6 – 2 Comparison of LED Type, Inverter Type & Caption Type

Table 6.2.1 Equipment Comparison of 3 Types

Item	Light Emitting Diode (LED) Type	Inverter Type	Caption Type
Compotision of equiptment	Composed with a Light Emitting Diode with dots, a display board to indicate trains departing time and a control operation device of the display board.	Composed with a display board, a display operation controller and its control device. Display units for inverter type are combined to inform departing time and so on.	Composed with a display board (by combing of units of caption type), to inform the train's departing time an operation of display board controller and its control device.
Means of Display	On a surface of combined units of composed 16 × 16 dots, a letter or a graphic display of 16×16 dots or 24×24 dots is converted.	Two wings, on which informing letters are written, are combined one display board by being put in parallel and vertically, then each upper wing is fallen one after another for display conversion by motor rotation.	Upper and lower drums are to be rolled with letter within films and to be lit by fluorescent lamps set inside. According to the order, the point is to be detected by a micro-switch or a approaching switch, then the display is to be changed by a rotatory motor or a reverse motor moved by a relay or a semiconducting control circuit.
Converting numbers in display units	3 φ 16×16 dots 64mm × 64mm 5 φ 16×16 dots 96mm × 96mm 8 φ 16×16 dots 144mm × 144mm	Length 60mm-70mm Width 45mm-800mm Length 90mm-100mm Width 63mm-800mm	Available from minimum length 100mm × width 140mm to maximum length 2m×2m length around.
Convertible numbers in display units	Unlimitted	Depends on the number of turning wings	Depends on the length of film (max.90)
Display colours	4 kinds such as Red, Green, Yellow, Orange. However, putting more than 2 LED chips into one dot makes it possible to display more colours.	Display letters and back colours have free choice in printing.	Free colour choice in display letters and back ground is made by printing.
Brightness (clearness)	Depends on colour distinctions, but the brightness is high because of its self-emitting and of its high hardness.	Quite well though the cleaness is very much influenced by the lighting from outside.	Passing-through ligting makes clear, brighter displays, for it is lit from inside.
Extent of visual angle	About 130° (65° is half of middle brightness.)	About 140°	About 140°
Consumption of electric power (per 1 unit)	About 10W (when all dots are on.)	At conversion about 5 W	About 15W while the display is to be changed.
Estimated length of life	About 1×10^5 hours (brightness will be reduced by half.)	Over the numbers of motion of display unit 1×10^6 times.	Over the numbers of motion of display unit 1×10^6 times.
Merits	1. Keeps long life with less maintenance with no moving parts. 2. Forming sizes can be set on the display according to the purpose of use and the place of installation, for units can be combined continuously to make one flat panel. 3. The volume of information on display is unlimitted, for letters and graphic matters can be displayed freely. 4. Can accept the change of display details easily on the spot when the time schedule is revised. 5. Can offer necessary information when necessary at real time. 6. Can put data in from films of cameras and video cameras.	1. Free choice of colours of display letters and back (ground) colours. 2. At the changing of display details, wings are partially and easily replaced. 3. Less electric power consumed except the time of conversion.	1. Free choice of colours of display letters and back (ground) colours. 2. The display size can be set according to the purpose and to the setting position by its wide display capacity.
Demerits	1. Such place of high brightness and the place receiving direct sun shines need a consideration of putting some hood. 2. Keep to consume electricity while on display.	1. Maintenance and checkings such as oiling and cleaning are required regularly, for it has movable parts. 2. Only printed letters on the wings can be displayed. 3. Need some time to get the right display, for its rotation is only one way. 4. Need lightings from outside. 5. The numbers of display are limited by the numbers of turning winds.	1. Maintenance and checkings such as oiling and cleaning are required regularly, for it has movable parts. 2. Can display information only printed on films. 3. Has one posibility of troubles caused by film elasticity influenced by humidity of open air. Caused static electricity helps dust adhered. 4. Films should be replaced when the change of informing details. 5. The convertible numbers of display are limitted by the length of a film.

Table 6.2.2 Comparison of each static display

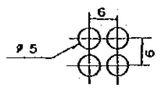
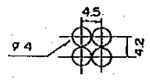
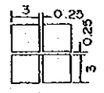
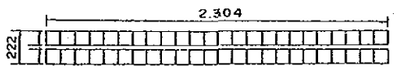
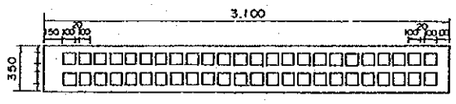
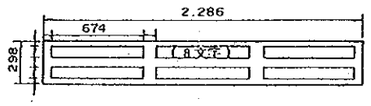
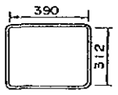
Item	Light Emitting Diode	Liquid Crystal Display	Plasma Display Panel	CRT (Cathode Ray Tube)
Outline of device	Composed with a light emitting diode with dots, a display board to indicate trains' departing time and emergency information, and of its controlling device.	Composed with dots combined through shutter process caused while the liquid crystal moving, a display board to inform such as destination and of its controlling device.	Composed wit dots combined by the radiation caused while the electric dischargings by neon gas, a display board to inform trains' departing time and emergency information, and of its controlling device.	Composed with a television receiving device in order to inform trains' departing time, general information, emergency information and so on by the fluorescent radiation of the cathode ray tube.
Means of display	By its self radiation of light emitting diode.	By the lighting inside when the liquid crystal is used as the shutter.	By the radiation caused through the electric dischargings of gas.	By the electronic beam radiation made on the fluorescent surface of the cathode ray tube.
Display colour	Green, Red, Yellow, Orange(mixed colour of red & green).	The colour of the filter put in front	Orange	Any colour is available using 3 basic colours of light.
The composition of display dot	The size of one dot is ϕ5 and 2 LED of green and red are combined. 	The size of one dot is ϕ4. 	One dot forms a quadrangle of each side lengthen 3mm. 	
The composition of display units	Composed with total 256 dots of 16 dots length and 16 dots width. Outward size of 1 unit 96×96mm Display board size of 1 unit 96×96mm The control circuit is set on the backside of the unit.	Composed with total 576 dots of 24 dots length and 24 dots width. Outward size of 1 unit 126.6×126.6mm Display board size of 1 unit 100.6×100.6mm The control circuit is set at the upper and lower side of the unit, and backside of unit can be passed through the light of fluorescence lamp.	Composed with total 2160 dots of 16 dots length and 135 dots width, and the display of 8 letters makes 1 unit. Outward size of 1 unit 150 ×760mm Display board size of 1 unit 79 ×674mm The control circuit is set on the backside of the unit.	Example of the tub of 22 inches. The display board is composed with 256×224 dots. The control circuit and the electic power supplying circuit are installed on the space made at the backside of the display device.
The composition of display panel	A panel is composed with units putting together on four sides with leaving no space in between.	Units can be put together on four sides, but with some space necessary in between.	Units need some space on four sides in between.	One information is displayed on one cathode ray tube. About 8 sets are disposed on line vertically.
The size of display device (Two lines-each line has 24 letters-make one display board)				
Recognition and its distance	The rate of contrast 1:25 over Distance: about 30 m (with reflection prevent filter)	The rate of contrast 1:7.5 Distance : about 28 m This device makes the rate of contrast lower, for inward lightnings pass through the polarizing plate.	The rate of contract 1:25 over Distance: about 30 m	White 100: 1 over, adjustable freely Distance : 3-4 m at 22 inches with 8 sets on line vertically
Visual angle	About 130° (Basic brightness reduced by half at 65°)	About 120° (Basic brightness reduced by half at 65°)	About 120° (Basic brightness reduced by half at 65°)	About 120°
Estimated length of life	1×10^5 hours (Brightness is reduced by half)	5×10^4 hours (The rate of contrast is to be one fifth of the first rate)	3×10^4 hours (Brightness is reduced by half)	About 3×10^4 hours (accumulated working time)
Electric power consumption	About 480W (while all dots are on) is to be reduced to less one third while usual information is displayed.	About 480W. Almost of the electric power is consumed to installed electric tubs.	About 570W (The display unit of 8 letters consumes about 32W when one third of it is on.)	About 100W.
Maintenance	The LED and its control circuit do not require ordinal maintenance, for they are semiconductors.	Has necessity of replacement of fluorescent lamps for lighting inward. Control circuit used semiconductor is not required ordinal maintenance.	Control circuit used semiconductor is not required ordinal maintenance.	Control circuit used semiconductor is not required ordinal maintenance. Needs cleanings, for dust is easily adhered by using high voltage.
Display function for words and sentences	Letters and sentences can be displayed at free position. Some location can accept high- bright LED units. 3 colours display is available.	1 unit displays 1 letter, there is space between units. Dots can't be chosen by installing location. Has a possibility of conversion of letter part to ground part at the location of wide angle.	The display should be laid out with care, for each display uses 1 unit of 8 letters and it has rather wider space in between. Dots can't be chosen by installing location.	Letters and sentences can be displayed at the free position. Information is displayed on several lines, for number of letters is limitted on a line. Free colour variation can be applied to the letters and the back ground.

Table 6.2.3 PIC'S Automatic Information with the Details of Indicator

Item			Details	Item			Details
Automatic Information	Information Items	Nearness	To inform at the nearness of trains	Automatic Indicator	Departing Signals	Type of Trains	Train's names, forwarding, party cars
		Arrivals	To inform at the arrivals of trains			Number of Train	By 4 numbers with 1 alphabet
		Departures	To inform at the departures of trains			Departure Time	To indicate trains' departure time
		Delays	To inform at the delays of trains			Destination	Names of destination
		Early Departure	To inform about the first train			Stops	
		Passing Trains	To inform about the passing trains			Time of Delays	
	Details of Information	For Passengers	To inform train's names			Number of Platform	
		Forwarding Cars	To inform about out-of-service cars				
		Party Trains	To inform about party trains		Arriving Signals	Type of Trains	Train's names
		Trains Number Unknown	To inform the right train if the number of corresponding train does not meet the indicated data. (Simple information)			Number of Train	By 4 numbers with 1 alphabet
						Time of Delays	
		Returnings	To inform about the returning trains			Number of Platform	
		Final Arrival	To inform about the final arriving trains			Arrrival Time	To indicate train's arrival time
		First Departure	To inform about the first departing trains			Origin	Name of original station

6 - 3 Features of Electronic Interlocking Equipment

(1) The relay-interlocking system (RRI type) now employed at New Delhi Station was planned by the Indian Railways, and constructed a decade ago. On the other hand, A new electronic interlocking system (SSI type), also developed in India, is now being tested at Brar Square. In addtion, the introduction of another electronic system (GEC type) has been authorized at Badli. If the existing relay-interlocking system of the New Delhi yard is to be modified by introducing the SSI-type electronic interlocking system, it should be done when the yard undergoes drastic modification of its track layout. Which will take place at the modernization of the New Delhi terminal.

(2) Economic merits of introducing electronic interlocking
The electronic-interlocking system is comprised of standardized hardware and software. The hardware consists of microcomputers and the software of a relay-interlocking function program applicable to every stationyard. The conditions particular to each yard, in terms of train operation and of interlocking switches and signals, are input in the form of data to be processed. The concrete economic benefits of the electronic interlocking system are as follows:

1) Inspection/maintenance methods can be standardized and even automatized resulting in lower maintenance costs.
2) The connection of electrical wires on sites can be minimized, so that construction time and cost can be reduced.
3) Modification of interlocking conditions can be performed by modifying the software alone, meaning additional investment can be economized on.
4) When some of the hardware is deteriorated, it can be repalaced by common electronic products. With the general tendency of hardware getting cheaper, a further reduction in the costs of construction/replacement can be expected.

5) Equipment of the electronic interlocking system is smaller in size than that of the relay-interlocking system. The size of the building and machineroom to house the system can be expected to be smaller.

(3) Technical Merits

At a large terminal, train operations and passenger information should be centrally controlled. The introduction of the electronic interlocking system would greatly contribute to this centralization. However, with the conventional relay-interlocking system, unlike the electronic interlocking system, it is technically impossible to achieve the following:

— Automatic determination of train routes or shunting locomotive routes.
— Automatic inputting of train operational status to a train operation information system.
— Provision of train operation information to a PIC system.

(4) Functional Comparison between Electronic and Relay Interlocking Equipment

The followings are the main functional differences between the electronic and relay interlocking equipment:

i) The train route on main lines and station lines are set automatically by inputting the desired train number, while the shunting route for rolling stock is automatically set by inputting the shunting route pattern number. The shunting route of rolling stock can also be set aurally.

ii) The railway schedule necessary for the automatic route control is built-in. For this reason, schedule preparing and correcting are required.

iii) The interlocking functions are all analyzed by the necessary software and combine with the site signal through an input-output relay. CTC or the electronic equipment which displays passenger information can be combined with this electronic apparatus.

iv) Maintenance locations (rail closing and signal stopping, etc.) can be controlled with the electronic interlocking equipment to improve the safety of maintenance work and to stave off the automatic routing into areas where maintenance is being conducted.

v) The VDU display control board is used in place of the conventional panel type control board for man-machine interfacing.

vi) The operating information which the electronic interlocking equipment controls, such as present train situations and train operating schedules can be presented at each location in a station. Further, the train operating situations for any lines can be presented at each location through the electronic interlocking equipment by combining with the train operating control system in the lines.

vii) Motion monitoring of the main parts of the electronic interlocking equipment and site signal apparatus is carried out automatically using information such as the operating records of operators or maintenance workers, control output records and accident records. This information is submitted when an accident occurs or when requested by the maintenance manager or operating instructors in the center.

Table 6.3.1 shows the functional comparisons between the electronic interlocking equipment and the relay interlocking equipment.

Fig. 6.3.1(a),(b)shows a diagram of system comparisons between the electronic interlocking equipment and the relay interlocking equipment.

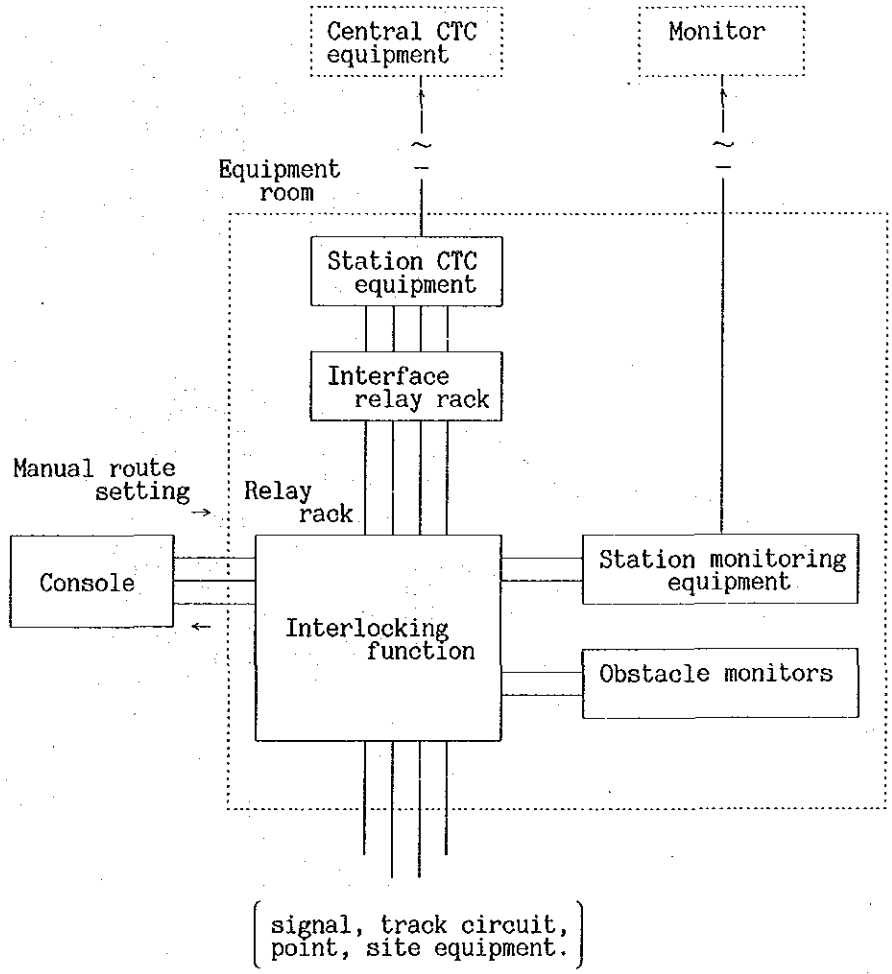
Table 6.3.1 Functional comparison between the electronic interlocking equipment and the relay interlocking equipment

Item		Relay interlocking equipment	Electronic interlocking equipment
Manual control (schedule for station works)	Operating control for train and Shunting schedule in a station	Manual control	Built-in operating schedule for trains and in stations
	Change by Department order or instruction	Manual control	Correct schedules
	Sequence control for station works	Manual control (schedule for station works)	· Control of setting sequence of starting route · Control of route setting between competitive regions · Control to avoid deadlock
	Control of train on lines		· Automatic receiving of train number from CTC or neighbor station or automatic display by train number accumulation system · Display of train number by tracking trains
	Transmission of operating informations		· Contact with a starting displays and broadcasting apparatus is possible · Safety broadcasting can be done for trains approaching the station · Operating conditions can be provided at each location in a station
	Setting and restoring routes	Setting and restoring manual operation	· Automatic setting (can also operate manually)
Interlocking	Interlocking	Relay connection	Software method
	Countermeasures against problems such as a track short circuiting	Addition of a time indexing relay	Shorting of track circuit by rolling stocks (Checking for the correct change in track circuits)

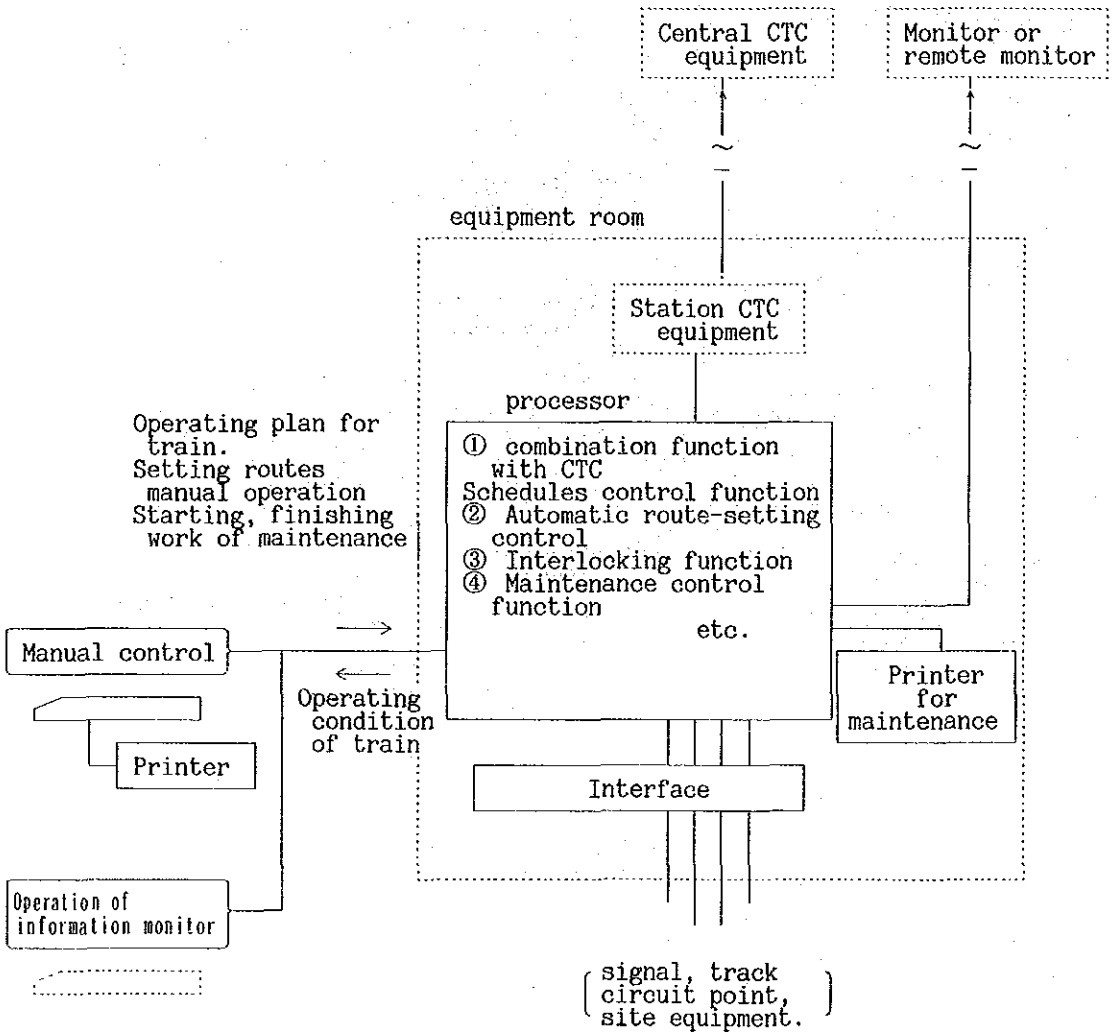
Item		Relay interlocking equipment	Electronic interlocking equipment
Interlocking	Monitoring abnormal operation of site signal apparatus	Manual monitoring	· Constant and automatic monitoring of equipment operation · Monitoring control response (Control against automatically when point cannot be converted.)
	Rail closing, stopping the use of signal apparatuses and operation of rolling stocks for maintenance	Manual control (Fitting attention cards and adding caps for levers)	· Control to invalidate route setting to designated regins where track circuits closed except for maintenance cars · Control to invalidate the setting of relevant routes for equipment which use is prohibited · Route control for maintenance rolling stocks
Addition of a time indexing relay	Control of operating and motion history	Juxtapose obstacle monitors	Lamp displaying and printing of operations and information
	Control of accident information	Control of accident information	· Lamp display and printing of accident information · Signal instructions/information for maintenance regions can be provided through the telephone line (Laying remote monitoring equipment).
Man-machine equipment		Panel type control board	CRT Type display control board
Interface with CTC		Relay contact	Electronic level/relay contact

Fig.6.3.1

(a) Relay Interlocking



(b) Eleotronic Interlocking



(2) System construction

Figure 6.3.2 shows the system construction of the electronic interlocking equipment. The following are the functional features of the equipment.

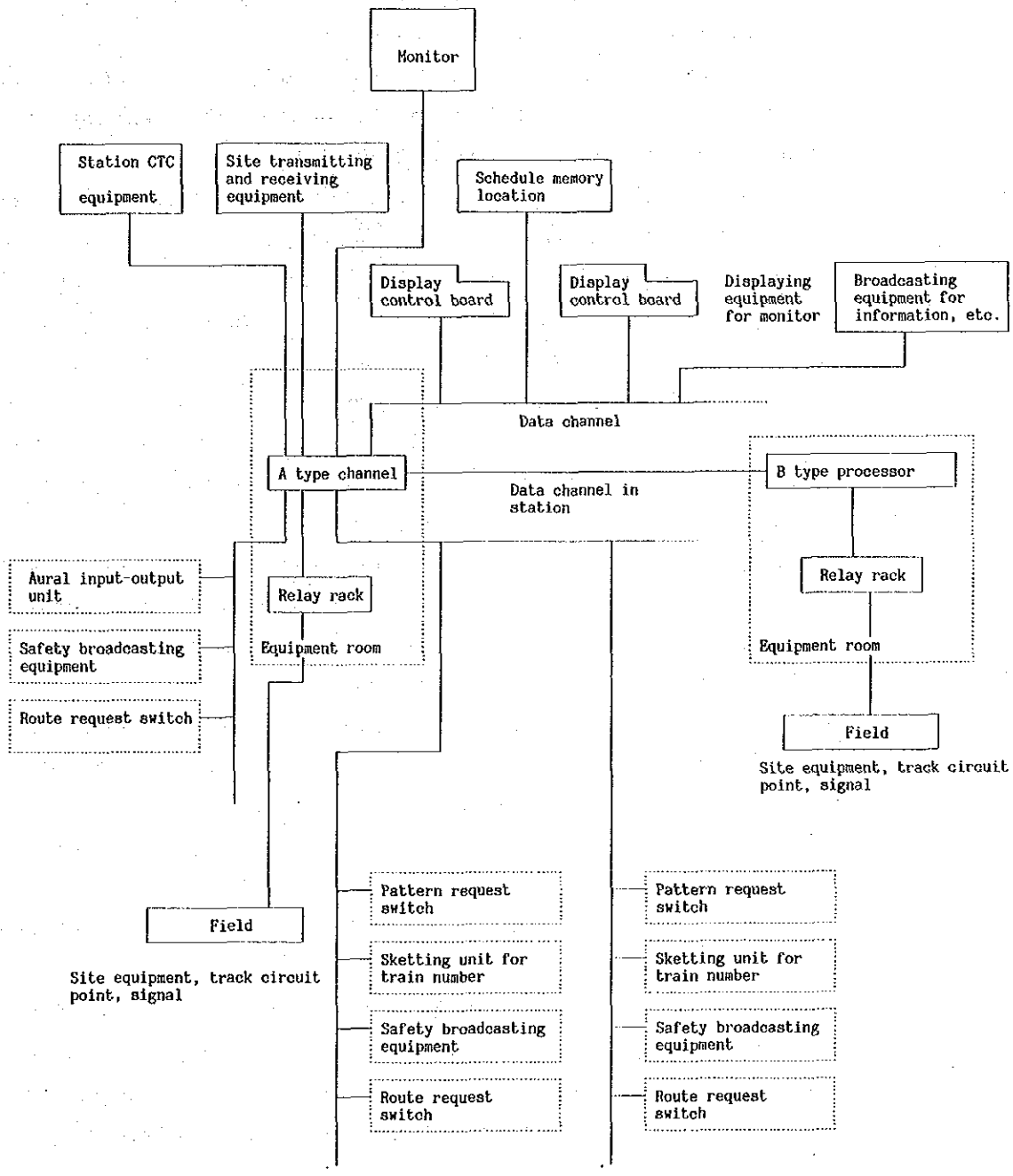


Fig. 6.3.2 Diagram showing system construction of electronic interlocking equipment

i) Display control board: A colour graphic display with high sensitivity is used and a schedule memory is used to store the basic schedule printer built-in to the display.

ii) Display for monitor: This display can be used at any location where the monitorings, such as the trains presently on line and the operating plan for trains, is desired.

iii) Data channel: This is a bound (64kbits/s) data channel which combines the electronic interlocking equipment with equipment it is used in stations which require data lot of transmitting informations or rapid response, like the display control board.
Optical fiber cables are used to construct the loop.

iv) Pattern request switch: This is a setting unit to input the operating pattern numbers from a work site when rolling stocks of the typical shunting in multi routes are started. This can also be carried out with the display control board.

v) Setting unit for train numbers: This is used when a train number newly made up is set from the site. The display control board can also be used to set a train number.

vi) Route request switch: This is used when a route setting is required for a train on a line (including a train at a station), and is set according to the starting line number. It is also possible to use the display control board.

vii) Safety broadcasting equipment: This is used in a station to make announcement safety when a train is approaching the station.

viii) Data channel in a station: This is a simple and low cost data channel (4,800bits/s) which combines the electronic interlocking equipment to the route request switch etc, scattered in a station, and constructed as a loop.

ix) Site transmitting and receiving equipment: This is used when site transmitting and receiving are dore automatically between two neighboring stations on a non-CTC line. An automatic system can be used by previously inputting the train arrival sequence on the display control board.

x) Aural input-output unit: This is used when a route setting is

aurally inputed from a site using radio equipment.

xi) Monitor: This is used when maintenance information for the electronic interlocking equipment is monitored and collected by instructors and others, who input the information remote monitors which are connected by the railway telephone line to central monitoring equipment and a personal computer.

6 - 4 Train Operation Information System

(1) Necessity for improvement

The train dispatcher for each section is responsible for collecting, recording, judging, and transmitting information concerning train operation related to the Delhi district and relevant lines in the present train dispatching system.

However, the present means of communicating mainly by dispatch telephone (omnibus type) makes it difficult to rapidly collect information over a broad area on such disruptions as train scheduling problems and to rapidly transmit instructions for restoring scheduled operation.

It is forecasted that train operation wil become even more congested with the increase in number of trains and their speeds, making rapid and suitable train operation more and more difficult.

On the other hand, the construction of a train operation information system for the Delhi district has already begun. Of course, it is important that this is expanded to each relevant section in the future and that these relevant sections be organically combined with the Delhi district.

Therefore, it is necessary to improve train dispatching by introducing the new information system described below, taking into consideration the above-mentioned operational background.

(2) Fundamental improvement policy

1) Adjust the present system to the train information system being constructed for the Delhi district. Clarify the conditions for combining the system in the Delhi district and the systems of each relevant sections.

2) Install RRI, Panels, or S.S.I. at relevant stations.

3) Install a train number inputting terminal at each branch-off station for trains going from relevant sections to non-relevant sections.

4) Establish a control center at each relevant section (Tundla, Ambala, Rewari, Shakaranpur, Moradabad, Mathura, Jakhal). That will link up with the system in the Delhi area.

5) Utilize the microwave circuit being planned for the transmission line: two to four channels for the microwave and two channels for the underground cable.

6) Use the real time process for processing and displaying information on train operation.

(3) Conditions for linking up CTCs

1) Automatic inputting of advanced train information. Only advanced train information for trains arriving in the Delhi area is manually inputted from station terminals (VDU) in the CTC of the Delhi area, but advanced trains information for all trains starting from and arriving in the Delhi area will be automatically inputted by linking up with the CTCs of the connecting lines.

2) Designation of advanced train information

Linking up the CTC for the Delhi area with the CTCs for the connecting lines will be done using train numbers (advanced train inforamtion).

3) Decentralized base system

When either the CTC for the Delhi area or a CTC for a connecting line stops functioning, the remaining functioning one will not be affected. In other words, they will function independently. At present, terminal station lying on the boarder of CTC and non-CTC areas must have advanced train information inputted to make the system complete.

4) Decentralized file system

Along with the introduction of a decentralized base system, train diagrams (Yearly, seasonal, daily), are not kept in one place (centralized) but decentralized. This result in restoration after an accident being rapid and smooth.

(4) Composition and functions of equipment

1) System outline

In a control center a train operation display board will indicate the status of all trains within a particular dispatcher's area, so that he can always grasp the situation of those trains. Furthermore, an automatic diagram recorder will be installed to relieve the instructor from complicated manual works. Also,

information display equipment for train operation, with functions such as a train delay time display delay alarm, train number changer, and train tracer will be installed to improve train operation management.

On the other hand, each station can get all the information if needs by installing only the information display equipment for train operation, which can input, change or eliminate train numbers. Moreover, main stations can improve passenger travel service by installing and combining other display equipment with the above-mentioned information display equipment for train operation. (see Table 6.4.1)

2) System construction

Figure 6.4.1 shows the relationship between the information system for train operation and other relevant systems. The functions of each component are as follows:

a) Central Processor

(a) Logical unit

Signalling, rail and scheduling information are inputted from the train number connector, transmitting unit, operator control panel, and floppy disk. Along with the calculation of delay time, making of train diagrams, train number control, and train tracing, all data that is to be displayed is outputted at the transmitting unit, train number connector, and terminal equipment.

(b) Transmitting unit

Signalling information, rail information, and handling information for the train number transmitter, etc., are inputted through a CTC central loop and outputted to the logic unit and train number connector. Furthermore, necessary information is inputted from operating trains, the train number connector, and the logic unit and outputted to the CTC central loop.

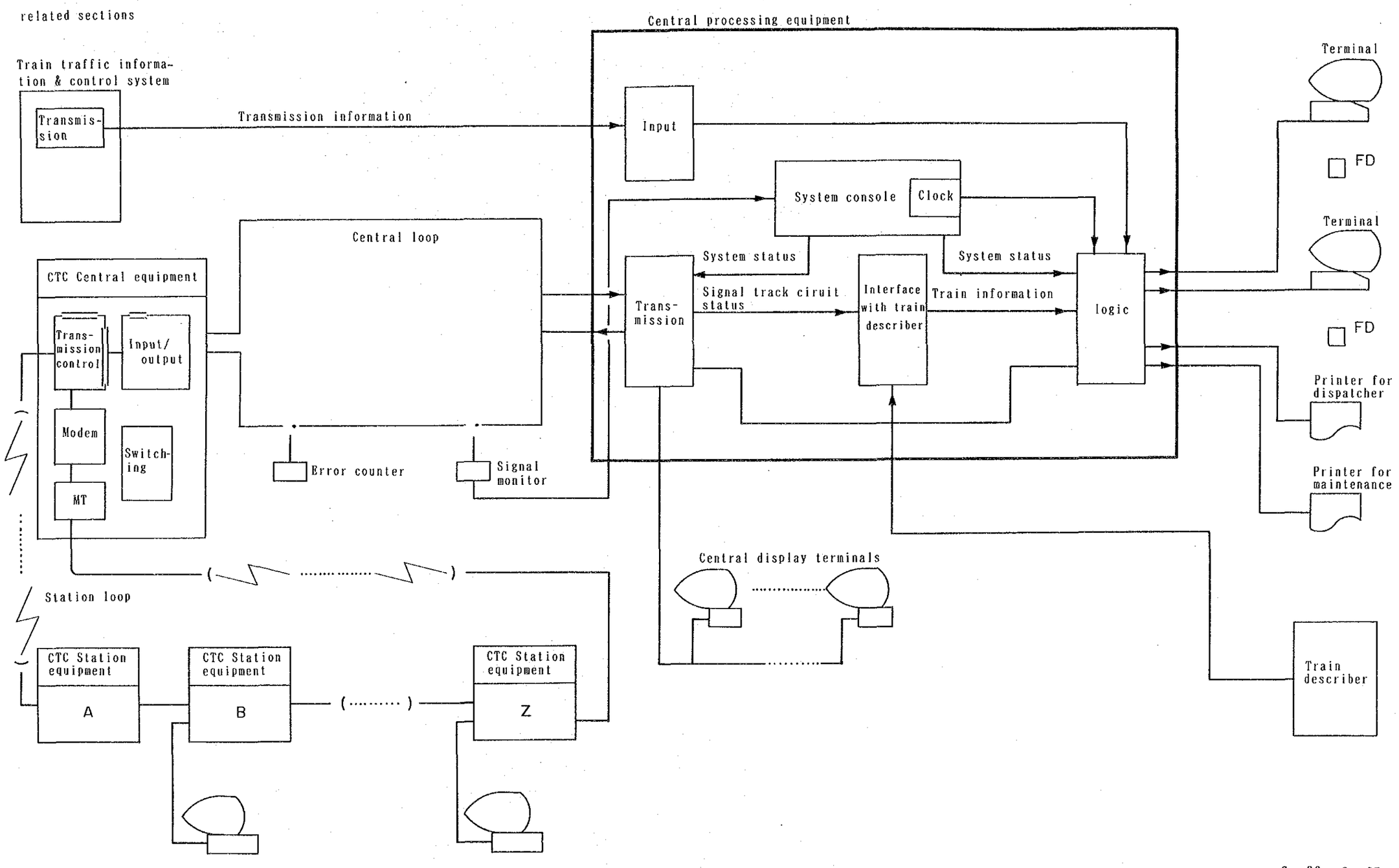
(c) Train number connector

The shifting and control of train numbers for a section are

Table 6.4.1 Range of train traffic control

	Control Center	Major stations (Locally controlled)	Ordinary stations (Remotely controlled)	Advanced train information stations
Delhi area	New Delhi Console (1)	New Delhi Delhi Main Ghaziabad Tughlakabad	Delhi Shahadara Panel A.B Sahibabad Tilak Bridge Okhla H.Nizamuddin	Mathura Khurja Hapur Meerut
	New Delhi console (2)	Delhi Cantt Shakurbasti	Delhi Kishangang Subzimandi Naya Azadpur Dayabasti Delhi Sarai Robilla Patel Nagar (BG)(MG) Brar Square Dlhi Safdarjang Lajpat Nagar	Banhpat road Rohtak Rewari Panipat
Related sections	Tundla	Hathras Tundla Aligarh Khurja Barhan	way stations except Major stations	Shikohabad Ghaziabad
	Ambala Cantt	Kurakshetra Panipat	ditto	Panipat Subzi Mandi
	Rewari	Khalil pur Garhi Harsaria	ditto	Garhi Harsaru Delhi Cantt
	Shaharanpur	Meerut City Muzad Nagar	ditto	Meerut City Ghaziabad
	Moradabad	Gajroula Hapur	ditto	Hapur Ghaziabad
	Mathura			Tuglakabad Palwal
	Jakhal			Shakurbasti Rohtak

Fig.6.4.1 System configuration of Train traffic information & control and other systems



conducted by inputting rail signals and train numbers from the transmitting unit and other equipment.

(d) Train information input unit on other lines

Extraction and arrangement of train information are conducted by inputting information transmitted from the input unit.

(e) Shared unit

The shared unit displays and monitors the operations of the central processor and designates the operating mode. It also creates the standard time for the system.

(f) Printer

Abnormal conditions occurring in the central processor and schedule are printed out by the printer.

b) Operator control panel

The operator control panel changes the data of the central processor by monitoring the copying and elimination of scheduled operation times. Then, it makes the necessary corrections and has them recorded in the processor.

c) Clock

Delays are calculated with the standard clock, which corrects automatically the time via a transmission.

3) Fundamental functions

The major functions of the information system for train operation are as follows:

a) Displaying present train location

The number of trains located in an area 3 stations and 4 sections from the center of a designated station are displayed.

b) Displaying delay time

The number of minutes a train is displayed for trains (up/down) between two stations at a determined time at the destination station.

c) Displaying trains being searched for

When a train number is designated by an operator at a control panel, the name of the station where the train is located and

number of minutes if it late are displayed.

d) Displaying reasons or causes for delays

When a train is delayed by an accident the reasons or causes and the estimated time needed for restoration are displayed by manipulating are central equipment.

e) Schedule data processing

The basic schedule and temporary schedule (sequence display data of train numbers, turnaround train number data, starting time data and train number data [4 numerals and 1 character]) are inputted from outside, stored, monitored, displayed and changed.

f) Schedule editing

This function can be used to prepare the temporary diagram using the basic diagram and prepare tomorrow's or today's operating diagram by referring to both.

6 - 5 Fundamental Functions of CTC

System and code composition are shown in Figure 6.5.1 and Table 6.5.1,2, respectively.

(1) Concept of intergrated operation

1) Monitor cycle

A polling frame is transmitted from the center to each station. If there is train operation information at this time, the relevant polling frame for adding this information is transmitted.

Each station selects necessary codes and the relevant stations transmit display information to the center. When the center finishes receiving the display frames from a relevant station, the center transmits a polling frame to the next station and this procedure is repeated.

When the center does not receive a display frame for a certain period of time after transmitting a polling frame, the center transmits the polling frame that displays all the information of the relevant stations.

2) Control cycle

When there is control information, the center transmits control frames via a control cycle after the completion of a polling cycle. Each station then receives and selects its code, with relevant stations carrying out control registration while transmitting their control answer frames to the center.

Each station returns to the polling cycle when the respective control answer frames are not received after transmission of the control frames.

(2) Fundamental functions

1) Central equipment

- Manages cycles
- Inputs and outputs information of automatic route control equipment, monitoring panels, etc., via the central loop. Supervise loop control at the same time.
- Character error detection

It calculates via inspection the number of times reception codes

are unacceptable and the number of times a station does not transmit.

- Built-in redundancy

  Includes a backup system so reception or transmission can be carried out in case of a main system malfunction.

- System changing

  Can change from its main to backup system via a switching circuit.

- System changing for station equipment and circuits and judgement of their functioning ability

  When there is a continuation of misprints at a station, it instructs said station's system to change to its backup. If there are still misprints after words, it changes to a detour circuit. If this does not work, the station is judged as unfit. Furthermore, when a control answer cannot be received from a station, even after a certain number of control cycles are executed, it judges the station's control as unfit. (The detour circuit is then manually or automatically changed.)

- When the central equipment is accessed, or when a station's equipment or control is repaired, the center transmits all control information to the related station.

2) Station equipment

- When a polling frame is received from the center to a related station, a display frame is prepared and transmitted.

  When the frame received from the center is a control frame, the station's relays and controlled and a control answer transmitted to the center.

- Displayed contents are periodically inputted and stored.

- Code trunking system

  Station equipment (trunking type) renews each frame received from the center to transmit to the terminal and renews each frame received from the terminal to transmit to the center.

- Built-in redundancy

  Station equipment transmits and receives with a backup system in case of malfunction.

- System changing

  The equipment changes between the backup and main systems via a switching circuit.

- Track circuit display

  Designated track circuits can be displayed as having no trains on their lines (and vice versa) upon a power outage by inputting information for such a case in advance.

Fig.6.5.1 Central Equipment

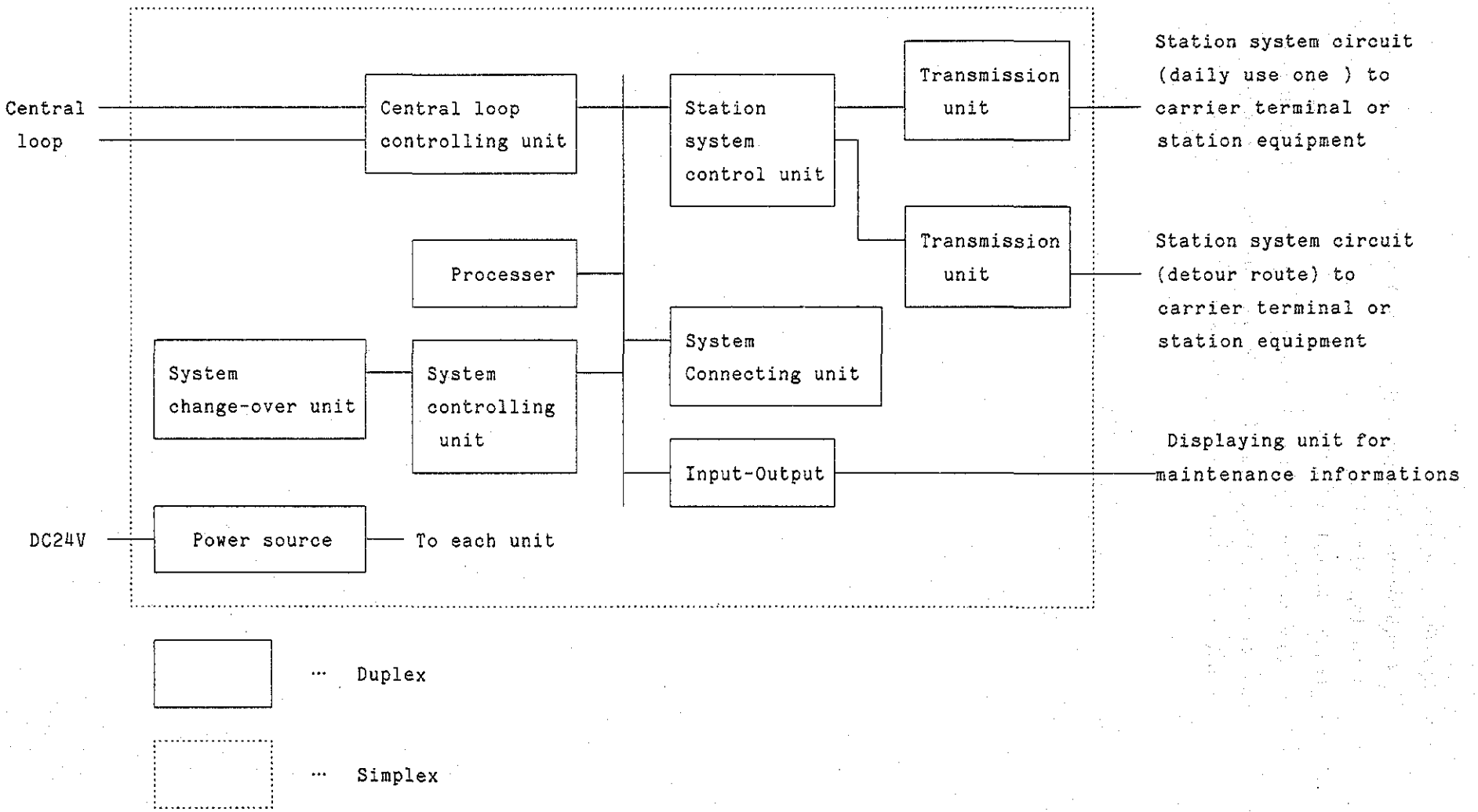


Fig.6.5.1

Frame construction

S	Header	Information

S ··· Start code
For basic band
For FM and PM

Construction of information

Polling header

Step	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16 ~ 23
Content	Kind			Station number						Other information						0	C R C
	0	0	0	2^0		~			2^5	2^0		~			2^5		

Maximum byte number for other information shall be 45.

Control header

Step	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16 ~ 23
Content	Kind			Station number						Control code number			1 CH	2 CH	0	0	C R C
	0	0	0	2^0		~			2^5	2^0	~	2^2					

1 CH ··· System change-over control: 1 channel
2 CH ··· System change-over control: 2 channels

Control code

Step	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16 ~ 23
Content	Kind			Station number						Group number			Control Content				C R C
	0	0	0	2^0		~			2^5	2^0	~	2^2					

24	25	26	27	28	29	30	31	32	~	38	39	40	41	~	47
Control Content												C. R. C			

Fig.6.5.2

Control answer

Step	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16 ~ 23
Content	Kind			Station number													C R C
	0	0	0	2^0	~				2^5	0	0	0	0	0	0	0	

Display header

Step	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16 ~ 23
Content	Kind			Station number						Display code number			Sy	FL	C	L	C R C
	0	0	0	2^0	~				2^5	2^0	~	2^2	k	K	RQ	FL	

SYK ··· Service system display
FLK ··· Inferior display
CRQ ··· Control request
LFL ··· Inferior circuit display

Control code

Step	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16 ~ 23
Content	Kind			Station number						Group number			Control Content				C R C
	0	0	0	2^0	~				2^5	2^0	~	2^2					

24	25	26	27	28	29	30	31	32	~	38	39	40	41 ~ 47
	Control Content											C R C	

Table 6.5.3 Integrated performance

Item		Performance or rating			Remarks
Logical operating system		Program processing			
	Operating system	Polling			
	Synchronous system	Frame synchronization			
	Code inspecting system	CRC *			
	Code transmitting system information	Basic band transmission	F M transmission	P M transmission	
	Transmitting rate for information	1,200 b/s 2,400 b/s	1,200 b/s	2,400 b/s	
	Code format	RZ isometry	NRZ isometry		
Number of controlling stations		Max.63			
Reliability (Average accident interval)		central equipment	1×10^6 hours or more		
		Station eauipment	1×10^6 hours or more		

* CRC generating polynominal is equal to $X^8 + X^7 + X^6 + X + 1$

Table 6.5.4 General electrical characteristics

Item		Unit	Performance	Remarks
Standard code width		μs	416	2,400 b/s
			833	1,200 b/s
Clock pulse		MHz	11.9808 ± 5 × 10^{-4} and 10.0000 ± 5 × 10^{-4}	
Operating power source voltage	Logical unit	V	Direct voltage (DC) 5 ± 5%	
	Relay		Direct voltage (DC) 24 $^{+20\%}_{-10\%}$	

Table 6.5.5 Transmitting characteristics

	Item		Unit	Performance	Remarks
	Transmitting level		dbm	0 or more	Raise 6db for transmission and lower 3db for receiving
	Receiving level	Standard		6 ~ -25	
		Lower limit		-27	
		Non-operating		-37	
F M	Line frequency	At the time of space	Hz	2,100 ± 10	
		At the time of mark		1,300 ± 10	
	Transmitting level			12 ± 3	Attenuate line transmitting output level with 2db unit
	Receiving level	Standard	dbm	0 ~ -25	
		Lower limit		-35	
	Receving level monitoring			-40 or under	
	Modulation and demodulation distortion		%	± 15	
P M	Transmitting level		dbm	0 ~ -31	Attenuate line transmitting output level with 1db unit
	Receiving level			0 ~ -40	
	Carrier frequency		Hz	1,800	
	Input-output impedance		Ω	600 ± 20%	

6 - 6 Study on Fixed Time Control of Railway Crossing

(1) Introduction

A study was conducted on a system for railway crossing control that would ensure a fixed warning time in spite of differences in train speeds, by calculating train speed detecting the operation of track circuits. Specifically, track circuits each of length 1 km were installed on the 7 km section in front of a crossing to identify train speed, and warning time was then calculated. Through the study, it was determined that:

1) If the train decelerates or accelerates on the 7 km section, the necessary warning time will at worst be fifths the scheduled warning time.
2) In the case of some low-speed trains, the necessary warning time is about two times the scheduled value. On all trains other than those mentioned above and those with a maximum speed of 160 km/h the actual warning value, can be limited to approximately 1.4 times the scheduled value.

As a second step, a study was conducted on the effect on warning time of a gate signal system which changes the block signal from red to green after closing the crossing. Track circuit conditions were the same as in the previous study.

(2) Crossing Warning Time with the Gate Signal System

1) Outline of Facilities

The following are the locations and signal colours under the gate signal system. (Refer to Fig.6.6.1)

- Braking distance of train is within 2 km on every type of train.
- Four aspect-indication (R, Y, YY, and G) can be made using the 1 km track circuits.
- In ordinary operation, braking starts at the YY signal, and the train stops at a point in front of the red signal.
- When the crossing is open to road traffic, the block signal at the crossing is red. It turns to a colour that allows re-starting, when the alarm starts and the crossing is closed.

・ The clossing gate is lowered at a specified time (to the second) after the alarm starts.

Under these conditions, the crossing warning time is controlled using train information obtained from track circuits.

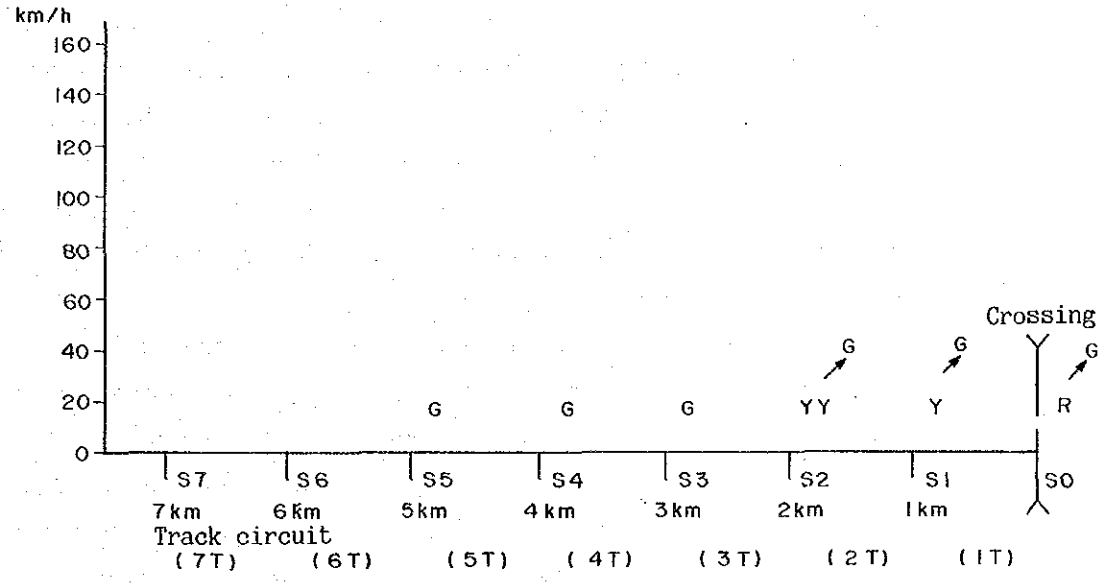


Fig. 6.6.1 Arrangement of Track Circuits and Signals

2) Study Items

Under the gate signal system, a train stops in front of the crossing if the block signal at the crossing is red and the crossing is not closed. (Here, it is assumed that back-up systems such as AWS will function perfectly.)

Accordingly, it is not necessary to study the warning time required for the safe disruption of the train schedule. The following items must be studied at this point.

a) Warning time for low-speed trains under normal operation

When a train reaches the block signal S_2 at the the border of sections 2T and 3T, the crossing should have already started warning and begun to close.

Accordingly, the minimum warning time realizable would be inversely proportional to the speed even if fixed-time control based on train information is attempted. This requires sufficient confirmation of the effects of warning time

reduction with respect to low-speed trains.

b) Warning time reserves with consideration for irregularities in train operation.

Due to errors in train speed calculation on 1 km track circuits, delay can occur, with respect to accelerating trains, in changing the indication of the block signal, S_2, from YY to G. If measures are taken so that the block signal, S_2, indicates G at an earlier time, in order to prevent the problem described above, the crossing warning time will increase. It is therefore necessary to study how much warning time reserve is required.

3) Warning Time for Low-speed Trains in Normal Operation

When a train reaches the block signal S_2, the crossing should have already started warning and should have begun to close. Otherwise, the train must decelerate because the block signal S_2 has not changed from YY to G. The warning time is at a minimum when it is designed so that the block signal S_2 changes from Y to G at the time the train reaches the signal. Under the precondition that the train is being operated at a constant speed, the minimum warning time is obtained using the following formula.

$T_{min} = 2km/v + to$

v : train speed

to: time required from the start of warning to the closing of the crossing

Table 6.6.1 Train Speed and Crossing Warning Time

Train Speed	Tmini(s) (to= 15s)	Tmini(s) (to= 30s)	Tmini(s) (to= 45s)
160	60	75	90
130	70	85	100
105	87	102	117
90	95	110	125
75	111	126	141
50	159	174	204

From the above table, it has been determined that:

- When the time from the start of warning to closing of the crossing is 30 seconds or less, the warning time, for trains running at a maximum speed of between 90 km/h and 160 km/h, can be reduced to 120 seconds (exception: 126 seconds for trains of 75 km/h);
- To decrease the warning time to 90 seconds or less, it is necessary to make t_2 about 15 seconds even if the trains operated are restricted to those with maximum speed of 105 km/h to 160 km/h.

4) Warning Time Reserve with Consideration for Abnormal Operation

A study has been conducted on how much warning time reserve is necessary to ensure that there will be no delay in the change of the indication at block signal S_2 when the train accelerates. The first case is where the time required for the train to reach block signal S_2 (in fixed-speed operation) is estimated by calculating the train speed using the 1 km track circuits. In this way the error in estimation, that is to say, the delay in changing the indication of S_2, is obtained. With regard to the three patterns of acceleration shown in Fig. 6.6.2, the delay in changing the indication of S_2 for different initial speeds was obtained through simulation. Table 6.6.2 shows the initial speeds when the delays in changing the indication are five seconds and ten seconds.

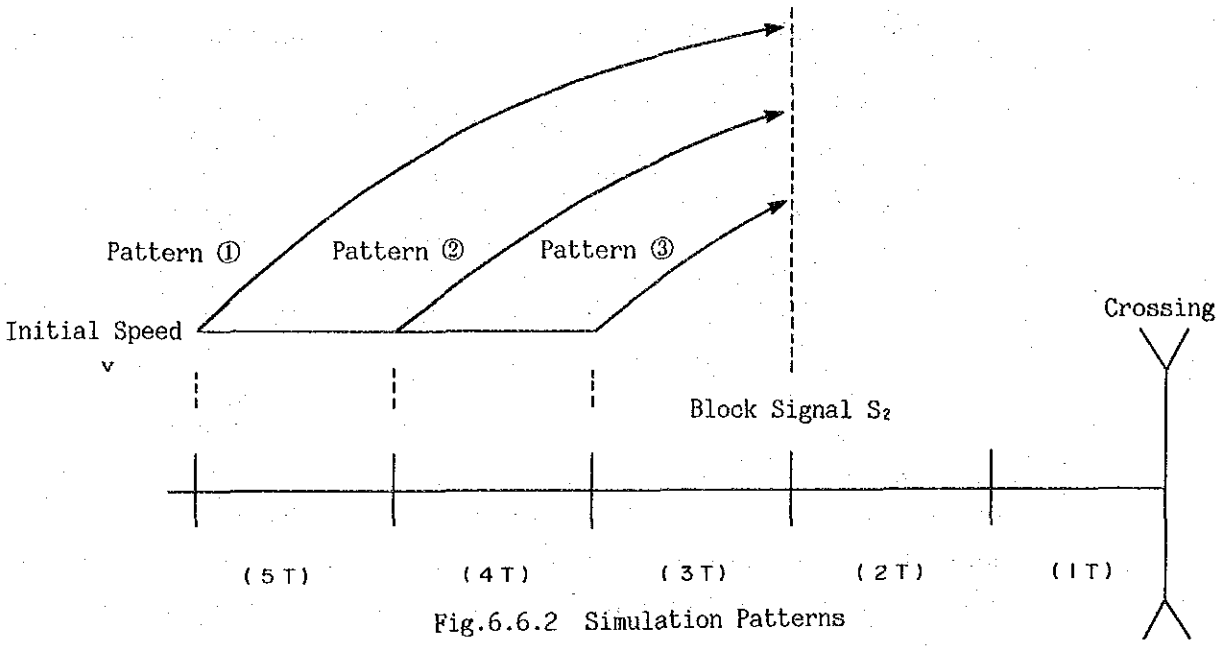


Fig.6.6.2 Simulation Patterns

Table 6.6.2 Relationship between Delay in Indication Change of Block Signal S_2 and Initial Train Speed

	Type of train 160 km/h				Type of train 130 km/h			
	Delay in indication change	v Initial speed (km/h) Patterns 1	2	3	Delay in indication change	v Initial speed (km/h) Patterns 1	2	3
to= 15 s	10<				10<			
	10	*	71	75	10	27	61	56
	| |				| |			
	5	49	102	96	5	58	77	72
	5>				5>			
to= 30 s	10<				10<			
	10	*	72	75	10	27	61	56
	| |				| |			
	5	49	102	96	5	58	77	72
	5>				5>			
to= 45 s	10<				10<			
	10	*	113	75	10	27	61	56
	| |				| |			
	5	52	138	97	5	58	77	72
	5>				5>			

From the results shown in Table 6.6.2, it has been found that acceleration, even from low speeds will have no influence on trains, if the warning starts about five seconds earlier than usual. For example, in the case of a train with a maximum speed of 160 km/h and with good acceleration performance, the delay in change of the indication of S_2 will be five seconds or less, when to = 30s, even if the train speeds are 49 km/h, 102 km/h, and 96 km/h when entering 5T, 4T, and 3T, respectively. Accordingly, a warning time reserve of about five seconds is considered appropriate to prevent delay in the change of the indication of S_2 when the train is accelerating.

(3) Conclusion

A study has been conducted on a system for controlling the warning time of a railway crossing utilizing train information from 1 km track circuits. Case involving the gate signal system were taken up, which to the following findings.

1) If the time required from the start of warning to the closing of the crossing is 30 seconds or less, the warning time can be limited to 120 seconds or less, for train with maximum speeds of 90 km/h to 160 km/h.
2) Even when the train is accelerating under irregular operational conditions, the sufficient time reserve, required to prevent the influence, of delay in changing the indication of the gate signal on the train is about five seconds. The 5 seconds increase in warning time has no affect on the above conclusions.

6 - 7 Simulation on its Performance Characteristics & Expandability of Passenger Information System in New Delhi Station

(1) Items on simulation

1) Types of data link control procedure and Basic transmission

2) Estimation of transmission rate, transmission delay time and data processing ability in terms of such variables as volume of transmission data and number of terminal

(2) Prerequisite

1) Electrical indicator

a) Departure board 19 units

b) Arrival board 2 units

2) Announcement facility

a) Loud speaker 21 units

3) Platform 16 faces

4) Number of trains 250 trains

near future 500 trains

(3) Data volume (Unit: character = 8bits)

1) Departure & Arrival boards (Total 26 characters)

a) Indication control information 6 characters

(Command, Classification of indicator, Group, Subgroup, Unit)

b) Indication data (Type of train, Train number, Arrival time, Destination, Stop station, Delay time)

2) Announcement Control Equipment 20 Characters

Control information 20 Characters

3) Console control information 16 Characters

(4) System Configuration

The system can be made by using the following local area networks.

1) Bus type

This is a topology in which all terminals are connected in parallel to a single pair of wires, coax, or optical fiber. An example, probagbly the best-known local network, is the Ethernet. (Fig. 6.7.1)

2) Star type

This topology has all terminals connected to an active central

hub that provides switching and access rights to the periphery terminals.

An example is a telephone exchange, either public or provate, that switches terminal lines to host computers. (Fig. 6.7.2)

3) Ring type

This topology is literally a ring of terminals that are connected, one to the next, with the last terminal connected back to the first.

Prime Computer's Ringnet and the Cambridge Ring are examples that have seen widespread implementation. (Fig.6.7.3)

Finally, Star type can be applied to Passenger Information Control system in this study because it is easy to accomplish Star type configuration and its central equipment can concentrately control data transmission with a few different Protocol. (Fig. 6.7.4)

(5) Relation between volume of transmission data & transmission time

1) Transmission control procedure

Basic data transmission control procedure (JIS x 5002)

(Refer to Fig. 6.7.5)

2) Volume of transmission data & transmission time

Number of transmission data for one window of electical indicators: D

$D = C_c + C_i$ (Characters)

$C_c = 7$ (ENQ ACK(2) STX ETX BCC EOT)

C_i (i = 1 to i Number of text)

Length of transmission data for an electical indicator with N widows: D_L

$$D_L = N \cdot (C_c + C_i)$$

Total number of transmission data for K sets of electical indicators: D_{LK}

$$D_{LK} = K \cdot N \cdot (C_c + C_i)$$

Hence, transmission time (T), transmission rate (B bits/sec)

$$T = \frac{1}{B} \cdot K \cdot N \cdot (C_c + C_i) \times 8 \text{ (Sec)}$$

K sets can be divided into the corresponding group in each

platform in order to shorten data transmission time. (Refer to Fig.6.7.6)

(6) Relation between number of terminal and data transmission time (Refer to Fig.6.7.7)

(7) Relation between Average Occupancy and Waiting time (Refer to Fig.6.7.8)

(8) CPU Occupancy factor and processing frequencies (Refer to Fig.6.7.9)

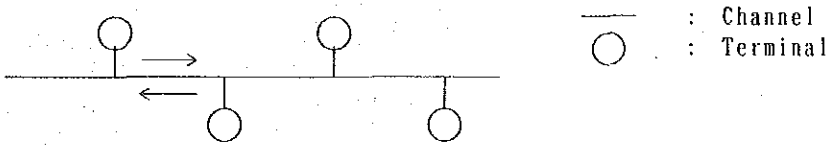


Fig. 6.7.1 Bus Local Network

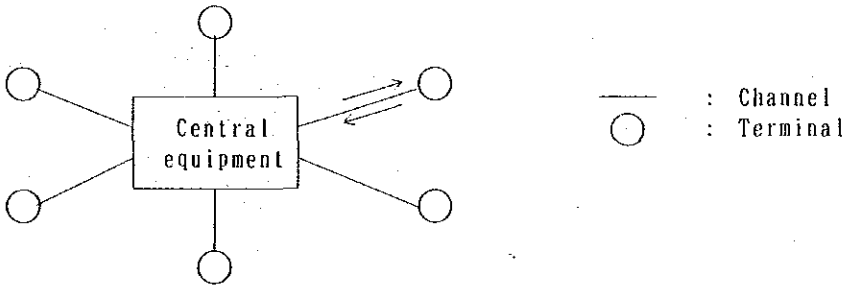


Fig. 6.7.2 Star Local Network

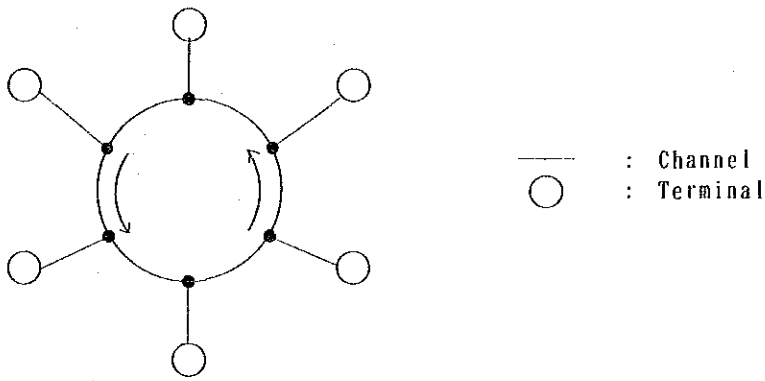


Fig. 6.7.3 Ring Local Network

Passenger Information Control System (PIC)

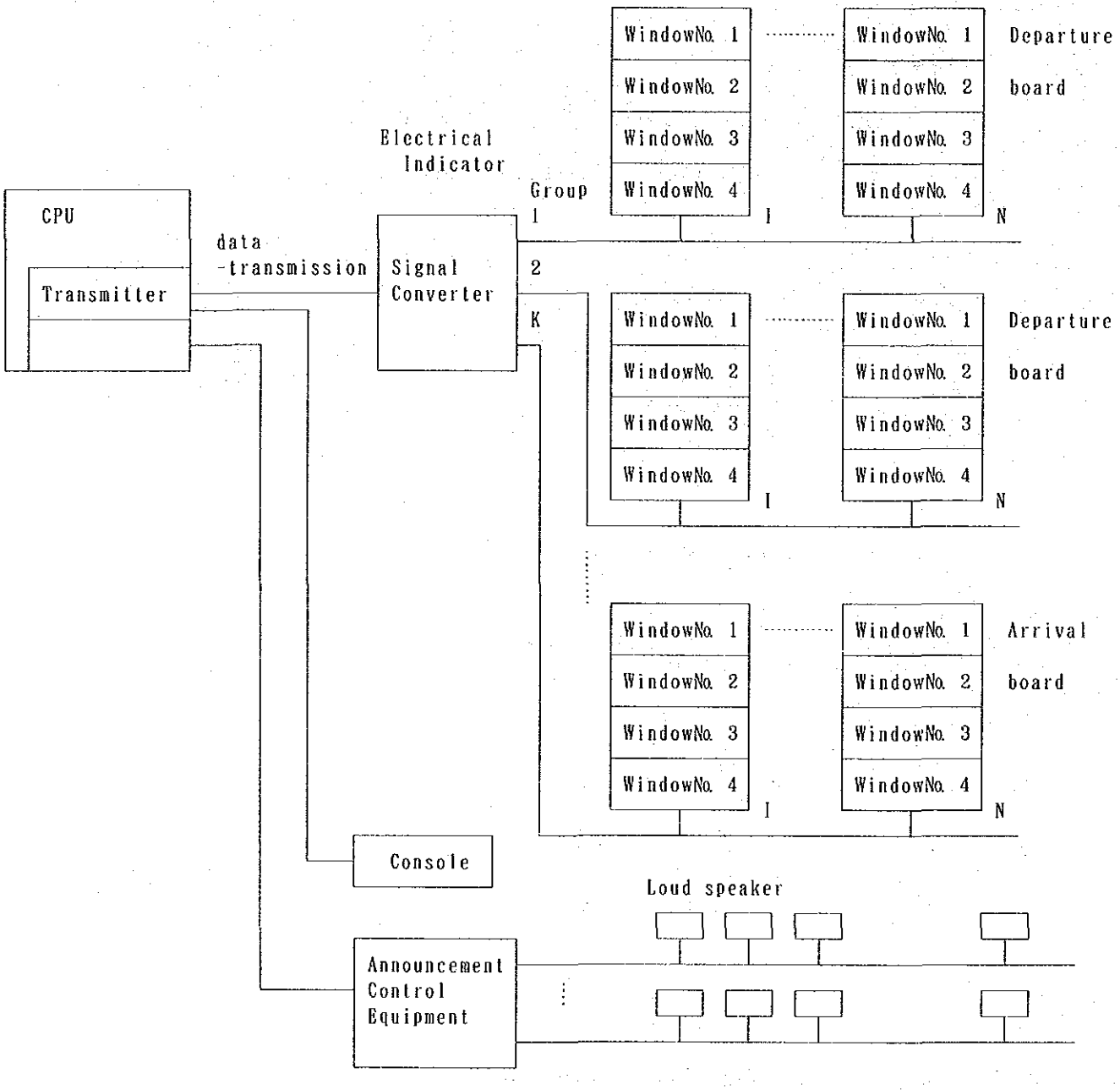


Fig. 6.7.4 Configuration Model

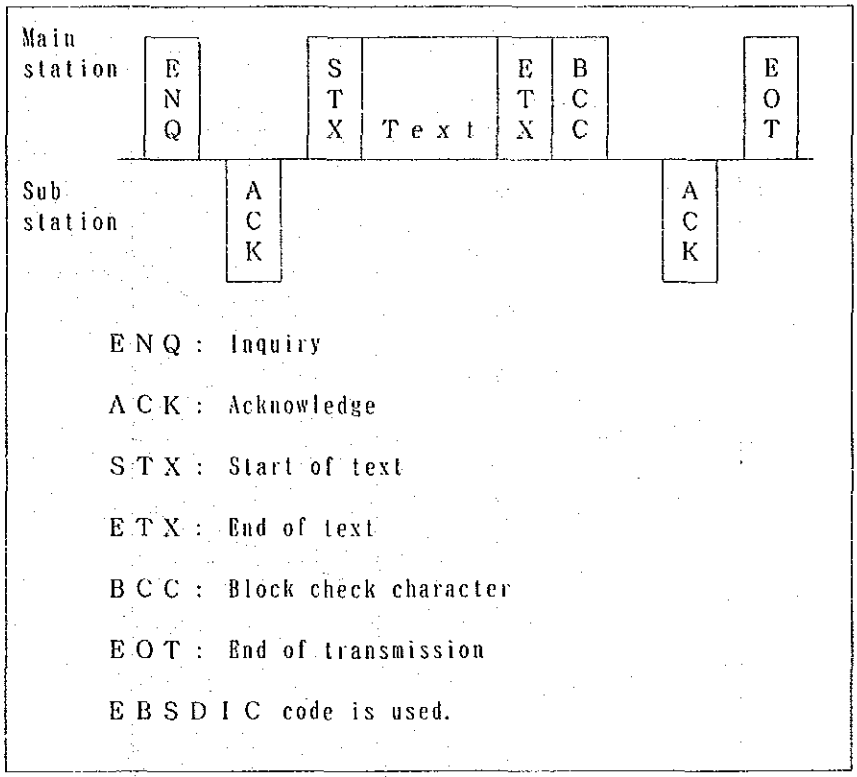
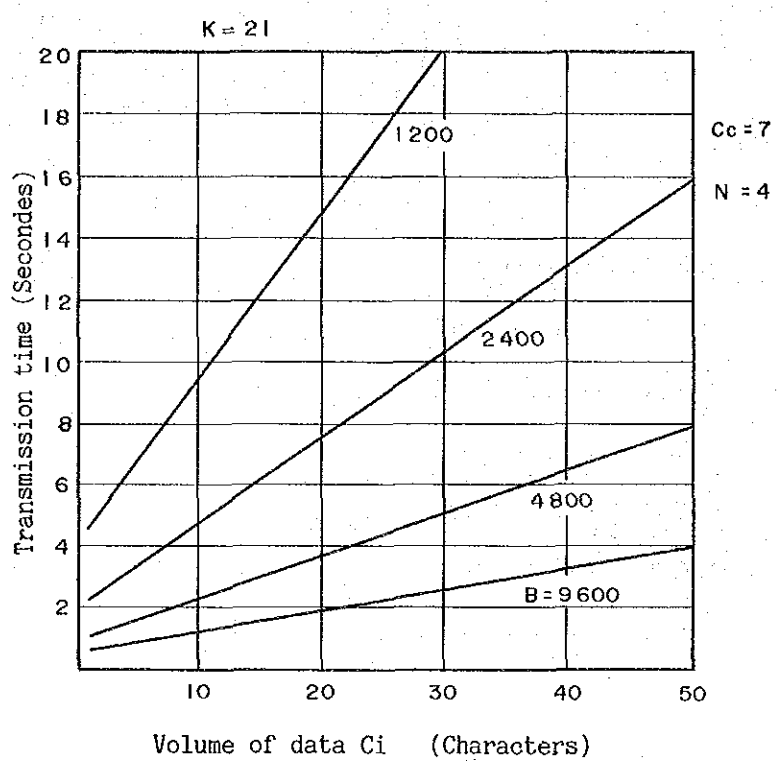


Fig. 6.7.5 Transmission Control Procedure



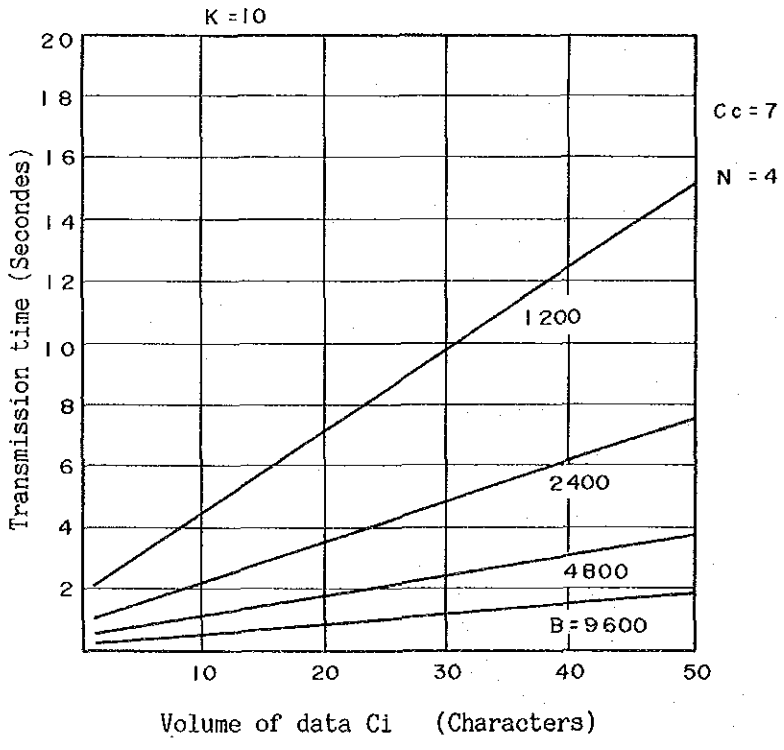
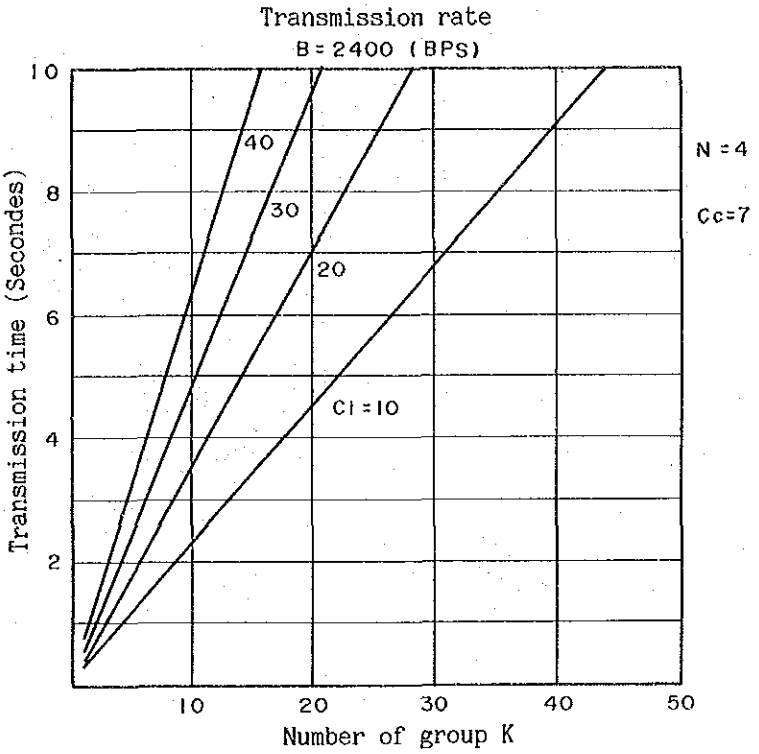
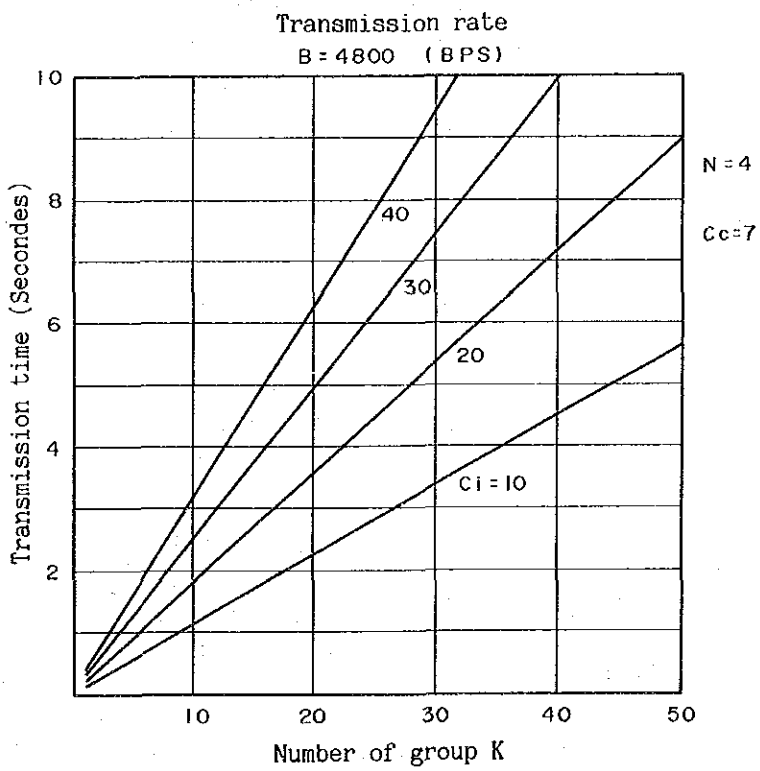


Fig.6.7.6 Volume of data and transmission time


Transmission rate
B = 2400 (BPS)
Transmission time (Secondes)
10
8
6
4
2
40
30
20
Ci = 10
N = 4
Cc=7
10
20
30
40
50
Number of group K


Transmission rate
B = 4800 (BPS)
Transmission time (Secondes)
10
8
6
4
2
40
30
20
Ci = 10
N = 4
Cc=7
10
20
30
40
50
Number of group K

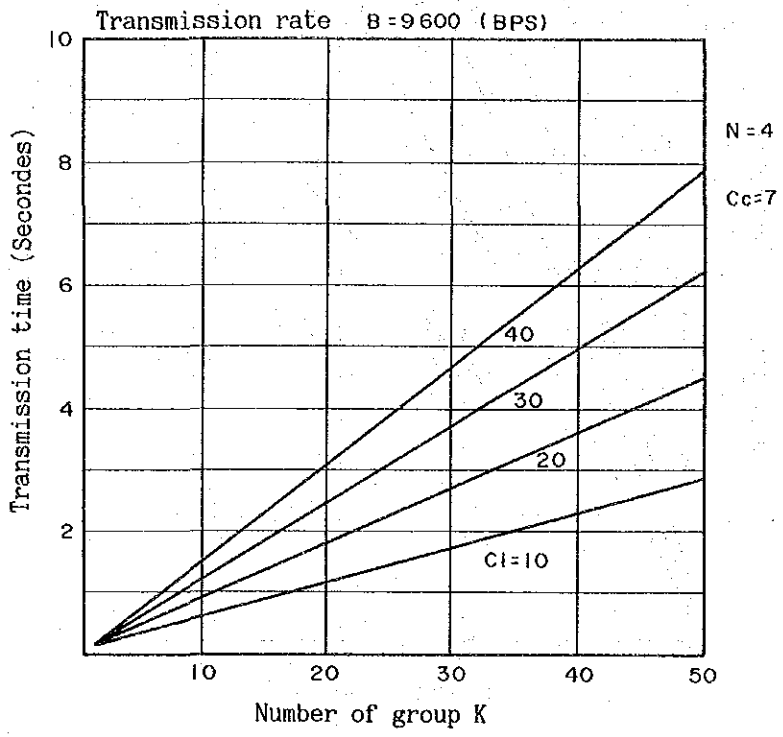
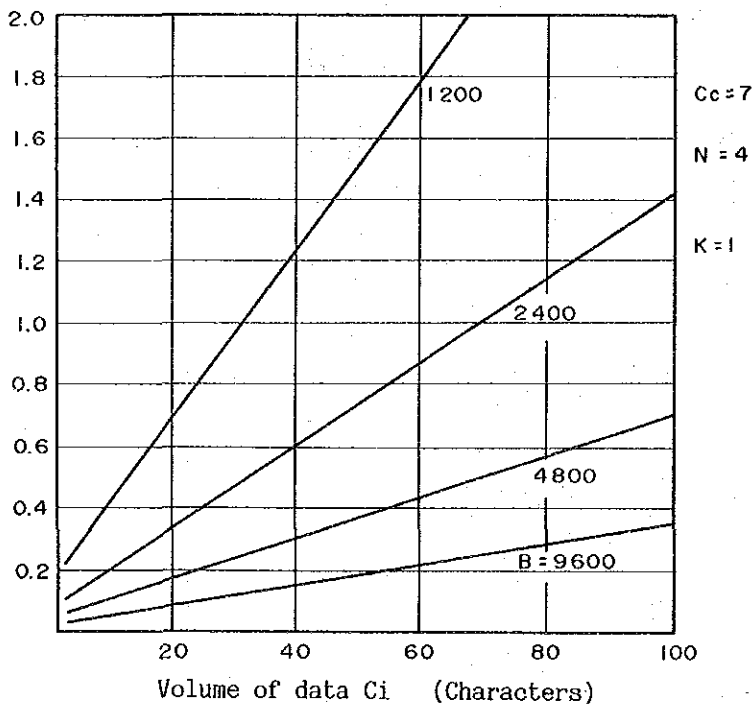
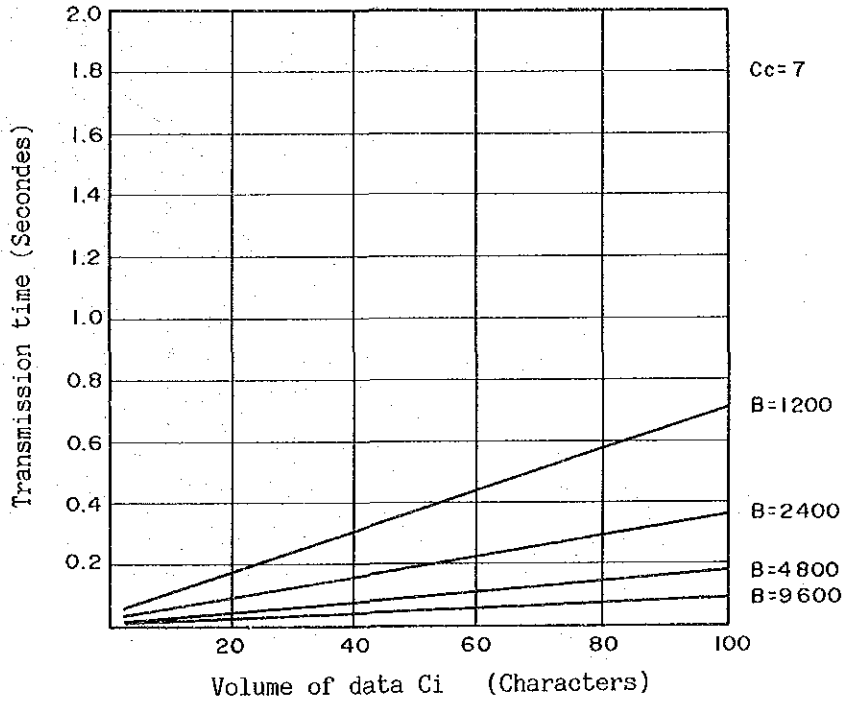


Fig.6.7.7 Number of group and transmission time



Volume of data and transmission time (Data will be transmitted only when contents of information change.)



Transmission time to console and Announcement contred equipment

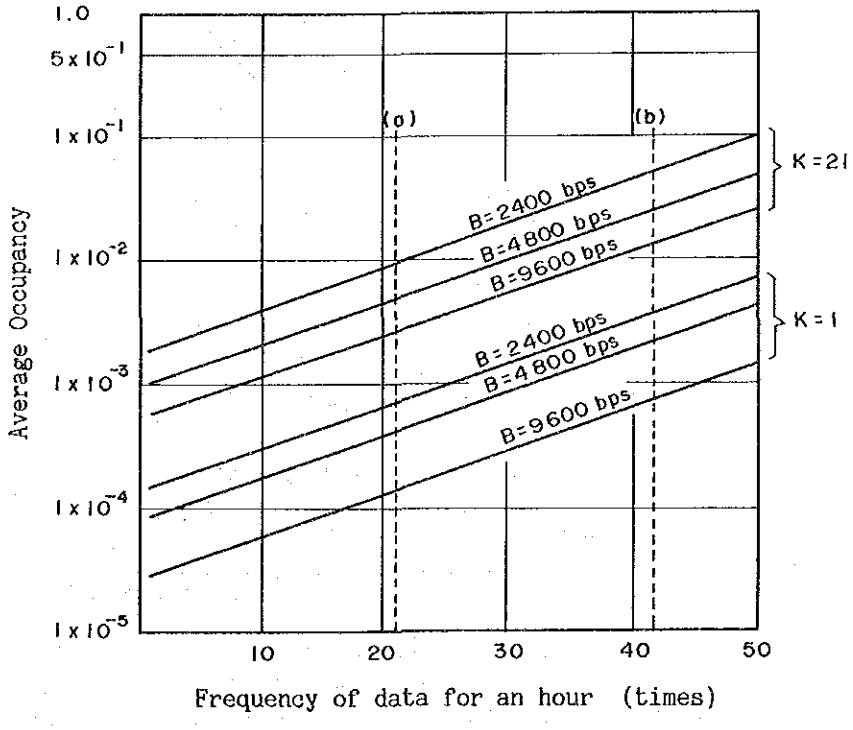
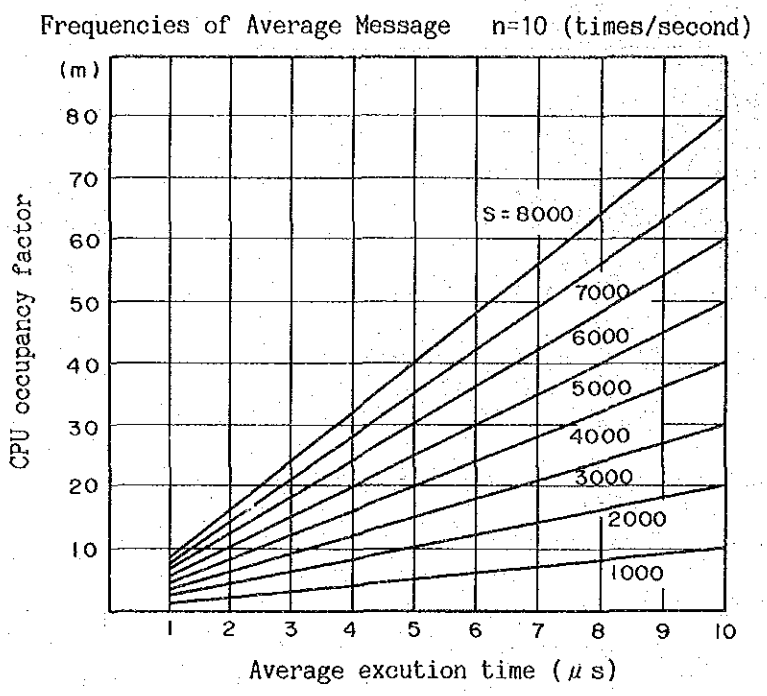
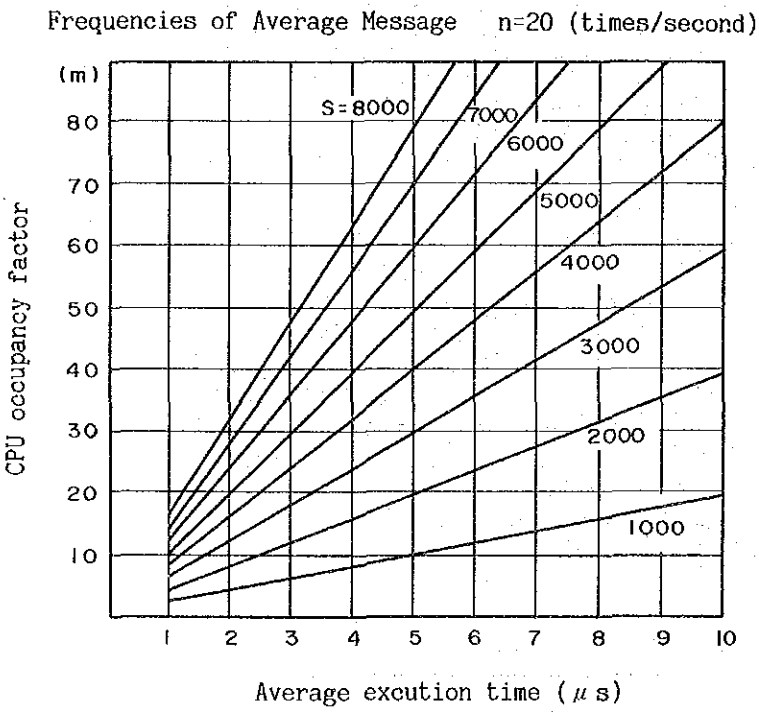


Fig.6.7.8 Occupancy





S: Number of instruction step in one message

Fig.6.7.9 CPU occupancy factor and processing frequencies

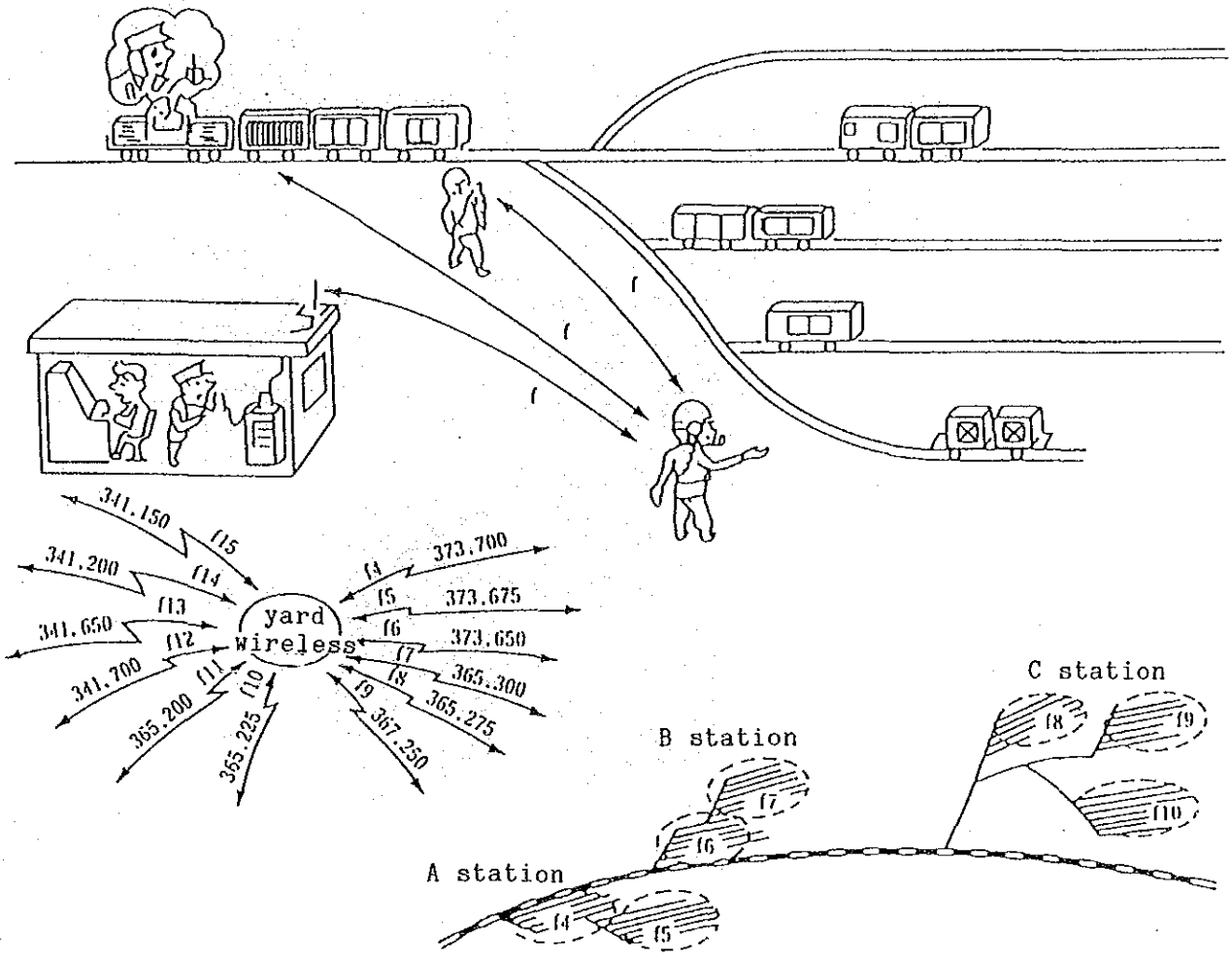


Fig.6.8.1 Yard Wireless

Portable Radio (Maintenance radio)

Configuratoin

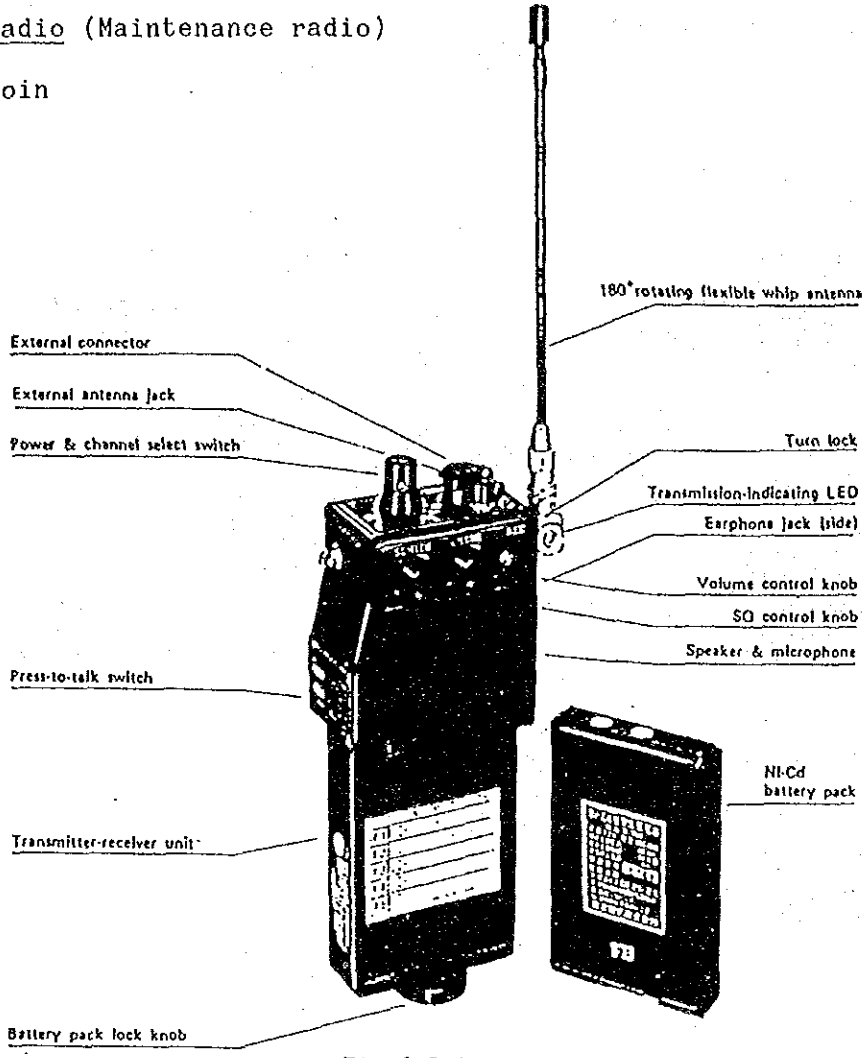


Fig.6.8.2

Performance Specifications

General	
Frequecy range	300MHz
Number of channels	1 to 5
Power source	DC 7.5V ± 10%, 450 mAH Ni-Cd battery pack
Battery life per charge	8 hours
Communication mode	2-way press-to-talk (simplex)
Temperature	-10 to +50℃
Size	165mm(H)× 60mm(W)× 38mm(D)
Weight	520g including battery pack

6 - 9 Sign and Pictograph

In public facilities, for purpose of being understood easily by everybody, some items and things are pictorialized instead of letters.
In railway stations, for the purpose of smooth passenger flow and guidance, pictograph is mostly used as the pictorialized way of expression.
As an effective information, the examples of sign and pictograph is Japan are as follows:

1) Examples of Pictograph

Discrimination


Telephone


Coffee Shop


Restroom

Guidance

Emergency

Up

Down

Prohibition


No Admittance


No Smoking


No Parking

Direction


Hold the belt


Departure


Indicate

Safety


Emergency Center


No Smoking No Fire


Warning

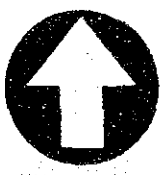

Hand off


Emergency Exit


Extinguisher

Arrow

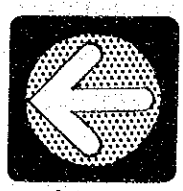

Tokyo Subway


Narita Airport


Osaka Exposition


Okinawa Exposition

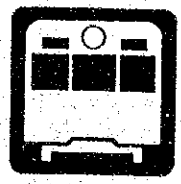
2) Sign and Pictograph used in Railway Stations

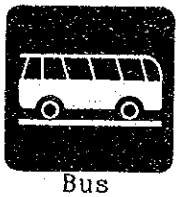

Arrow


Men

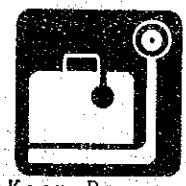

Women


Sinkansen


Commuter Train


Bus


Taxi


Keep Baggage

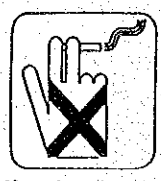

Escalator Up


Escalator Down


Stairs Up

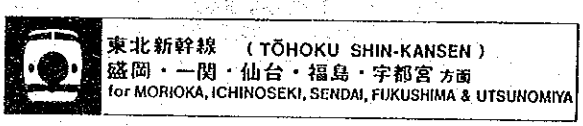

Stairs Down

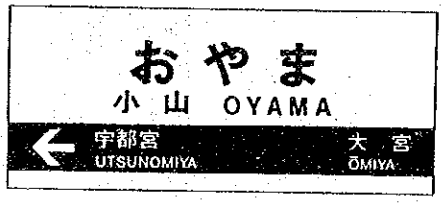

Telephone


No Smoking


Facilities of the Physically Handicapped

Main Sign in Sinkansen Concourse.





3) Pictograph used in Fukuoka City

7 － 1 Tracks Installed OHE in New Delhi Station

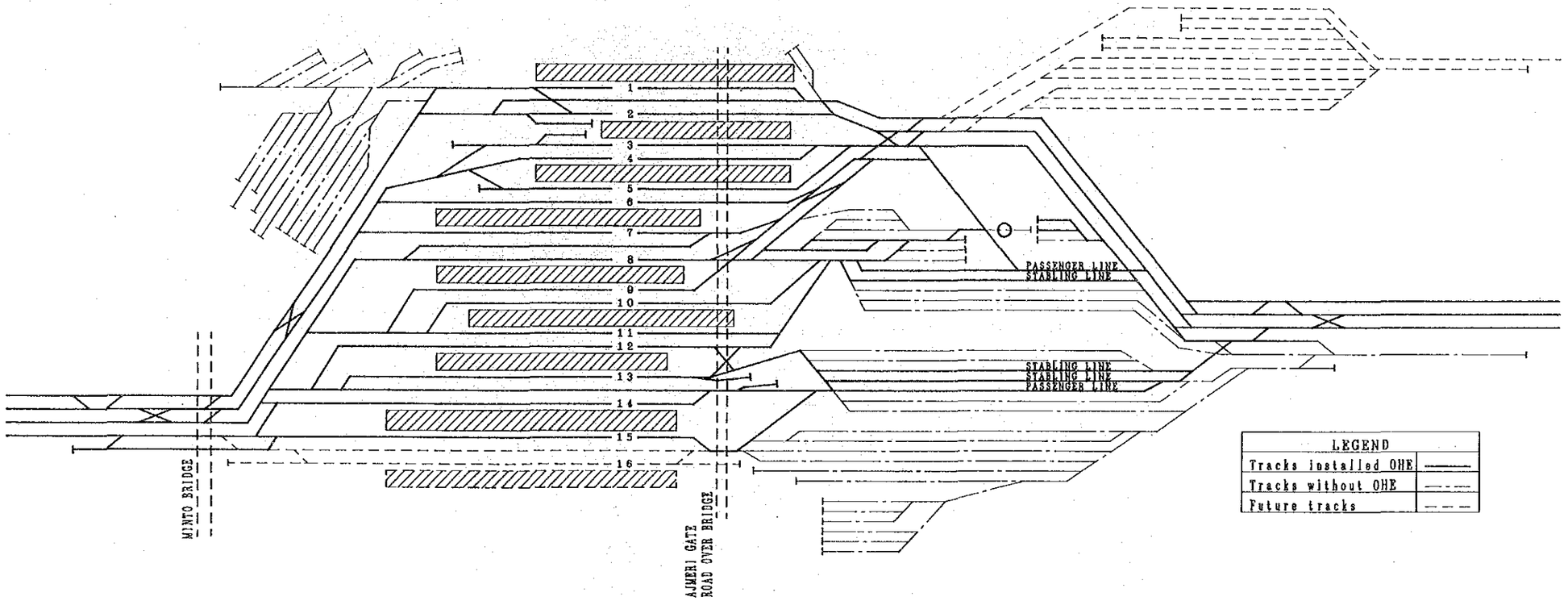


Fig. 7 － 1 Tracks Installed OHE

8 - 1 Examples of Night Soil Treatment on Passenger Coaches in Japan

8 - 1 - 1 History of Soil Treatment Equipment in Trains

The first installation of night soil treatment equipment on JR (Japan Railways) passenger coaches was on the Shinkansen (high speed-Bullet Train) in 1964, when the Shinkansen commenced passenger services.

In the early stages toilets were equipped with tanks which simply stored soil with toilet flush water (storage-type). The storage-type tank became almost full after six hours in service (Tokyo-Osaka one round trip). The foul water draw out operation after every six hours service barred improvements in train operation efficiency.

In order to extend draw out intervals, circulation-type (flush water is recirculated after treatment in the tank) soil treatment equipment has been in practical use since 1967. The Shinkansen and long distance coaches have been refitted with circulation-type toilets, thus prolonging foul water draw out intervals. The majority of coaches are fitted with the circulation-type, which is still in service today.

A few ordinary coaches were fitted with crush-type equipment for the purposes of testing and trial use began in 1960. The soil from the toilet is sterilized by chemicals and crushed, then flows out as sludge from coaches onto the track bed. However, this type had many problems with its complicated mechanism and the difficulty of crushing alien substances thrown into the toilet. For these reasons the installation of this type was discontinued and those coaches equipped with the crush-type were switched to the circulation-type after 1969.

There are some electic car (EMU) with cassette-type equipment (filter and drain off system) for local service lines. These cars belong to terminals where soil treatment facilities are not installed. The principle of this type is to catch soil in an adsorbent filter, filtered water is drawn out onto the track when the car stops in a station. When the cassette is full it can be burned. This type is preferable for light duty.

Tank size of the circulation-type differs with the type and construction of a coach. Japan Railways has tanks of 300, 600 and 1,000 liters capacity currently in service.

capacity currently in service.

Fig.8.1.1 shows circulation-type soil treatment system.

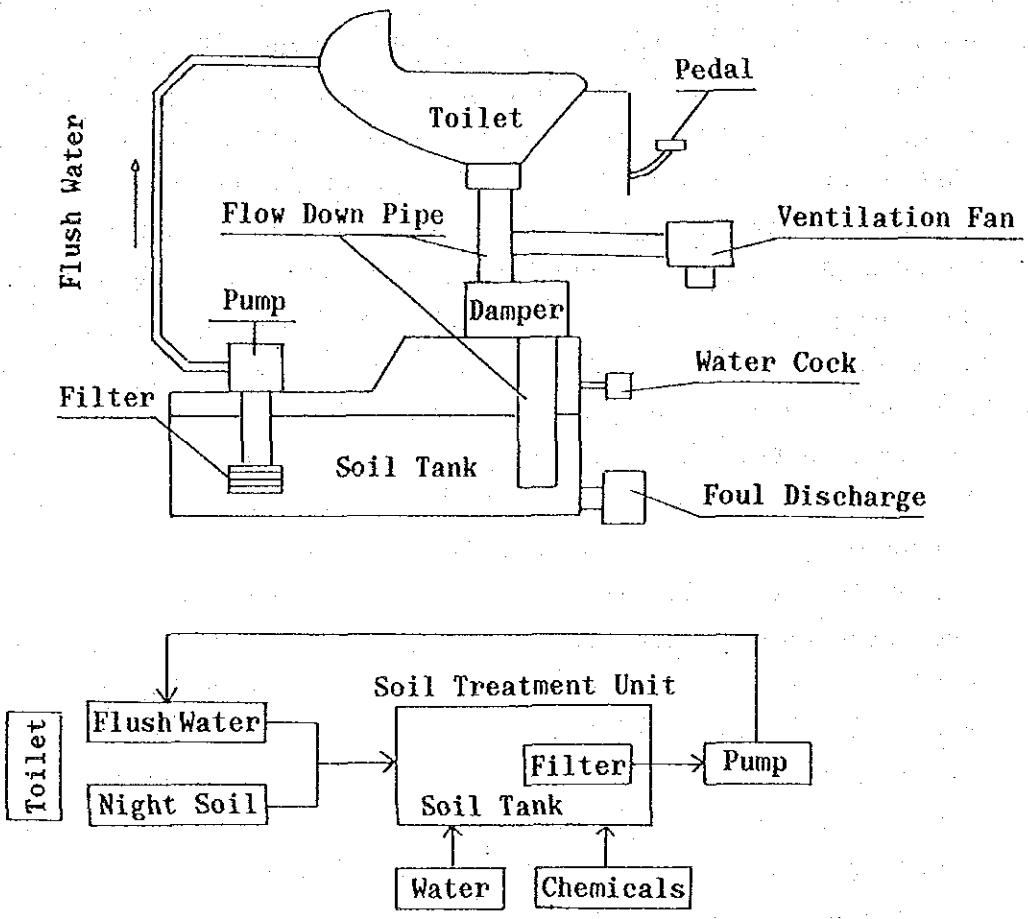


Fig.8.1.1 Circulation-Type Soil Treatment System on the Train

8 - 1 - 2 Ground Treatment Facilities of Foul Water

Ground facilities are roughly classified into "draw-out" and "disposal" systems.

(1) Soil draw out system

Soil with foul water is removed with a hose. A tank water feed pipe, trap box and underground duct are also necessary. This equipment is usually fitted on the washing track (or occasionally on the inspection track). The optimum interval for emptying soil tanks varies with train service hours, tank capacity, frequency of lavatory use by passengers, chemical effect and odour. Taking into account these factors it is generally possible to serve three or four days continuously. However, it is more desirable to draw out every two or three days in practice.

Fig.8.1.2 shows the soil draw out arrangement on the washing track.

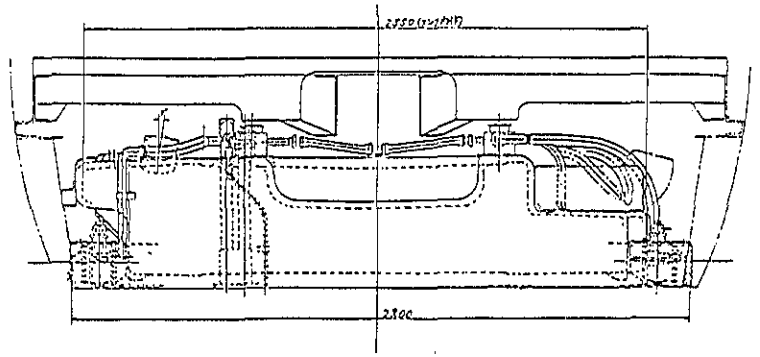
(2) Disposal facility

1) Discharge to municipal sewer

If the municipal government has already supplied a sewage disposal pipe, foul water from the train can be siphoned directly to the sewer line. In this case impurities in the water must follow sewer control regulations and /or local drainage control laws if applicable.

2) Independent disposal facility and river outflow

If a train terminal is located outlside the service area of public sewer disposal, an independent treatment facility must be installed and treated water can be discharged into the river.



Soil Tank Details
(1,000 ℓ for the Shinkansen)

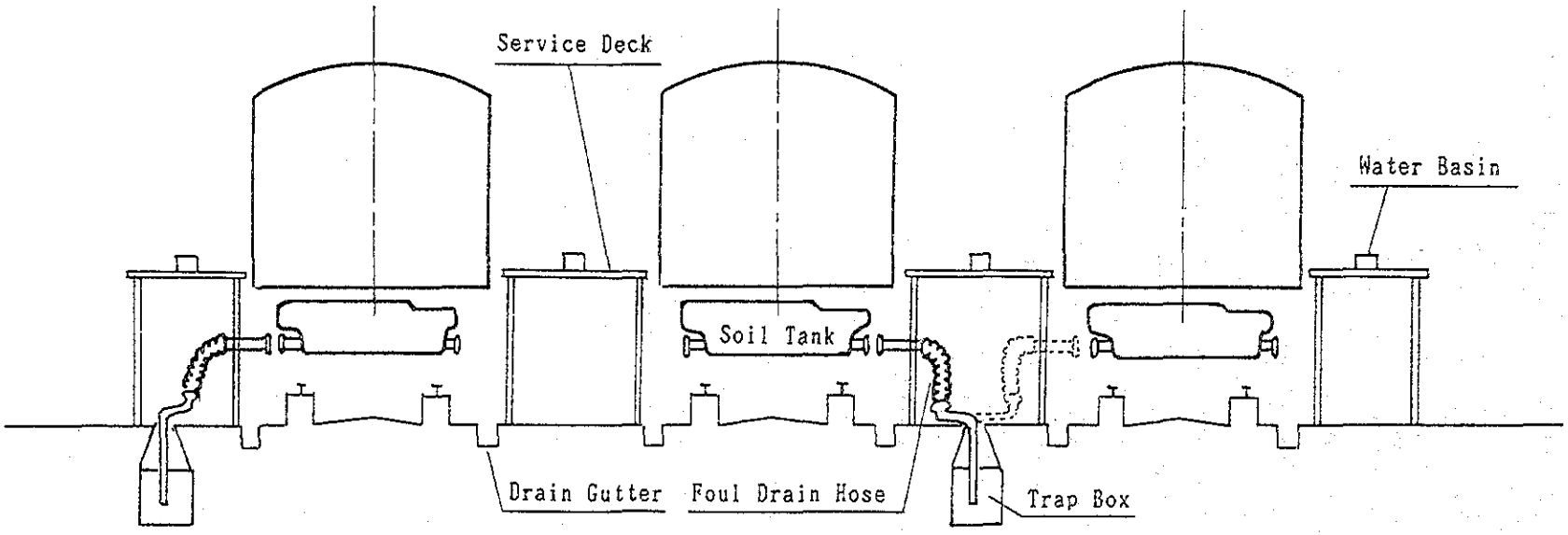


Fig.8.1.2 Train Washing Deck & Foul Water Discharge Arrangement

8 – 2 Examples of Parcel Handling at the Station

These are two types of machine for handling parcels in stations, hand driven and power driven. Hand driven machine includes the two wheeled pushcart and four wheeled handcart, and power driven machine includes telpher, elevator, tow car , forklift and conveyer.

Parcels assorted to each direction are carried to parcel vans at respective platforms on carts hauled by manpower or tow car on the ground, platforms or via underground route.

As to the systems of lateral movement between respective platforms, an overhead telpher or an underground route are the most practical solutions.

8 – 2 – 1 Overhead Telpher System

Parcels loaded on carts are lifted by an electric hoist, transported over the tracks and down onto the platform, it does not require manpower.

The telpher is shuttle system serving all platforms, but its capacity is rather small. It is therefore applicable to stations with less platforms and somewhat smaller parcel loads.

Fig.8.2.1 shows a typical telpher system.

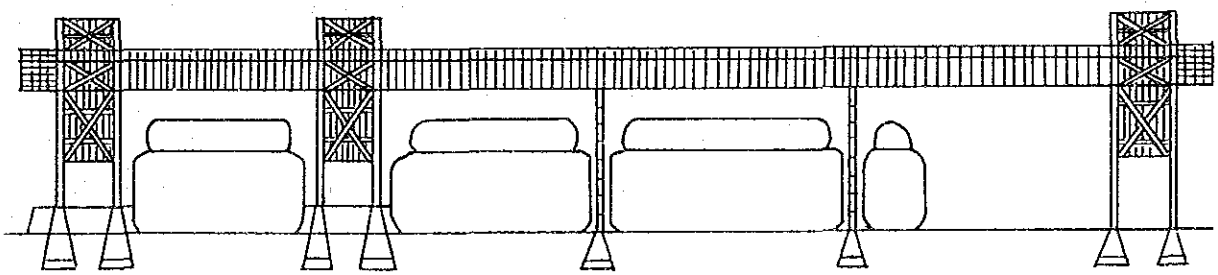


Fig.8.2.1 Overhead Telpher

8 - 2 - 2 Lift and underground route system

A tow car hauls parcel carts from the sorting area to the lift. The lift can be designed with a capacity of two or three carts if necessary. On the platform the cart can be transported by hand or tow car. It is possible to design the doors of the lift to open on the opposite side at the platform level for ease of loading/unloading carts.

Handling Capacity of Lift

Assuming one cart carries a load of 600 kg, moving cycle of lift (stop underground → unloaded cart out → loaded cart in → up → stop platform → loaded cart out → unloaded cart in → down → stop underground) is four minutes for a one cart lift, five minutes for a two cart lift, handling capacities of lift at each platform can be calculated in the following manner.

(1) Lift for one cart

$$\frac{60\text{min/hour}}{4\text{ min/ cart}} \times 600\text{ kg/cart} = 9{,}000\text{ kg/hour}$$

(2) Lift for two carts

$$\frac{60\text{min/hour}}{5\text{ min/2 carts}} \times 600\text{ kg/cart} = 14{,}000\text{ kg/hour}$$

The lift system is capable of handling large ammounts of parcels and is suitable for large stations. There are differences and inequalities in handling parcels between each platform. The optimum size and quantity of lift are defined by train operation schedules and seasonal fluctuation. A ramp is recommended for underground route access in order to avoid bottle necks and to enable a tow car to haul several carts at once.

Fig.8.2.2 shows a typical lift and underground route system.

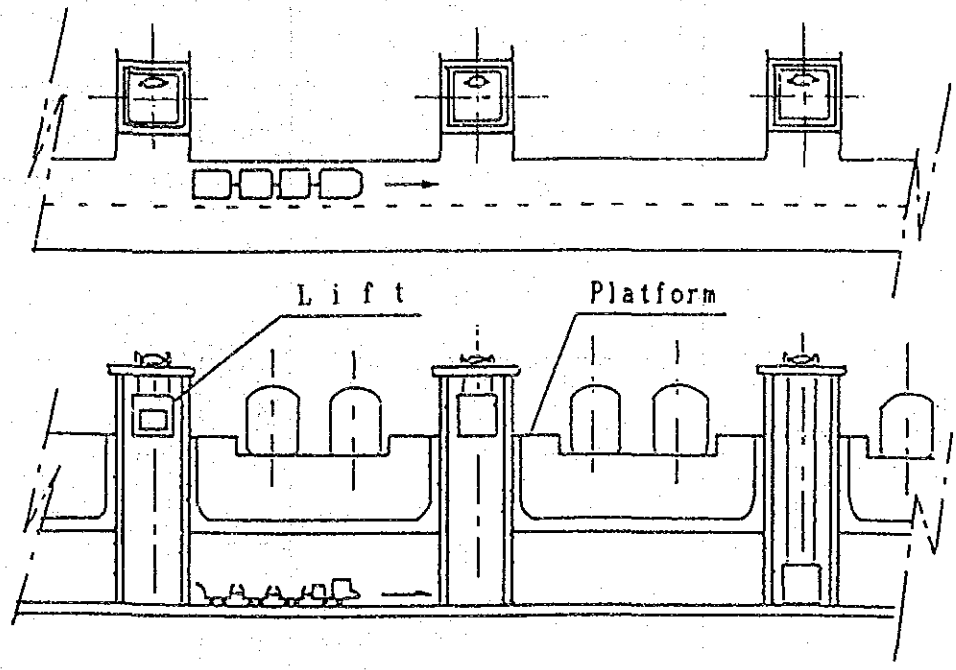


Fig.8.2.2 Lift and Underground Route

Table 8.2.1 Camparison of Lift and Telpher Systems

	Lift and Underground Route System	Overhead Telpher System
Construction	reinforced concrete (underground)	steel structure (overbridge)
Number of Cart	1 ~ 2	1
Moving Manner	concurrent service	shuttle service
Number of Platform	more than 3 ~ 4	less than 3 ~ 4
Stand-by Position	underground and/or platform	platform
Cart Operater	either ride or not ride	not ride
Construction Cost	more expensive due to underground route	more economical since underground construction is not necessary
Station Scale	large station	medium/small station

The following mechanical equipment is also applicable for parcel handling

(1) Tow Car

A battery or gasoline driven vehicle for towing parcel carts. There are two types of car, i.e., towing only and towing with parcel space.

(2) Carriage Cart

A four wheeled wagon for carrying the parcel from sorting area to unloading area. It can be towed by hand or by tow car.

(3) Forklift

A power driven vehicle with forks for carrying heavy parcels and pallets. It can be powered by battery, gasoline or diesel depending on the situation.

(4) Pallet

This can be used for through transportation in order to save loading/unloading time and energy at parcel vans. There are two kinds of pallet, skid type and box type.

(5) Conveyer

A conveyer can be used for sorting incoming parcels and loading and unloading the parcel vans. Fixed type or semifixed type is usually used for sorting, and portable type for loading/unloading the vans.

8 - 3 Examples of Mechanical Car Washers for Passenger Coaches in Japan

Washing the exterior of passenger coach is usually performed manually and requires much labour and time. Installation of mechanical car washers has become popular in order to save labor and increase train rotation speeds. Washing and keeping the coach body clean is essential to passenger services, but workers dislike it, and if a regular washing procedure is not followed, dirt tends to build up. The mechanical car washer has advantages of saving time and labour as well as increased woker safety.

The main elements present in the dirt are ferric oxdies, carbon, dust, mud, oil and fat. The degree of dirtness differs with bare metal and painted surfaces and depends on running distances, trains speed and the area of service.

There are various washing methods. The suitable arrangement of equipment should be designed considering the number of cars to be washed daily, washing cycle and train operation schedules. The early type of mechanical washer was the water injection type. The disadvantage of this type was that a lot of water was required for washing the coach and that water containing detergent leaked into the coaches as the water injection pressure was rather high. Recently the rotating brush type has been commonly adopted. The type of brush is determined by the body shape (upper and lower parts of car elevation) and it is possible to design divided brushes in order to wash the coach side more efficiently. There are two methods to wash the body : brushing with water only, and with water and detergent. However, it is easier to remove dirt with detergent. The most difficult materials to remove with water only are mainly the ferric oxides, oils and fats which become strongly fixed during service.

Coach sides should be kept as flat as possible without unevenness or obstruction in order to make brushing more effective.

Typical mechanical washer arrangements are shown on Fig.8.3.1 and Fig.8.3.2. And Fig.8.3.3 shows an example of car washer layout at the terminal.

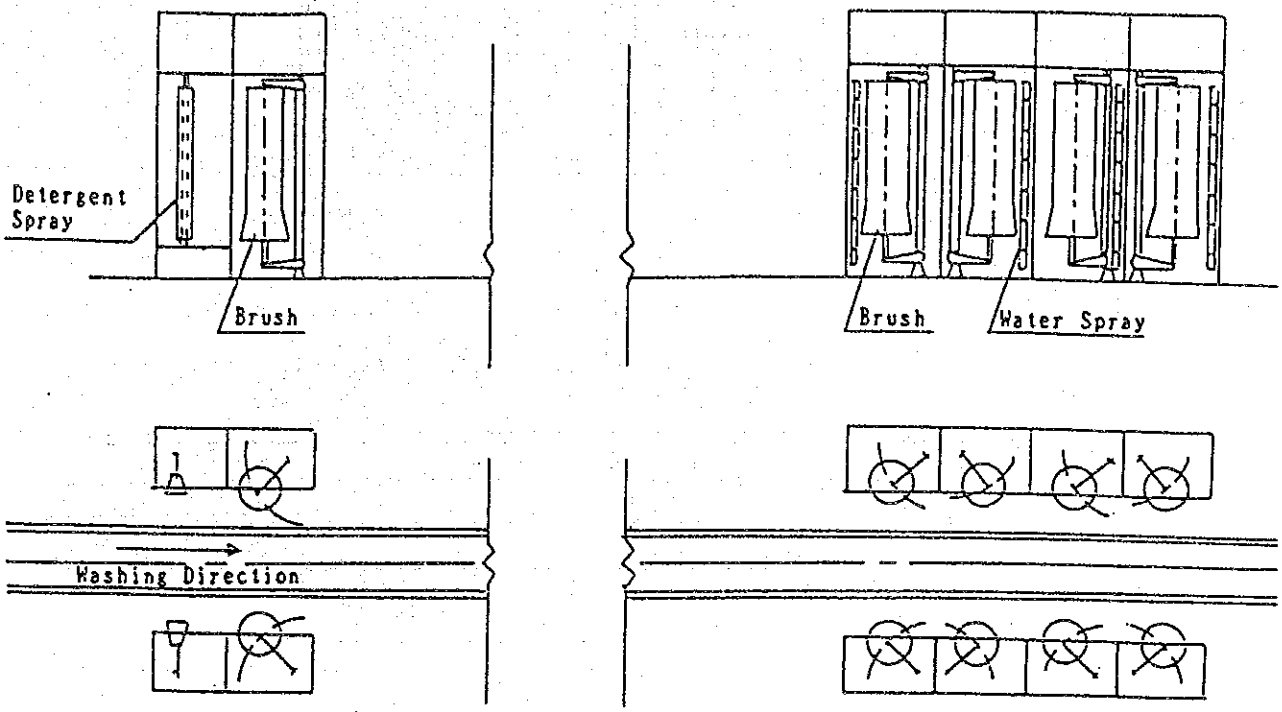


Fig.8.3.1 Through Washing

(Remarks)

- One way (through) washing with a distance between detergnet spraying and rinsing with water to allow for detergent reaction time.
- This arrangement is suitable for large terminals as long as the necessary distance is available.

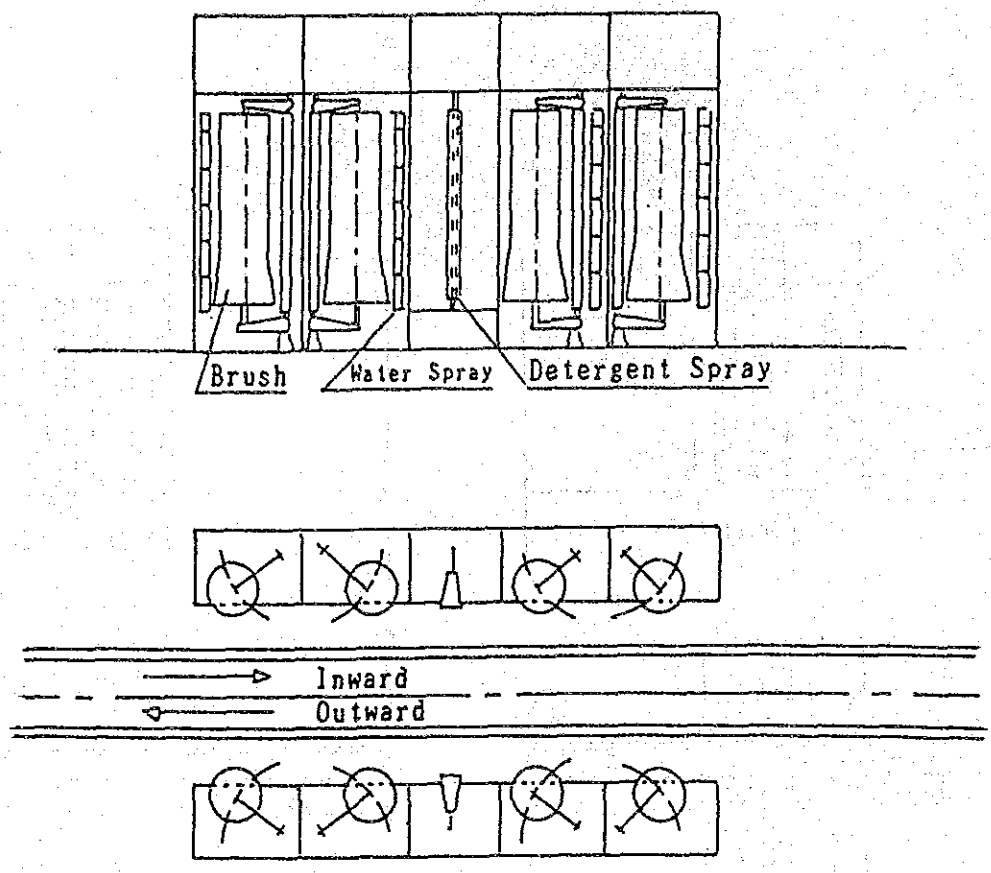


Fig.8.3.2 Two Way Washing (Reciprocating Washing)

(Remarks)

- Train moves in one direction through detergent spray and in opposite direction through water brush.
- This arrangement is suitable where a shunting track is available at the end of the washing track, offers better washing results, and occupies less space.

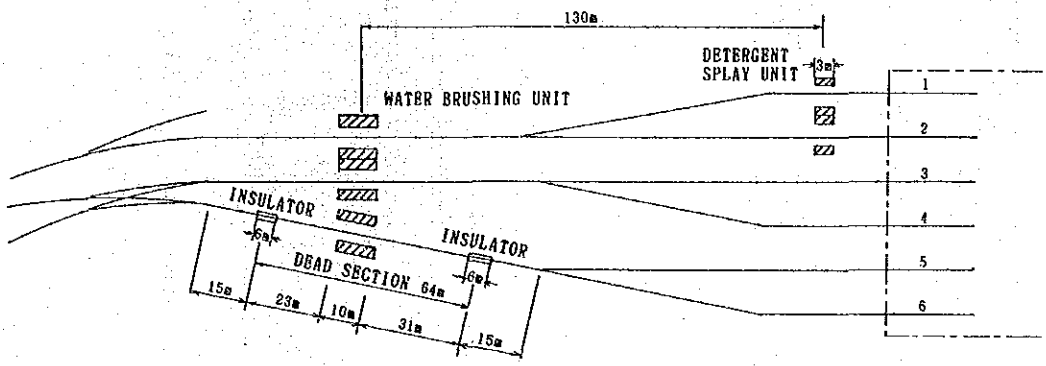


Fig.8.3.3 Car Washer Layout at The Shinkansen Terminal

A tyical car washer complex arrangement of one way (through) washing is shown in Fig.8.3.4.

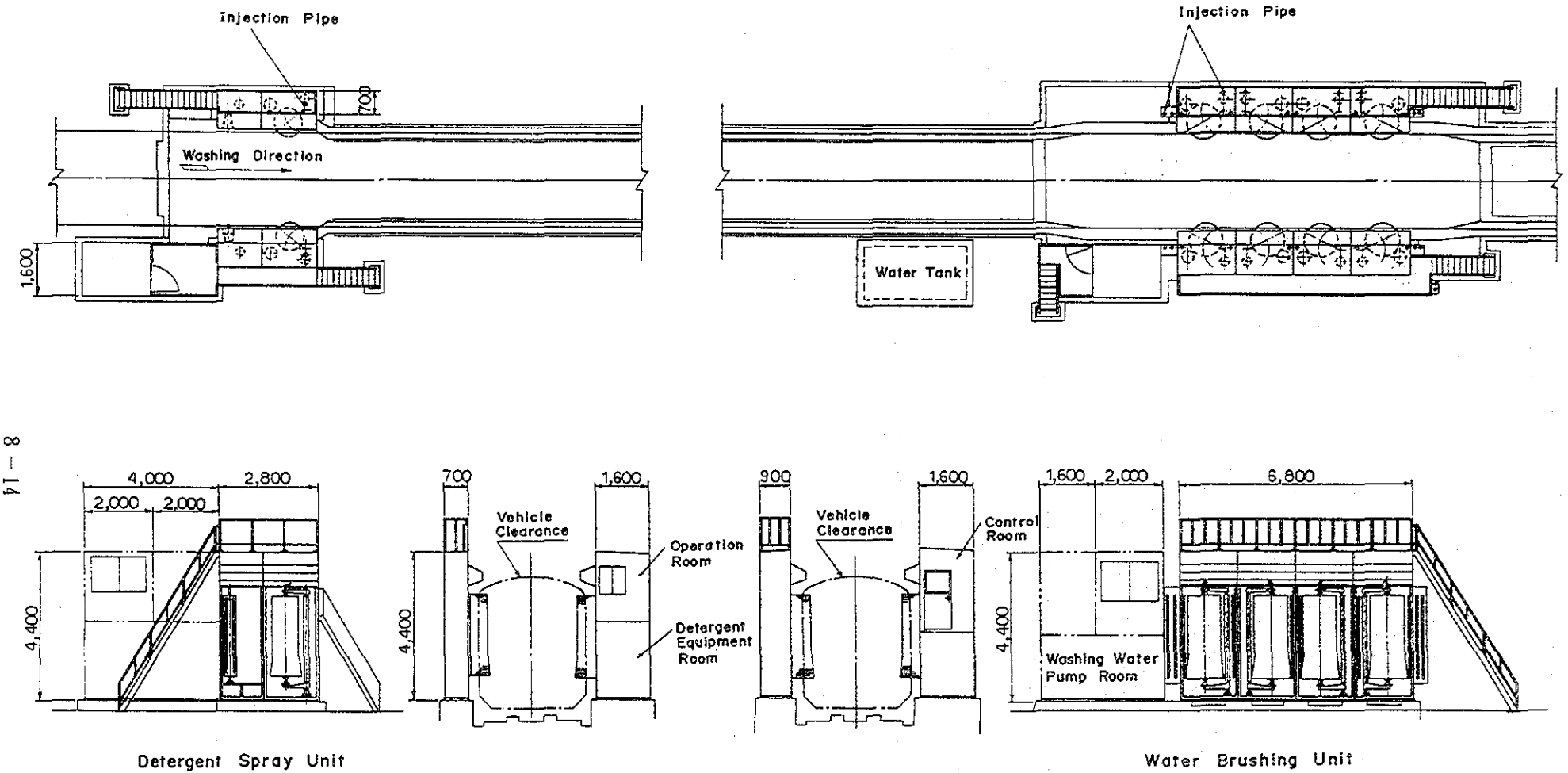


Fig 8·3·4 CAR WASHING COMPLEX ARRANGEMENT

8 - 4 Air Conditioning System

The air conditioning sysytem is comprised of the following elements.

(1) Chiller package unit with compressor, condenser and evaporator.
(2) Chilled water pump
(3) Condenser water pump
(4) Cooling tower
(5) expansion tank
(6) Chemical water treatment assembly
(7) Air handling unit
(8) Grilles/diffusers
(9) Chilled water, condenser water and incidential piping
(10) Control panel
(11) Air duct
(12) Thermal insulation

Fig.8.4.1 shows schematic diagram of Air Conditioning system.

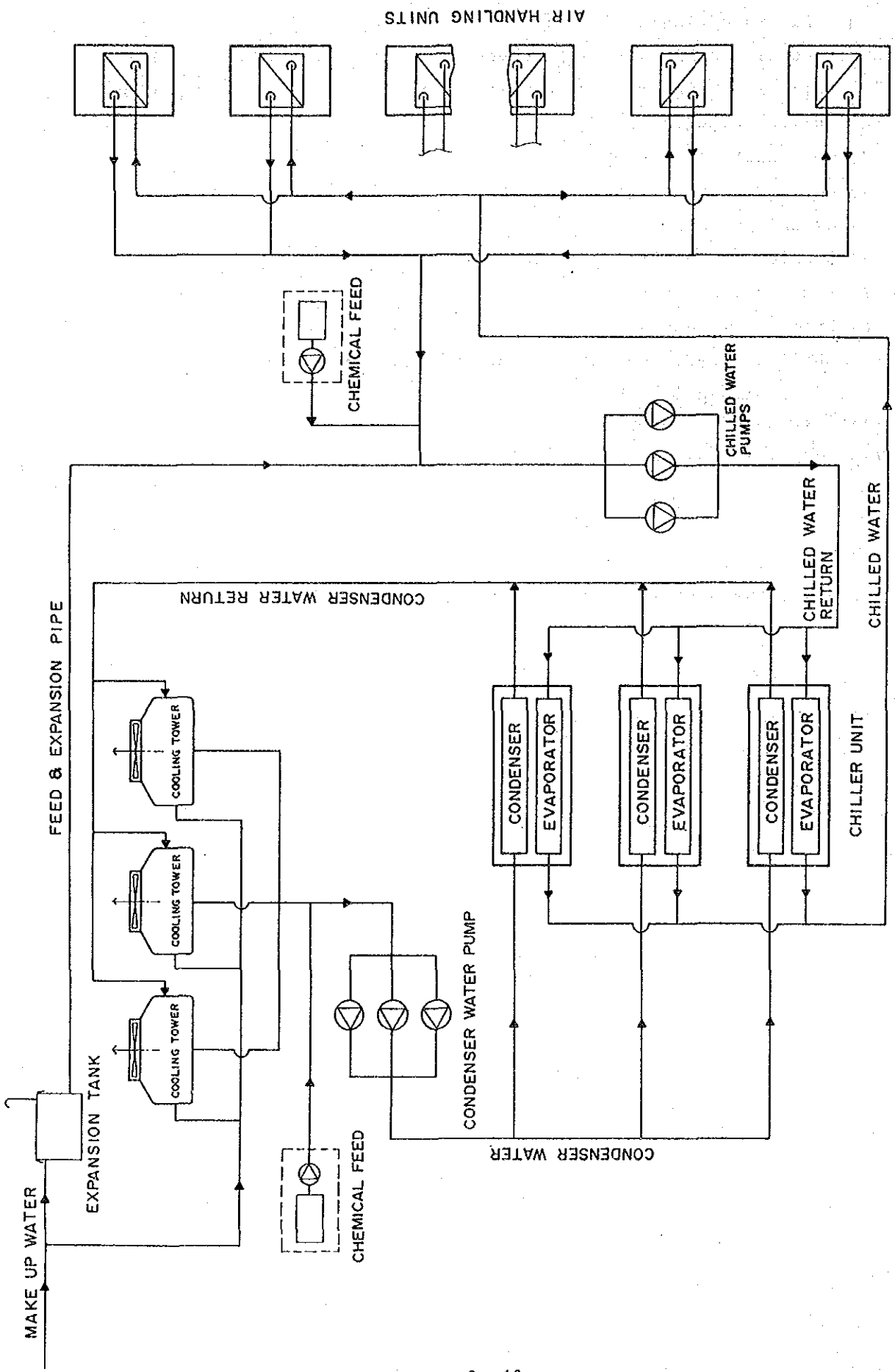


Fig 8·4·1 SCHEMATIC DIAGRAM OF AIR CONDITIONING SYSTEM

9 - 1 Economic Analysis

Table 9.1.1 Estimated Cost of Increased Rolling Stock

(Rs. in millions)

Gauge	Type of Rolling Stock		Average Unit Price	1994-1995		1999-2000		2004-2005		2009-2010	
				No. of Vehicles	Price	No. of Vehicles	Price	No. of Vehicles	Price	No. of Vehicles	Price
B.G.	Passenger	EL (Long)	18.30 (14.27)	-	0 (0)	3	54.90 (42.81)	-	0 (0)	-	0 (0)
		EL (M/E, Local)	12.65 (9.87)	3	37.95 (29.61)	5	63.25 (49.35)	-	0 (0)	20	253.00 (197.40)
		DEL	13.20 (10.30)	2	26.40 (20.60)	5	66.00 (51.50)	1	13.20 (10.30)	-	0 (0)
	Goods	EL	16.00 (12.48)	16	256.00 (199.68)	28	448.00 (349.44)	1	16.00 (12.48)	26	416.00 (324.48)
		DEL	13.20 (10.30)	6	79.20 (61.80)	12	158.40 (123.60)	9	118.80 (92.70)	-	0 (0)
	Passenger	EMU	2.00 (1.56)	64	128.00 (99.84)	17	34.00 (26.52)	9	18.00 (14.04)	-	0 (0)
		Coach	1.74 (1.27)	499	868.26 (633.73)	471	819.54 (598.17)	60	104.40 (76.2)	-	0 (0)
	Goods	Wagon	0.60 (0.44)	3,686	2,211.16 (1,621.84)	6,854	4,112.40 (3,015.76)	1,285	771.00 (565.40)	878	526.80 (386.32)
M.G.	Passenger	DEL	9.00 (7.02)	1	9.00 (7.02)	2	18.00 (14.04)	3	27.00 (21.06)	3	27.00 (21.06)
	Goods	DEL	9.00 (7.02)	2	18.00 (14.04)	1	9.00 (7.02)	2	18.00 (14.04)	2	18.00 (14.04)
	Passenger	Coach	1.45 (1.06)	35	50.75 (37.10)	47	68.15 (49.82)	73	105.85 (77.38)	80	116.00 (84.80)
	Goods	Wagon	0.19 (0.14)	323	61.37 (45.22)	88	16.72 (12.32)	268	50.92 (37.52)	219	41.61 (30.66)
Total				4,637	3,746.09 (2,770.48)	7,533	5,868.36 (4,340.35)	1,711	1,243.17 (921.12)	1,228	1,398.41 (1,058.76)

Note: Prices in brackets show economic prices.

Table 9.1.2 Economic Analysis for the New Delhi Station Project (1)

(UNIT : 1000 RS)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
INVESTMENT DIFFERENCE	899448	832130	1005864	1422265	1684648	444984	846070	807762	702211	509311
WITH	899448	832130	1005864	1422265	1684648	1333104	1287304	1249036	1143445	950545
ELECTRIFICATION	56453	2825	6508	36524	137695	15917	35499	22021	34293	0
SIGNAL & TELECOM	179264	0	0	185355	226269	224178	243524	178271	141836	77477
CIVIL WORK	652431	136675	247526	506056	628054	212139	125611	180674	99246	4998
LAND ACQ & COMP	11300	0	59200	1700	0	12800	14600	0	0	0
ROLLING STOCKS	0	692630	692630	692630	692630	868070	868070	868070	868070	868070
-SALVAGE VALUE	0	0	0	0	0	0	0	0	0	0
WITHOUT	0	0	0	0	0	888120	441234	441274	441234	441234
BUS	0	0	0	0	0	209244	53424	53742	53424	53424
TRUCK	0	0	0	0	0	678876	387810	387532	387810	387810
-SALVAGE VALUE	0	0	0	0	0	0	0	0	0	0
OPERATING COSTS DIFF	0	0	0	0	0	-424544	-719863	-1016824	-1313462	-1612214
WITH	0	0	0	0	0	414857	537224	657981	779028	897962
WORKING EXPENSE	0	0	0	0	0	354918	469101	583284	697467	811651
PASSENGER	0	0	0	0	0	106518	137744	168971	200197	231425
GOODS	0	0	0	0	0	248400	331357	414313	497270	580226
MAINTENANCE COST	0	0	0	0	0	59939	68123	74697	81561	86311
ELECTRIC FACILITY	0	0	0	0	0	5988	6417	7360	7885	8815
SIGNAL & TELECOM	0	0	0	0	0	6755	9130	11711	13600	15102
CIVIL WORK	0	0	0	0	0	47196	52576	55626	60076	62394
ROLLING STOCKS	0	0	0	0	0	0	0	0	0	0
WITHOUT	0	0	0	0	0	839401	1257087	1674805	2092490	2510176
MAINTENANCE COST	0	0	0	0	0	346260	535581	724811	914131	1103452
BUS	0	0	0	0	0	26846	33701	40596	47450	54305
TRUCK	0	0	0	0	0	319414	501880	684215	866681	1049147
PERSONNEL COST	0	0	0	0	0	238390	333202	428169	522981	617793
BUS	0	0	0	0	0	130942	164374	198005	231437	264869
TRUCK	0	0	0	0	0	107448	168828	230164	291544	352924
FUEL COST	0	0	0	0	0	254751	388304	521825	655378	788931
BUS	0	0	0	0	0	37901	47578	57312	66989	76666
TRUCK	0	0	0	0	0	216850	340726	464513	588389	712265
PAS TIME SAVING BENEFIT	0	0	0	0	0	189000	251024	315808	384384	455512
CASHFLOW FOR EIRR	-899448	-832130	-1005864	-1422265	-1684648	168560	124817	524870	995635	1558415
EIRR (%)	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5

Table 9.1.2 Economic Analysis for the New Delhi Station Project (2)

(UNIT : 1000 RS)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
INVESTMENT DIFFERENCE	-257322	70744	70744	-138500	42841	-634662	-318280	-318320	-318538	-226689
WITH	184230	184230	184230	184230	209473	211760	211760	211760	211760	275049
ELECTRIFICATION	0	0	0	0	20245	0	0	0	0	0
SIGNAL & TELECOM	0	0	0	0	0	0	0	0	0	58291
CIVIL WORK	0	0	0	0	4998	0	0	0	0	4998
LAND ACQ & COMP	0	0	0	0	0	0	0	0	0	0
ROLLING STOCKS	184230	184230	184230	184230	184230	211760	211760	211760	211760	211760
-SALVAGE VALUE	0	0	0	0	0	0	0	0	0	0
WITHOUT	441552	113486	113486	322730	166632	846422	530040	530080	530398	501738
BUS	53742	24804	24804	234048	78228	78864	58830	59148	59466	30528
TRUCK	387810	88682	88682	88682	88404	767558	471210	470932	470932	471210
-SALVAGE VALUE	0	0	0	0	0	0	0	0	0	0
OPERATING COSTS DIFF	-1915192	-1992505	-2069821	-2147135	-2224189	-2301801	-2358437	-2415373	-2472044	-2528980
WITH	1012966	1042938	1072908	1102878	1132848	1162819	1190318	1217816	1245313	1272811
WORKING EXPENSE	925833	955805	985775	1015745	1045715	1075686	1103185	1130683	1158180	1185678
PASSENGER	262651	271816	280980	290144	299309	308473	316328	324182	332035	339889
GOODS	663182	683989	704795	725601	746406	767213	786857	806501	826145	845789
MAINTENANCE COST	87133	87133	87133	87133	87133	87133	87133	87133	87133	87133
ELECTRIC FACILITY	8815	8815	8815	8815	8815	8815	8815	8815	8815	8815
SIGNAL & TELECOM	15924	15924	15924	15924	15924	15924	15924	15924	15924	15924
CIVIL WORK	62394	62394	62394	62394	62394	62394	62394	62394	62394	62394
ROLLING STOCKS	0	0	0	0	0	0	0	0	0	0
WITHOUT	2928158	3035443	3142729	3250013	3357037	3464620	3548755	3633189	3717357	3801791
MAINTENANCE COST	1292813	1337720	1382628	1427535	1472313	1517261	1557194	1597169	1637012	1676987
BUS	61200	64382	67565	70747	73930	77153	77846	78581	79315	80050
TRUCK	1231613	1273338	1315063	1356788	1398383	1440108	1479348	1518588	1557697	1596937
PERSONNEL COST	712804	742362	771920	801478	830992	860749	877332	894114	910852	927634
BUS	298500	314022	329544	345066	360588	376309	379692	383274	386856	390438
TRUCK	414304	428340	442376	456412	470404	484440	497640	510840	523996	537196
FUEL COST	922541	955361	988181	1021000	1053732	1086610	1114229	1141906	1169493	1197170
BUS	86400	90893	95386	99878	104371	108922	109901	110938	111974	113011
TRUCK	836141	864468	892795	921122	949361	977688	1004328	1030968	1057519	1084159
PAS TIME SAVING BENEFIT	530640	570996	612796	655046	699696	745790	774354	802032	830976	859026
CASHFLOW FOR EIRR	2703154	2492757	2611873	2940681	2881044	3682253	3451071	3535725	3621658	3614695
EIRR (%)	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5

Table 9.1.2 Economic Analysis for the New Delhi Station Project (3)

(UNIT : 1000 RS)

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
INVESTMENT DIFFERENCE	-495180	-319802	-162299	-165094	-44268	-822130	-530676	-495695	-501142	-19948
WITH	6240	2928	4611	2452	102966	4576	0	5765	0	685310
ELECTRIFICATION	0	0	0	0	20245	0	0	0	0	47875
SIGNAL & TELECOM	6240	2928	4611	2452	0	0	0	0	0	532597
CIVIL WORK	0	0	0	0	82721	4576	0	5765	0	4998
LAND ACQ & COMP	0	0	0	0	0	0	0	0	0	0
ROLLING STOCKS	0	0	0	0	0	0	0	0	0	99840
-SALVAGE VALUE	0	0	0	0	0	0	0	0	0	0
WITHOUT	501420	322730	166910	167546	147234	826706	530676	501460	501142	705258
BUS	30210	234048	78228	78864	58830	59148	59466	30528	30210	234048
TRUCK	471210	88682	88682	88682	88404	767558	471210	470932	470932	471210
-SALVAGE VALUE	0	0	0	0	0	0	0	0	0	0
OPERATING COSTS DIFF	-2585617	-2585617	-2585617	-2585617	-2585617	-2585617	-2585617	-2585617	-2585617	-2585617
WITH	1300309	1300309	1300309	1300309	1300309	1300309	1300309	1300309	1300309	1300309
WORKING EXPENSE	1213176	1213176	1213176	1213176	1213176	1213176	1213176	1213176	1213176	1213176
PASSENGER	347743	347743	347743	347743	347743	347743	347743	347743	347743	347743
GOODS	865433	865433	865433	865433	865433	865433	865433	865433	865433	865433
MAINTENANCE COST	87133	87133	87133	87133	87133	87133	87133	87133	87133	87133
ELECTRIC FACILITY	8815	8815	8815	8815	8815	8815	8815	8815	8815	8815
SIGNAL & TELECOM	15924	15924	15924	15924	15924	15924	15924	15924	15924	15924
CIVIL WORK	62394	62394	62394	62394	62394	62394	62394	62394	62394	62394
ROLLING STOCKS	0	0	0	0	0	0	0	0	0	0
WITHOUT	3885926	3885926	3885926	3885926	3885926	3885926	3885926	3885926	3885926	3885926
MAINTENANCE COST	1716920	1716920	1716920	1716920	1716920	1716920	1716920	1716920	1716920	1716920
BUS	80743	80743	80743	80743	80743	80743	80743	80743	80743	80743
TRUCK	1636177	1636177	1636177	1636177	1636177	1636177	1636177	1636177	1636177	1636177
PERSONNEL COST	944217	944217	944217	944217	944217	944217	944217	944217	944217	944217
BUS	393821	393821	393821	393821	393821	393821	393821	393821	393821	393821
TRUCK	550396	550396	550396	550396	550396	550396	550396	550396	550396	550396
FUEL COST	1224789	1224789	1224789	1224789	1224789	1224789	1224789	1224789	1224789	1224789
BUS	113990	113990	113990	113990	113990	113990	113990	113990	113990	113990
TRUCK	1110799	1110799	1110799	1110799	1110799	1110799	1110799	1110799	1110799	1110799
PAS TIME SAVING BENEFIT	888350	912330	936310	961380	985360	1009340	1036590	1063840	1091090	1118340
CASHFLOW FOR EIRR	3969147	3817749	3684226	3712091	3615245	4417087	4152883	4145152	4177849	3723905
EIRR (%)	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5

Table 9.1.2 Economic Analysis for the New Delhi Station Project (4)

(UNIT : 1000 RS)

	2020
INVESTMENT DIFFERENCE	-3791470
WITH	-5573626
ELECTRIFICATION	0
SIGNAL & TELECOM	0
CIVIL WORK	0
LAND ACQ & COMP	0
ROLLING STOCKS	0
-SALVAGE VALUE	5573626
WITHOUT	-1782156
BUS	78228
TRUCK	471210
-SALVAGE VALUE	2331594
OPERATING COSTS DIFF	-2585617
WITH	1300309
WORKING EXPENSE	1213176
PASSENGER	347743
GOODS	865433
MAINTENANCE COST	87133
ELECTRIC FACILITY	8815
SIGNAL & TELECOM	15924
CIVIL WORK	62394
ROLLING STOCKS	0
WITHOUT	3885926
MAINTENANCE COST	1716920
BUS	80743
TRUCK	1636177
PERSONNEL COST	944217
BUS	393821
TRUCK	550396
FUEL COST	1224789
BUS	113990
TRUCK	1110799
PAS TIME SAVING BENEFIT	1145590
CASHFLOW FOR EIRR	7522677
EIRR (%)	19.5

9 − 2 Financial Analysis

9 − 2 − 1 Financial Analysis for the New Delhi Station Project (Unit : 1000RS)

<< INCOME STATEMENT >>

	1990	1991	1992	1993	1994	1995	1996	1997	1998
Operating Profit	0	0	0	0	0	287,294	539,304	794,229	1,049,058
Operating Revenue	0	0	0	0	0	937,423	1,372,418	1,807,413	2,242,408
PASSENGER	0	0	0	0	0	223,449	281,539	339,629	397,719
Long Express	0	0	0	0	0	8,205	10,731	13,258	15,784
Mail Express	0	0	0	0	0	158,102	199,692	241,282	282,873
Local	0	0	0	0	0	57,142	71,116	85,089	99,063
GOODS	0	0	0	0	0	713,974	1,090,879	1,467,784	1,844,689
Coal	0	0	0	0	0	263,373	433,035	602,697	772,358
Cement	0	0	0	0	0	37,250	49,587	61,924	74,262
Pol	0	0	0	0	0	193,140	252,544	311,947	371,351
Food Grains	0	0	0	0	0	46,812	81,539	116,266	150,994
Iron & Steel	0	0	0	0	0	76,825	118,793	160,762	202,730
Fertilizers	0	0	0	0	0	41,174	55,882	70,591	85,299
Others	0	0	0	0	0	55,400	99,498	143,597	187,695
Operating Expense	0	0	0	0	0	650,129	833,114	1,013,184	1,193,350
WORKING EXPENSE	0	0	0	0	0	405,238	535,811	666,384	796,957
PASSENGER	0	0	0	0	0	121,742	157,734	193,727	229,719
GOODS	0	0	0	0	0	283,496	378,077	472,657	567,237
MAINTENANCE COST	0	0	0	0	0	76,525	86,536	94,640	103,142
DEPRECIATION	0	0	0	0	0	168,366	210,766	252,161	293,252

<< INVESTMENT >>

INVESTMENT TOTAL	1,043,600	1,098,509	1,290,289	1,774,644	2,115,759	1,696,995	1,640,469	1,605,953	1,482,372
Foreign Currency Total	0	0	0	2,204	71,359	0	0	0	0
Local Currency Total	1,043,600	1,098,509	1,290,289	1,772,440	2,044,400	1,696,995	1,640,469	1,605,953	1,482,372
* NEW DELHI STATION	266,400	115,529	231,056	460,392	624,431	0	0	0	0
Foreign Currency Total	0	0	0	2,204	71,359	0	0	0	0
Local Currency Total	266,400	115,529	231,056	458,188	553,072	0	0	0	0
CIVIL WORK	197,400	112,155	224,308	360,146	473,898	0	0	0	0
Foreign Currency	0	0	0	2,204	19,843	0	0	0	0
Local Currency	197,400	112,155	224,308	357,942	454,055	0	0	0	0
SIGNALS & TELCON	35,000	0	0	80,000	113,409	0	0	0	0
Foreign Currency	0	0	0	0	51,516	0	0	0	0
Local Currency	35,000	0	0	80,000	61,893	0	0	0	0
ELECTRIFICATION									
Local Currency	34,000	3,374	6,748	20,246	37,124	0	0	0	0
* DELHI AREA									
Local Currency Total	213,300	46,460	117,693	189,803	236,778	167,245	114,961	194,778	188,702
CIVIL WORK									
Local Currency	155,300	46,460	59,430	156,592	157,116	135,500	86,716	156,784	116,402
SIGNALS & TELCON									
Local Currency	28,500	0	0	12,800	33,100	19,600	4,000	13,100	32,900
ELECTRIFICATION									
Local Currency	29,500	0	1,063	20,411	46,562	1,345	9,645	24,894	39,400
LAND ACQUISITION									
Local Currency	0	0	57,200	0	0	10,800	14,600	0	0

	1990	1991	1992	1993	1994	1995	1996	1997	1998
* RELEVENT SECTIONS									
Local Currency Total	563,900	0	5,020	187,929	318,030	336,080	351,838	237,505	120,000
CIVIL WORK									
Local Currency	422,900	0	3,020	76,414	114,098	115,090	62,373	58,405	0
SIGNALS & TELCOM									
Local Currency	129,700	0	0	107,000	129,600	222,100	258,500	179,100	120,000
ELECTRIFICATION									
Local Currency	0	0	0	2,815	74,332	16,890	30,965	0	0
LAND ACQUISITION									
Local Currency	11,300	0	2,000	1,700	0	2,000	0	0	0
* ROLLING STOCK									
Local Currency Total	0	936,520	936,520	936,520	936,520	1,173,670	1,173,670	1,173,670	1,173,670
-Salvage Value									
Int. During Construction	53,483	131,262	225,122	353,423	513,999				
<< FINANCE PROGRAM >>									
FINANCE TOTAL									
Borrowing	1,097,083	1,229,771	1,515,411	2,128,067	2,629,758	1,696,995	1,640,469	1,605,953	1,482,372
Repayment	0	0	0	0	0	0	0	0	0
Balance	1,097,083	2,326,853	3,842,264	5,970,331	8,600,089	10,297,084	11,937,553	13,543,506	15,025,878
Interest	53,483	131,262	225,122	353,423	513,999	666,309	772,940	877,327	973,681
FINANCE in FOREIGN CURRENCY									
Borrowing	0	0	0	2,246	72,780	0	0	0	0
Repayment	0	0	0	0	0	0	0	0	0
Balance	0	0	0	2,246	75,026	75,026	75,026	75,026	75,026
Interest	0	0	0	42	1,421	1,876	1,876	1,876	1,876
FINANCE in LOCAL CURRENCY									
Borrowing	1,097,083	1,229,771	1,515,411	2,125,821	2,556,978	1,696,995	1,640,469	1,605,953	1,482,372
Repayment	0	0	0	0	0	0	0	0	0
Balance	1,097,083	2,326,853	3,842,264	5,968,085	8,525,063	10,222,058	11,862,527	13,468,480	14,950,852
Interest	53,483	131,262	225,122	353,381	512,578	664,434	771,064	875,451	971,805
* NET CASHFLOW	0	0	0	0	0	-210,649	-22,870	169,063	388,629
* CUMULATIVE NET CASHFLOW	0	0	0	0	0	-210,649	-233,519	-64,456	304,173
<< CASH FLOW STATEMENT >>									
CASH IN	1,097,083	1,229,771	1,515,411	2,128,067	2,629,758	2,152,655	2,390,539	2,652,343	2,824,682
Operating Profit	0	0	0	0	0	287,294	539,304	794,229	1,049,058
Depreciation	0	0	0	0	0	168,366	210,766	252,161	293,252
Borrowing	1,097,083	1,229,771	1,515,411	2,128,067	2,629,758	1,696,995	1,640,469	1,605,953	1,482,372
CASH OUT	1,097,083	1,229,771	1,515,411	2,128,067	2,629,758	2,363,304	2,413,409	2,483,280	2,456,053
Investment	1,043,600	1,098,509	1,290,289	1,774,644	2,115,759	1,696,995	1,640,469	1,605,953	1,482,372
Int. During Construction	53,483	131,262	225,122	353,423	513,999	0	0	0	0
Repayment	0	0	0	0	0	0	0	0	0
Interest	0	0	0	0	0	666,309	772,940	877,327	973,681
Cash Flow For FIRR	-1,043,600	-1,098,509	-1,290,289	-1,774,644	-2,115,759	-1,241,335	-690,399	-559,563	-140,062
FIRR % ==========>	12.13%								

<< INCOME STATEMENT >>

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Operating Profit	1,308,562	1,577,149	1,650,001	1,723,951	1,797,901	1,871,851	1,947,980	2,002,536	2,057,428	2,113,239
Operating Revenue	2,677,404	3,112,399	3,228,515	3,344,810	3,461,106	3,577,401	3,693,701	3,785,827	3,877,952	3,970,077
PASSENGER	455,810	513,900	538,275	562,829	587,383	611,937	636,495	642,486	648,476	654,467
Long Express	18,311	20,838	20,838	20,838	20,838	20,838	20,844	20,844	20,844	20,844
Mail Express	324,463	366,053	382,143	398,591	415,039	431,487	447,933	452,494	457,055	461,616
Local	113,036	127,009	135,294	143,400	151,506	159,612	167,718	169,148	170,577	172,007
GOODS	2,221,594	2,598,499	2,690,240	2,781,982	2,873,723	2,965,465	3,057,206	3,143,341	3,229,476	3,315,610
Coal	942,020	1,111,682	1,130,151	1,148,620	1,167,089	1,185,558	1,204,027	1,221,130	1,238,233	1,255,335
Cement	86,599	98,936	105,015	111,094	117,174	123,253	129,332	135,054	140,775	146,497
Pol	430,754	490,158	521,060	551,963	582,865	613,768	644,670	673,798	702,925	732,053
Food Grains	185,721	220,448	233,330	246,211	259,093	271,974	284,856	297,107	309,358	321,608
Iron & Steel	244,699	286,667	292,813	298,959	305,105	311,251	317,397	323,016	328,635	334,255
Fertilizers	100,008	114,716	118,905	123,094	127,282	131,471	135,660	139,563	143,466	147,370
Others	231,794	275,892	288,966	302,041	315,115	328,190	341,264	353,674	366,083	378,493
Operating Expense	1,368,841	1,535,249	1,578,514	1,620,860	1,663,205	1,705,550	1,745,721	1,783,290	1,820,524	1,856,839
WORKING EXPENSE	927,530	1,058,102	1,093,131	1,128,159	1,163,187	1,198,216	1,233,244	1,261,464	1,289,684	1,317,904
PASSENGER	265,712	301,704	312,423	323,142	333,861	344,579	355,298	362,899	370,500	378,101
GOODS	661,818	756,398	780,708	805,017	829,327	853,636	877,946	898,565	919,184	939,804
MAINTENANCE COST	108,994	109,876	109,996	109,996	109,996	109,996	109,271	109,676	109,996	109,996
DEPRECIATION	332,318	367,271	375,388	382,705	390,022	397,339	403,206	411,951	420,844	428,939

<< INVESTMENT >>

INVESTMENT TOTAL	1,257,170	253,628	248,630	248,630	248,630	248,630	303,841	284,678	279,680	279,680
Foreign Currency Total	0	0	0	0	0	0	0	0	0	0
Local Currency Total	1,257,170	253,628	248,630	248,630	248,630	248,630	303,841	284,678	279,680	279,680
* NEW DELHI STATION	0	4,998	0	0	0	0	24,161	4,998	0	0
Foreign Currency Total	0	0	0	0	0	0	0	0	0	0
Local Currency Total	0	4,998	0	0	0	0	24,161	4,998	0	0
CIVIL WORK	0	4,998	0	0	0	0	0	4,998	0	0
Foreign Currency	0	0	0	0	0	0	0	0	0	0
Local Currency	0	4,998	0	0	0	0	0	4,998	0	0
SIGNALS & TELCOM	0	0	0	0	0	0	0	0	0	0
Foreign Currency	0	0	0	0	0	0	0	0	0	0
Local Currency	0	0	0	0	0	0	0	0	0	0
ELECTRIFICATION										
Local Currency	0	0	0	0	0	0	24,161	0	0	0
* DELHI AREA										
Local Currency Total	19,500	0	0	0	0	0	0	0	0	0
CIVIL WORK										
Local Currency	0	0	0	0	0	0	0	0	0	0
SIGNALS & TELCOM										
Local Currency	19,500	0	0	0	0	0	0	0	0	0
ELECTRIFICATION										
Local Currency	0	0	0	0	0	0	0	0	0	0
LAND ACQUISITION										
Local Currency	0	0	0	0	0	0	0	0	0	0

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
* RELEVENT SECTIONS										
Local Currency Total	64,000	0	0	0	0	0	0	0	0	0
CIVIL WORK										
Local Currency	0	0	0	0	0	0	0	0	0	0
SIGNALS & TELCOM										
Local Currency	64,000	0	0	0	0	0	0	0	0	0
ELECTRIFICATION										
Local Currency	0	0	0	0	0	0	0	0	0	0
LAND ACQUISITION										
Local Currency	0	0	0	0	0	0	0	0	0	0
* ROLLING STOCK										
Local Currency Total	1,173,670	248,630	248,630	248,630	248,630	248,630	279,680	279,680	279,680	279,680
-Salvage Value										
Int. During Construction										
<< FINANCE PROGRAM >>										
FINANCE TOTAL										
Borrowing	1,257,170	248,630	248,630	248,630	248,630	248,630	279,680	279,680	279,680	279,680
Repayment	0	0	0	0	0	0	3,751	3,751	3,751	3,751
Balance	16,283,048	16,531,678	16,780,308	17,028,938	17,277,568	17,526,198	17,802,127	18,078,056	18,353,984	18,629,913
Interest	1,055,397	1,071,558	1,087,719	1,103,880	1,120,041	1,136,202	1,154,381	1,172,466	1,190,552	1,208,637
FINANCE in FOREIGN CURRENCY										
Borrowing	0	0	0	0	0	0	0	0	0	0
Repayment	0	0	0	0	0	0	3,751	3,751	3,751	3,751
Balance	75,026	75,026	75,026	75,026	75,026	75,026	71,275	67,523	63,772	60,021
Interest	1,876	1,876	1,876	1,876	1,876	1,876	1,876	1,782	1,688	1,594
FINANCE in LOCAL CURRENCY										
Borrowing	1,257,170	248,630	248,630	248,630	248,630	248,630	279,680	279,680	279,680	279,680
Repayment	0	0	0	0	0	0	0	0	0	0
Balance	16,208,022	16,456,652	16,705,282	16,953,912	17,202,542	17,451,172	17,730,852	18,010,532	18,290,212	18,569,892
Interest	1,053,521	1,069,682	1,085,843	1,102,004	1,118,165	1,134,326	1,152,505	1,170,685	1,188,864	1,207,043
* NET CASHFLOW	585,483	867,865	937,670	1,002,776	1,067,882	1,132,988	1,168,893	1,233,271	1,283,969	1,329,789
* CUMULATIVE NET CASHFLOW	689,656	1,757,521	2,695,190	3,697,966	4,765,849	5,898,837	7,067,730	8,301,002	9,584,971	10,914,759
<< CASH FLOW STATEMENT >>										
CASH IN	2,898,050	2,193,051	2,274,019	2,355,286	2,436,553	2,517,820	2,630,867	2,694,167	2,757,952	2,821,857
Operating Profit	1,308,562	1,577,149	1,650,001	1,723,951	1,797,901	1,871,851	1,947,980	2,002,536	2,057,428	2,113,239
Depreciation	332,318	367,271	375,388	382,705	390,022	397,339	403,206	411,951	420,844	428,939
Borrowing	1,257,170	248,630	248,630	248,630	248,630	248,630	279,680	279,680	279,680	279,680
CASH OUT	2,312,567	1,325,186	1,336,349	1,352,510	1,368,671	1,384,832	1,461,973	1,460,896	1,473,983	1,492,069
Investment	1,257,170	253,628	248,630	248,630	248,630	248,630	303,841	284,678	279,680	279,680
Int. During Construction	0	0	0	0	0	0	0	0	0	0
Repayment	0	0	0	0	0	0	3,751	3,751	3,751	3,751
Interest	1,055,397	1,071,558	1,087,719	1,103,880	1,120,041	1,136,202	1,154,381	1,172,466	1,190,552	1,208,637
Cash Flow For FIRR	383,710	1,690,793	1,776,759	1,858,026	1,939,293	2,020,560	2,047,346	2,129,809	2,198,592	2,262,497

<< INCOME STATEMENT >>

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Operating Profit	2,169,050	2,231,997	2,225,124	2,225,904	2,225,086	2,224,995	2,234,725	2,227,606	2,224,892	2,226,521
Operating Revenue	4,062,203	4,154,328	4,154,328	4,154,328	4,154,328	4,154,328	4,154,328	4,154,328	4,154,328	4,154,328
PASSENGER	660,457	666,448	666,448	666,448	666,448	666,448	666,448	666,448	666,448	666,448
Long Express	20,844	20,844	20,844	20,844	20,844	20,844	20,844	20,844	20,844	20,844
Mail Express	466,177	470,739	470,739	470,739	470,739	470,739	470,739	470,739	470,739	470,739
Local	173,436	174,865	174,865	174,865	174,865	174,865	174,865	174,865	174,865	174,865
GOODS	3,401,745	3,487,880	3,487,880	3,487,880	3,487,880	3,487,880	3,487,880	3,487,880	3,487,880	3,487,880
Coal	1,272,438	1,289,541	1,289,541	1,289,541	1,289,541	1,289,541	1,289,541	1,289,541	1,289,541	1,289,541
Cement	152,218	157,940	157,940	157,940	157,940	157,940	157,940	157,940	157,940	157,940
Pol	761,180	790,308	790,308	790,308	790,308	790,308	790,308	790,308	790,308	790,308
Food Grains	333,859	346,110	346,110	346,110	346,110	346,110	346,110	346,110	346,110	346,110
Iron & Steel	339,874	345,493	345,493	345,493	345,493	345,493	345,493	345,493	345,493	345,493
Fertilizers	151,273	155,176	155,176	155,176	155,176	155,176	155,176	155,176	155,176	155,176
Others	390,902	403,312	403,312	403,312	403,312	403,312	403,312	403,312	403,312	403,312
Operating Expaense	1,893,153	1,922,331	1,929,204	1,928,424	1,929,242	1,929,333	1,919,603	1,926,722	1,929,436	1,927,807
WORKING EXPENSE	1,346,125	1,374,345	1,374,345	1,374,345	1,374,345	1,374,345	1,374,345	1,374,345	1,374,345	1,374,345
PASSENGER	385,701	393,302	393,302	393,302	393,302	393,302	393,302	393,302	393,302	393,302
GOODS	960,423	981,042	981,042	981,042	981,042	981,042	981,042	981,042	981,042	981,042
MAINTENANCE COST	109,996	107,781	109,914	109,837	109,925	109,954	105,069	108,991	109,986	109,511
DEPRECIATION	437,033	440,206	444,945	444,242	444,971	445,034	440,189	443,386	445,106	443,951

<< INVESTMENT >>

INVESTMENT TOTAL	279,680	95,109	6,820	7,398	5,040	2,680	112,788	30,361	0	12,898
Foreign Currency Total	0	51,516	0	0	0	0	22,047	0	0	0
Local Currency Total	279,680	43,593	6,820	7,398	5,040	2,680	90,741	30,361	0	12,898
* NEW DELHI STATION	0	73,409	0	4,998	0	0	102,588	24,161	0	4,998
Foreign Currency Total	0	51,516	0	0	0	0	22,047	0	0	0
Local Currency Total	0	21,893	0	4,998	0	0	80,541	24,161	0	4,998
CIVIL WORK	0	0	0	4,998	0	0	102,588	0	0	4,998
Foreign Currency	0	0	0	0	0	0	22,047	0	0	0
Local Currency	0	0	0	4,998	0	0	80,541	0	0	4,998
SIGNALS & TELCOM	0	73,409	0	0	0	0	0	0	0	0
Foreign Currency	0	51,516	0	0	0	0	0	0	0	0
Local Currency	0	21,893	0	0	0	0	0	0	0	0
ELECTRIFICATION										
Local Currency	0	0	0	0	0	0	0	24,161	0	0
* DELHI AREA										
Local Currency Total	0	17,180	2,300	0	2,620	2,680	10,200	6,200	0	7,900
CIVIL WORK										
Local Currency	0	0	0	0	0	0	10,200	6,200	0	7,900
SIGNALS & TELCOM										
Local Currency	0	17,180	2,300	0	2,620	2,680	0	0	0	0
ELECTRIFICATION										
Local Currency	0	0	0	0	0	0	0	0	0	0
LAND ACQUISITION										
Local Currency	0	0	0	0	0	0	0	0	0	0

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
* RELEVENT SECTIONS										
Local Currency Total	0	4,520	4,520	2,400	2,420	0	0	0	0	0
CIVIL WORK										
Local Currency	0	0	0	0	0	0	0	0	0	0
SIGNALS & TELCOM										
Local Currency	0	4,520	4,520	2,400	2,420	0	0	0	0	0
ELECTRIFICATION										
Local Currency	0	0	0	0	0	0	0	0	0	0
LAND ACQUISITION										
Local Currency	0	0	0	0	0	0	0	0	0	0
* ROLLING STOCK										
Local Currency Total	279,680	0	0	0	0	0	0	0	0	0
-Salvage Value										
Int. During Construction										
<< FINANCE PROGRAM >>										
FINANCE TOTAL										
Borrowing	279,680	0	0	0	0	0	0	0	0	0
Repayment	3,751	3,751	3,751	3,751	3,751	3,751	3,751	3,751	3,751	3,751
Balance	18,905,842	18,902,091	18,898,339	18,894,588	18,890,837	18,887,085	18,883,334	18,879,583	18,875,831	18,872,080
Interest	1,226,723	1,226,629	1,226,535	1,226,441	1,226,348	1,226,254	1,226,160	1,226,066	1,225,972	1,225,879
FINANCE in FOREIGN CURRENCY										
Borrowing	0	0	0	0	0	0	0	0	0	0
Repayment	3,751	3,751	3,751	3,751	3,751	3,751	3,751	3,751	3,751	3,751
Balance	56,269	52,518	48,767	45,016	41,264	37,513	33,762	30,010	26,259	22,508
Interest	1,501	1,407	1,313	1,219	1,125	1,032	938	844	750	656
FINANCE in LOCAL CURRENCY										
Borrowing	279,680	0	0	0	0	0	0	0	0	0
Repayment	0	0	0	0	0	0	0	0	0	0
Balance	18,849,572	18,849,572	18,849,572	18,849,572	18,849,572	18,849,572	18,849,572	18,849,572	18,849,572	18,849,572
Interest	1,225,222	1,225,222	1,225,222	1,225,222	1,225,222	1,225,222	1,225,222	1,225,222	1,225,222	1,225,222
* NET CASHFLOW	1,375,608	1,346,713	1,432,963	1,432,555	1,434,919	1,437,344	1,332,215	1,410,814	1,440,273	1,427,944
* CUMULATIVE NET CASHFLOW	12,290,368	13,637,081	15,070,044	16,502,599	17,937,518	19,374,862	20,707,077	22,117,891	23,558,164	24,986,108
<< CASH FLOW STATEMENT >>										
CASH IN	2,885,762	2,672,202	2,670,069	2,670,146	2,670,058	2,670,029	2,674,914	2,670,992	2,669,997	2,670,472
Operating Profit	2,169,050	2,231,997	2,225,124	2,225,904	2,225,086	2,224,995	2,234,725	2,227,606	2,224,892	2,226,521
Depreciation	437,033	440,206	444,945	444,242	444,971	445,034	440,189	443,386	445,106	443,951
Borrowing	279,680	0	0	0	0	0	0	0	0	0
CASH OUT	1,510,154	1,325,489	1,237,106	1,237,591	1,235,139	1,232,685	1,342,699	1,260,179	1,229,724	1,242,528
Investment	279,680	95,109	6,820	7,398	5,040	2,680	112,788	30,361	0	12,898
Int. During Construction	0	0	0	0	0	0	0	0	0	0
Repayment	3,751	3,751	3,751	3,751	3,751	3,751	3,751	3,751	3,751	3,751
Interest	1,226,723	1,226,629	1,226,535	1,226,441	1,226,348	1,226,254	1,226,160	1,226,066	1,225,972	1,225,879
Cash Flow For FIRR	2,326,402	2,577,093	2,663,249	2,662,748	2,665,018	2,667,349	2,562,126	2,640,631	2,669,997	2,657,574

<< INCOME STATEMENT >>

	2019	2020
Operating Profit	2,224,892	2,249,250
Operating Revenue	4,154,328	4,154,328
PASSENGER	666,448	666,448
Long Express	20,844	20,844
Mail Express	470,739	470,739
Local	174,865	174,865
GOODS	3,487,880	3,487,880
Coal	1,289,541	1,289,541
Cement	157,940	157,940
Pol	790,308	790,308
Food Grains	346,110	346,110
Iron & Steel	345,493	345,493
Fertilizers	155,176	155,176
Others	403,312	403,312
Operating Expaense	1,929,436	1,905,078
WORKING EXPENSE	1,374,345	1,374,345
PASSENGER	393,302	393,302
GOODS	981,042	981,042
MAINTENANCE COST	109,986	101,339
DEPRECIATION	445,106	429,394

<< INVESTMENT >>

INVESTMENT TOTAL	0	757,353
Foreign Currency Total	0	0
Local Currency Total	0	757,353
* NEW DELHI STATION	0	186,698
Foreign Currency Total	0	0
Local Currency Total	0	186,698
CIVIL WORK	0	0
Foreign Currency	0	0
Local Currency	0	0
SIGNALS & TELCOM	0	155,000
Foreign Currency	0	0
Local Currency	0	155,000
ELECTRIFICATION		
Local Currency	0	31,698
* DELHI AREA		
Local Currency Total	0	71,140
CIVIL WORK		
Local Currency	0	0
SIGNALS & TELCOM		
Local Currency	0	57,220
ELECTRIFICATION		
Local Currency	0	13,920
LAND ACQUISITION		
Local Currency	0	0

	2019	2020
* RELEVENT SECTIONS		
Local Currency Total	0	371,515
CIVIL WORK		
Local Currency	0	0
SIGNALS & TELCOM		
Local Currency	0	361,780
ELECTRIFICATION		
Local Currency	0	9,735
LAND ACQUISITION		
Local Currency	0	0
* ROLLING STOCK		
Local Currency Total	0	128,000
-Salvage Value		7,530,222
Int. During Construction		
<< FINANCE PROGRAM >>		
FINANCE TOTAL		
Borrowing	0	0
Repayment	3,751	3,751
Balance	18,868,329	18,864,578
Interest	1,225,785	1,225,691
FINANCE in FOREIGN CURRENCY		
Borrowing	0	0
Repayment	3,751	3,751
Balance	18,756	15,005
Interest	563	469
FINANCE in LOCAL CURRENCY		
Borrowing	0	0
Repayment	0	0
Balance	18,849,572	18,849,572
Interest	1,225,222	1,225,222
* NET CASHFLOW	1,440,461	8,222,071
* CUMULATIVE NET CASHFLOW	26,426,569	34,648,641
<< CASH FLOW STATEMENT >>		
CASH IN	2,669,997	2,678,645
Operating Profit	2,224,892	2,249,250
Depreciation	445,106	429,394
Borrowing	0	0
CASH OUT	1,229,536	-5,543,427
Investment	0	-6,772,869
Int. During Construction	0	0
Repayment	3,751	3,751
Interest	1,225,785	1,225,691
Cash Flow For FIRR	2,669,997	9,451,514

9 - 2 - 2 Data for Financial Analysis of the Project within Delhi Area

(1) Objective

These data are for a financial analysis of the Project, when it is made following the IR planning rules.

(2) Definition of the Project

In this case, the impacts the project will give or the project will be given, will be assumed to be limited within Delhi Area. The Project for this analysis can therefore be described as follows:

New Delhi Station is modernized and other terminal facilities within Delhi Area are improved so as to make the New Delhi modernization possible, where the investment cost for the improved facilities outside Delhi Area and the rolling stock is not counted, but the traffic increase within Delhi Area attributable to the said improvement outside Delhi Area is counted.

(3) Method of Cash Flow Calculation

Cash flow calculation was made based on the method, premises and cost/revenues dealt with in the paragraphs, (8-1 through 8-4). For each of these items, the Team's counterpart's agreement and consent were sought for and obtained.

The method employed in a few feasibility study reports of N.R. (such as Project Report & Estimate N.R. for Final Location Engineering - Cum - Traffic Survey for Doubling of Allahabad - Prayag - Phaphaman Section and others) was also referenced.

(4) Investment Cost of the Project

The estimated investment cost consists of (1) the investment made under the Action Plan and (2) the investment corresponding with the Column "Subtotal" of Table 5.5.1 (5) which comprises of "Delhi Area" and "Terminal". They can be classified according to the work categories as shown in the Table (4)-1.

Table (4)-1 The Estimated Investment Cost of the Project

(Unit: Rs in thousand)

Department	New Delhi Station	Delhi Area	Total
Civil Work	1,170,507 (197,400)	997,600 (155,300)	2,168,107 (352,700)
Signalling & Telecommunication	193,409 (35,000)	135,000 (28,500)	328,409 (63,500)
Electrification & Power Supply	67,492 (34,000)	143,320 (29,500)	210,812 (63,500)
Total	1,431,408 (266,400)	1,275,920 (213,300)	2,707,328 (479,700)
Grand Total	1,697,808	1,489,220	3,187,028

Note: The costs in brackets show the costs planned in the Action Plan (on-going) below:

1) New Delhi Station (Phase I): washing/stabling lines at Nizamuddin and 2 additional platforms
2) Sahibabad to Ghaziabad 4th line
3) Ghaziabad: Remodelling of yard
4) Residual value (to be subtracted as negative investment in the final year of the Project life) was calculated according to the method employed in the feasibility reports of the Northern Railway and with the consent of the Team's counterparts.

(5) Incremental Operating Cost

1) Incremental working expense

Working expense is calculated by the following equation:

Working expense

= Working expense per train-km (Table 8.3.5)

× Incremental train-kms within Delhi Area (Table (5)-1)

Table (5)-1 Imcremental Train-kms Within Delhi Area

(Unit: 1000train-km)

Item	1995	2000	2005	2010
Passenger				
Diesel	156	297	409	518
Electric	305	504	504	504
Total	461	801	913	1,022
Goods				
Diesel	△ 860	△ 1,056	△ 1,044	△ 1,032
Electric	1,303	2,339	2,339	2,339
Total	443	1,283	1,295	1,307

Note: Figures with △ mean deficit value.

2) Incremental Maintenance and Depreciation costs

They are calculated applying the maintenance rate and depreciation method (referred to in 8-3-2 (2) and (3)) to the incremental assets in the project.

3) Result

Table (5)-2 Incremental Operating Cost

(Unit: Rs in thousand)

Item	1995	2000	2005	2010
Passenger working expense	30,801	53,447	60,837	67,946
Goods working expense	46,033	120,941	121,887	122,834
Sub total	76,834	174,388	182,724	190,780
Maintenance cost	53,959	69,516	68,911	67,475
Depreciation cost	39,999	48,951	48,301	44,950
Total	170,792	292,855	299,936	303,205

Note: Working expense, depreciation cost and maintenance cost are calculated based on the data submitted by N.R. as a result of discussion with the counterparts.

(6) Incremental Operating Revenue

1) Diverted traffic

As a result of completion of the project, there will be traffic diverted from other modes. The traffic volume of these diverted

passenger and goods which leave/arrive and pass through the Delhi Area are estimated by the demand forecast considering the transport capacity.

The diverted traffic volumes of passenger-kms and of tonne-kms, each per year, are shown in Table (6)-1 and (6)-2 respectively. For reference, their breakdown in terms of inward/outward/through-traffic (See Note) in tonne-kms and tonnage is given in Tables (6)-3 and (6)-4.

Table (6)-1 Diverted Traffic Volume of Passengers

(Unit: 1000 passenger-km)

Type of train \ Year	1995	2000	2005	2010
Long Express	7,361	16,980	16,980	16,980
Mail/Express	370,689	820,816	954,599	1,063,401
Local	234,950	513,204	653,421	721,619
Total	613,000	1,351,000	1,625,000	1,802,000

Table (6)-2 Diverted Traffic Volume of Goods

(Unit: 1000 tonne-km)

Commodity \ Year	1995	2000	2005	2010
Coal	181,000	525,000	581,000	629,000
Cement	42,000	96,000	131,000	164,000
POL	67,000	159,000	206,000	249,000
Food Grains	51,000	166,000	220,000	266,000
Iron & Steel	31,000	87,000	101,000	112,000
Fertilizers	36,000	89,000	110,000	129,000
Others	55,000	162,000	218,000	271,000
Total	463,000	1,284,000	1,567,000	1,820,000

Table (6)-3 Diverted Traffic Volume of Goods in Delhi Area/Year

(IN THOUSAND TONNE-KM/YEAR)

COMMODITY	FLOW	1995	2000	2005	2010
COAL	INWARD	79,000	262,000	262,000	262,000
	OUTWARD	0	0	0	0
	THROUGH	102,000	263,000	319,000	367,000
	SUB TOTAL	181,000	525,000	581,000	629,000
CEMENT	INWARD	23,000	49,000	69,000	90,000
	OUTWARD	0	0	0	0
	THROUGH	19,000	47,000	62,000	74,000
	SUB TOTAL	42,000	96,000	131,000	164,000
P.O.L.	INWARD	5,000	17,000	18,000	18,000
	OUTWARD	0	0	0	0
	THROUGH	62,000	142,000	188,000	231,000
	SUB TOTAL	67,000	159,000	206,000	249,000
FOOD GRAINS	INWARD	5,000	14,000	21,000	26,000
	OUTWARD	1,000	5,000	5,000	5,000
	THROUGH	45,000	147,000	194,000	235,000
	SUB TOTAL	51,000	166,000	220,000	266,000
IRON & STEEL	INWARD	8,000	27,000	28,000	28,000
	OUTWARD	0	0	0	0
	THROUGH	23,000	60,000	73,000	84,000
	SUB TOTAL	31,000	87,000	101,000	112,000
FERTILIZERS	INWARD	4,000	7,000	9,000	11,000
	OUTWARD	0	0	0	0
	THROUGH	32,000	82,000	101,000	118,000
	SUB TOTAL	36,000	89,000	110,000	129,000
OTHERS	INWARD	7,000	26,000	29,000	33,000
	OUTWARD	1,000	6,000	8,000	9,000
	THROUGH	47,000	130,000	181,000	229,000
	SUB TOTAL	55,000	162,000	218,000	271,000
TOTAL	INWARD	131,000	402,000	436,000	468,000
	OUTWARD	2,000	11,000	13,000	14,000
	THROUGH	330,000	871,000	1,118,000	1,338,000
	TOTAL	463,000	1,284,000	1,567,000	1,820,000

Table (6)-4 Diverted Goods Traffic in Delhi Area

(IN TONNE/DAY)

COMMODITY	FLOW	1995	2000	2005	2010
COAL	INWARD	3,641	20,851	20,851	20,851
	OUTWARD	0	0	0	0
	THROUGH	3,767	12,772	14,822	16,719
	SUB TOTAL	7,408	33,623	35,672	37,570
CEMENT	INWARD	943	2,830	3,837	4,843
	OUTWARD	17	17	17	17
	THROUGH	803	1,993	2,543	3,031
	SUB TOTAL	1,764	4,841	6,396	7,891
P.O.L.	INWARD	129	719	719	719
	OUTWARD	0	0	0	0
	THROUGH	2,908	6,952	9,390	11,688
	SUB TOTAL	3,036	7,671	10,109	12,407
FOOD GRAINS	INWARD	486	1,255	1,914	2,573
	OUTWARD	26	552	565	565
	THROUGH	1,673	8,097	10,416	12,613
	SUB TOTAL	2,185	9,905	12,895	15,751
IRON & STEEL	INWARD	489	2,707	2,721	2,734
	OUTWARD	16	64	96	113
	THROUGH	924	2,994	3,446	3,864
	SUB TOTAL	1,429	5,766	6,263	6,710
FERTILIZERS	INWARD	109	397	452	520
	OUTWARD	17	84	101	118
	THROUGH	1,303	3,560	4,220	4,824
	SUB TOTAL	1,430	4,042	4,773	5,462
OTHERS	INWARD	193	2,642	2,771	2,916
	OUTWARD	186	1,023	1,178	1,302
	THROUGH	1,380	6,058	7,749	9,349
	SUB TOTAL	1,759	9,723	11,698	13,567
TOTAL	INWARD	5,991	31,402	33,264	35,156
	OUTWARD	262	1,741	1,958	2,115
	THROUGH	12,759	42,427	52,584	62,087
	TOTAL	19,011	75,570	87,806	99,358

Note:

The revenue of goods traffic passing through the Delhi Area is included in the above Table.

As per the following reasons.

a. In the case which the goods goes to "C" zone from "A" zone passing through "B" zone and all revenue does not belong to "A" or "C" zone, the portion of distance passing through "B" zone belongs to goods traffic revenue of "B" zone generally.

b. As "B" zone requires the working expense and maintenance cost of track and roadbed etc., for the goods trains passing through "B" zone, "B" zone should recieve the revenues according to the kilometrage.

c. In the Delhi Area, investments in the track doubling, modernization of signalling system and elimination of surface crossing etc. are planned. These investments are not only intended for originating/terminating traffic but also for passing-through traffic.

It is impossible to apportion these imvestments to each traffic.

2) Result (increase in operating revenue)

Increase in operating revenue is calculated as follows:

Passenger revenue = Diverted passenger traffic (passenger-km)
× Unit fare per passenger-km

Goods revenue = Diverted goods traffic (tonne-km)
× Unit tariff per tonne-km

Table (6)-5 Passenger Revenue Increase

(Unit: Rs in thousand)

Year / Type of train	1995	2000	2005	2010
Long Express	2,503	5,773	5,773	5,773
Mail/Express	37,068	82,082	95,460	106,340
Local	11,748	25,660	32,671	36,081
Total	51,319	113,515	133,904	148,194

Table (6)-6 Goods Revenue Increase

(Unit: Rs in thousand)

Commodity \ Year	1995	2000	2005	2010
Coal	45,793	132,825	146,993	159,137
Cement	12,516	28,608	39,038	48,872
POL	34,974	82,998	107,532	129,978
Food Grains	8,466	27,556	36,520	44,156
Iron & Steel	13,609	38,193	44,339	49,168
Fertilizers	8,568	21,182	26,180	30,702
Others	15,235	44,874	60,386	75,067
Total	139,161	376,236	460,988	537,080

(7) Incremental Net Earnings

Table (7)-1 Net Earnings from Passenger Traffic Increase

(Unit: Rs in thousand)

Item	1995	2000	2005	2010
Revenue	51,319	113,515	133,904	148,194
Working Expense	30,801	53,447	60,837	67,946
Net earnings	20,518	60,068	73,067	80,248

Table (7)-2 Net Earnings from Goods Traffic Increase

(Unit: Rs in thousand)

Item	1995	2000	2005	2010
Revenue	139,161	376,236	460,988	537,080
Working Expense	46,033	120,941	121,887	122,834
Net earnings	93,128	255,295	339,101	414,246

(8) A Trial Calculation of FIRR

Apart from the actual IR planning practices, a trial calculation of cash flow and net cash flow was made purely for a reference purpose. The calculation follows the same standard discounted cash flow technique, as applied in Chapter 8 of the Final Report

and assumes the same financing plans as adopted in Chapter 8.

1) Summary of cash flow

The investment, the incremental operating revenue and cost thus identified, the cash flow and net cash flow is worked out as shown in the computer output, attached in subsequent paragraph. It can be summarized in the Table (8)-1.

Table (8)-1 Summary of Cash Flow Analysis

(Unit: Rs in thousand)

Plan	Item	1995	2000	2005	2010
	Operating revenue	190,480	489,751	594,892	685,274
	Passenger Goods	51,319 139,161	113,515 376,236	133,904 460,988	148,194 537,080
	Operating expenses	170,792	292,855	299,936	303,205
	Working expense Maintenance cost Depreciation	76,834 53,959 39,999	174,388 69,516 48,951	182,724 68,911 48,301	190,780 67,475 44,950
	Operating profit	19,688	196,896	294,956	382,069
	Investment	167,245	4,997	24,161	90,589
	Cash flow	△ 107,558	240,850	319,096	336,430
1	Borrowing	167,245	0	0	0
	Loan repayment	0	0	3,751	3,751
	Interest payment	197,415	231,081	231,081	230,612
	Net cash flow (Cumulative NCF)	△ 137,728 (△ 137,728)	9,769 (△ 405,597)	84,264 (△ 69,213)	102,067 (624,369)
	Net profit	△ 177,727	△ 34,185	63,875	151,457
2	Borrowing	167,245	0	0	0
	Loan repayment	0	5,219	5,219	5,219
	Interest payment	201,599	235,265	233,245	231,225
	Net cash flow (Cumulative NCF)	△ 141,912 (△ 141,912)	366 (△ 435,920)	80,632 (△ 136,741)	99,986 (543,334)
	Net profit	△ 181,911	△ 38,369	61,711	150,844

Note: Figures with △ mean deficit value.

NCF means net cash flow.

2) Result of cash flow analysis

In both financial plan 1 and 2, the net cash flow becomes positive from 2000.

In the base case, when it is assumed that the investment made in and after 1995 is not financed by new borrowing, the fiscal year in which the net cash flow turns into surplus would be 2000 and the cumulative deficit would be Rs. 953 millions in 1999.

Total new investment cost accumulated from 1995 would be Rs 685 millions.

The year when the cumulative deficit turns positive would be 2007.

In the base case, maximum operating profit is Rs. 385 millions in 2015 and maximum loan balance is Rs. 3,601 millions in 1999.

3) FIRR

In terms of discounted cash flow technique, FIRR works out to 7.30% by computer model.

(9) A Trial Sensitivity Analysis

A sensitivity analysis was conducted from pessimisitic point of view i.e. 10% decrease in revenue and 50% increse in investment cost. The result is shown in Table (9)-1.

Table (9)-1 Result of Sensitivity Analysis

	Case	FIRR %
a	Base case	7.30
b	10% revenue reduction	6.00
c	20% revenue reduction	4.57
d	10% cost overrun	6.50
e	20% cost overrun	5.80
f	50% cost overrun	4.12
g	b + d	5.25

(Reference 1)

Financial Analysis of the Project within Delhi Area (Unit : 1000RS)

<< INCOME STATEMENT >>

	1990	1991	1992	1993	1994	1995	1996	1997	1998
Operating Profit	0	0	0	0	0	19,688	53,833	90,374	122,977
Operating Revenue	0	0	0	0	0	190,480	250,334	310,188	370,043
PASSENGER	0	0	0	0	0	51,319	63,758	76,197	88,637
Long Express	0	0	0	0	0	2,503	3,157	3,811	4,465
Mail Express	0	0	0	0	0	37,069	46,072	55,074	64,077
Local	0	0	0	0	0	11,748	14,530	17,313	20,095
GOODS	0	0	0	0	0	139,161	186,576	233,991	281,406
Coal	0	0	0	0	0	45,793	63,199	80,606	98,012
Cement	0	0	0	0	0	12,516	15,734	18,953	22,171
Pol	0	0	0	0	0	34,974	44,579	54,184	63,788
Food Grains	0	0	0	0	0	8,466	12,284	16,102	19,920
Iron & Steel	0	0	0	0	0	13,609	18,526	23,443	28,359
Fertilizers	0	0	0	0	0	8,568	11,091	13,614	16,136
Others	0	0	0	0	0	15,235	21,163	27,091	33,018
Operating Expenes	0	0	0	0	0	170,792	196,501	219,814	247,065
WORKING EXPENSE	0	0	0	0	0	76,834	96,345	115,856	135,366
PASSENGER	0	0	0	0	0	30,801	35,330	39,859	44,389
GOODS	0	0	0	0	0	46,033	61,015	75,996	90,978
MAINTENANCE COST	0	0	0	0	0	53,959	57,751	60,183	64,990
DEPRECIATION	0	0	0	0	0	39,999	42,405	43,775	46,709

<< INVESTMENT >>

INVESTMENT TOTAL	479,700	161,989	348,749	650,195	861,209	167,245	114,961	194,778	188,702
Foreign Currency Total	0	0	0	2,204	71,359	0	0	0	0
Local Currency Total	479,700	161,989	348,749	647,991	789,850	167,245	114,961	194,778	188,702
* NEW DELHI STATION	266,400	115,529	231,056	469,392	624,431	0	0	0	0
Foreign Currency Total	0	0	0	2,204	71,359	0	0	0	0
Local Currency Total	266,400	115,529	231,056	458,188	553,072	0	0	0	0
CIVIL WORK	197,400	112,155	224,308	360,146	473,898	0	0	0	0
Foreign Currency	0	0	0	2,204	19,843	0	0	0	0
Local Currency	197,400	112,155	224,308	357,942	454,055	0	0	0	0
SIGNALS & TELCOM	35,000	0	0	80,000	113,409	0	0	0	0
Foreign Currency	0	0	0	0	51,516	0	0	0	0
Local Currency	35,000	0	0	80,000	61,893	0	0	0	0
ELECTRIFICATION									
Local Currency	34,000	3,374	6,748	20,246	37,124	0	0	0	0
* DELHI AREA									
Local Currency Total	213,300	46,460	117,693	189,803	236,778	167,245	114,961	194,778	188,702
CIVIL WORK									
Local Currency	155,300	46,460	59,430	155,592	157,116	135,500	86,716	156,784	116,402
SIGNALS & TELCOM									
Local Currency	28,500	0	0	12,800	33,100	19,600	4,000	13,100	32,900
ELECTRIFICATION									
Local Currency	29,500	0	1,063	20,411	46,562	1,345	9,645	24,894	39,400
LAND ACQUISITION									
Local Currency	0	0	57,200	0	0	10,800	14,600	0	0
-Salvage Value									
Int. During Construction	24,584	42,769	66,322	110,062	170,506				

<< FINANCE PROGRAM >>

	1990	1991	1992	1993	1994	1995	1996	1997	1998
FINANCE TOTAL									
Borrowing	504,284	204,749	415,071	760,257	1,031,715	167,245	114,961	194,778	188,702
Repayment	0	0	0	0	0	0	0	0	0
Balance	504,284	709,033	1,124,104	1,884,361	2,916,076	3,083,321	3,198,282	3,393,060	3,581,762
Interest	24,584	42,760	66,322	110,062	170,506	197,415	204,887	217,548	229,813
FINANCE in FOREIGN CURRENCY									
Borrowing	0	0	0	2,246	72,780	0	0	0	0
Repayment	0	0	0	0	0	0	0	0	0
Balance	0	0	0	2,246	75,026	75,026	75,026	75,026	75,026
Interest	0	0	0	42	1,421	1,876	1,876	1,876	1,876
FINANCE in LOCAL CURRENCY									
Borrowing	504,284	204,749	415,071	758,011	958,936	167,245	114,961	194,778	188,702
Repayment	0	0	0	0	0	0	0	0	0
Balance	504,284	709,033	1,124,104	1,882,114	2,841,050	3,008,295	3,123,256	3,318,034	3,506,736
Interest	24,584	42,760	66,322	110,020	169,086	195,539	203,012	215,672	227,938
* NET CASHFLOW	0	0	0	-0	0	-137,728	-108,649	-83,399	-60,127
* CUMULATIVE NET CASHFLOW	0	0	0	-0	-0	-137,728	-246,377	-329,776	-389,903

<< CASH FLOW STATEMENT >>

CASH IN	504,284	204,749	415,071	760,257	1,031,715	226,932	211,199	328,927	358,389
Operating Profit	0	0	0	0	0	19,688	53,833	90,374	122,977
Depreciation	0	0	0	0	0	39,999	42,405	43,775	46,709
Borrowing	504,284	204,749	415,071	760,257	1,031,715	167,245	114,961	194,778	188,702
CASH OUT	504,284	204,749	415,071	760,257	1,031,715	364,660	319,848	412,326	418,515
Investment	479,700	161,989	348,749	650,195	861,209	167,245	114,961	194,778	188,702
Int. During Construction	24,584	42,760	66,322	110,062	170,506	0	0	0	0
Repayment	0	0	0	0	0	0	0	0	0
Interest	0	0	0	0	0	197,415	204,887	217,548	229,813
Cash Flow For FIRR	-479,700	-161,989	-348,749	-650,195	-861,209	-107,558	-18,723	-60,629	-19,015

FIRR % ==========> 7.30%

<< INCOME STATEMENT >>

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Operating Profit	156,179	196,896	215,307	234,676	254,044	273,413	294,957	310,167	325,712	342,178
Operating Revenue	429,897	489,751	510,748	531,784	552,820	573,856	594,892	612,969	631,045	649,121
PASSENGER	101,076	113,515	117,562	121,647	125,733	129,819	133,904	136,762	139,620	142,478
Long Express	5,119	5,773	5,773	5,773	5,773	5,773	5,773	5,773	5,773	5,773
Mail Express	73,079	82,082	84,695	87,386	90,078	92,769	95,460	97,636	99,812	101,988
Local	22,878	25,660	27,093	28,488	29,882	31,277	32,671	33,353	34,035	34,717
GOODS	328,821	376,236	393,186	410,137	427,087	444,038	460,988	476,206	491,425	506,643
Coal	115,419	132,825	135,659	138,492	141,326	144,159	146,993	149,422	151,851	154,279
Cement	25,390	28,608	30,694	32,780	34,866	36,952	39,038	41,005	42,972	44,938
Pol	73,393	82,998	87,965	92,812	97,718	102,625	107,532	112,021	116,510	121,000
Food Grains	23,738	27,556	29,349	31,142	32,934	34,727	36,520	38,047	39,574	41,102
Iron & Steel	33,276	38,193	39,422	40,651	41,881	43,110	44,339	45,305	46,271	47,236
Fertilizers	18,659	21,182	22,182	23,181	24,181	25,180	26,180	27,084	27,989	28,893
Others	38,946	44,874	47,976	51,079	54,181	57,284	60,386	63,322	66,258	69,195
Operating Expenes	273,718	292,855	295,441	297,109	298,776	300,443	299,936	302,802	305,332	306,944
WORKING EXPENSE	154,877	174,388	176,055	177,722	179,389	181,057	182,724	184,335	185,946	187,557
PASSENGER	48,918	53,447	54,925	56,403	57,881	59,359	60,837	62,258	63,680	65,102
GOODS	105,959	120,941	121,130	121,319	121,509	121,698	121,887	122,077	122,266	122,455
MAINTENANCE COST	69,402	69,516	69,636	69,636	69,636	69,636	68,911	69,516	69,636	69,636
DEPRECIATION	49,439	48,951	49,751	49,751	49,751	49,751	48,301	48,951	49,751	49,751

<< INVESTMENT >>

INVESTMENT TOTAL	19,500	4,998	0	0	0	0	24,161	4,998	0	0
Foreign Currency Total	0	0	0	0	0	0	0	0	0	0
Local Currency Total	19,500	4,998	0	0	0	0	24,161	4,998	0	0
* NEW DELHI STATION	0	4,998	0	0	0	0	24,161	4,998	0	0
Foreign Currency Total	0	0	0	0	0	0	0	0	0	0
Local Currency Total	0	4,998	0	0	0	0	24,161	4,998	0	0
CIVIL WORK	0	4,998	0	0	0	0	0	4,998	0	0
Foreign Currency	0	0	0	0	0	0	0	0	0	0
Local Currency	0	4,998	0	0	0	0	0	4,998	0	0
SIGNALS & TELCOM	0	0	0	0	0	0	0	0	0	0
Foreign Currency	0	0	0	0	0	0	0	0	0	0
Local Currency	0	0	0	0	0	0	0	0	0	0
ELECTRIFICATION										
Local Currency	0	0	0	0	0	0	24,161	0	0	0
* DELHI AREA										
Local Currency Total	19,500	0	0	0	0	0	0	0	0	0
CIVIL WORK										
Local Currency	0	0	0	0	0	0	0	0	0	0
SIGNALS & TELCOM										
Local Currency	19,500	0	0	0	0	0	0	0	0	0
ELECTRIFICATION										
Local Currency	0	0	0	0	0	0	0	0	0	0
LAND ACQUISITION										
Local Currency	0	0	0	0	0	0	0	0	0	0

-Salvage Value
Int. During Construction

<< FINANCE PROGRAM >>

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
FINANCE TOTAL										
Borrowing	19,500	0	0	0	0	0	0	0	0	0
Repayment	0	0	0	0	0	0	3,751	3,751	3,751	3,751
Balance	3,601,262	3,601,262	3,601,262	3,601,262	3,601,262	3,601,262	3,597,511	3,593,759	3,590,008	3,586,257
Interest	231,081	231,081	231,081	231,081	231,081	231,081	231,081	230,987	230,893	230,800
FINANCE in FOREIGN CURRENCY										
Borrowing	0	0	0	0	0	0	0	0	0	0
Repayment	0	0	0	0	0	0	3,751	3,751	3,751	3,751
Balance	75,026	75,026	75,026	75,026	75,026	75,026	71,275	67,523	63,772	60,021
Interest	1,876	1,876	1,876	1,876	1,876	1,876	1,876	1,782	1,688	1,594
FINANCE in LOCAL CURRENCY										
Borrowing	19,500	0	0	0	0	0	0	0	0	0
Repayment	0	0	0	0	0	0	0	0	0	0
Balance	3,526,236	3,526,236	3,526,236	3,526,236	3,526,236	3,526,236	3,526,236	3,526,236	3,526,236	3,526,236
Interest	229,205	229,205	229,205	229,205	229,205	229,205	229,205	229,205	229,205	229,205
* NET CASHFLOW	-25,463	9,769	33,977	53,345	72,714	92,083	84,264	119,382	140,819	157,378
* CUMULATIVE NET CASHFLOW	-415,366	-405,597	-371,620	-318,275	-245,561	-153,477	-69,213	50,169	190,987	348,365

<< CASH FLOW STATEMENT >>

CASH IN	225,118	245,848	265,058	284,426	303,795	323,164	343,258	359,118	375,463	391,929
Operating Profit	156,179	196,898	215,307	234,676	254,044	273,413	294,957	310,167	325,712	342,178
Depreciation	49,439	48,951	49,751	49,751	49,751	49,751	48,301	48,951	49,751	49,751
Borrowing	19,500	0	0	0	0	0	0	0	0	0
CASH OUT	250,581	236,079	231,081	231,081	231,081	231,081	258,993	239,736	234,645	234,551
Investment	19,500	4,998	0	0	0	0	24,161	4,998	0	0
Int. During Construction	0	0	0	0	0	0	0	0	0	0
Repayment	0	0	0	0	0	0	3,751	3,751	3,751	3,751
Interest	231,081	231,081	231,081	231,081	231,081	231,081	231,081	230,987	230,893	230,800
Cash Flow For FIRR	186,118	240,850	265,058	284,426	303,795	323,164	319,097	354,120	375,463	391,929

FIRR % ==========>

<< INCOME STATEMENT >>

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Operating Profit	358,643	382,070	375,197	376,059	375,241	375,243	384,973	377,854	375,139	376,769
Operating Revenue	687,198	685,274	685,274	685,274	685,274	685,274	685,274	685,274	685,274	685,274
PASSENGER	145,336	148,194	148,194	148,194	148,194	148,194	148,194	148,194	148,194	148,194
Long Express	5,773	5,773	5,773	5,773	5,773	5,773	5,773	5,773	5,773	5,773
Mail Express	104,164	106,340	106,340	106,340	106,340	106,340	106,340	106,340	106,340	106,340
Local	35,399	36,081	36,081	36,081	36,081	36,081	36,081	36,081	36,081	36,081
GOODS	521,862	537,080	537,080	537,080	537,080	537,080	537,080	537,080	537,080	537,080
Coal	156,708	159,137	159,137	159,137	159,137	159,137	159,137	159,137	159,137	159,137
Cement	46,905	48,872	48,872	48,872	48,872	48,872	48,872	48,872	48,872	48,872
Pol	125,489	129,978	129,978	129,978	129,978	129,978	129,978	129,978	129,978	129,978
Food Grains	42,629	44,156	44,156	44,156	44,156	44,156	44,156	44,156	44,156	44,156
Iron & Steel	48,202	49,168	49,168	49,168	49,168	49,168	49,168	49,168	49,168	49,168
Fertilizers	29,798	30,702	30,702	30,702	30,702	30,702	30,702	30,702	30,702	30,702
Others	72,131	75,067	75,067	75,067	75,067	75,067	75,067	75,067	75,067	75,067
Operating Expenes	308,555	303,205	310,077	309,215	310,034	310,031	300,302	307,420	310,135	308,505
WORKING EXPENSE	189,168	190,780	190,780	190,780	190,780	190,780	190,780	190,780	190,780	190,780
PASSENGER	66,524	67,946	67,946	67,946	67,946	67,946	67,946	67,946	67,946	67,946
GOODS	122,644	122,834	122,834	122,834	122,834	122,834	122,834	122,834	122,834	122,834
MAINTENANCE COST	69,636	67,475	69,608	69,596	69,595	69,594	64,709	68,631	69,626	69,151
DEPRECIATION	49,751	44,950	49,690	48,930	49,660	49,658	44,813	48,010	49,730	48,575

<< INVESTMENT >>

INVESTMENT TOTAL	0	90,589	2,300	4,998	2,620	2,680	112,788	30,361	0	12,898
Foreign Currency Total	0	51,516	0	0	0	0	22,047	0	0	0
Local Currency Total	0	39,073	2,300	4,998	2,620	2,680	90,741	30,361	0	12,898
* NEW DELHI STATION	0	73,409	0	4,998	0	0	102,588	24,161	0	4,998
Foreign Currency Total	0	51,516	0	0	0	0	22,047	0	0	0
Local Currency Total	0	21,893	0	4,998	0	0	80,541	24,161	0	4,998
CIVIL WORK	0	0	0	4,998	0	0	102,588	0	0	4,998
Foreign Currency	0	0	0	0	0	0	22,047	0	0	0
Local Currency	0	0	0	4,998	0	0	80,541	0	0	4,998
SIGNALS & TELCOM	0	73,409	0	0	0	0	0	0	0	0
Foreign Currency	0	51,516	0	0	0	0	0	0	0	0
Local Currency	0	21,893	0	0	0	0	0	0	0	0
ELECTRIFICATION										
Local Currency	0	0	0	0	0	0	0	24,161	0	0
* DELHI AREA										
Local Currency Total	0	17,180	2,300	0	2,620	2,680	10,200	6,200	0	7,900
CIVIL WORK										
Local Currency	0	0	0	0	0	0	10,200	6,200	0	7,900
SIGNALS & TELCOM										
Local Currency	0	17,180	2,300	0	2,620	2,680	0	0	0	0
ELECTRIFICATION										
Local Currency	0	0	0	0	0	0	0	0	0	0
LAND ADQUISITION										
Local Currency	0	0	0	0	0	0	0	0	0	0

-Salvage Value
Int. During Construction

<< FINANCE PROGRAM >>

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
FINANCE TOTAL										
Borrowing	0	0	0	0	0	0	0	0	0	0
Repayment	3,751	3,751	3,751	3,751	3,751	3,751	3,751	3,751	3,751	3,751
Balance	3,582,505	3,578,754	3,575,003	3,571,251	3,567,500	3,563,749	3,559,998	3,556,246	3,552,495	3,548,744
Interest	230,706	230,612	230,518	230,425	230,331	230,237	230,143	230,049	229,956	229,862
FINANCE in FOREIGN CURRENCY										
Borrowing	0	0	0	0	0	0	0	0	0	0
Repayment	3,751	3,751	3,751	3,751	3,751	3,751	3,751	3,751	3,751	3,751
Balance	56,269	52,518	48,767	45,016	41,264	37,513	33,762	30,010	26,259	22,508
Interest	1,501	1,407	1,313	1,219	1,125	1,032	938	844	750	656
FINANCE in LOCAL CURRENCY										
Borrowing	0	0	0	0	0	0	0	0	0	0
Repayment	0	0	0	0	0	0	0	0	0	0
Balance	3,526,236	3,526,236	3,526,236	3,526,236	3,526,236	3,526,236	3,526,236	3,526,236	3,526,236	3,526,236
Interest	229,205	229,205	229,205	229,205	229,205	229,205	229,205	229,205	229,205	229,205
* NET CASHFLOW	173,937	102,067	188,317	185,815	188,198	188,233	83,103	161,702	191,162	178,833
* CUMULATIVE NET CASHFLOW	522,302	624,369	812,686	998,501	1,186,699	1,374,932	1,458,035	1,619,737	1,810,899	1,989,731

<< CASH FLOW STATEMENT >>

CASH IN	408,394	427,020	424,887	424,989	424,900	424,901	429,785	425,864	424,869	425,344
Operating Profit	358,643	382,070	375,197	376,059	375,241	375,243	384,973	377,854	375,139	376,769
Depreciation	49,751	44,950	49,690	48,930	49,660	49,658	44,813	48,010	49,730	48,575
Borrowing	0	0	0	0	0	0	0	0	0	0
CASH OUT	234,457	324,952	236,570	239,174	236,702	236,668	346,682	264,162	233,707	246,511
Investment	0	90,589	2,300	4,998	2,620	2,680	112,788	30,361	0	12,898
Int. During Construction	0	0	0	0	0	0	0	0	0	0
Repayment	3,751	3,751	3,751	3,751	3,751	3,751	3,751	3,751	3,751	3,751
Interest	230,706	230,612	230,518	230,425	230,331	230,237	230,143	230,049	229,956	229,862
Cash Flow For FIRR	408,394	336,431	422,587	419,991	422,280	422,221	316,997	395,503	424,869	412,446

FIRR % ==========>

<< INCOME STATEMENT >>

	2019	2020
Operating Profit	375,139	383,732
Operating Revenue	685,274	685,274
PASSENGER	148,194	148,194
Long Express	5,773	5,773
Mail Express	106,340	106,340
Local	36,081	36,081
GOODS	537,080	537,080
Coal	159,137	159,137
Cement	48,872	48,872
Pol	129,978	129,978
Food Grains	44,156	44,156
Iron & Steel	49,168	49,168
Fertilizers	30,702	30,702
Others	75,067	75,067
Operating Expenes	310,135	301,542
WORKING EXPENSE	190,780	190,780
PASSENGER	67,946	67,946
GOODS	122,834	122,834
MAINTENANCE COST	69,626	65,607
DEPRECIATION	49,730	45,156

<< INVESTMENT >>

INVESTMENT TOTAL	0	257,838
Foreign Currency Total	0	0
Local Currency Total	0	257,838
* NEW DELHI STATION	0	186,698
Foreign Currency Total	0	0
Local Currency Total	0	186,698
CIVIL WORK	0	0
Foreign Currency	0	0
Local Currency	0	0
SIGNALS & TELCOM	0	155,000
Foreign Currency	0	0
Local Currency	0	155,000
ELECTRIFICATION		
Local Currency	0	31,698
* DELHI AREA		
Local Currency Total	0	71,140
CIVIL WORK		
Local Currency	0	0
SIGNALS & TELCOM		
Local Currency	0	57,220
ELECTRIFICATION		
Local Currency	0	13,920
LAND ACQUISITION		
Local Currency	0	0
-Salvage Value		2,012,870
Int. During Construction		

<< FINANCE PROGRAM >>

	2019	2020
FINANCE TOTAL		
Borrowing	0	0
Repayment	3,751	3,751
Balance	3,544,992	3,541,241
Interest	229,768	229,674
FINANCE in FOREIGN CURRENCY		
Borrowing	0	0
Repayment	3,751	3,751
Balance	18,756	15,005
Interest	563	469
FINANCE in LOCAL CURRENCY		
Borrowing	0	0
Repayment	0	0
Balance	3,526,236	3,526,236
Interest	229,205	229,205
* NET CASHFLOW	191,349	1,950,495
* CUMULATIVE NET CASHFLOW	2,181,081	4,131,575

<< CASH FLOW STATEMENT >>

CASH IN	424,869	428,888
Operating Profit	375,139	383,732
Depreciation	49,730	45,156
Borrowing	0	0
CASH OUT	233,519	-1,521,607
Investment	0	-1,755,032
Int. During Construction	0	0
Repayment	3,751	3,751
Interest	229,768	229,674
Cash Flow For FIRR	424,869	2,183,920

FIRR %

(Reference 2) Explanation of FIRR Calculation

The Financial Internal Rate of Return (FIRR) is calculated as an index for evaluating the profitability of the project as mentioned 8-1-2.

It is expressed by the following equation:

$$0 = \sum_{i=1}^{n} \frac{A_i}{(1 + FIRR)^{i-1}}$$

where: n : Project life

A_i : Cash flow

Cash flow = Operating profit + Depreciation cost
- Investment cost

For example, in the case project life is 11 years, the above equation is expressed as follows:

$$0 = \frac{A_1}{(1 + FIRR)^{1-1}} + \frac{A_2}{(1 + FIRR)^{2-1}} + \frac{A_3}{(1 + FIRR)^{3-1}}$$
$$\cdots\cdots\cdots\cdots\cdots\cdots \frac{A_{11}}{(1 + FIRR)^{11-1}}$$

The FIRR is the discount rate which would make aggregate total of the net present value of cash flow for each year of project life become zero.

Note: The net present value is explained as follws:

In the case which Rs 1,000 is deposited to the bank at the rate of 10%, after two years, principal and interest is Rs 1,210.

The equation is as follows:

Rs 1,000 x $(1 + 0.1)^2$ = Rs 1,210

In another expression, net present value of Rs 1,210 after two years is Rs1,000.

The equation is as follows:

$$\text{Rs } 1{,}000 = \frac{\text{Rs } 1{,}210}{(1 + 0.1)^2}$$

For example, refer to the following table.

(Unit:Rs in thousand)

Item \ Year	1	2	3	4	5	6	7	8	9	10	11	Total
Operating Profit	0	-60	140	240	240	240	204	204	204	204	204	1,820
Depreciation	0	90	90	90	90	90	126	126	126	126	126	1,080
Investment	1,000	0	0	0	0	200	0	0	0	0	0	1,200
Residual value											120	120
Cash flow	-1,000	30	230	330	330	130	330	330	330	330	450	1,820
Net presentvalue (Discounted at the rate of 20.07%)	-1,000	25	159	191	159	52	110	92	76	64	72	0

In this case, the project life is 11 years and the discount rate of 20.07% (FIRR) would make aggregate total of the net present value of cash flow for each year become zero.
This means that the entrepreneur is able to pay the interest at the rate of 20.07% for the borrowing funds.

10－1 Rate for Projects for Investment Cost

10－1－1 Percentage for Contingency, Supervision Charge and General Charge

Category	Supervision Charge	Contingency	General Charge
Track Work	1	3	8.5
Civil Work	2	3	8.5
Signalling & Telecommunication			
- Construction	2	3	9.1
- Improvement	2	3	13.2
Electrification			
- Construction	2	3	8.5
- Improvement	2	3	11.45

10－1－2 Analysis of Rate for each work

BG track work

- 52kg/m Rail, 1660 PRC sleeper
  Ballast cushion 25cm — 2,240,000 Rs/km
- 52kg/m Rail, CST/9 with wooden sleeper
  at joing M+7, Ballast cushion 25cm — 2,000,000 Rs/km
- 52kg/m Rail, CST/9 with wooden sleeper
  at joing M+7, Ballast cushion 20cm — 1,850,000 Rs/km
- 52kg/m Rail, wooden sleeper M+7,
  Ballast cushion 25cm — 2,420,000 Rs/km
- 52kg/m Rail, wooden sleeper M+4,
  Ballast cushion 20cm — 2,210,000 Rs/km
- 52kg/m Rail 1 in 12 turnout wooden sleeper
  and Ballast — 260,000 Rs/set

- 52kg/m Rail 1 in 8½ turnout wooden sleeper and Ballast — 210,000 Rs/set
- Dismantling of track (CST/9 or wooden) — 45,000 Rs/km
- Dismantling of turnout 1 in 12, 1 in 8½ — 6,000 Rs/set

MG track work

- 90R Rail CST/9 sleeper 1540/km Ballast cushion 20cm — 1,400,000 Rs/km
- 75R Rail CST/9 sleeper 1308/km Ballast cushion 20cm — 1,200,000 Rs/km
- 90R Rail 1 in 12 turnout with wooden sleeper and Ballast — 200,000 Rs/set
- 90R Rail 1 in 8½ turnout with wooden sleeper and Ballast — 110,000 Rs/set
- Dismantling of track — 30,000 Rs/km
- Dismantling of turnout 1 in 12, 1 in 8½ — 4,500 Rs/set

10－2 Estimation of Investment Cost

10－2－1 New Delhi Station

1. Track and Structure

1,000 Rs

Description	Quantity	Rate	Unit	Amount
(1) Road Bed				2,734
Drainage				
・situ concrete drain for passenger lines of platform and cross drain	6,300	200	m	1,260
・drain between tracks	7,590	150	m	1,139
Sub Total				2,399
Supervision Charge	2,399	2	%	48
Contingencies	2,447	3	%	73
General Charges	2,520	8.5	%	214
Total				2,734

1,000 Rs

Description	Quantity	Rate	Unit	Amount
(2) Platform				119,235
· H.P.Platform	17,530	250	m²	4,383
· Concrete bed for passenger lines of platform	2,440	4,000	m	9,760
· Car washing platform	11,590	3,000	m	34,770
· Inspection pit on washing lines	7,220	2,000	m	14,440
· Water Pipes for car washing φ 80mm	13,380	130	m	1,739
φ 100mm	6,495	170	m	1,104
φ 150mm	4,695	330	m	1,549
hydrant	1,440	360	@	518
· Asphalt pavement between washing tracks and for parcel route	43,840	100	m²	4,384
· Parcel underpass	500	38,000	m	19,000
· Front Plaza and Parking Area	100,000	107.5	m²	10,750
· Dismantling of Tracks and Others	Ls.			2,204
Sub Total				104,601
Supervision Charge	104,601	2	%	2,092
Contingencies	106,693	3	%	3,201
General Charges	109,894	8.5	%	9,341
Total				119,235

(3) Station Building				
Over Track Station Building	27,000	18,000	m²	486,000
West Gate Station Building (Improvement)	5,000	5,000	m²	25,000
East Gate Station Building	12,000	12,000	m²	144,000
Luggage shed	2,400	8,000	m²	19,200
Platform shed (Remove)	20,600	50	m²	1,030
Platform shed (Newly)	30,000	1,600	m²	48,000

1,000 Rs

Description	Quantity	Rate	Unit	Amount
· Plumbing	Ls			3,300
Exterior	Ls			3,230
DLI ~ NDLS Hindrance (Build.)	57,000	100	m^2	5,700
DLI ~ NDLS For Substitution (Build.)	40,000	1,500	m^2	60,000
Sub Total				795,460
Supervision Charge	795,460	2	%	15,909
Contingencies	811,369	3	%	24,341
General Charges	835,710	8.5	%	71,035
Total				906,745
(4) Provision of Tracks				65,916
· Turnouts				
52kg-1 in 12	24	260×10^3	set	6,240
52kg-1 in 8½	41	210×10^3	set	8,610
52D.S.S.-1 n 8½	1	$1,250 \times 10^3$	set	1,250
· Tracks				
52kg-PRC	3.89	$2,240 \times 10^3$	km	8,714
52kg-Wood	2.13	$2,210 \times 10^3$	km	4,708
52kg-CST/9	4.64	$2,000 \times 10^3$	km	9,280
Tracks for washing and Passenger lines of Platform (excluding track beds)	9.76	$1,450 \times 10^3$	km	14,152
Dismantling of tracks & switch-over of tracks	Ls			4,872
Sub Total				57,826
Supervision Charge	57,826	2	%	1,156
Contingencies	58,982	3	%	1,770
General Charges	60,752	8.5	%	5,164
Total				65,916

2. Machine and Equipment

1,000 Rs

Description	Quantity	Rate	Unit	Amount
(1) Car Washing Machine and Reparing Equipment				
(a) car washing complex	1	8,600	set	8,600
(b) machinery and equipment for checking and reparing the coach	Ls			2,600
				11,200
Supervision Charge	11,200	2	%	224
Contingencies	11,424	3	%	343
General Charges	11,767	8.5	%	1,000
Custom duties	9,382	135	%	12,666
Total				25,433
(2) Escalator and Lift				
(a) escalator	4	2,500	nos	10,000
(b) parcel lift	15	750	nos	11,250
				21,250
Supervision Charge	21,250	2	%	425
Contingencies	21,675	3	%	650
General Charges	22,325	8.5	%	1,898
Total				24,223
(3) Air Conditioning Facility	1	23,000	set	23,000
Supervision Charge	23,000	2	%	460
Contingencies	23,460	3	%	704
General Charges	24,164	8.5	%	2,054
Total				26,218

1,000 Rs

Description	Quantity	Rate	Unit	Amount
(4) Electric Power Equipment				
(a) Electrical facilities at platform passenger line and stabiling line	11	372,000	line	4,092
Battery charger	1	427,200	set	427
Sub Total				4,519
Supervision Charge				86
Contingencies				145
General Charges				412
Total				5,162
(b) Electrical facilities at washing line	12	458,500	line	5,502
Supervision Charge				96
Contingencies				168
General Charges				496
Total				6,264
(c) Substation	1,500	3,932,000	KVA	5,899
Supervision Charge				118
Contingencies				180
General Charges				527
Total				6,724

1,000 Rs

Description	Quantity	Rate	Unit	Amount
(d) Illumination				
· Concourse, waiting room and building	36,640	400	m^2	14,656
· Platform and bridge	19,800	300	m^2	5,940
· Substation and machine room	3,000	200	m^2	600
· 415V under ground cable	7,920	304.5	m	2,412
· 415V cable in building	8,360	232	m	1,940
Sub Total				25,548
Supervision Charge				1,085
Contingencies				783
General Charges				2,281
Total				29,697
(e) Front plaza	1	1,829,000	set	1,829
· 415V underground cable	4,960	304.5	m	1,510
· Polelight	55	5,800	set	319
Supervision Charge				36
Contingencies				56
General Charges				164
Total				2,085
Electric Power Equipment Total				49,932

3. Signalling and Telecommunication

(1) Signalling				
Route Relay Interlocking	Ls			102,775
Sub Total				102,775
Supervision Charge	102,775	4	%	4,111
Contingncies	106,886	3	%	3,207
General Charges	110,093	9	%	9,907
Total				120,000

1,000 Rs

Description	Quantity	Rate	Unit	Amount
(2) Telecommunication				
Passenger Information System	Ls			23,120
{ Controller				
Indicator				
Seat Reservation Terminal				
I.T.V.				
Others }				
Telecommunication (building)	Ls			12,280
Sub Total				35,400
Supervision Charge	35,400	4	%	1,416
Contingencies	36,816	3	%	1,104
General Charges	37,920	9	%	3,413
Custom duties	19,440	165	%	32,076
Total				73,409

4. Electrification

OHE				
Over head equipment	9.84	1,350,000	km	13,284
Return wire	9.84	93,000	km	915
Dismantling of OHE	8.54	139,000	km	1,187
Sub Total				15,386
Supervision Charge				308
Contingencies				470
General Charges				1,374
Total				17,539

10－2－2 Delhi Area

1. Rumpura Cabin～Naya Azadpur : Grade-separation and doubling

1,000 Rs

Description	Quantity	Rate	Unit	Amount
(1) Civil Work				
a. Structures				
・No.1 Bridge span 25m 3 tracks H = 6.4m	75	70,000	m	5,250
・No.2 Bridge span 25m 3 tracks H = 11.0m	75	75,000	m	5,625
・No.3 Bridge Box-Rahmen	39	65,000	m	2,535
・No.4 Bridge span 20m 2 tracks	40	65,000	m	2,600
・No.5 Bridge span 21m (Over Track Bridge)	42	65,000	m	2,730
・No.6 Bridge span 20m	40	65,000	m	2,600
・No.7,8 Bridge span 20m (H = 4.0m)	80	60,000	m	4,800
・No.9 O.R.B. ℓ =19, W=40m	19	220,000	m	4,560
・Concrete Viaduct	1,200	26,500	m	31,800
・Road bed	14.0	120,000	km	1,680
Sub Total				64,180
Supervision Charge	64,180	2	%	1,284
Contingencies	65,464	3	%	1,964
Total				67,428
b. Track Work				
・52kg track, PRC sleeper (BG)	9.5	2,240,000	km	21,280
・MG track laying	2.0	1,250,000	km	2,500
・Turnout set 1 in 12	4	250,000	set	1,000
・Dismantling track (BG)	1.4	220,000	km	308
・Dismantling track (MG)	1.5	125,000	km	187
・Dismantling turnouts	9	25,000	set	225
・Rail laying at turnouts	0.5	2,000,000	km	1,000
・Miscellaneous work	26,500	10	%	2,650
Sub Total				29,150

1,000 Rs

Description	Quantity	Rate	Unit	Amount
Supervision Charge	29,150	1	%	291
Contingencies	29,441	3	%	883
Total				30,324
Civil work Total				97,752
General Charges	97,752	8.5	%	8,308
Total				106,060
(2) Signalling & Telecommunication facilities	9.7	928,000	km	9,001
General charges	9,001	13.2	%	1,188
Total				10,189
Grand Total				116,249
	Approximate		Rs	116million

2. Rumpura Cabin~ Naya Azadpur; Electrification

・Over head equipment	19.4	1,350,000	km	26,190
・SSP	1	3,000,000	set	3,000
Sub Total				29,190
Supervision Charge	29,190	2	%	583
Contingencies	29,773	3	%	893
General Charges	30,666	8.5	%	2,606
Total				33,274
	Approximate		Rs	33million

4. Delta area at Nizamuddin ; Improvement of turnouts

1,000 Rs

Description	Quantity	Rate	Unit	Amount
· Replacement to New high speed turnouts	6	1,000,000	set	6,000
· New crossing	3	500,000	set	1,500
Sub Total				7,500
General Charges	7,500,000	8.5	%	637
Signalling faccilities	7,500,000	30	%	2,250
General Charges	2,250,000	13.2	%	297
Sub Total				2,547
Grand Total				10,684
	Approximate		Rs	11million

3. Tilak Bridge ~ Sahibabad; Track Quadrupling and Grade-separation at 'B' Panel. Route Length 15.1km

Civil Work			Rs	261.3million
Signalling & Telecommu-nication			Rs	15.3million
Electrification			Rs	53.3million
Grand Total				329.9
	Approximate		Rs	330million
(1) Civil work				
a. Land acquisition	45	300,000	Hec	13,500
b. Earthwork and structure				
· Road bed	14.2	200,000	km	2,840
· Temporary road bed	2.0	100,000	km	200
· U type wall	1	4,000,000	set	4,000
Sub total				7,040

1,000 Rs

Description	Quantity	Rate	Unit	Amount
c. Bridge				
· Yamuna Bridge ℓ = 600m	600	160,000	m	96,000
· Other bridge (double)	260	130,000	m	33,800
· R.U.B at Ring Road	120	70,000	m	8,400
Sub total				138,200
(Above cost including Supervision Charge and contingencies)				
d. Track work				
· 52kg/m Rail P.R.C sleeper 15.1km× 2	30.2	2,250,000	km	67,950
· 1 in 12 turnout	8	300,000	set	2,400
· Dismantle and replacement	1	1,000,000	Ea	1,000
· Temporary track	4	1,900,000	km	7,600
Sub total				78,950
Supervision Charge	78,950,000	1	%	789
Contingencies	79,739,000	3	%	2,392
Total				82,131
Civil work Total				240,871
General charges	240,871	8.5	%	20,474
Total				261,345
(2) Signalling & Telecom. facilities	15.1	928,000	km	14,012
General charges	14,012	9.1	%	1,275
				15,287

1,000 Rs

Description	Quantity	Rate	Unit	Amount
(3) Electrification				
・OHE	30.2	1,350,000	km	40,770
・SSP	2	3,000,000	set	6,000
Sub total				46,770
Supervision Charge	46,770	2	%	935
Contingencies	47,705	3	%	1,431
General charges	49,136	8.5	%	4,176
Total				53,312

5. Holambi Kalan goods terminal

This cost is used by NR study

	1,000Rs
(1) Civil Work	
Land	9,420
Earth work	34,111
Track work	43,730
Bridge	1,475
Station facilities	
Platform and shed	55,867
Office building	4,868
Other building and shed	4,947
Residential building	28,277
Station machinery and equipment	2,333
Sub total	185,028
General Charges (8.5 %)	15,727
Civil Total	200,755

(2) Signalling & Telecommunication

Underground signa.Cable	5,372
Train control equipment	15,786
Telecom. facilities	9,169
Total	30,327
General Charges (9.1 %)	2,759
S & T Total	33,086

(3) Electrical Equipment

Power distribution, Stationary plant, Transformer sub-station Controlling	22,300
General Charges (8.2 %)	1,828
Total	24,128
Grand total	257,969,000Rs
Approximate	Rs 258 million

6. Bijwasan MG goods terminal

Civil work	Rs 250.8 million	(① + ④)
Signalling & Telecom.	Rs 18.6 million	(② + ⑤)
Electric Power	Rs 10.7 million	(③)

1,000 Rs

Description	Quantity	Rate	Unit	Amount
Bijwasan Goods Terminal				
(1) Civil work				
a. Land Acquisition				47,000
b. Road bed and structures (MG)				
· Road bed earthwork	950,000	32	m^3	30,400
· Fence	2,000	1,065	m	2,130
· Drainage of yard	13,990	150	m	2,099
· Goods platform	23,440	180	m^2	4,219
· Shed on Goods Pf.	23,440	1,000	m^2	23,440
· Station office Building	4,000	1,500	m^2	6,000
· Other building	8,000	1,200	m^2	9,600

1,000 Rs

Description	Quantity	Rate	Unit	Amount
c. (BG)				
· Goods platform	8,240	250	m^2	2,060
· Shed on Goods Pf.	8,240	1,000	m^2	8,240
· Inspection pit	80	2,000	m	160
· Pavement	89,000	100	m	8,900
· Drainage between tracks	2,700	150	m	405
(Station Machinery)	1	9,080,000	set	9,080
Sub total				106,733
Supervision Charge	106,733	2	%	2,134
Contingencies	108,867	3	%	3,266
Total				112,133
d. Track (MG)				
· 90R, CST/9, track laying	18.0	1,400,000	km	25,200
· 90R, 1 in 12 turnouts	12	200,000	set	2,400
· 90R, 1 in 8½ turnouts	29	110,000	set	3,190
· Dead end	12	4,200	set	50
(BG)				
· 52kg CST/9, track laying	8.3	2,000,000	km	16,600
· 52kg 1 in 8½ turnouts	14	210,000	set	2,940
· 52kg track on pit	80	1,450	m	116
· Dead end	8	6,500	set	52
Sub total				50,548
Supervision charge	50,548	1	%	505
Contingencies	51,053	3	%	1,532
				52,585
Civil work total				211,718
general charges 8.5 %	164,718	8.5	%	14,001
① Total				225,719

1,000Rs

Description	Quantity	Rate	Unit	Amount
(2) Signalling & Telecommu-nication				
Signalling facilities	1		set	8,400
Telecom. facilities	1		set	2,100
② Total				10,500
(3) Electrical equipment				
・SS	1	3,152,000	set	3,152
・Illumination in Yard	1		set	1,479
・Other Lighting	1		set	3,600
・Underground Cable	1		set	1,092
				9,323
Supervision Charge	9,323,000	2	%	186
Contingencies	9,509,000	3	%	285
General charges	9,794,000	8.5	%	832
③ Total				10,626

Bijwasan MG goods terminal: Extention of single BG line from Delhi Cant to new Bijwasan terminal.

Route length 8.0 km

1,000Rs

Description	Quantity	Rate	Unit	Amount
・Road bed	8.0	400,000	km	3,200
・Bridge and other structure	1	700,000	set	700
				3,900
Track Laying				
52kg.CST/9 (include S.C)	8.0	2,400,000	km	19,200
Civil Total				23,100
General Charges	23,100,000	8.5	%	1,963
④ Total				25,063

1,000 Rs

Description	Quantity	Rate	Unit	Amount
Signalling & Telecom.	8.0	928,000	km	7,424
General Charges	7,424,000	9.1	%	675
⑤ Total				8,099

7. Patel Nagar MG passenger terminal

Patel Nagar 1,000 Rs

Civil Work	Rs	94.4million
Signalling & Telecom.	Rs	9.8million
Electrification	Rs	16.2million

Sarai Rohilla ; maintenance facilities

Civil Work	Rs	51.6million
Signalling & Telecom.	Rs	2.3million

Grand Total	Rs	174.3million
Approximate	Rs	174million

1,000 Rs

Description	Quantity	Rate	Unit	Amount
Patel Nagar Station (1) Civil work				
a. Land acquisition (circulating area)	10,000	1,000	m^2	10,000
b. Road bed				
· Road way work	1,000	16	m^2	16
· Circulating area pavement	10,000	120	m^2	1,200
· Preparation for Road bed	10,000	10	m^2	100
· Drain between tracks	6,000	85	m	510
Sub total				1,826
Supervision Charge	1,826,000	2	%	36
Contingencies	1,862,000	3	%	55
				1,917
c. Track work				
MG Track				
· 90R, CST/9, Track laying	5.4	1,400,000	km	7,560
· 75R, CST/9, Track laying	1.3	1,200,000	km	1,560
· 90R, 1 in 12 turnouts	9	200,000	set	1,800
· 90R, 1 in 8 ½ turnouts	14	110,000	set	1,540

1,000 Rs

Description	Quantity	Rate	Unit	Amount
· 90R, D.C 1 in 12	1	110,000	set	110
· 90R, D.C 1 in 8½	4	110,000	set	480
· Shift of existing tracks with repairing	1.1	200,000	km	220
· Dismantling track	4.2	30,000	km	126
· Dismantling turnout	16	4,500	set	72
· Dismantling D.C.	4	4,500	set	18
Sub Total				13,486
BG Track				
· 52kg Rail, wooden sleeper laying	3.2	2,210,000	km	7,072
· 90R, CST/9	1.3	1,640,000	km	2,132
· 52kg Rail 1 in 12 turnout	5	260,000	set	1,300
· 52kg Rail 1 in 8½ turnout	13	210,000	set	2,730
· D.C 1 in 8½	1	120,000	set	120
· Shift of existing track with repairing	2.0	320,000	km	640
· Dismantling tracks	7.0	45,000	km	315
· Dismantling turnouts	19	6,000	set	114
Sub Total				14,423
Track work Total				27,909
Supervision Charge	27,909,000	1	%	279
Contingencies	28,188,000	3	%	845
Total				29,033

1,000 Rs

Description	Quantity	Rate	Unit	Amount
d. Station facilities				
· MG passenger Pf.	12,600	200	m^2	2,520
· Shed on Platform	12,600	1,000	m^2	12,600
· Washing apron at Arrival/departure line	2,250	3,500	m	7,875
· Dismantling Pf.(MG)	3,000	100	m^2	300
· Dismantling F.O.B.	300	480	m^2	144
· BG passenger Pf.	5,400	210	m^2	1,134
· Shed on Platform	5,400	1,000	m^2	5,400
· Dismantling Pf.(BG)	4,500	100	m^2	450
· New Foot over Bridge	2,000	3,200	m^2	6,400
· Station Building (New)	2,000	1,500	m^2	3,000
· Passage with pavement for Paracel	600	90	m^2	54
· Station Machinery	39,877	10	%	3,988
Sub Total				43,865
Supervision Charge	43,865,000	2	%	877
Contingencies	44,742,000	3	%	1,342
Total				46,084
Civil work Total				87,034
General Charges	87,034,000	8.5	%	7,397
Total				94,431
(2) Signalling & Telecom ; This cost is 30 % of track works				
· facilities	29,033,000	30	%	8,710
· General charges	8,710,000	13.2	%	1,149
				9,859

1,000 Rs

Description	Quantity	Rate	Unit	Amount
(3) Electrification				
OHE	8.75	1,350,000	km	11,812
· Electric power equipment	1	2,400,000	set	2,400
Sub total				14,212
Supervision Charge	14,212,000	2	%	284
Contingencies	14,496,000	3	%	435
General Charges	14,931,000	8.5	%	1,269
Total				16,200

Sarai Rohilla

(4) Civil work				
a. Track work (MG)				
· 90R, CST/9 Track laying	8.1	1,400,000	km	11,340
· Track laying on pit	3.3	950,000	km	3,135
· 1 in 8½ turnout	33	110,000	set	3,630
· Shift of existing tracks	1.2	200,000	km	240
· Dismantling tracks	20.0	30,000	km	600
· Dismantling turnouts	90	4,500	set	405
Sub total				19,350
Supervision Charge	19,350,000	1	%	193
Contingencies	19,543,000	3	%	586
Total				20,129

1,000 Rs

Description	Quantity	Rate	Unit	Amount
b. Maintenance facilities				
Car washing pit	2,700	1,600	m	4,320
Pavement	9,340	100	m^2	934
Washing stage	3,220	3,000	m	9,660
Hydrant (ϕ 50)	315	360	Ea	113
Water pipe (ϕ 100)	3,150	110	m	346
Drain (ϕ 300 ~ 450)	1,400	150	m	210
Ac sick line shed	360	1,500	m^2	540
Sick line shed	1,000	1,500	m^2	1,500
Sick line pit	115	1,600	m	184
Sick line machine & equipment	1	3,000,000	set	3,000
Dismantling platform	6,800	100	m^2	680
Dismantling goods plf.	11,200	80	m^2	896
Dismantling of shed	11,200	50	m^2	560
Dismantling office	2,200	80	m^2	176
Maintenance of office	2,000	1,500	m^2	3,000
				26,119
Sub total		26.1		
Supervision Charge	2	26,119	%	522
Contingencies	3	26,641	%	799
Total				27,440
Civil work total				47,569
General charges	47,569,000	8.5	%	4,043
Total				51,612
(5) Signalling & Telecom. ; 10 % of track work facilities	20,129,000	10	%	2,012
General charges	2,012,000	13.5	%	272
Total				2,284

8. Delhi Station ; BG facilities at MG area after shifting to Bijwasan

Civil work	Rs 24.6 million
Signalling & Telecom.	Rs 4.1 million
Electrification	Rs 5.8 million

1,000 Rs

Description	Quantity	Rate	Unit	Amount
(1) Civil work				
a. Track				
· 52kg wooden track laying	3.0	2,210,000	km	6,630
· 52kg 1 in 12 turnout	5	260,000	set	1,300
· 52kg 1 in 8 ½ turnout	11	210,000	set	2,310
· D.C. 1 in 8 ½	1	120,000	set	120
· 1 in 16 curved turnout	2	330,000	set	660
· Dismantling 75R	7.1	30,000	km	213
· Dismantling turnouts	36	4,500	set	162
sub total				11,395
Supervision Charge	11,395,000	1	%	114
Contingencies	11,509,000	3	%	345
Total				11,854
6. Passenger facilities				
Pavement on Pf.	8,800	80	m^2	704
Platform wall	1,000	700	m	700
Dismantling washing stage	900	30	m	27
Dismantling washing pit	900	50	m	45
Dismantling Pf.	400	100	m^2	40
Shed on Pf.	8,800	1,000	m^2	8,800
Sub total				10,316
Supervision Charge	10,316,000	2	%	206
Contingencies	10,522,000	3	%	315
Total				10,837

1,000Rs

Description	Quantity	Rate	Unit	Amount
Civil Total				22,691
General charges	22,691,000	8.5	%	1,928
Total				24,619

(2) Signalling & Telecom. ; 30 % of track work

facilities	11,854	30	%	3,556
General charges	3,556,000	13.2	%	469
Total				4,025

(3) Electrification				
OHE	3.75	1,350,000	km	5,063
Supervision Charge	5,063,000	2	%	101
Contingencies	5,164,000	3	%	155
General charges	5,319,000	8.5	%	452
Total				5,771

9. Delhi Area ; Automatic Signalling

a. Delhi~ Naya Azadpur	6.9	928,000	km	6,403
b. Delhi~ New Delhi	3	928,000	km	2,784
c. Delhi~ Shakur Basti	7.19	928,000	km	6,672
d. Nizamuddin ~ Tuglakabad	16	928,000	km	14,848
e. Lajpat Nagar ~ Tuglakabad	9	928,000	km	8,352
Total				39,059
		Approximate	Rs	39million

10－2－3 Relevant Section

(1) Ghaziabad ~ Tundla section

Modernization of Signalling System, including improvement turnout and OHE etc.

Route length (Doubled track): 183.84 km

This cost is estimated based on "Railway Improvement Plan of Transport Capacity and Train speed on the Delhi - Kampur Section" by JICA.

a. Civil work	
· Road bed	17.8 million Rs
· Platform	3.7
· Bridge	5.7
· Building	16.2
· Track work ; Improvement of Aligah, Tundla and Ghaziabad stn. and turnouts of other stations	162.3
Sub Total	205.7
b. Signalling	
· level crossing facilities, signalling & telecommunication equipments track circuit etc.	428.0
c. Electrification	
· Over head equipments	15.5
· Sub station	19.3
· Other incidential equipment (including contingencies, supervision charge and General charges)	21.5
Grand Total	690 million Rs

(2) Delhi Holambi : Kalan ; Electrification

Route length (Doubled track) 20.1 km

1,000 Rs

Description	Quantity	Rate	Unit	Amount
OHE	40.2	1,350,000	km	54,270
SSP	2	3,000,000	set	6,000
Sub total				60,270
Supervision Charge	60,270,000	2	%	1,205
Contingencies	61,475,000	3	%	1,844
General charges	63,319,000	8.5	%	5,382
Total				68,701
		Approximate	Rs	69 million

(3) Naya Azadpur~ Ambala ; Automatic Signalling

Route length (Doubled track) 188.24 km

1,000 Rs

Description	Quantity	Rate	Unit	Amount
Line facilities	161.2	928×10^3Rs/km	km	149,594
Station facilities	7	$5,116\times 10^3$Rs/km	set	35,812
Total				185,406
		Approximate	Rs	185million

(4) Shakur Basti~ Rohtak ; Automatic Signalling

Route length (Doubled track) 59.72 km

1,000 Rs

Description	Quantity	Rate	Unit	Amount
Line facilities	51.72	928×10^3Rs/km	km	47,996
Station facilities	9	$5,116\times 10^3$Rs/km	set	46,044
Total				94,040
		Approximate	Rs	94 million

(5) Samar Gopalpur~Kinana ; Traok doubling

Route length 34.74 km

1,000 Rs

Description	Quantity	Rate	Unit	Amount
Land	34.74	100,000	km	3,474
Earth work & Structure	34.74	1,470,000	km	51,068
Track	34.74	2,400,000	km	83,376
Sub total				137,918
General charges	137,918	8.5	%	11,723
Total				149,641
Signalling Telecommunication	34.74	1,300,000	km	45,162
Grand Total				194,803
		Approximate	Rs	195 million

(6) Barsola ~ Ghaso ; Track doubling

Route length 18.54 km

1,000 Rs

Description	Quantity	Rate	Unit	Amount
Land	18.54	100,000	km	1,854
Earth work & Structure	18.54	1,470,000	km	27,254
Track	18.54	2,400,000	km	44,496
Sub total				73,604
General charges	73,604	8.5	%	6,256
Total				79,860
Signalling Telecommunication	18.54	1,300,000	km	24,102
Grand Total				103,962
		Approximate	Rs	104 million

(7) Palwal~ Mathura ; Modernization of Signalling System

Route length (Doubled track) 83.00 km

1,000 Rs

Description	Quantity	Rate	Unit	Amount
Signalling system	83.00	2,310,000	km	191,730

Approximate Rs 192 million

(8) Patel Nagar ~ Rewari ; Automatic Signalling

Route length (Doubled track) 74.48 km

1,000 Rs

Description	Quantity	Rate	Unit	Amount
Line facilities	65.48	928,000	km	60,765
Station facilities	10	5,116,000	set	51,160
Total				111,925

Approximate Rs 112 million