.

Case 2 --- Long term standing of troubled cars mainly due to the shortage of spare parts when necessary will substancially reduce the total number of available cars.

Case 3 --- Insufficient supply of consuming parts of rolling stock such as pantograph strips, brake blocks and carbon brashes for motor commutators will also cause inefficient railcar availability.

The system of railroad service is completely different from that of road, because in most cases, the suspension or confusion of services will fall to the responsibility of railroad management. So, the management side of the system is always required to check the system and keep it in good conditions.

7. Operation and Maintenance Cost

7-1 Item Included in the Operation and Maintenance Cost

The following items are included in the estimation of MRT's operation and maintenance cost (running cost).

(1) Personnel expense

(2) Management overhead --- Expense to cover miscellaneous management/operation of the system.

(3) Maintenance cost --- Cost for the procurement of maintenance parts and materials. Personnel expense is not counted in this item though it would be for the staff to engage in the maintenance of vehicles and facilities.

(4) Power expense --- Expense of electricity for train operations. The one for other purpose is considered in the previous item of management overhead.

7-2 Running Cost of MRT System

For the basic case of MRT project in Guayaquil, the running cost is summerized in Table 7-2.1. Detailed explanation is given item by item in the following sections. For various cases other than the basic one is described in the Section 8.

Table 7-2.1 RUNNING COST OF MRT SYSTEM

Basic case (1000 Sucre)

	1990	1993	1996	2000	2010-
Personnel expense	188,280	191,160	194,040	196,920	206,136
Management overhead	43,304	43,967	44,629	45,292	47,411
Maintenance cost	187,984	211,410	243,384	261,081	328,869
Power expense	112,788	126,984	134,400	153,072	180,456
TOTAL	532,356	573,521	616,453	656,365	762,872

7-3 Personnel Expense

1) Ranking by wages

All MRT staff including the General Manager are classified into four ranks. They are;

a. Top Class Officer (81,000 Sucre/Month)
..... General Manager
Inspecting Engineer
Auditor
Department Manager

b. Senior Staff (42,000 Sucre/Month)
.... Section Chief of Head Office
Stationmaster

a. Middle Class Staff (29,000 Sucre/Month)
..... Assistant Master of field organs
Secretary
Office members

a. Junior Staff (24,000 Sucre/Month)
..... Field workers
Crew members
Security Guards

2) Personnel expense in Basic case

For the Basic case, the number of staff by wage ranks and their annual personnel expenses by year is estimated in Table 7-3.1. Detailed calculation of each is shown in Appendix 1-10.

Table 7-3.1 PERSONNEL EXPENSE

	1990	1993	1996	2000	2010-
Top Class Officer	[10] 9,720				
Senior Staff	[16] 8,064				
Middle Class Staff	[120] 41,760				
Junior Staff	[447] 128,736	[457] 131,616	[467] 134,496	[477] 137,376	[509] 146,592
TOTAL	[593] 188,280	[603] 191,160	[613] 194,040	[623] 196,920	[655] 206,136

Note: Figures in brackets is the number of staff concerned.

7-4 Management Overhead

Management overhead is estimated as 23 per cent of personnel expense.

This rate is from the statistics of seven major private railways in Tokyo. Management overhead includes all the cost of miscellaneous items not clearly defined in other items described in the Section 7-1.

Exact estimated amount of management overhead is shown in Table 7-2.1.

7-5 Maintenance Cost

Maintenance cost does not include personnel expense of those engaging in the maintenance work.

In case of a weak budget, there is a trend in general to curtail the budget of maintenance as far as possible. However, this way of thinking is not preferable in a long run to keep the system continuously in good condition.

Maintenance cost is the sum of four items, i.e., rolling stock, track, electrical facilities, and other facilities. Unit cost of maintenance has been based on the Japanese statistics, but some assumption has been introduced to make the unit cost more realistic in its application in Ecuador. It is the rate of imported materials to the total ones for maintenance. It has been assumed as follows.

Table 7-5.1 RATE OF IMPORTED MATERIALS FOR MAINTENANCE

	Imported	Domestically Procured
for Rolling Stock	100 %	0 %
for Track	50 %	50 %
for Electrical Facilities	80 %	20 %

To each percentage of the Japanese unit cost, it is amended as multiplied by 1.1 for imported materials due to some processing in international trade, and by 0.5 for domestically procured materials due to lower production cost in Ecuador including personnel cost. However, this modification has not been taken into account for rolling stock maintenance. The reason is in its uncertain maintenance experience in Ecuador. it is not always necessary to trace the Japanese maintenance system to all the part of rolling stock. It is recommended to establish the most preferable Ecuadorian system in the earliest possible future by confirming what part of rolling stock would require stressed inspection and repair.

For the basic case by year, total maintenance cost is as follows.

Table 7-5.2 MAINTENANCE COST

Basic case (1000 Sucre)

	1990	1993	1996	2000	2010-
Rolling Stock	76,020	86,880	108,600	114,030	146,610
Track	52,733	58,591	62,987	68,845	85,176
Electrical Fac'y	48,590	53,972	58,021	63,428	78,468
Other Facility	10,641	11,967	13,776	14,778	18,615
TOTAL	187,984	211,410	243,384	261,081	328,869

In the Table 7-5.2, figures of 'Other Facility' has been calculated as multiplication by 0.06 of the total of the above three ones. This conversion rate is from the Japanese statistics. All the details are shown in Appendix 1-11.

7-6 Power Expense

1) Unit rate of power consumption

Unit rate of power consumption for train operations is assumed as 2.5 kWh/car-km. This is based on the statistics of seven major private railways in Tokyo.

2) Daily car-km of Guayaquil MRT system

For the basic case in this Report, in which the entire MRT route of 14.7km is to be opened at a time, the daily car-km for the 'Basic case' is as follows. Its detailed calculation is shown in Appendix 1-12.

Year	Car-km/day
1990	26,460 km
1993	29,400 km
1996	31,605 km
2000	34,545 km
2010	42,640 km

3) Power expense by year

Annual power expense of MRT system for train operation and air-conditioning of railcars is estimated as follows. Its detailed calculation is shown in Appendix 1-13 and 1-14. Unit cost of power used in the Appendix is the Ecuadorian system applied to governmental customers. (reffer to Appendix 1-15)

Year	Annual power expense (1000 Sucre)
1990	112,788
1993	126,984
1996	134,400
2000	153,072
2010	180,456

8. Figures for Staged Construction Cases

8-1 Outline of Staged Construction Cases

Staged construction cases are outlined in Table 1-1.1 in the former section 1-1, and their general characteristics are summarized as bellow:

(1) Cases A-1 to D-1 have a same reach of the Basic Case after completion of the whole route, while cases E, F and G have a different goal in their final stage due to the difference in their section of services.

(2) As for cases C-1, C-2, D-1 and G, of which first opening section is in the southern part of the route, their mainline facilities are same as the others, but their depot and maintenance shop have to be constructed in already inhabited area 'Guasmo'. Accordingly, their land acquisition and compensation costs are estimated higher than others.

(3) In extension of the opening section, some modifications such as removal of turnout (seissors crossing for setting back trains), reset of trolley wire, etc. are required. Their works, however, are easy and costs are cheap since the provisional terminals (9 de Octubre and/or Centro Civico Station where trains are set back) are in the straight track section.

(4) In order to formulate the staged construction plans, not only MRT construction plan but also plans for bus route reorganization and coordination between the MRT and the bus in the MRT terminals should be examined. Especially, securing the transferring function between the MRT provisional terminal and the bus is quite important in the partial opening stage.
The abovementioned matters are examined in the later section 2-4 in next PART 2.

Figures of their principal planning items are summarized in Table 8-1.1

8-2 Figures expressed in Detail

1) Transport Plan

Shown in Table 8-2.1

2) Project Cost

Project cost by case and investment year estimated based on 'Basic Case' are summarized in Table 8-2.2 and 8-2.3. All the details are clarified in Appendix 1-9.

3) Number of staff by case

Office organization and the number of office members is same as in the 'Basic Case'. Among the field organs, Civil Maintenance Depot and Electircal Maintenance depot has the same organization and the same number of staff for various cases as in the 'Basic case'. Number of station staff changes in conformity with the section opened for services. Number of crew members changes in conformity with the daily train hours which is calculated from the route length of train services, the number of trains scheduled per day and transition time at terminals where crew members are required to change their working cabin for services of reverse operation. Detailed calculation of the number of staff is shown in Appendix 1-10. Summarized figures are shown in Table 8-2.4

4) Running cost of MRT system by case

Running cost of MRT system by case is summarized in Table 8-2.5. All the detailed figures are clarified in Appendix 1-10 to 1-15.

Table 8-1.1 FIGURES FOR STAGED CONSTRUCTION CASES (1)

Item \ Tested Case / Year		Basic Case					Case A-1	
		1990	1993	1996	2000	2010-	1990	1993
Operating Kilometerage (km)		14.7					6.7	14.7
Number of Stations		12					5	12
Transport Demand	Number of passengers per day	401,000	447,000	482,000	530,000	646,000	170,000	447,000
	Maximum passengers per day in one direction	105,000	121,000	131,000	145,000	177,000	80,000	121,000
	Maximum passengers per hour in one direction	12,600	14,500	15,700	17,400	21,200	9,600	14,500
Transport Plan	Schedule time for one direction (minutes)	29	29	29	29	29	13	29
	Headway in a peak hour (minutes)	4.6	4.0	3.8	3.3	2.7	6.0	4.0
	Number of trains required	13	15	18	19	24	5	15
	Number of cars required (incl. reserved cars)	70	80	100	105	135	30	80
Project Cost by Staged Year (million Sucres)		24,901	1,876	1,616	519	2,363	11,881	15,207
Total Project Cost (up to 2010) (million Sucres)		31,300					31,600	
Number of Staff		593	603	613	623	655	367	603
Running Cost (million Sucres/year)		532	574	616	656	763	272	574

(Note)
1. Figures after 1996 expect project cost in 1996 are same as Basic Case.
   Project cost in 1996 is as bellow:
   Case A-1: 1,616 million Sucres
2. Transport capacity: 1,008 person/train
3. Schedule Speed: 30 Km/hr
4. Prices in 1985 and exchange rate: 1US$ = 120 Sucres = 210 Japanese Yens

Table 8-1.1 FIGURES FOR STAGED CONSTRUCTION CASES (2)

Item \ Tested Case / Year		Case A-2		Case B-1		Case C-1		Case C-2		Case D-1	
		1990	1993	1990	1993	1990	1993	1990	1993	1990	1993
Operating Kilometerage (km)		6.7	9.1	9.1	14.7	5.6	14.7	5.6	8.0	8.0	14.7
Number of Stations		5	8	8	12	5	12	5	8	8	12
Transport Demand	Number of passengers per day	170,000	304,000	275,000	447,000	92,000	447,000	92,000	239,000	223,000	447,000
	Maximum passengers per day in one direction	80,000	94,000	83,000	121,000	45,000	121,000	45,000	93,000	88,000	121,000
	Maximum passengers per hour in one direction	9,600	11,300	9,900	14,500	5,400	14,500	5,400	11,100	10,600	14,500
Transport Plan	Schedule time for one direction (minutes)	13	18	18	29	11	29	11	16	16	29
	Headway in a peak hour (minutes)	6.0	5.0	6.0	4.0	10.0	4.0	10.0	5.0	5.5	4.0
	Number of trains required	5	8	7	15	3	15	3	7	7	15
	Number of cars required (incl. reserved cars)	30	45	40	80	20	80	20	40	40	80
Project Cost by Staged Year (million Sucres)		11,881	5,550	15,874	11,201	11,902	16,533	11,902	6,109	16,875	11,573
Total Project Cost (up to 2010) (million Sucres)		31,700		31,600		32,900		33,000		32,900	
Number of Staff		367	460	450	603	341	603	341	452	450	603
Running Cost (million Sucres/year)		272	339	341	574	218	574	218	345	338	574

(Note)
1. Figures after 1996 expect project cost in 1996 are same as Basic Case . Project cost in 1996 is as bellow: Case A-2: 11,367 million Sucres; Case C-2: 12,143 million Sucres; Other cases: same as Basic Case
2. Transport capacity: 1,008 person/train
3. Schedule Speed: 30 Km/hr
4. Prices in 1985 and exchange rate: 1US$ = 120 Sucres = 210 Japanese Yens

Table 8-1.1 FIGURES FOR STAGED CONSTRUCTION CASES (3)

Item \ Tested Case / Year		Case E					Case F					Case G				
		1990	1993	1996	2000	2010-	1990	1993	1996	2000	2010-	1990	1993	1996	2000	2010-
Operating Kilometerage (km)		6.7					9.1					8.0				
Number of Stations		5					8					8				
Transport Demand	Number of passengers per day	170,000	191,000	206,000	228,000	278,000	275,000	304,000	327,000	358,000	436,000	223,000	239,000	251,000	268,000	327,000
	Maximum passengers per day in one direction	80,000	87,500	93,000	100,000	122,000	83,000	94,000	103,000	113,000	138,000	88,000	93,000	96,000	99,000	107,000
	Maximum passengers per hour in one direction	9,600	10,500	11,200	12,000	14,600	9,900	11,300	12,300	13,500	16,500	10,600	11,100	11,500	11,900	12,800
Transport Plan	Schedule time for one direction (minutes)	13	13	13	13	13	18	18	18	18	18	16	16	16	16	16
	Headway in a peak hour (minutes)	6.0	5.5	5.0	5.0	4.0	6.0	5.0	4.6	4.3	3.5	5.5	5.0	5.0	5.0	4.6
	Number of trains required	5	6	6	6	7	7	8	9	9	13	7	7	7	7	8
	Number of cars required (incl. reserved cars)	30	35	35	35	40	40	45	50	50	75	40	40	40	40	45
Project Cost by Staged Year (million Sucres)		11,896	1,443	0	0	442	15,886	1,440	383	0	1,995	16,885	1,030	0	0	469
Total Project Cost Unit 2010 (million Sucres)		13,880					19,700					18,400				
Number of Staff		367	373	377	377	383	450	460	462	466	482	450	452	452	452	462
Running Cost (million Sucres/year)		272	287	294	294	314	341	367	377	385	448	338	345	345	345	379

(Note) 1. Transport capacity: 1,008 person/train

2. Schedule Speed: 30 Km/hr

3. Prices in 1985 and exchange rate: 1US$ = 120 Sucres = 210 Japanese Yens

Table 8-2.1 TRANSPORT PLAN BY CASE (1)

Item / Case / Year	Basic Case					Case A-1	
	1990	1993	1996	2000	2010-	1990	1993
a. Operating kilometerage (km)	14.7	14.7	14.7	14.7	14.7	6.7	14.7
b. Transport demand in a peak hour (person/hour/one way)	12,600	14,500	15,700	17,400	21,200	9,600	14,500
c. Schedule time (minute)	29	29	29	29	29	13	29
d. Stopping time at terminals (minute)	1	1	3.8	3.3	2.7	1	1
e. No. of train operations in a peak hour in one way	13	15	16	18	22	10	15
f. Transport capacity (person/hour/one way)	13,100	15,120	16,130	18,140	22,180	10,080	15,120
g. Headway in a peak hour (minute)	4.6	4.0	3.8	3.3	2.7	6.0	4.0
h. No. of operating trains in a peak hour (train)	13	15	18	19	24	5	15
i. No. of trains reserved for inspection and repair (train)	1	1	2	2	3	1	1
j. No. of required cars (car)	70	80	100	105	135	30	80
k. No. of train operations per day in two way	360	400	430	470	580	300	400

(Note)

1. Projected transport capacity: 1,008 person/train (train formation made by 5 cars)
2. Schedule speed: 30 km/hr
3. e = b/1008
4. f = e x 1008
5. g = 60/e
6. h = (c+d) x 2/g
7. j = (h+j) x 5
8. Figures after 1996 (1996, 2000, 2010 -) are same as Basic Case.

Table 8-2.1 TRANSPORT PLAN BY CASE (2)

Item \ Case / Year	Case A-2		Case B-1		Case C-1		Case C-2		Case D-1	
	1990	1993	1990	1993	1990	1993	1990	1993	1990	1993
a. Operating kilometerage (km)	6.7	9.1	9.1	14.7	5.6	14.7	5.6	8.0	8.0	14.7
b. Transport demand in a peak hour (person/hour/one way)	9,600	11,300	9,900	14,500	5,400	14,500	5,400	11,100	10,600	14,500
c. Schedule time (minute)	13	18	18	29	11	29	11	16	16	29
d. Stopping time at terminals (minute)	1	1	1	1	1	1	1	1	1	1
e. No. of train operations in a peak hour in one way	10	12	10	15	6	15	6	12	11	15
f. Transport capacity (person/hour/one way)	10,080	12,100	10,080	15,120	6,050	15,120	6,050	12,100	11,090	15,120
g. Headway in a peak hour (minute)	6.0	5.0	6.0	4.0	10.0	4.0	10.0	5.0	5.5	4.0
h. No. of operating trains in a peak hour (train)	5	8	7	15	3	15	3	7	7	15
i. No. of trains reserved for inspection and repair (train)	1	1	1	1	1	1	1	1	1	1
j. No. of required cars (car)	30	45	40	80	20	80	20	40	40	80
k. No. of train operations per day in two way	300	350	300	400	180	400	180	350	330	400

(Note)

1. Projected transport capacity: 1,008 person/train (train formation made by 5 cars)
2. Schedule speed: 30 km/hr
3. e = b/1008
4. f = e x 1008
5. g = 60/e
6. h = (c+d) x 2/g
7. j = (h+j) x 5
8. Figures after 1996 (1996, 2000, 2010 -) are same as Basic Case.

Table 8-2.1 TRANSPORT PLAN BY CASE (3)

Item \ Case / Year	Case E					Case F					Case G				
	1990	1993	1996	2000	2010-	1990	1993	1996	2000	2010-	1990	1993	1996	2000	2010-
a. Operating kilometerage (km)	6.7					9.1					8.0				
b. Transport demand in a peak hour (person/hour/one way)	9,600	10,500	11,200	12,000	14,600	9,900	11,300	12,300	13,500	16,500	10,600	11,100	11,500	11,900	12,800
c. Schedule time (minute)	13	13	13	13	13	18	18	18	18	18	16	16	16	16	16
d. Stopping time at terminals (minute)	1	1	1	1	1	1	1	1	1	3.5	1	1	1	1	1
e. No. of train operations in a peak hour in one way	10	11	12	12	15	10	12	13	14	17	11	12	12	12	13
f. Transport capacity (person/hour/one way)	10,080	11,090	12,100	12,100	15,120	10,080	12,100	13,100	14,110	17,140	11,090	12,100	12,100	12,100	13,100
g. Headway in a peak hour (minute)	6.0	5.5	5.0	5.0	4.0	6.0	5.0	4.6	4.3	3.5	5.5	5.0	5.0	5.0	4.6
h. No. of operating trains in a peak hour (train)	5	6	6	6	7	7	8	9	9	13	7	7	7	7	8
i. No. of trains reserved for inspection and repair (train)	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1
j. No. of required cars (car)	30	35	35	35	40	40	45	50	50	75	40	40	40	40	45
k. No. of train operations per day in two way	300	330	350	350	400	300	350	360	380	450	330	350	350	350	360

(Note)
1. Projected transport capacity: 1,008 person/train (train formation made by 5 cars)
2. Schedule speed: 30 km/hr
3. e = b/1008
4. f = e x 1008
5. g = 60/e
6. h = (c+d) x 2/g
7. j = (h+j) x 5
8. Figures after 1996 (1996, 2000, 2010 -) are same as Basic Case.

Table 8-2.2 PROJECT COST BY CASE

(Unit: Million Sucres in 1985 prices)

Tested Case \ Currency \ Staged Year	1990		1993		1996		2000		2010		Total		Opening year and operating kilometerage
	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	
	Total		Total		Total		Total		Total		Total		
Basic Case	8,579	16,322	348	1,528	46	1,570	13	506	36	2,327	9,022	22,253	1990: 14.7 km
	24,901		1,876		1,616		519		2,363		31,275		
Case A-1	4,247	7,634	4,794	10,413	46	1,570	ditto		ditto		9,136	22,450	1990: 6.7 km
	11,881		15,207		1,616						31,586		1993: 14.7 km
Case A-2	4,247	7,634	1,824	3,726	3,052	8,315	"		"		9,172	22,508	1990: 6.7 km 1993: 9.1 km
	11,881		5,550		11,367						31,680		1996: 14.7 km
Case B-1	5,681	10,193	3,357	7,844	46	1,570	"		"		9,133	22,440	1990: 9.1 km
	15,874		11,201		1,616						31,573		1993: 14.7 km
Case C-1	5,143	6,759	5,260	11,273	46	1,570	"		"		10,498	22,435	1990: 5.6 km
	11,902		16,533		1,616						32,933		1993: 14.7 km
Case C-2	5,143	6,759	1,849	4,260	3,496	8,647	"		"		10,537	22,499	1990: 5.6 km 1993: 8.0 km
	11,902		6,109		12,143						33,036		1996: 14.7 km
Case D-1	6,616	10,259	3,791	7,782	46	1,570	"		"		10,502	22,444	1990: 8.0 km
	16,875		11,573		1,616						32,946		1993: 14.7 km
Case E	4,246	7,650	345	1,098	-	-	-	-	6	436	4,597	9,184	1990: 6.7 km
	11,896		1,443		-		-		442		13,781		
Case F	5,680	10,206	344	1,096	2	381	-	-	21	1,974	6,047	13,657	1990: 9.1 km
	15,886		1,440		383		-		1,995		19,704		
Case G	6,615	10,270	333	697	-	-	-	-	15	454	6,963	11,421	1990: 8.0 km
	16,885		1,030		-		-		469		18,384		

(Note) 1. Cases E, F and G are for partial opening and no further construction of the system.

2. Project cost in 1985 prices on commercial base (not economic price)
1 US Dollar = 120 Sucres = 210 Japanese Yens as of October, 1985 by free market rate.

Table 8-2.3 PROJECT COST BY INVESTMENT YEAR

(Unit: Million Sucres in 1985 prices)

Case \ Year	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996 -1998	1999	2000 -2008	2009	2010 -2015	Total
Basic Case	217	12,342	12,342	0	563	1,313	0	0	1,616	0	519	0	2,363	0	31,275
Case A-1	133	5,874	5,874	213	7,497	7,497	0	0	1,616	0	ditto	0	ditto	0	31,586
Case A-2	133	5,874	5,874	72	2,739	2,739	167	5,600	5,600	0	"	0	"	0	31,680
Case B-1	162	7,856	7,856	167	5,517	5,517	0	0	1,616	0	"	0	"	0	31,573
Case C-1	112	5,895	5,895	241	8,146	8,146	0	0	1,616	0	"	0	"	0	32,933
Case C-2	112	5,895	5,895	71	3,019	3,019	199	5,972	5,972	0	"	0	"	0	33,036
Case D-1	141	8,367	8,367	199	5,687	5,687	0	0	1,616	0	"	0	"	0	32,946
Case E	134	5,881	5,881	0	433	1,010	0	0	0	0	0	0	442	0	13,781
Case F	162	7,862	7,862	0	432	1,008	0	0	383	0	0	0	1,995	0	19,704
Case G	141	8,372	8,372	0	309	721	0	0	0	0	0	0	469	0	18,384

(Note) Project cost by investment year is calculated by (Distribution ratio to each investment year) x (cost in each staged year shown in Table 8-2.2)

Distribution ratio to each staged year is as bellow:

1) For 1990
- All cases: 1987 (20% of engineering services); 1988, 1989 (50% of the remind)

2) For 1993
- Basic Case , Case E, F, G: 1991 (30%); 1992 (70%)
- Other cases : 1990 (30% of engineering services); 1991, 1992 (50% of the remind)

3) For 1996
- Case A-2, Case C-2: 1993 (30% of engineering services); 1994, 1995 (50% of the remind)
- Other cases : 1995 (100%)

4) For 2000 and 2010 -
- All cases : 1999 (100%); 2009 (100%)

Table 8-2.4 NUMBER OF MRT STAFF

Case & year		Office	Station	Railcar Depot	Other Field Organs	TOTAL	
A-1	1990	78	120	125	44	367	1990
	1993	78	292	189	44	603	1993
	1996	78	292	199	44	613	1996
	2000	78	292	209	44	623	2000
	2010-	78	290	241	44	655	2010-
A-2	1990	78	120	125	44	367	1990
	1993	78	193	145	44	460	1993
	1996	78	292	199	44	613	1996
	2000	78	292	209	44	623	2000
	2010-	78	292	241	44	655	2010-
B-1	1990	78	193	135	44	450	1990
	1993	78	292	189	44	603	1993
	1996	78	292	199	44	613	1996
	2000	78	292	209	44	623	2000
	2010-	78	292	241	44	655	2010-
C-1	1990	78	120	99	44	341	1990
	1993	78	292	189	44	603	1993
	1996	78	292	199	44	613	1996
	2000	78	292	209	44	623	2000
	2010-	78	292	241	44	655	2010-
C-2	1990	78	120	99	44	341	1990
	1993	78	193	137	44	452	1993
	1996	78	292	199	44	613	1996
	2000	78	292	209	44	623	2000
	2010-	78	292	241	44	655	2010-
D-1	1990	78	193	135	44	450	1990
	1993	78	292	189	44	603	1993
	1996	78	292	199	44	613	1996
	2000	78	292	209	44	623	2000
	2010-	78	292	241	44	655	2010-
E	1990	78	120	125	44	367	1990
	1993	78	120	131	44	373	1993
	1996	78	120	135	44	377	1996
	2000	78	120	135	44	377	2000
	2010-	78	120	141	44	383	2010-
F	1990	78	193	135	44	450	1990
	1993	78	193	145	44	460	1993
	1996	78	193	147	44	462	1996
	2000	78	193	151	44	466	2000
	2010-	78	193	167	44	482	2010-
G	1990	78	193	135	44	450	1990
	1993	78	193	137	44	452	1993
	1996	78	193	137	44	452	1996
	2000	78	193	137	44	452	2000
	2010-	78	193	147	44	462	2010-

Table 8-2.5 RUNNING COST OF MRT SYSTEM

(1000 Sucre)

Case & year		Personnel expense	Management overhead	Maintenance cost	Power cost	TOTAL	
A-1	1990	120,540	27,724	75,333	48,492	272,089	1990
	1993	191,160	43,967	211,410	126,984	573,521	1993
	1996	194,040	44,629	243,384	134,400	616,453	1996
	2000	196,920	45,292	261,081	153,072	656,365	2000
	2010-	206,136	47,411	328,869	180,456	762,872	2010-
A-2	1990	120,540	27,724	75,333	48,492	272,089	1990
	1993	148,500	34,155	116,449	68,328	339,472	1993
	1996	194,040	44,629	243,384	134,400	616,453	1996
	2000	196,920	45,292	261,081	153,072	656,365	2000
	2010-	206,136	47,411	328,869	180,456	762,872	2010-
B-1	1990	145,620	33,493	101,107	60,696	340,916	1990
	1993	191,160	43,967	211,410	126,984	573,521	1993
	1996	194,040	44,629	243,384	134,400	616,453	1996
	2000	196,920	45,292	261,081	153,072	656,365	2000
	2010-	206,136	47,411	328,869	180,456	762,872	2010-
C-1	1990	113,052	26,002	43,482	35,496	218,032	1990
	1993	191,160	43,967	211,410	126,984	573,521	1993
	1996	194,040	44,629	243,384	134,400	616,453	1996
	2000	196,920	45,292	261,081	153,072	656,365	2000
	2010-	206,136	47,411	328,869	180,456	762,872	2010-
C-2	1990	113,052	26,002	43,482	35,496	218,032	1990
	1993	146,196	33,625	102,867	61,896	344,584	1993
	1996	194,040	44,629	243,384	134,400	616,453	1996
	2000	196,920	45,292	261,081	153,072	656,365	2000
	2010-	206,136	47,411	328,869	180,456	762,872	2010-
D-1	1990	145,620	33,493	99,630	59,244	337,987	1990
	1993	191,160	43,967	211,410	126,984	573,521	1993
	1996	194,040	44,629	243,384	134,400	616,453	1996
	2000	196,920	45,292	261,081	153,072	656,365	2000
	2010-	206,136	47,411	328,869	180,456	762,872	2010-
E	1990	120,540	27,724	75,333	48,600	272,197	1990
	1993	122,268	28,122	85,157	51,924	287,471	1993
	1996	123,420	28,387	87,879	54,276	293,962	1996
	2000	123,420	28,387	87,879	54,276	293,962	2000
	2010-	125,148	28,784	100,427	59,904	314,263	2010-
F	1990	145,620	33,493	101,461	60,696	341,270	1990
	1993	148,500	34,155	116,448	68,328	367,431	1993
	1996	149,076	34,287	124,044	69,876	377,283	1996
	2000	150,228	34,552	127,726	72,984	385,490	2000
	2010-	154,836	35,612	169,445	88,200	448,093	2010-
G	1990	145,620	33,493	99,630	59,244	337,987	1990
	1993	146,196	33,625	102,867	61,932	344,620	1993
	1996	146,196	33,625	102,867	61,932	344,620	1996
	2000	146,196	33,625	102,867	61,932	344,620	2000
	2010-	149,076	34,287	122,495	73,140	378,998	2010-

PART 2

OTHER IMPROVEMENT PLANS RELATED TO INTRODUCTION OF MRT

PART 2 OTHER IMPROVEMENT PLANS RELATED TO INTRODUCTION OF MRT

1. Planning Policy

The operations of the MRT will not only produce better results on the present transport system, but also bring various effects on environments along the MRT route, especially around stations such as new development of commercial areas, housing in the suburbs, and other influences.

Several measures should be adopted to maximise good results and minimize disadvantages. They are not necessarily required for the MRT, but expected to make the MRT work effective and contribute to urban developments in various areas.
The concept of such improvement measures and examination of environmental problems are shown as follows.

2. Scheme of Public Transport Network Development

After the introduction of the MRT, the public transport network shall be reorganized on the viewpoint to maximize the social benefits and minimize the users' inconvenience, utilizing the MRT.
The contents consist of reorganization of the bus routes, preparation of the connection points and other improvements of accessibility to the Rio Guayas side from the MRT stations.

2-1 Reorganization of Bus Routes

Basic idea of bus routes reorganization written in Supplementary Volume 1, Section 1-4 in PART 3 is applied to each existing bus route, considering the followings.

(1) Maximum utilization of the MRT with high level of service such as high speed and big transport capacity.

(2) To prevent passenger from unnecessary transferring between the MRT and buses.

(3) To reduce bus operation costs and to recover intensive efficiency, eliminating too long route through congested roads.

(4) To secure even for the road users to receive benefits by recovering smooth road running condition brought by reduction of bus traffic.

In addition to the above, following characteristics of the areas are taken into account.

(1) Because the roads across the section between Cerro el Carmen and Estero Salado are congested with heavy traffic and its congestion is forecast to increase gradually in future, it is desirable that the MRT caters for the traffic demand for public transport across this section.

(2) The density of bus routes in the kernel part of the CBD has been gradually decreasing because of the deteriorating traffic conditions like the crowded streets and car-parkings on the street sides. As one of the countermeasurs, a transit mall is desirable for passengers to access easily to the MRT station.

The measures for rearrangement of bus routes by area are as follows (see Figure 2-1.1).

① Guasmo Sur, Oeste, Central

The existing bus route pattern

Many routes through Av. 25 de Julio operate between Guasmo and Centro Civico or Parque Victoria. In order to enter the CBD, it is necessary for most passengers to transfer to other routes.

After introduction of the MRT

All routes are connected with the MRT at Guasmo station. In case that the MRT operates only between Terminal Terrestre and Centro Civico, they are linked at Centro Civico station.