## 3.11 ROLLING STOCK AND MAINTENANCE

### 3.11.1 Rolling Stock

#### (1) Current situation

1) Organization

The organization chart of the Rolling Stock Department is shown in Figure 3.11.1.

2) Maximum years of service

- Diesel electric locomotive : 25 years
- Gas Turbine power car : 20 years
- Power supply car : 35 years
- Passenger Car
  - Air conditioned : 30 years
  - Normal : 36 years
- Freight car
  - Iron Ore : 30 years
  - Tank : 36 years
  - Normal : 40 years
- Crane car : 40 years

3) Rolling stock

Current situation of rolling stock is shown in Appendix 3.11, as follows.

| | |
|---|---|
| Table 3.11.1 | Particulars of Locomotive and Train Unit |
| Table 3.11.2 | Current Conditions of Locomotive and Train Unit |
| Table 3.11.3 | Number of Locomotives by First Service Year |
| Table 3.11.4 | Transition Number on Book (Diesel Loco., Train Unit) |
| Table 3.11.5 | Particulars and Current Conditions of Passenger Car |
| Table 3.11.6 | Age-wise Passenger Car |
| Table 3.11.7 | Transition Number on Book (Passenger Car) |
| Table 3.11.8 | Particulars of Freight Car |
| Table 3.11.9 | Age-wise Freight Car |
| Table 3.11.10 | Transition Number on Book (Freight Car) |
| Table 3.11.11 | History of Each Locomotive |

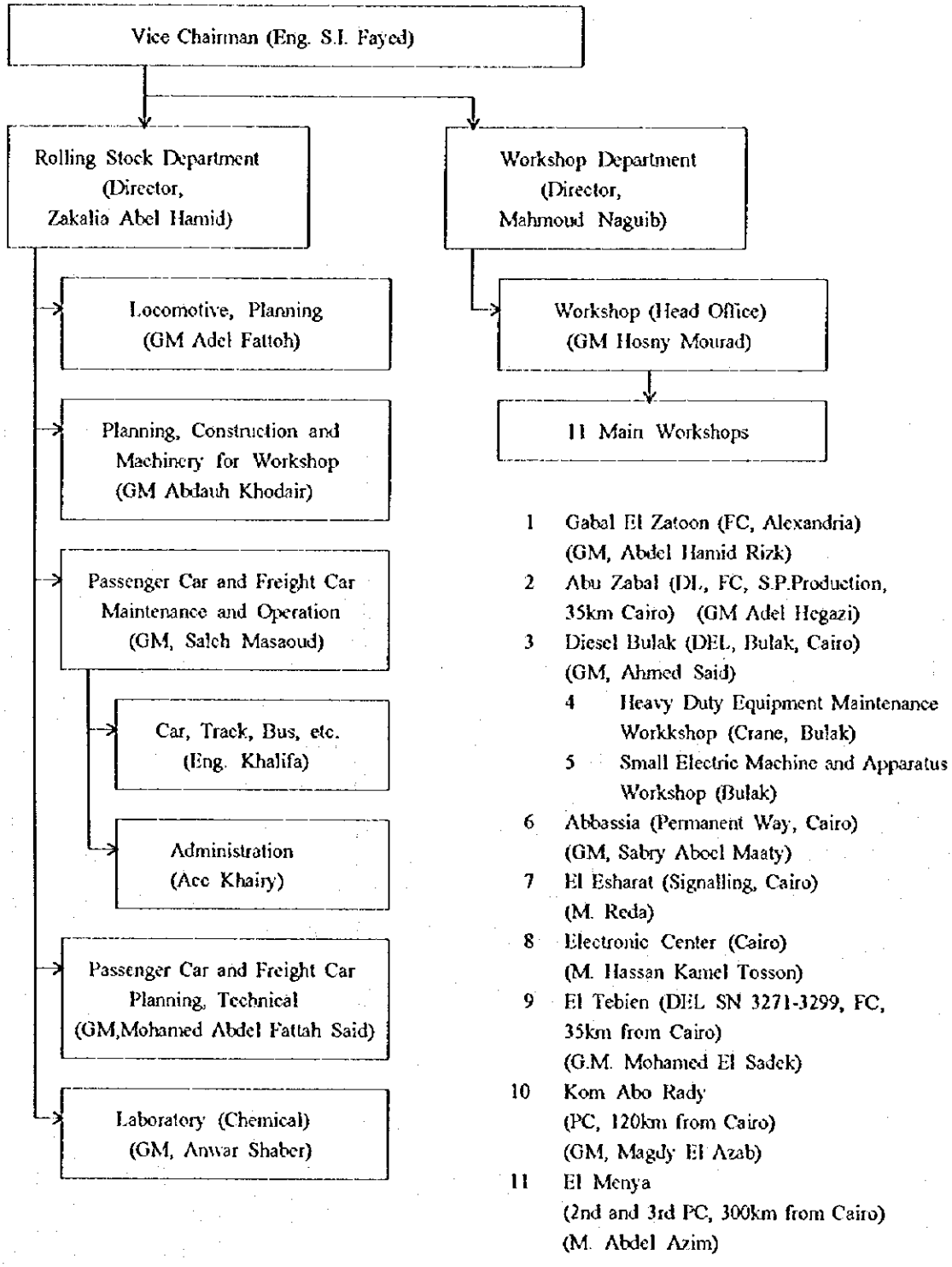



**Fig. 3.11.1 Organization Chart of Rolling Stock Department and Workshop Department**

**(2) Current problems**

1) Locomotive availability is very low. This problem will be analyzed in Clause 4.2.8 "Raise the Availability of Rolling Stock."

2) Local production should be increased. Egyptian rolling stock manufacturer SEMAF Co. is manufacturing electric railcars for Cairo Metro, and Passenger Coaches (PC) and Freight Cars (FC) for ENR. As for electric railcars, SEMAF Co. can manufacture carbody and bogie frames, and assemble equipment and passenger facilities, along with piping and wiring. Almost all the main equipment is imported. Local production should be developed even for traction motors, for which ENR has the technology to perform complete repairs.

Local locomotive production should be considered, because locomotives are very expensive. After 2001, ENR may be obliged to procure many locomotives to replace old locomotives.

According to the comments in the Interim Report, ENR has taken steps to domestically manufacture 100 locomotives by SEMAF Co. SEMAF Co. is trying to modify its factory by joint ventures with some foreign enterprises. The price of locally produced locomotives is expected to be about 60% of imported complete locomotives, if electric machines such as the traction motor and main and auxiliary generators are also produced domestically. SEMAF Co. could produce them with the above-mentioned ENR technology and technical transfers from the joint ventures.

**(3) Rolling stock plan**

1) Assumptions

a. There are no DELs, PCs or FCs having already more than their maximum years of service, as of January 1995.
b. Ages of PC and FC as of January, 1995 are given in 5 year age groups. Their ages in each column is regarded as the average age. For example, in age column 30, the average age is assumed to be 27.5 years.
c. The rolling stock plan does not include shunting locomotives, assuming that locomotives older than 25 years are used as shunting locomotives.
d. Brakes are planned to be installed in FCs, leaving only 3,279 FCs without brakes in 2012 (except sugar cane FCs).

2) Number of rolling stock

Based on the maximum years of service, the number of DELs, PCs, and FCs available in Jan. 1995, and still in service in 1995, 2002, 2007, and 2012 are shown in Table 3.11.12 for DEL, Table 3.11.13 for PCs, and Table 3.11.14 for FCs of Appendix 3.11.

3) Number of rolling stock to be procured in 1996-2002, 2003-2007 and 2008-2012

Based on the necessary number of rolling stock in 2002, 2007, 2012 forecast by the Study Team, and Tables 3.11.12, 3.11.13 and 3.11.14 of Appendix 3.11, rolling stock to be procured in each phase is shown in Table 3.11.15 of Appendix 3.11.

4) Rolling stock cost

a. The average cost of rolling stock is assumed in each phase: 1995-2002, 2002-2007, and 2007-2012.

b. DEL: Cost is calculated for Figure 3.11.2 "ENR Locomotive Price" as follows :

(a) Cost of DEL is shown in US$ in Figure 3.11.2. Based on the conversion rate of 3.4 LE/US$ in 1995, and the inflation rate of LE shown in Table 3.11.16 of Appendix 3.11, conversion from US$ to LE is made on the assumption that US$ has no inflation.

(b) Example:
① Unit cost of DEL (2475HP) in column 1996-2002 of Table 3.10.17 of Appendix 3.11 is shown in average value between cost of 1995 and that of 2002.
② Cost of DEL (2475HP) in 1995 is $2,294,000 or 7,800,000 LE.
③ Cost of DEL (2475HP) in 2002 is $2,927,000.
④ $2,927,000 = 9,952,000 LE in 1995, or 14,898,000 LE (2002).
⑤ Unit cost of DEL (2475HP) in column 1996-2002, therefore, is 11,349,000 LE. (rounded to 11,350,000 )

c. PC and FC
(a) Given cost is shown in Table 3.11.16 of Appendix 3.11.
(b) Given cost is converted to that of 1995, using inflation rate given by the Study Team, as shown in Table 3.11.16 of Appendix 3.11.
(c) The difference between average cost of group 1 and group 5 in Table 3.11.16 of Appendix 3.11 is considered the cost of carbody (318,000 LE). This is a reasonable cost.
(d) Based on costs of group 4, group 5, and carbody, mean cost of one PC (AC) car is assumed at 2,170,000 LE in 1995.
(e) Based on costs of group 3, the mean cost of one PC normal car is assumed at 560,000 LE in 1995.

d. Metro electric car (EC)
Based on the Japanese made EC, assuming no inflation, the cost of EC is estimated at ¥532,000,000/unit (3 cars, 1994) for Line No.1, and ¥1,265,000,000/unit (6 cars, 1995) for Line No.2. In 1995, 17,700,000 LE/unit for Line No.1 and 42,200,000 LE/unit for Line No.2.

5) Investment plan of rolling stock

Based on Table 3.11.15 of Appendix 3.11, the investment plan of rolling stock is shown in items 1～3 of Table 3.11.17 of Appendix 3.11. For FC, new procurement is not necessary and only brake installation FCs without brakes is considered in 1996 - 2002.

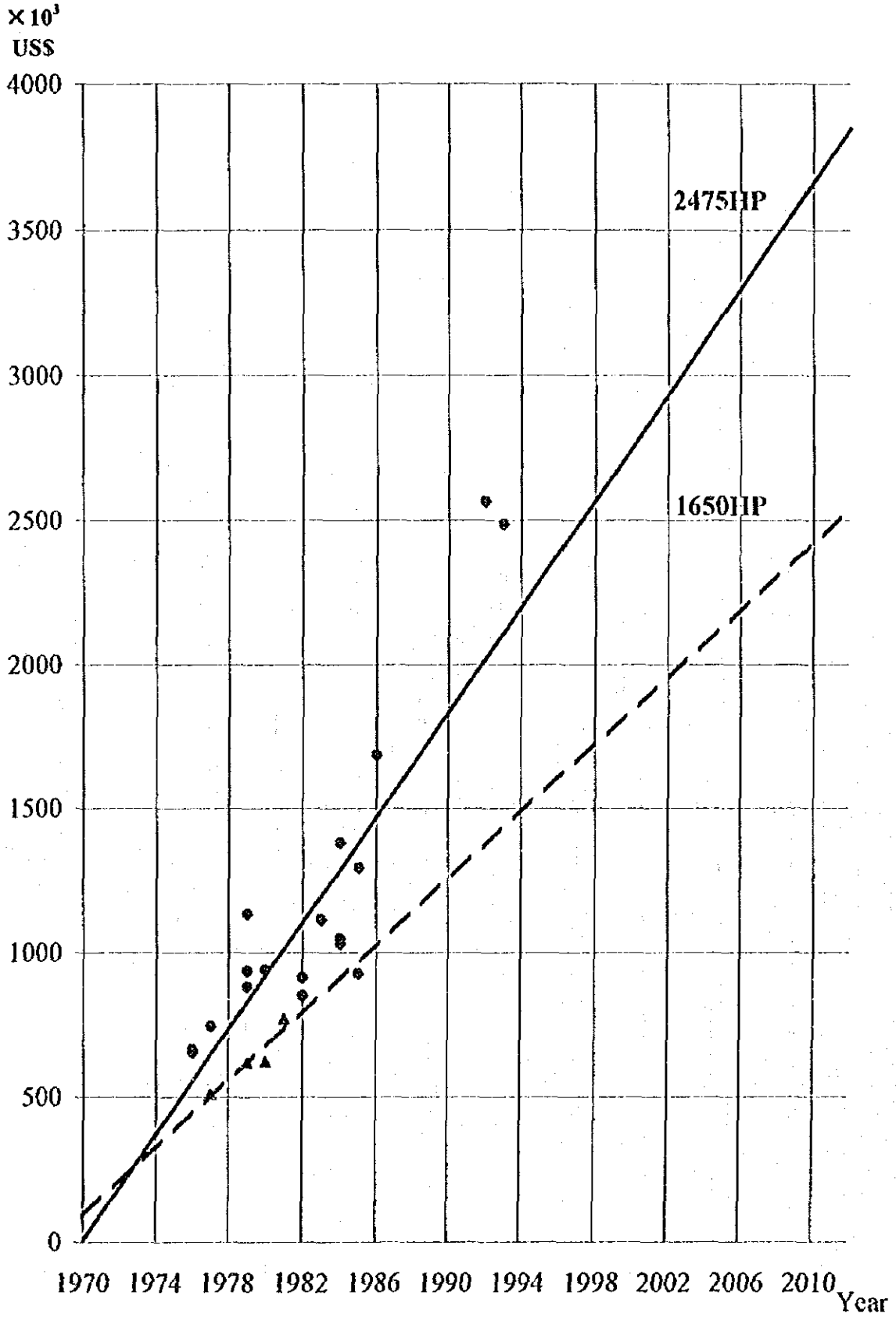



**Fig. 3.11.2 ENR Locomotive Price (Method of Least Squares)**

### 3.11.2 Rolling Stock Maintenance

#### (1) Organization

The organization chart of Workshop Department is also shown in Fig. 3.11.1.

#### (2) Maintenance cycle and execution place

1) Locomotive (DEL)
Maintenance cycle and maintenance locations (workshop or depot) for locomotives are shown in Table 3.11.18 of Appendix 3.11.

2) Passenger coach (PC)
Maintenance cycle and maintenance locations for passenger coaches are as follows:

| | |
|---|---|
| Daily | : Depot |
| 3 months | : Depot |
| 1.5 years | : Workshop or depot |

3) Freight car (FC)
Maintenance cycle and maintenance locations for freight cars are as follows:

| | |
|---|---|
| Daily | : Depot |
| 3 months | : Depot |
| 1 year | : Overhaul of iron ore wagon at workshop |
| 2 years | : Overhaul of tank wagon at workshop |
| 3 years | : Overhaul of hopper wagon at workshop |
| 4 years | : Overhaul of normal wagon at workshop |

#### (3) Current situation and problems of workshop and depot

There are 9 workshops and 12 depots for rolling stock maintenance in ENR. The current situations and problems of these workshops and depots are as follows :

1) Workshops

a. Gabal El Zatoon (Alexandria)
This well equipped FC maintenance workshop was constructed in 1987 to replace an old workshop built in 1898. Overhaul (OH) of almost all of ENR's FC is carried out here. The working environment is very good, and worker morale is very high. Production is increasing in spite of decreasing number of workers. Computerization is now proceeding. This workshop is also in charge of OH of a few PCs for Abu Qir Line. As for OH of PCs, it is recommended that work to clean the inside of PCs should be improved.

b. Abu Zabal (Abu Zabal)
The main jobs here are production of wheel-sets, brake shoes, and various spare parts. OH of DEL less than 2000 HP, in support of Diesel Bulak Workshop, and OH of shunting locomotives are carried out. OH of FC is also carried out, about one third of overhaul work at Gabal EL Zatoon Workshop. Worker morale is high in spite of a poor working environment due to an old building and facilities. Production statistics are well prepared using a personal computer. It is recommended, however, that cleanliness and arrangement

in shops should be improved.

c. Diesel Bulak (Cairo)
This workshop which is responsible for OH of almost all DELs is now being remodeled. The incoming and outgoing shop, and the engine shop are almost completed. Completion of a repair line for main generators and traction motors is expected soon. As for the engine shop, the oily floor may cause a possible slip accidents. It is recommended that saw dust should be scattered, which makes it easy to clean the floor at the end of each day. This workshop should strive to be as clean as the Gabal El Zatoon and Kom Aborady workshops. A computerized inventory control system for spare parts of DELs is being developed in this workshop, and quick completion of a system covering all DEL maintenance workshops and depots should be developed.

d. Kahraba El Anaber
This workshop belongs to Diesel Bulak Workshop and has the technology of complete repair of small electric rotating machines.

e. El Markaz El Electrony
This workshop was established in 1988, and is in charge of maintenance of electronic equipment and parts for rolling stock and other equipment. Inventory control for many kind of parts is manual. Computer inventory control should be introduced as soon as possible.

f. EL Tebien
This workshop was established in 1985 for maintenance of DEL and FC for iron ore transportation on Baharia Line. These DEL and FC face severe operating conditions from desert sand, large temperature fluctuations, many curved tracks, and heavy loads. The workshop itself is suffering from cement pollution. However, the workshop makes efforts to keep the working environment clean and worker morale is high. As for cement pollution, the problem should be resolved to maintain basic health standards in ENR. This workshop has the technology of complete repairs of main generators and traction motors.

g. Kom Aborady
This workshop was established in 1987 for maintenance of PCs. It has excellent technology and facilities. Under the Spanish project, excellent deluxe passenger cars remodeled from old PCs are being produced. The low technical level of new technicians is an important problem for many workshops and depots. Resolving this problem is very difficult. Education and on-the-job-training methods recently adopted by this workshop seem to be effective. Namely, some skilled workers have been transferred from other workshops, and those workers are now returning to their original workshops after completing technical transfer to new technicians.

h. Tura El Balad
This modern workshop completed in 1987 is in charge of maintenance of Metro Electric Railcars (EC). Almost all of the maintenance of EC are contracted outside ENR. In comparison with other ENR workshops, this workshop seems to lack sufficient work, despite a good working environment with modern facilities. ENR's EC maintenance system may be reconsidered. Metro ECs are maintained in better condition than other ENR suburban PCs.

i. Other workshops
These are Abbassia for permanent way, El Esharat for signaling, and El Moadat El Anaber for heavy equipment. El Esharat Workshop established in 1960 is very clean and well

arranged, in spite of its old building and facilities. Worker moral is very high, and there are useful tools and testing equipment devised by technicians themselves.
The Mahmoud Abdel Salam Co. workshop is very clean and well arranged in spite of old building and facilities. Worker morale is very high and maintenance of deluxe PCs is excellent. All the maintenance records are computerized. The necessary number of coaches for train operation has always been 100% provided. ENR workshops have many things to learn from this company. This company proves that cleanliness and good arrangement are fundamental for safety, quality work, productivity, morale, improvement, etc.

2) Depots

Table 3.11.19 of Appendix 3.11 shows locomotives by depot. The following improvements are suggested for the following depots which were analyzed : Farz (for DEL, Turbo Train and PC); Bulak Dakroor (DEL and FC); Abu Ghatis (PC); Tanta (DEL, PC and FC); Hadra (DEL and PC); Kabary (DEL and FC); Zagazig (DEL, PC and FC); Mansura (DEL and PC); Aswan (DEL, PC and FC); Luxor (DEL, PC and FC).

a. In general, the working environment of depots is worse than that of workshops. Even though they have worse working environments such as old buildings and facilities, narrow working space, etc., cleanliness and good arrangement should still be improved for safety, work quality, productivity, etc.

b. Many depots have oily and rough working floors and walking paths, including track beds between rails. Tanta Depot scatters sawdust on the oily floor and path. Aswan Depot scatters sand on the oily DEL inspection deck. Other depots should learn from these examples for safety. As for rough surfaces, each depot should flatten surfaces when there is idle working time between jobs, preparing necessary materials and providing a bonus if necessary. This method is useful for raising morale, in Japan's experience.

c. Many pits in depots for rolling stock inspection are in bad condition, such as lack of depth, no lighting, and no facility to discharge oil and water. Many pits are filled in by oily mud.

d. No depot has effluent treatment facility to separate oil and water from drainage. Such facilities should be planned in the near future for the depots situated in city centers.

e. Many depots suffer from spare parts shortages. Rapid completion of a computerized inventory control system is important. Especially, wheel-sets are often lacking. Wheel-lathes should be installed for main depots of each Region (Hadra Depot of West Delta, Mansura Depot of North Delta).

f. Each depot should have a lifting shop with electric overhead crane to increase working efficiency (Zagazig Depot, Mansura Depot).

g. Many people commented that the track in their depot should be repaired.

h. Low technical level of new technicians is a major problem for many depots. The experience of Kom Aborady Workshop as mentioned above is a good example. On-the-job-training is always the best way to resolve this problem.

i. Both inside and outside of PCs are dirty, even though automatic carbody washing and cleaning equipment are installed in some locations. A proper way should be found to maintain clean carbodies, at least to the same degree as the Metro electric railcars. A systematic carbody washing and cleaning system may be established, or suitable paint durable

for Egypt's climate may be used.

j. As for maintenance of axle bearings, independent clean rooms should be prepared, similar to Abu Ghatis Depot.

k. Farz Depot is in charge of DEL, Turbo Train and PC. It is a very large depot with complicated grounds. Farz Depot is responsible for more than half of main line DELs.

l. Improvement of Hadra Depot is high priority, considering the importance of Cairo-Alexandria Line. The working environment of this depot is the worst. There is much room for improvement by its own efforts as described in the above item b. Also, an underground wheel lathe should be installed.

**(4) Overhaul of rolling stock**

1) Overhaul of DEL

At present, overhaul of DEL is carried out in Diesel Bulak Workshop (for main line DELs), Abu Zabal Workshop (shunting DELs and main line DELs to support Diesel Bulak Workshop), and Tebien Workshop (Baharia and Safaga line DELs).

In 2012, ENR may have about 800 main line DELs. Therefore, if Diesel Bulak Workshop after completion of its remodeling does not have overhaul capacity of 200 DELs per year, some action will be necessary, such as further investment in this workshop or rebuilding of Farz Depot, or support by or new investment in Abu Zabal Workshop and Tebien Workshop. Another option would be to shorten necessary days (cycle time) for DEL overhaul from incoming to outgoing by manpower increase or higher efficiency from more mechanized maintenance facilities.

2) Overhaul of PC

At present, overhaul of PCs is carried out in Kom Aborady Workshop, Menya Workshop, and Mahmoud Abdel Salam Co. for deluxe PCs.

Kom Abdorady Workshop is designed for maintenance capacity of 1650 PCs for 1.5 years overhaul, 1250 PCs for 3 years overhaul, and 450 PCs for 12 years overhaul. Currently, maintenance is only performed for 1.5 year PC overhauls. Therefore, the maintenance capacity of this Workshop is more than 3350 PCs per year. Annual maintenance capacity of Menya Workshop is 120 PCs for 1.5 year overhauls. ENR now has 1.5 year overhaul capacity for more than 3500 PCs, except deluxe PCs. Such capacity is enough to maintain about 5,000 PCs in 2012.

3) Overhaul of FC

FC overhaul is carried out in Gabal El Zatoon Workshop, Abu Zabal Workshop (1/3 of the volume of repairs at Gabal EL Zatoon Workshop), and Tebien Workshop (for Baharia and Safaga Line FCs). Gabal El Zatoon Workshop annually overhauls 2,400 FCs and performs heavy repairs of 500 FCs, for a total of about 12,000 FCs. Abu Zabal Workshop may have overhaul capacity of 800 FCs per year. Tebien Workshop may have overhaul capacity of 850 iron ore FCs per year, sometimes supported by Gabal El Zatoon Workshop.

In 2012, ENR may have about 14,000 FCs. ENR now has overhaul capacity of 4,000 FCs per year. Such capacity is enough to maintain about 14,000 FCs in 2012.

### (5) Investment plan for rolling stock maintenance

1) Assumptions
As described in section 3.11.2, the following assumptions are made :
a. Installation of electric overhead traveling cranes is planned for Zagazig Depot and Mansura Depot, along with building improvements.
b. Installation of under floor wheel lathe is planned for Hadra Depot and Mansura Depot.
c. Construction is started from 1996 and completed in 2002.

2) Investment plan for rolling stock maintenance
Investment plan for rolling stock maintenance is shown in item 4 of Table 3.11.17, Appendix 3.11.

### (6) Recommendations : Accounting system of rolling stock maintenance

The budget for rolling stock maintenance seems to be decided by adjusting last year's budget, multiplying by factors such as inflation, work volume increase rate, etc. In order to promote future development of ENR, a more reasonable method should be found. For example, Japanese Railways uses the following system.

1) Standard necessary man-power (man-hours or man-days)
Standard necessary man-power cost calculated from average wages for all related workers, and average material costs are calculated annually for all kinds of maintenance such as daily, 2 weeks, monthly, 18 months, 3 years, 12 years, etc. Similar calculations are made for all types of rolling stock, such as various types of locomotives, passenger coaches and freight cars. Unit manpower and price are also decided for spare parts.

2) Number of rolling stock to carry out the regular maintenance and number of spare parts to be produced in the following year are estimated.

3) Then, the budget necessary for the regular maintenance, etc. in the following year is estimated.

4) Temporary repairs are estimated by statistical probability.

5) Advantages of this system
a. Through the above system, the reasonable number of workers is estimated. Surplus or shortage of workers is estimated.
b. If some workshops and depots have surplus workers, they should be transferred to other places which have a shortage of workers, or they should work to improve the workshop or depot itself, referring to 3.11.2-(3)-2)-b, or the concerned administration should find new work from inside or outside ENR.

## 3.12 PERMANENT WAY AND STATION

As mentioned before, the railway network of ENR consists of 43 lines/segments, total length of lines are 4,401 kilometers including one newly constructed line. Total track length is 8,579 kilometers, including main siding tracks.
In order to make train operation smooth, these tracks are daily inspected and maintained, to minimized track irregularities and meet maintenance standards for the grade of each line. Track maintenance organization and systems are as follows.

### 3.12.1 Track Maintenance Organization and Personnel

Track work is executed under the banner of Vice Chairman of Permanent Way & Signaling/Telecommunication. Track maintenance is carried out by 7 Regions, which are the same as ENR traffic Regions.
Each Region has 2 or 3 Track Maintenance Districts, and each District has several Zones. The site works are mostly carried out by Track Gangs in each Zone. Each Gang consists of a Foreman, Sub-Foreman and several gangs. Track maintenance organization and personnel are shown in Appendix 3.12.1.

### 3.12.2 Existing Track Situation

**(1) Track structure of each line**
The track structure of 1st Class is mostly composed of UIC 54 kg/m Rail, RC sleeper (PC Mono-block or RC Twin-block), K type fastening or Pandrol, and crushed stone ballast. Only for Qena - Safaga and Qena - Abu Tartour lines (now under construction), UIC 60 kg/m Rail are used. The track structures on other 2nd and 3rd Class lines are not uniform; i.e. rails are UIC 54 kg/m, 52 kg/m and 47 kg/m, sleepers are RC, steel, and wooden, etc.

**(2) Situation of track rehabilitation work**
The track rehabilitation work has been actively carried out in all Egypt, on a contract basis. The majority of 1st Class lines and 2nd Class lines have been rehabilitated, except some station yards. Recently, the rehabilitation work was focused on remaining station yards and 3rd Class lines.
The track structure on each line is shown in Appendix 3.12.2.

### 3.12.3 Track Inspection and Maintenance System

**(1) Track inspection system**
For the track maintenance, there are two types of track inspection systems. One is manual inspection, the other one is carried out by track measuring car. Inspection by measuring car, which is conducted by the head office, is mostly allocated for main lines, which are maintained by mechanical tamping machines. On the Cairo - Alexandria main line, the measuring car inspects every month.

**(2) Track maintenance**
Generally, the largest share of track maintenance work is ballast tamping. There are two types of tamping work in ENR: mechanical tamping and manual tamping.
At present, ENR has 32 tamping machines (M.T.T.) including 7 switch tamping machines, 20 ballast regulators, and 6 ballast cleaners.

Tamping work by M.T.T. is mostly on main lines. This work is mostly carried out by 2 track maintenance companies, based on contracts using these machines, even for work that was directly carried out by ENR previously. These 2 track maintenance companies were established as joint ventures of ENR in 1985. One is EGERCO (51% owned by ENR, 49% by Germany companies). The other one is EGYFRAIL (51% ENR, 49% French companies). Track maintenance by M.T.T. is not directly carried out by ENR staff themselves, even though ENR owns the M.T.T. machines. Furthermore, these M.T.T. are mostly operated by experts from Germany and France.
These two companies also carry out track renewal work and laying of new tracks. In fiscal 1994/95, EGERCO carried out 648 km of track maintenance work, 139 km of track renewal and laid 225 km of new track. EGYFRAIL carried out 728 km of track maintenance work and 122 km of track renewal work.
Meanwhile, the track maintenance work by ENR itself is mostly carried out manually by gangs without machines, except fastening and tightening work, rail holing, and rail sawing. The ballast tamping work, which is a large share of track maintenance work, is carried out by Beaters (Tamping Picks).

**(3) Proposals for track maintenance and stations**
In view of the situation mentioned above, and considering increase of track maintenance work from increased number of trains and faster trains, the following items should be considered subjects to improve for the time being.

**1) Lack of mechanical track maintenance**
As mentioned above, the tamping work by M.T.T. is mostly carried out for main lines and other important lines. Other lines are maintained by manual tamping work, that is to say suitable track maintenance work is not carried out for other lines. For this purpose, smaller mechanical equipment should be purchased, in addition to the increased number of M.T.T. machines.

**2) Lack of mobility for gangs**
There are 2 types of gangs. One is a normal gang which is assigned for a short distance section. The other one is a Flying gang which is assigned for a long section covering several normal gangs. They use the railway for travel and transporting tools and material. They have no trucks. In order to promote efficient track maintenance, flexible and frequent transport equipment like pick-up trucks should be provided, especially for Flying gangs.

**3) Weakness of turnout on main lines**
Observing the track condition, particularly in station yards, there are still many worn out or inadequate turnouts for the increasing numbers of trains and faster trains. These should be replaced in accordance with the grade of line.

## 3.13 SIGNALING AND TELECOMMUNICATION

### 3.13.1 Safety System for Train Operation

#### (1) Train block and signaling system

**1) Staff blocking**

Staff blocking is mainly used as regular blocking for single track lines in ENR, designed to enable a single train to travel in a blocked section, holding an exclusive token (staff) as authorized permission to pass. The block system has no track circuit and is not interlocked with signals and point machines, so that human attention is required for train operation.

The cabin-to-cabin linkage for blocking is presently carried out through overhead wires, and partially by underground cable. Communication to traffic control center is mainly by radio. Mechanical signals with semaphore are used for staff-blocked sections in ENR. The current problem with staff blocking is in the overhead wire linkage, because the wires are subject to unexpected cutoff.

**2) Tyris blocking**

A Tyris blocking system is presently installed in some double track lines in ENR.

The Tyris system has no token (staff) for blocking, while this system is equipped with blocking instruments which are electrically interlocked with those of adjacent cabins and signals.

Since token handling is not needed and signal linkage is secured, the frequency of train traffic can be increased to some extent. However with no track circuit installed, human attention is required for train operation. The cabin-to-cabin linkage for blocking is currently performed through overhead wires, and partially underground cables. Contact to the traffic control center is the same as for staff blocking. The mechanical signals with semaphore are currently installed for Tyris block sections, except for the section between Asyut and Sohag..

**3) Tokenless blocking**

The tokenless blocking system is currently applied to the double track section between Sohag and Luxor. This system is considered a system added to the short length track circuit to the Tyris blocking. Since short length track circuits are installed near both starting and home signal, while at the same time interlocked with signals and blocking instruments, the safety of train operation is improved. However, block instrument handling is needed in the signal cabin. The cabin-to-cabin linkage is currently made through overhead wires or underground cables.

The mechanical signals with semaphore are presently employed for this section.

**4) Automatic blocking**

The automatic blocking system is designed to automatically control the signal aspects by train travel through a continuous track circuit, so that the system is seen as one of the most reliable blocking systems. This system is employed on main trunk lines of ENR to allow high frequency train traffic

and ensuring its safety.
5 signals are currently applied on the 3 position-indicator over the wayside signal post. The 5 signals are classified as follows :

| | |
|---|---|
| Green light (G) | 120 or 140 km/h |
| Green flash light (GF) | 90 km/h |
| Yellow light (Y) | 60 km/h |
| Yellow flash light (YF) | 30 km/h (for loop line, curve, lineside work) |
| Red (R) | 0 km/h |

The signal transmission for intermediate blocking is conducted through the underground cable.

**5) Interlocking devices**
Interlocking systems applied in ENR are classified as follows :

* Electric relay interlocking with route selective capability -- Sections controlled by CTC, and Stations (Alexandria, Sidi Gaber, Kafr El Dawar, Damanhur, Itay El Barud, Kafr El Zayat, Tanta) in an electrified signal section.
* Electro-mechanical interlocking -- Electrified signal section other than the above
* Mechanical interlocking -- Mechanical signal section

**6) Railroad crossing devices**
The railroad crossings are attended by keepers on the 24 hours basis, and important crossings are also attended by policemen. Radio contact with a traffic control center is available and tape-recorded. 300 railroad crossings are equipped with bell warnings interlinked with approach track circuits at 1.5 to 3 km ahead of the crossings. There used be automatic barrier crossings, but they were removed due to mechanical problems.

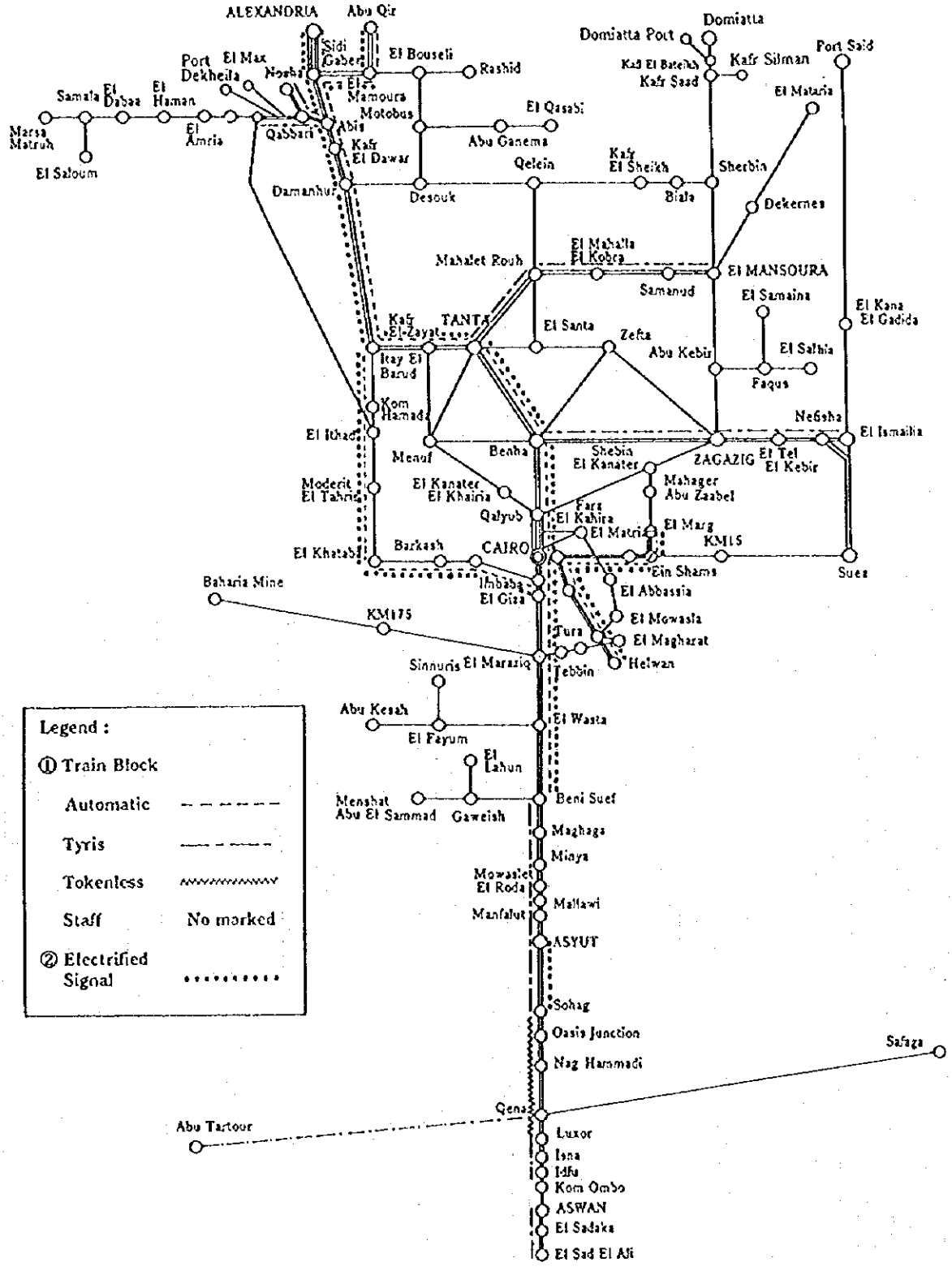



Fig.3.13.1 Train Block & Electrified Signal

**(2) Train speed control**

Automatic Train Control (ATC) is introduced for the train speed control and traffic safety on the main trunk lines (Alexandria through Cairo to Luxor, Itay EL Barud to Imbaba, Metro line). This system automatically controls train speed according to signal indications, so that an absolute stop at red signal can also be set automatically.

This system is comprised of a combination of ground coils installed at a signal locality, and pick-up and control devices on-board, where signal-interlinked instructions are magneto-electrically transmitted through the ground coil, according to the restricted speed. ENR operates trains on a priority manual operation basis, and on ATC support basis. The system features the capability of train operation in bad visibility like in foggy weather. Additionally, it tape-records both signal indications and brake operation of the trains. This ATC applied in ENR is different from the one applied in Japan, where speed and signal information is continuously picked up through AF track circuit, with train detection signals incorporated.

ENR has not yet installed the absolute train stop except for the ATC sections. Absolute train stop herein referred to means a system like ATS (Automatic Train Stop) forcibly stops the train if the driver should overlook a stop signal.

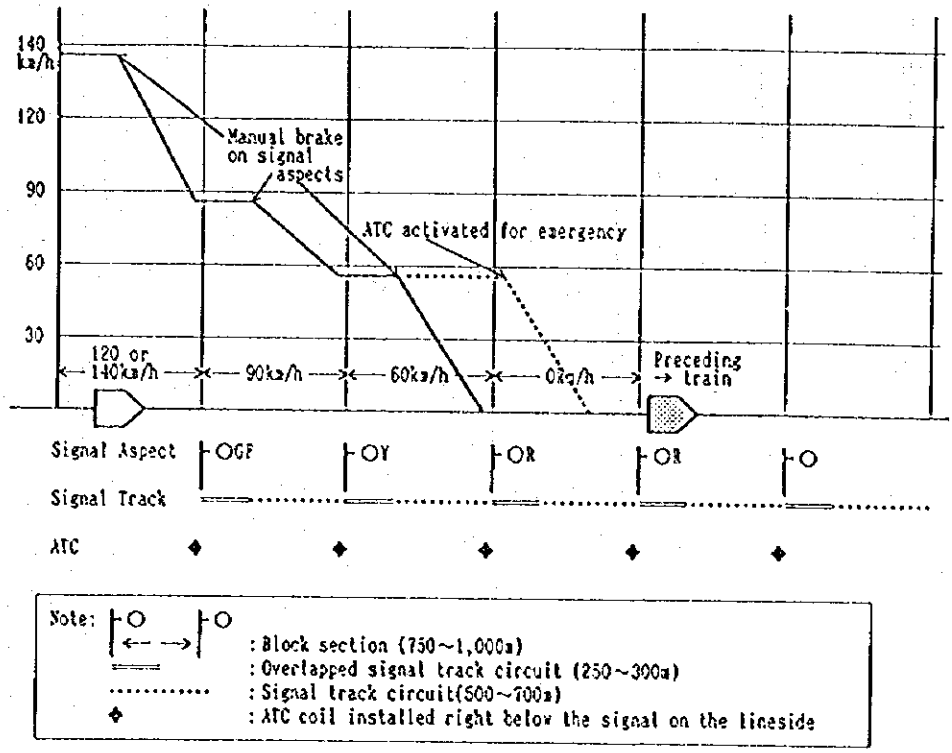



Fig.3.13.2 Speed Check & Control by Automatic Signal & ATC

### 3.13.2 Traffic Control System

#### (1) Centralized Control of Train Traffic (CCTT)

Centralized Control of Train Traffic (hereinafter tentatively referred to as CCTT) is the system that provides for train dispatching and vehicle dispatching in ENR.
The train dispatching is carried out by giving the commands or instructions to way stations, signal cabins, and train drivers through two-way communications.
Each dispatcher tracks the train movement and describes the tracking chart.
In addition, the communications among CCTT, train drivers, and way stations are tape-recorded on 24 hours for the purpose of checking in the event of accidents. The CCTT centers are established in 8 places as shown in Fig.3.13.4.
Current problems with the system :

① Contact between the center of CCTT and the train driver is limited to a simultaneous-single call in the assigned range due to the system mechanism.
② Wire circuit is of low reliability due to unstable overhead lines.
③ Direct calls are not available among way stations or signal cabins, so the call is subject to interchange of CCTT.

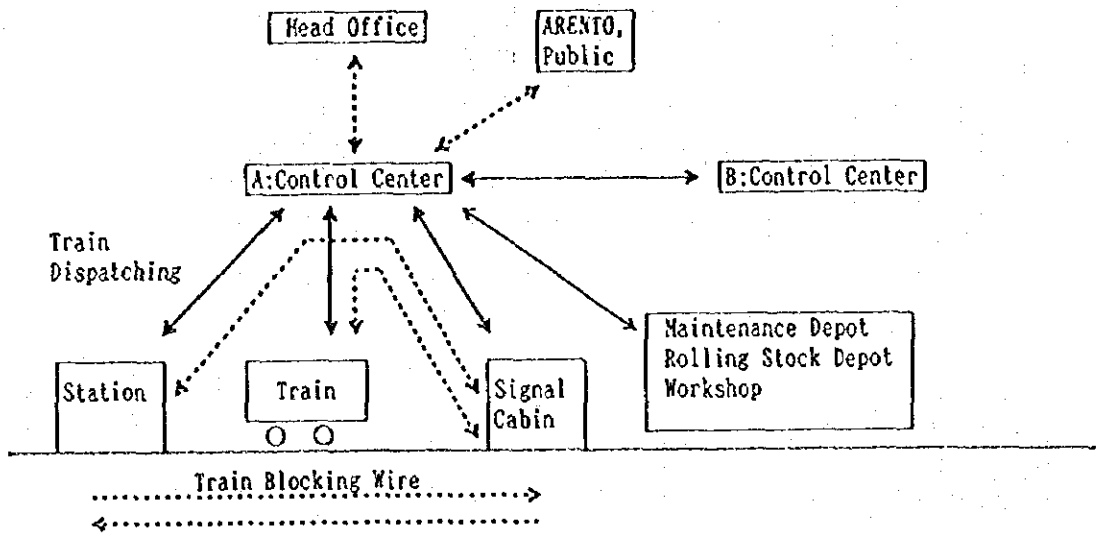



Fig.3.13.3 Schematic Diagram of Information Exchange of CCTT

**(2) Centralized Traffic Control (CTC)**

At present, CTC is partially installed for the electrified signal section in ENR.
CTC covered sections and their centers are shown in Fig.3.13.4.

The section between Cairo and El Giza is scheduled to be equipped with CTC, the center of which is in Cairo.

Installation of CTC is intended for increased train frequency on ENR's trunk lines.

Major CTC facilities and their functions are as follows :

① Display and control panel
- Display and control of track route, signal and point machine, rail road crossing, power supply at stations, swing bridge. Display of train movements through track circuit.

② Train describer
- Automatic train travel recording.

③ CCTT - contact telephone
- Communication between CTC center and CCTT center.

④ Maintenance telephone
- Communication between CTC center and signal equipment at site.

The CTC system has been developed as a device that helps operators control the train traffic and that improves the efficiency of traffic control.
In the future, CTC should be incorporated into CCTT in the same room, for integrated information control of traffic.

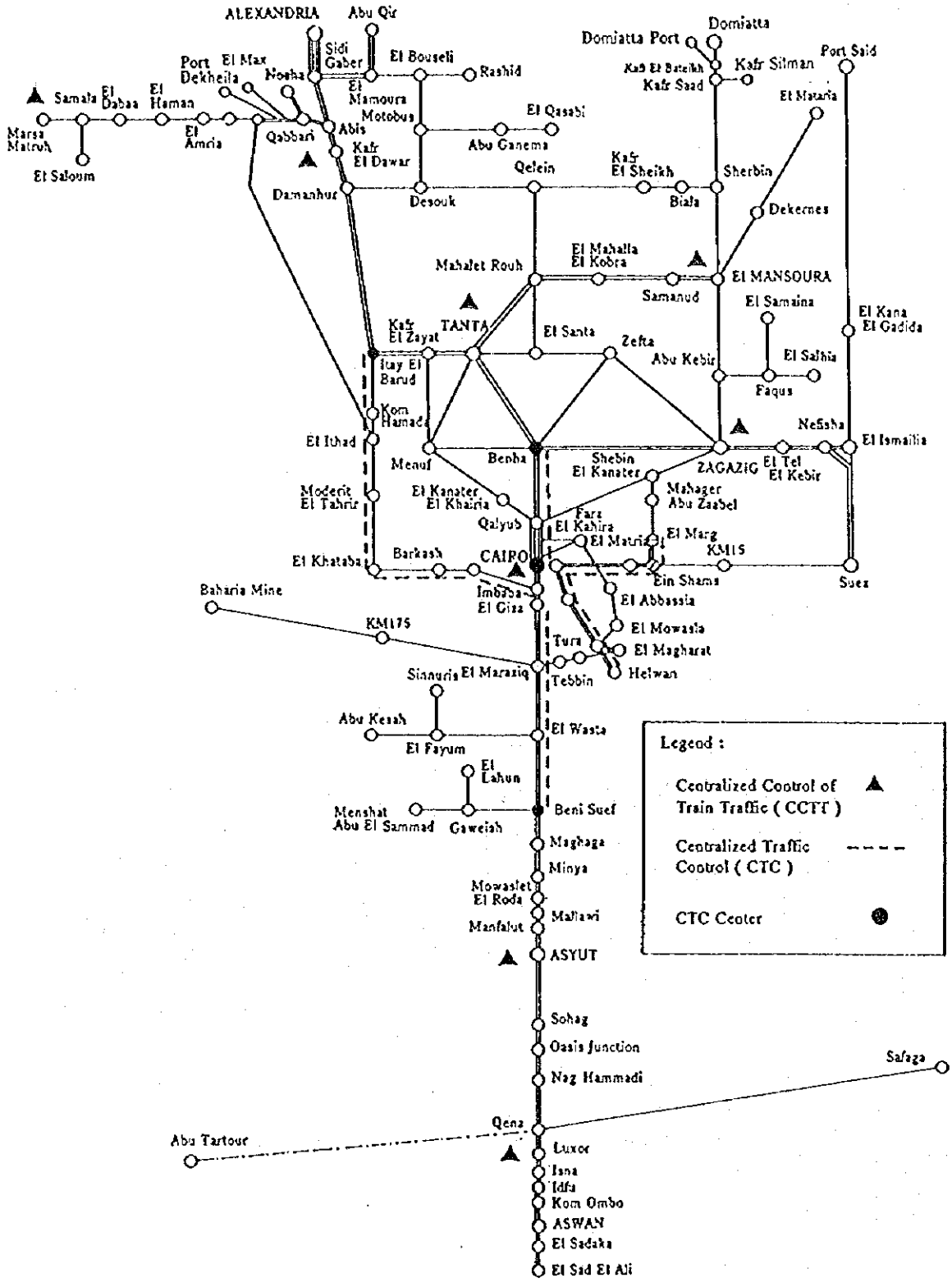



Fig. 3.13.4 Centralized Control of Train Traffic ( CCTT ) & Centralized Traffic Control ( CTC )

### 3.13.3 Information Transmission and Control System

**(1) Radio transmission network**

ENR's telecommunications primarily consist of radio installations which are intended for radio communication for train traffic control and internal service work, the network of which is shown in Figure 3.13.5.

Major radio stations are mutually interlinked, each of which has a group of sub-radio stations under its control. The sub-radio stations serve as repeaters for communication between CCTT and waystations or train drivers.

UHF : Connected between traffic control centers (main radio stations).

* Frequency -- 800 MHz～950 MHz (2GHz : under study for projected line)
* Transmission channel -- 72 channels for respective control center, including hot standby
* Spacing between repeating stations -- 40～50 km (approximately)

VHF : Connect radio stations, including repeating stations in railway stations, signal cabins, and trains.

| | |
|---|---|
| * Frequency | 148 MHz～172 MHz |
| * Transmission channels | 2 channels (minimum)～6 channels (maximum) |
| * Distance covered | 50 km (approximately) |

**(2) Cable and wire transmission**

Cables and wires applied to ENR are owned by ARENTO (Arab Republic National Telecommunication Organization).

As mentioned in 3.13.1,(1),1), 2), 3), the signal transmission for train blocking is currently conducted by aerial wires or partly by ground cables. These wires and cables are owned and operated by ARENTO, except for those in the section of El Cabbari to El Ithad. Cable and wire transmission is also used for backup linkage among CCTT and way stations.
The status of aerial wires is currently unstable due to unexpected cutoff or obsolescence.

**(3) Telephone exchanges** - ENR has 2 types of telephone exchanges, crossbar and digital.

* Crossbar exchange units (16 locations):

El Qabbari, Tanta, Benha, Zagazig, El Ismailia, Mahagar Abu Zaabel, Cairo, El Magarat, El Wasta, Minya, Asyut, Sohag, Qena, Luxor, Aswan.

* Digital exchange units (11 locations):

Alexandria, Marsa Matruh, El Qabbari, Tanta, Zagazig, Cairo, Minya, Asyut, Sohag, Luxor, Aswan

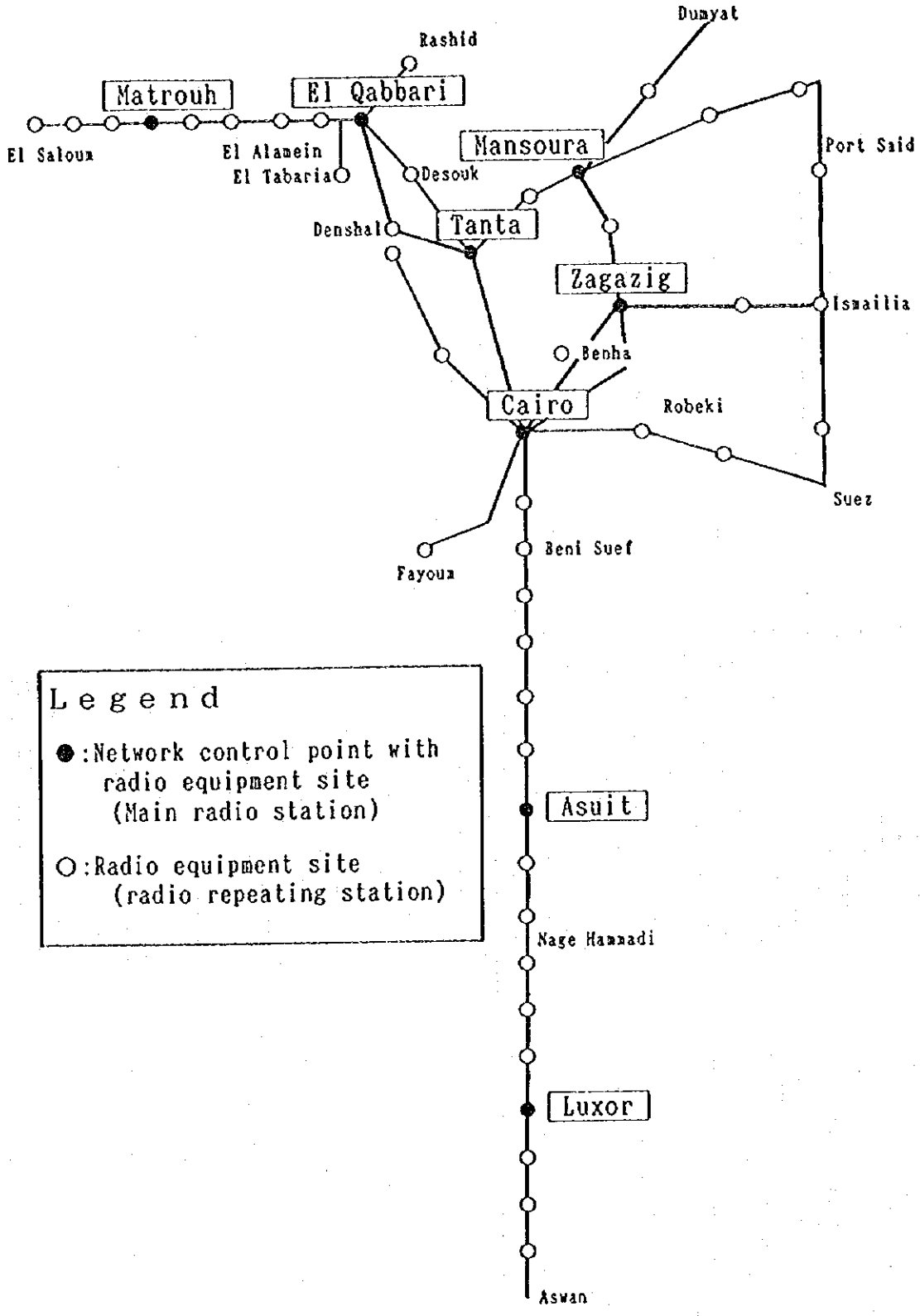



Fig. 3.13.5 Radio Network in ENR

**(4) Transmission for business management**

Coaxial cable or fiberoptic cable for a nationwide railway communications system has not been installed, so the quantity and quality of information transmission is limited. Information transmission for improving business performance like seat reservations entirely depends on the outside network.

### 3.13.4 Electricity Supply

ENR has no electric traction system, with the exception of Metro line. The electricity supply referred to is for signals, telecommunications, lighting, etc.

**(1) Electricity supply for the electrified signal section**

In the electrified signal section, electricity is supplied from the municipal power department, with voltage of 11 kV in main railway stations. Power reception is normally conducted by double circuits for enhanced reliability.
Also, generators are installed in case of a commercial power cutoff. Groups of batteries are also installed for special loads for which no temporary power interruption is allowed.
For small stations in between, power is transmitted from the power source in main stations via double circuits.
The power transmission lines and information lines are generally underground cables for security.

**(2) Power supply for the non-electrified signal section**

As for the major point like traffic control centers, the power is supplied in the same way as for the electrified signal section. But for intermediate stations, power is supplied at the low voltage of 220/380V on a double circuit basis.

The signal cabins and radio repeating stations are equipped with solar power supply units in the region where no commercial electricity is yet provided, and also equipped with it as short term compensator where the voltage is unstable.

### 3.13.5 Maintenance

Maintenance personnel is distributed in the ratio of 4% for engineers and 47 % for technicians, under the leadership of the Signal & Telecommunication Department.

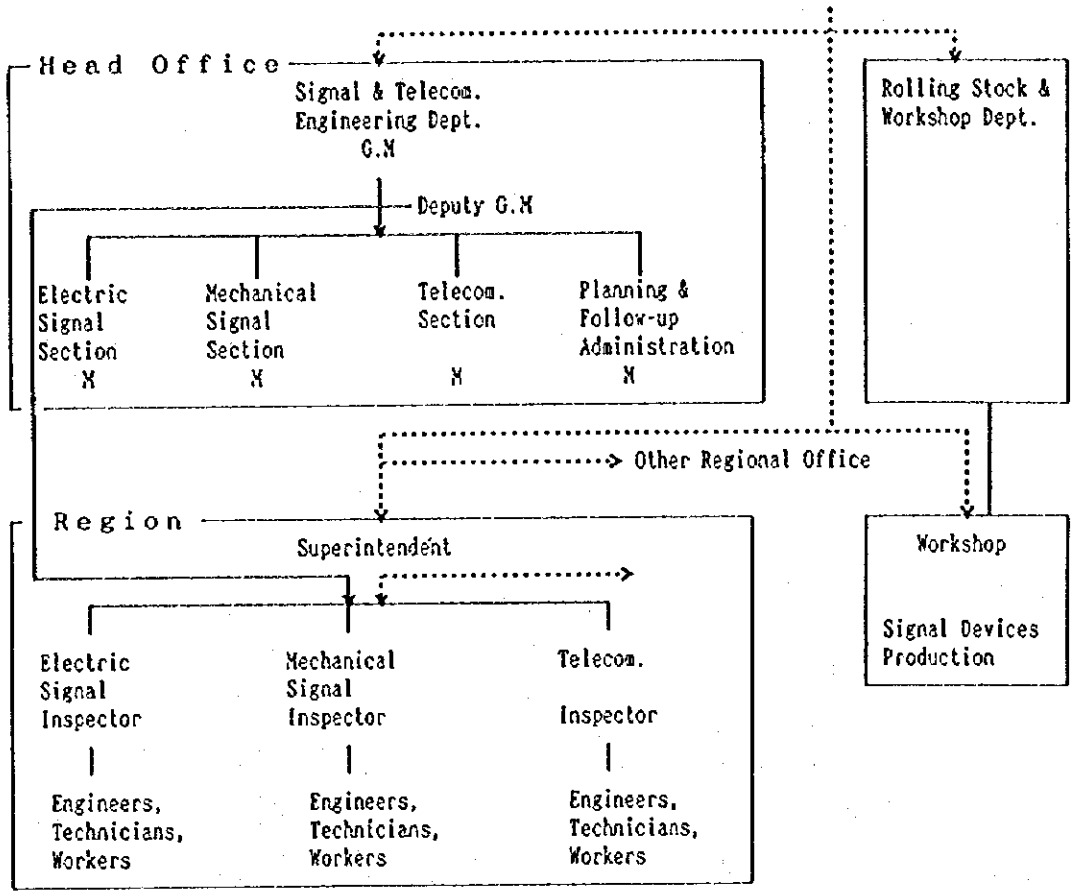



Fig. 3.13.6 Maintenance Structure

## 3.14 INFORMATION SYSTEM

### 3.14.1 Overview of Current ENR Information Systems

Currently ENR has an information systems department which is under the Vice Chairman for Finance. Currently they have two major applications. One is the commercial system. The other is the ticket reservation system. The commercial system was established in 1987 and the ticket reservation system in 1994. The commercial system is an old type system which is called "data entry", and mainly it is operated by batch system. The ticket reservation system is a newer, so it is operated by an on-line system. Both systems have magnetic tapes used for storage and backup.
Few applications are seen in other departments. One is a statistic system for the Operations Department using EXCEL, and data is input manually. A PC-based inventory control system is available for stores in workshops. Some applications use ORACLE for DOS, and others use DBASE IV. To connect data from separate workshops, diskettes are used. The Operations Department and the workshop has programmers for each system.

#### (1) Application programs

ENR's application programs are shown on Table 3.14.1. Application programs which are prepared by TPA are shown on Table 3.14.2.

**Table 3.14.1 ENR's application programs**

| | |
|---|---|
| Ticket reservation system | Inventory control system |
| Expense system | Project names and their contents |
| Urgent freight system | Freight system |
| Stores system | Accounts system |
| Pensions system | Statistical system of urgent packages |
| Named ticket system | Paper ticket system |
| Distance and ticket price system | Subscription system |
| Main payroll statement | Bank account system |
| Client account system | Freight statistics system |
| Freight statistics analysis system | Statistics system (operation) |

**Table 3.14.2 Application programs by TPA**

| | |
|---|---|
| Operation management system | Rolling stock management system |
| Infrastructure management system (Track, Signal, and bridge) | Infrastructure management system (Metro) |

#### (2) Hardware

Except for the inventory control system and the statistics system of the Operation department, all applications are on ICL mainframes. One is the S39-XP for commercial systems. The other is the S39-DX230 for the ticket reservation system (fault tolerant system which has two S39-DX230). Magnetic tape units are attached to this system.

#### (3) Software (operating system, middleware)

The operating system for the mainframe is called VME which is supplied from ICL. An ICL

original tp monitor is also used for the on-line system of ticket reservations. These two software are not an open system yet. ICL also has OPEN-VME and OPEN-TP, which can be connected to the latest open architecture systems. ENR software can be upgraded to these new ones. Programs have to be converted to be suitable for this new software. Open-VME already fits XPG4.

**(4) Network**

The ticket reservation system ENR uses (EGYPTNET) is a public data transmission network, serviced by ARENTO. The protocol is X.25. For the data entry system, ENR uses telephone lines to submit the data to the mainframe.

**(5) Operations**

Currently the whole system is operated by ENR employees. They already have 24 hour operation by 3 shifts.
The ticket reservation system is normally available from 5 a.m. to 10 p.m. and the commercial system is normally available from 8 a.m. to 3 p.m.. The batch system starts after the ticket reservation system is finished. It normally takes 3 hours.

**(6) Technical level and telecommunication infrastructure in Egypt**

The technical level of computers is similar to the USA or European countries. ENR can get the latest systems from vendors. Unfortunately network infrastructure is not sufficient in Egypt.

### 3.14.2 Notable Points of Current Figures

There are some points that should be considered in order to make a future plan of information system for ENR. These points are described below.

**(1) Organization**

ENR doesn't have an information systems department which takes charge of the entire ENR system demand. This means that it is difficult for ENR to have a total overview for computerization.

**(2) Mainframe orientation**

Most ENR applications are processed by main frame. It takes very long time to satisfy end-user demands.

**(3) Network infrastructure**

Weak network infrastructure is a major problem. To make an ideal system, ENR needs to connect each office, workshop, etc.

**(4) Data collection**

Currently, all data is input in Cairo office, except for some in Zagazig. This means that it is difficult to check the results of inputs, because the data is from the regions.

## 3.15 DIVERSIFIED BUSINESS IN ENR

### 3.15.1 Miscellaneous Revenues in ENR

Table 3.15.1 shows the breakdown of miscellaneous revenues in ENR, excluding Metro during fiscal years 1992/93 - 1994/95.
The current share of miscellaneous revenues in total revenue amount during fiscal year 1992/93 - 1994/95 is as below:

(million LE)

| | 1992/93 | 1993/94 | 1994/95 |
|---|---|---|---|
| Total Revenues | 484 | 542 | 618 |
| Miscellaneous Revenues | 90 | 109 | 105 |
| (%) | 19% | 20% | 17% |

According to interviews with ENR staff (both financial and commercial departments), the miscellaneous revenues in this Table are explained as follows:

(a) Rent lands:
Rental of land (ENR property) near station/track to private companies and individuals (for cultivation). Rental land area is very small.

(b) Rent machines:
Machine rental such as lifts/cranes in freight stations for consignors.

(c) Rent buffets:
Buffet rental such as cafe shop/canteen in the ENR stations. Such rentals are on a contract basis (bidding). ENR has no standard unit price per square meter. Buffets in ENR's major stations (Cairo, Alexandria, Luxor, Aswan etc.) are managed by ACCOR Company, which is a French-Egyptian joint venture. Buffets in non-major stations are managed by other companies.

(d) Rent housing:
Housing rental for ENR staff/employees in areas where accommodation conditions are difficult, such as Desert areas (for example, project-basis housing rentals during construction of new railway lines in desert areas.)

(e) Rent rest house:
Rest house rental for ENR staff/employees, when they make business trips and stay at ENR rest houses.

(f) Other rent

(g) Water: ENR provides water to outsiders using ENR facilities.

(h) Electricity:
ENR provides electricity to outsiders using ENR facilities.

(i) Service revenues:
Revenues from ENR consulting services to private companies.

(j) Consignment note revenues:

**Table 3.15.1 Breakdown of Miscellaneous Revenues in ENR (Excluding Metro)**

(Unit: Million LE)

| Items of Breakdown: | | 1992/93 Actual | 1993/94 Actual | 1994/95 Actual | (%) in 1994/95 |
|---|---|---|---|---|---|
| (a) | Rent Lands | - | - | - | - % |
| (b) | Rent Machines | 0.6 | 0.8 | 0.8 | 1.2% |
| (c) | Rent Buffets | 0.2 | 0.2 | 0.2 | 0.3% |
| (d) | Rent Housing | 0.2 | 0.2 | 0.2 | 0.3% |
| (e) | Rent Rest House | 0.2 | 0.2 | 0.2 | 0.3% |
| (f) | Other Rents | 2.1 | 2.2 | 2.4 | 3.6% |
| | (Rents Subtotal (a)-(f)) | (3.3) | (3.6) | (3.8) | (5.8%) |
| (g) | Waters | - | - | - | - % |
| (h) | Electricity Powers | - | - | - | - % |
| (i) | Service Revenues | 0.2 | 0.2 | - | - % |
| (j) | Consignment Notes Revenues | 0.1 | 0.1 | 0.1 | 0.2% |
| (k) | Sub-products Revenues | 37.1 | 63.0 | 41.7 | 63.3% |
| (l) | Treatment Costs | 0.1 | 0.1 | 0.1 | 0.2% |
| | (Services Subtotal (g)-(l)) | (37.5) | (63.4) | (41.9) | (63.6%) |
| (m) | Conductors Fines | 11.5 | 13.0 | 12.1 | 18.4% |
| (n) | Later Fines | 2.4 | 2.2 | 1.4 | 2.1% |
| (o) | Demurage Charges | 1.5 | 4.0 | 1.4 | 2.1% |
| (p) | Coah Yard Penalties | 0.5 | 0.5 | 0.5 | 0.8% |
| (q) | Compensation for Damages | - | - | 0.5 | 0.8% |
| | (Fines Subtotal (m)-(q)) | (15.9) | (19.7) | (15.9) | (24.1%) |
| (r) | Advertizing | - | - | - | - % |
| (s) | Production Sweeping | 0.5 | 0.5 | 0.7 | 1.1% |
| (t) | Others | 2.2 | 3.8 | 3.6 | 5.5% |
| | (Total (a)-(t)) | (59.4) | (91.0) | (65.9) | 100.0% |
| (u) | Revenues Accrued in Previous Year | 31.0 | 18.0 | 39.2 | |
| Total including (u) | | 90.4 | 109.0 | 105.1 | |

Source: Financial Department, ENR

Note: 1) Edited based on the data from ENR

2) " - " shows small amount of value (not zero).

Revenues from fees for application sheets (consignment note) submitted from passengers to ENR when purchasing seasonal tickets and Kilometer-tickets, and from consignors to ENR when consigning freight transportation.

(k) Sub-product revenues:
Revenues from sub-products (equipment and parts) which ENR workshops produce in accordance with orders from outside authorities or private companies.

(l) Treatment cost:
Payment of hospital cost by ENR staff/employees when they use ENR's hospital.

(m) Conductor fines:
Fines for passengers who have no ticket when conductors inspect.

(n) Late fines (Overtime Charges):
Fines (charges) for consignors when loading/unloading time of their freight exceeds the limitation of time in freight station.

(o) Demurrage charge:
Charges for consignors when their freights occupy platforms in freight stations.

(p) Coach yard penalty:
Penalty for passengers who get on coach of train from coach yard, not from the station.

(q) Compensation for damages:
Compensation for ENR's damages from outsiders (for example, when a vehicle damages railway crossing facilities).

(r) Advertising:
Fee for advertising billboards in stations, rented out on a bidding basis. ENR has no standard unit price per board.

(s) Production sweeping:
Revenues from disposing of products as waste.

(t) Other

(u) Revenues accrued in previous year

### 3.15.2 Management Contracts and Joint Companies

ENR has some management contracts and joint companies as follows:

#### (1) Management contracts

#### 1) Management contract with ACCOR Company

This management contract is for the business of managing sleeping cars and dining services in the train operated between Cairo - Luxor - Aswan. The contract between ENR and ACCOR is on a profit sharing basis (ENR: 87%, ACCOR: 13%). ACCOR is a French hotel management company. The contract has been operating since 1980.

**2) Management contract with Mahamed Abedel Salam Company**

This management contract is for sleeping car maintenance with the Mahamed Abedel Salam Company (Egyptian company). The contract is on a fee basis. (ENR pays the cost of sleeping car maintenance).

**(2) Joint companies**

**1) Egyfrail Company**
This joint company is with a French company. The business is for maintenance and renewal of tracks. The lines covered are: (1) Cairo area; (2) Metro Line; (3) Lower Egypt (main line of Cairo - Alexandria).

**2) Egerco Company**
This joint company is with a German company for maintenance and renewal of tracks. The lines covered are: (1) Upper Egypt (main line of Cairo - Aswan); (2) Qena - Safaga (Safaga sea port); (3) Qena - Abo Tartor (new line, construction of track). ENR owns 51% of the capital in the above two joint companies. The Chairman of the Board of Directors of these companies are appointed from ENR.

**3.15.3 Re-estimation of Revenues of Diversified Business in ENR**

**(1) Extraction of diversified business from items of miscellaneous revenues**

According to interviews with ENR staff, out of the items of the miscellaneous revenues previously mentioned, some items are assumed to be unrelated to the category of diversified business.

For example, the items of "rent housing", "rent rest house", and "treatment cost" which are related to ENR staff/employees are excluded as internal revenues. The "consignment note revenues" are handling charges. The items of "fines", "production sweeping" and "others" are also not included in the category of diversified business. The item of "revenues accrued in previous year" is treated as an adjustment item in financial accounts, not an actual diversified business.

**(2) Revenues from joint ventures and joint companies**

The profit share in joint ventures and the profit from joint companies are assumed to be included in revenues related to diversified business in this analysis.

**(3) Re-estimation of revenues of diversified business in ENR**

As a result, the re-estimation of revenues of diversified business in ENR (excluding Metro) is shown in Table 3.15.2.

In the share ratio of revenues in the fiscal year 1994/95, the predominant category is "Sub-products revenues" (80%), followed by "Profit related to Joint Venture and Joint Company" (13%) and "Related to rental" (7%). The share ratio in revenue amount of the estimated

diversified business revenues in ENR to the total revenue amount during fiscal years 1992/93 - 1994/95 was :

(million LE)

| | 1992/93 | 1993/94 | 1994/95 |
|---|---|---|---|
| Total Revenues | 484 | 542 | 618 |
| Revenues of Diversified Business | 65 | 81 | 52 |
| (%) | 13% | 15% | 8% |

Compared with the case of miscellaneous revenues, the share of total revenues shows decreasing values. The predominant revenue item in the diversified businesses is "Sub-product Revenue". This can be seen as an effective utilization of workshop facilities and manpower in workshops. However, the share of "Rental" is rather small. There is a possibility to increase rental revenues by effective utilization of ENR property.

**Table 3.15.2 Re-estimated Revenues of Diversified Business in ENR (Excluding Metro)**

(Unit: Million LE)

| Items | | 1992/93 Actual | 1993/94 Actual | 1994/95 Actual | (%) in 1994/95 |
|---|---|---|---|---|---|
| (a) | Rent Land | - | - | - | - % |
| (b) | Rent Machines | 0.6 | 0.8 | 0.8 | 1.5% |
| (c) | Rent Buffets | 0.2 | 0.2 | 0.2 | 0.4% |
| (d) | Other Rent | 2.1 | 2.2 | 2.4 | 4.6% |
| | (Subtotal of (a)-(d)) | (2.9) | (3.2) | (3.4) | (6.5%) |
| (e) | Water Provision | - | - | - | - % |
| (f) | Electricity Provision | - | - | - | - % |
| (g) | Service Revenues | 0.2 | 0.2 | - | - % |
| (h) | Sub-products Revenues | 37.1 | 63.0 | 41.7 | 80.0% |
| (i) | Advertising | - | - | - | - % |
| | (Subtotal of (e)-(i)) | (37.3) | (63.2) | (41.7) | (80.0%) |
| (j) | Profit Share in Joint Ventures | 23.2 | 11.0 | 4.1 | 7.9% |
| (k) | Profit from Joint Companies | 1.7 | 4.0 | 2.9 | 5.6% |
| | (Subtotal of (j)-(k)) | (24.9) | (15.0) | (7.0) | (13.4%) |
| | Total | 65.1 | 81.4 | 52.1 | 100.0% |

Source: Re-estimated by Study Team.

Note: 1) Compiled based on the data from ENR.

2) "-" shows a small amount of value (not zero).

## 3.16 RELATIONSHIP WITH GOVERNMENT

### 3.16.1 Current Relationship between MOT and ENR

#### (1) Reviewing ENR Law

Upon reviewing the ENR Law, the Study Team noted the following regarding the relationship between MOT and ENR management :

a) Supervision by MOT (Article 1)

b) Establishment of joint stock companies
ENR may establish joint stock companies, alone, or with other partners after the approval of the Minister of Transport (Article 4).

c) Funds
The funds allocated and assigned by the State are the capital and the resources of ENR, as the case may be (Articles 5 and 6). The resources also include the difference of the prices due to ENR according to Article 12.

d) Tariff increase
To be approved by the Minister of Transport (Article 12).
The General Budget of the State bears the difference between the Board approved prices and the amount which the State specified less than the Board prices.

e) Appointment of Chairman
To be appointed by the President of Egypt (Article 15) (by delegation, now by the Prime Minister)

f) Appointment of a member of the Board of Directors
To be appointed by the Minister of Transport (Article 16)

g) Approval of the decisions of the Board of Directors
To be approved by the Minister of Transport (Article 19). Board reserves the right to enforce its decision by a second vote.

h) Formation of Administration Council
To be formed according to a decree of MOT (Article 20)

i) Issuance of the regulations
To be effected by a decree of MOT (Article 25)

#### (2) Relationship between MOT and ENR

As noted from the above, all operations and management of ENR are generally subject to the supervision of MOT, and in practice, it is almost requisite to obtain the consent of MOT to any decision of ENR on important matters. In this respect, one thing to be noted is that certain representatives of the Board of Directors and Administration Council (Chairman, Vice-Chairmen and certain General Managers) meet monthly at MOT to discuss and exchange views

as to certain topics for consideration. The merit of this meeting in the practical aspects would be very important, and it is easily understandable that a consensus will be formed at this meeting and subsequent meetings (if not formed at one meeting) among the people attending this meeting, if they realize that discrepancy in opinions can be avoided and the situation allows compromise. This consensus if once obtained will become the base for the subsequent formal decisions at the meetings of the Board of Directors and Administration Council. This decision making process helps to smooth operation of business and subsequently obtaining the formal consent of MOT when the formal decision of the Board is later submitted to MOT for approval, if the decision reflects the policy of MOT to the extent necessary. Thus the second vote has never been exercised for implementation of the initial Board decision submitted to MOT, which is exercisable when this Board decision is rejected by MOT. This prior consensus method also applies to the Cabinet's approval of tariff increases discussed in 3.16.3 below.

### 3.16.2 Budget Approval at the People of Assembly

ENR has its own budget, and the fiscal year of ENR matches the fiscal year of the State, i.e. from July to June of each year (Article 8, ENR Law). The ENR budget is approved at the People of Assembly as part of the national budget. In practice, between January and March each proposal of the respective departments is studied within ENR. ENR prepares its proposal for the budget. This proposal is discussed within a committee including representatives from the Ministry of Planning, Ministry of Finance, and the Central Agency for Administration.
After preparing the budget in its final shape, and after approval of the Board of Directors of ENR, and approval of the Minister of Transport, the proposal is submitted to the Ministry of Finance, which includes it within the total budget.

### 3.16.3 Tariff Increase to be approved by the Cabinet

Decision on prices and tariffs for services performed by ENR is one of the principal duties of the Board of Directors of ENR (Article 17). The Administration Council prepares or review a draft tariff increase, and submits its comments and suggestions to the Board of Directors for its review. In practice, sub-committees are formed to study each of the respective issues in the draft tariff increase to be reviewed by the Administration Council.

The Tariff Regulation provides for a detailed schedule for tariffs for passengers cargoes depending upon the nature of the service and in accordance with the classification of passengers and cargo clients. From 1990 to 1994 ENR raised tariffs by 15% average every year, but in 1995 the increase was 14%. Generally, the tariff increase in the first 5 years was to cover costs, but in 1995 the rate of increase was reduced to cope with competition with other transportation modes. The decision of ENR management on this tariff increase was to follow the ordinary decision-making process, but one thing we should note here on this matter is a special provision under the ENR Law. According to Article 12 of the Law, ENR's tariff is implemented by a decree from MOT after submission to the Cabinet, and if the State specifies such tariff to be less than ENR proposed tariff, the State budget bears the difference between them. But so far the Cabinet approved such increase as proposed by ENR, and thus no compensation was made from the State budget. Please see the prior consensus method discussed in 3.16.1(2) above.

### 3.16.4 New Business to be approved by MOT.

The matter of related business was generally examined in 3.1.2(1) above. But, if the nature of new business is not directly connected with transport, it would be questionable whether or not operation of such business is allowed under the ENR Law. For example, if operation of hotel business, department stores, and/or real estate development on the land currently used by ENR, are planned as one of its side businesses, it would be beneficial to both ENR and its expected customers. ENR passengers may use these facilities, but people without ENR tickets may also use the facilities. The ENR Law does not specifically prohibit ENR from conducting such businesses, thus one may think that ENR may enter into such business because it is not prohibited. But, since almost all of the land currently used by ENR is owned by the Government, ENR should comply with any requirement for use of the land for such purpose (i.e. to obtain a lease/permission for use of the land, or to purchase the relevant portion from the Government). Also, if any such businesses is regulated under other laws, and especially if privatization of such business is considered for other companies under the general economic and political plan of the State, ENR would have no chance to enter into such business (such as bus or truck business). It is to be noted that the plan and activity of ENR must be in the frame of such general plan of the State (Articles 2 and 17 of ENR Law).

# CHAPTER 4 BUSINESS IMPROVEMENT PROPOSAL

## 4.1 MANAGEMENT STRATEGY

### 4.1.1 ENR's Changing Environment

#### (1) Progress of privatization & move towards a market economy

Since 1990, Egypt's government has introduced reforms which is steadily moving Egypt towards a market economy. The privatization of state owned enterprises is an especially important step, as they play an important role in the economy. The privatization process has been slower than planned, but the government expresses a strong desire to push forward, and the tempo is likely to increase.
ENR must realize that the move to a market economy will have important impacts on ENR in the medium and long term.

#### (2) Trend toward less Government support

The Egyptian government is trying to encourage economic growth through economic reform and deregulation. The government is privatizing state owned enterprises and encouraging private enterprises to become the center of economic growth. Government subsidies are being reduced, and this trend is expected to continue.

#### (3) Increasing competition and changing market structure

How will market economy development impact the transportation system and transport market? Providers and users of transport service will be forced to become increasingly competitive in the market economy.
Private companies already play an important role in road vehicle transport. With tough competition, the role and profitability of state owned bus and truck companies is decreasing. To make them more competitive, the government plans to privatize its bus and truck companies in the next few years.

#### (4) Diversification of consumer needs

Consumer needs are expected to become more diverse with increasing incomes. Consumers are expected to increasingly value quality, in addition to price. Consumers will value more rapid, accurate, and pleasant transport.

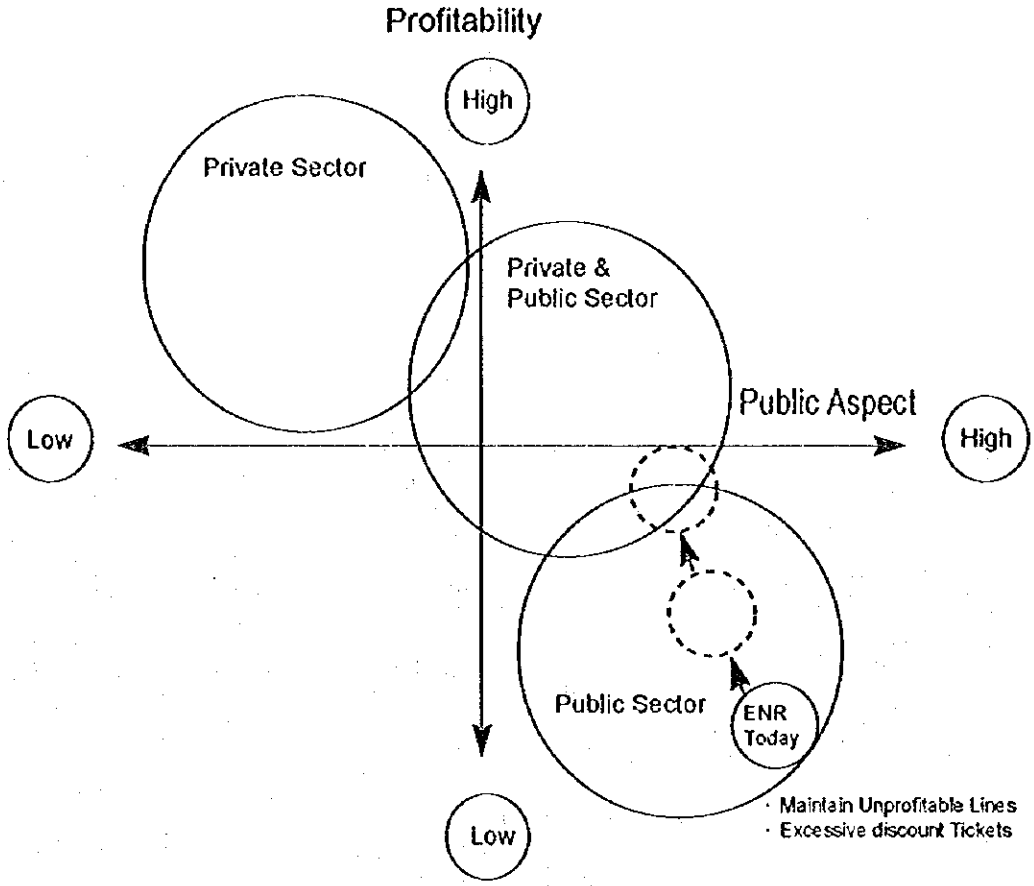
#### (5) Multiple large investment projects

Egypt's economic development plans through 2012 will require several large investment projects like the Sinai Peninsula railway development. Railway service will be considered for new cities and communities now relying on road transport, like 10$^{th}$ of Ramadan, Sadat City, and 6 October.

### 4.1.2 Response to Changing Environment

**(1) Emphasize profitability**

ENR has maintained its public service aspect up until now, but must increasingly emphasize profitability. ENR must build a more efficient organization to compete in the market economy.
This is shown in the diagram below :




**(2) Clarification of roles**

It is important to clarify the roles of the government and ENR, especially regarding new line investment and discounts to meet government policy. ENR cannot bear these burdens if it is to become a more independent organization responsible for its finances.

**(3) Market needs**

The market reforms will force ENR to adapt to consumer needs. ENR will need to consider service improvement if it wants to raise its fares, and set tariffs taking competing transport mode tariffs into consideration. ENR will need to build an organization which emphasizes marketing, in addition to operations.

**(4) Take advantage of railway strengths**

ENR must build a strategy based on the railway's essential qualities to compete with other transport modes.
ENR must compete based on its strengths of safe, high speed, punctual and large volume transport. This requires ENR to allocate its main resources to its Main Lines. On the contrary, to operate trains on the lines of very low traffic volume is nothing but a waste of precious resources.
(see 4.2.3, 4.2.13)

**(5) Strengthening cost competitive position**

ENR must recognize that price is set by the market in a market economy. This means that ENR must be cost competitive to increase profitability. This requires a slim organization with only necessary staff, and withdrawal from unprofitable operations.
(see 4.2.7 - 4.2.10)

**(6) Emphasize information**

Accurate information for management decisions is essential in the market. ENR requires rapid, accurate analysis based on reliable data. Decisions based on such analysis are necessary. ENR needs to rebuild its data collection system.
(see 4.2.12)

**(7) Strengthen management system**

ENR does not just need more passengers. ENR's business will be improved when it increases revenues. Therefore, ENR needs to realize its management problems resulting in free riders.
(see 4.2.2)

**(8) Change ENR employee attitudes**

ENR competition will be private companies, and its users will also be mostly private. To compete, it is natural that employee attitudes must change.

## 4.2 BUSINESS IMPROVEMENT ITEMS

### 4.2.1 Promote the Market Oriented Tariff Policy

#### (1) Reform of pricing principle and tariff structure

**1) Passenger**

a. Experience of Japan

(a) Abolished of seat classes
In the age of JNR (Japanese National Railway) before privatization, there were three seat classes based on the principle of charging "what the traffic will bear". But as motorization developed, competitive modes like buses and private cars appeared and the significance of JNR seat classes lost its merits. Now, there are only two kinds of seats. These are "normal seat", and a more deluxe "green seat".

(b) Full cost pricing principle
JR (after privatization) and other private railway companies apply "Full Cost Pricing Principle" to their pricing. This is regulated in Railway Enterprise Law, Article 16, Clause 2. In this principle, "Full Cost" is defined as suitable cost plus suitable profits. Tariffs are set so that total revenues equal total costs. There are two methods of calculating "suitable profits", as follows :

i. Accumulating cost method
In this method, suitable cost includes interest on loans (non-operating cost) and revenues from equity dividends as suitable profit. The formula is as follows :

Total Cost = Operating Cost + Interest paid + Capital Profits

ii. Fair return method
Suitable profits are calculated by multiplying the value of investment ("Rate Base": value of assets truly and clearly necessary for operating the enterprise) to the rate of return. The formula is as follows :

Total Cost = Operating Cost + (Rate Base X Rate of Return)

These total costing principles have the following advantages :

- Arbitrary pricing is difficult to carry out because tariff is set based on cost.
- Basis for calculation is relatively understandable.
- The enterprise will neither earn excessive profits, nor experience deficits, and can get a fair return.
- Investment cost is easy to add to cost for pricing, in case long-term and large scale investment capital is needed.
- "Regulatory Lag" which is understood as "the period for reviewing fares", gives the incentive of management efficiency.

On the contrary, the following problems exist :

- Because it is difficult for the government as a regulator to know cost information under efficient production, the corporation neglects to strive to minimize cost, and is inclined to add costs from inefficient production. Therefore, incentives for improvements in management efficiency and technology are difficult to implement, and the tariff is not likely to improve. This point is the biggest problem of this principle.
- If rate of return is higher than capital cost, the more the rate base increases, the more the return increases. There will be an incentive to invest too much capital to increase return. This phenomena is called, "Averch-Jonson Effect".
- Some time lag called "Regulatory Lag" will happen during the period from application to approval for revision of tariffs. It is pointed out that there is possibility that regulatory lag will make the enterprise late to cope with market changes and suffer considerable damages.

When major private railway companies revise their tariffs, management efforts are evaluated as one criteria for approval of tariff revision. Management efforts are evaluated for the following items :

- Efforts to increase revenue : This is the amount of increased revenue from management efforts of each company in the future.
- Efforts to improve productivity : This is the amount of saved personnel costs.
- Efforts to rationalize or improve management : This is amount of the saved maintenance and other costs.

(c) Tariff structure by region

Unified tariff structure of JR was abolished and tariff structure by region was established as follows :

i. Tariff for Transport between Trunk Lines
ii. Tariff for Transport between Local Lines
iii. Tariff for Specified Section Operated by Electric Train (Urban Area)

But these tariffs were applied to all six passenger companies in unified form. Thus this tariff system does not mean complete abolishment of unified tariff system. Nevertheless, three small island passenger companies have recently revised their tariff structures to cope with their difficult financial situations in 1996. These revisions have been carried out by taking account of their own market situations and characteristics. A more complete abolishment of the unified tariff system is being realized in the six JR companies.

(d) Yardstick method

According to this method, the specified enterprises will be stimulated to promote their management efficiency by obtaining incentives from business results of other enterprises. These incentives are obtained by comparison of some regionally divided enterprises of one nationwide monopolistic enterprise controlled by government or by comparison among enterprises of which market entry is limited to the specified region.

The privatization by dividing JNR (now JR) into several companies is said to have been realized by making use of the effects of "Yardstick Competition". But some problems are pointed out as follows :

- There are not always many enterprises which are comparable because of their geographical or demand conditions.

- Different service levels are not always reflected in this method.

(e) Regulation for upper limit

The Ministry of Transport reported publicly the draft for revision of the tariff system of railway passengers on February 1996. The characteristics of new system are as follows :

- The maximum tariff will be set based on the total costs of the enterprise, and tariffs less than maximum tariff can be flexibly set.
- The period for calculating costs will be postponed from the current one year, to two or three years. According to existing principle, the tariff level is assessed based on annual "Total Cost" so that the revenues and expenditures in the year after tariff revision might be balanced. In the new system, the waiting period for a tariff raise will be longer (two or three years), so there is incentive to increase efficiency, because stable tariffs mean that reduced costs will increase profits.
- Providing to the public information regarding methods of calculation of "Total Cost" and business results of railway companies. This is in response to criticism that the process of assessment of approval for tariff revisions has not always been clear.

(f) Price cap method

With this method, the percentage of tariff raise will be controlled less than the difference of "percent price increase" and "percent productivity increase". This method was introduced by British Telecommunication Company in England in 1984 when it was privatized, and by Gas Corporation when it was also privatized. In the U.S.A., this method was applied to AT&T for price regulation in 1989, and applied to Telephone Companies in some cities in the U.S.A. The following merits have been pointed out.

- Upper limit of tariff increase is set at the difference of "percent price increase" and "percent productivity increase". If the enterprise can improve productivity faster than the rate used to calculate the upper limit and thus to determine the price, the remaining profit increase remains in the enterprise. This provides an incentive for efficient management and technology innovation.
- Avoids the complex process for costing by a regulatory organization, necessary for tariff revision.
- Tariffs lower than the upper limit are freely set by the enterprise, so it can easily cope with competitor tariff reductions, and there is possibility that cheaper tariffs will be provided.

But the following problems are pointed out :

- If competition is not complete, tariffs may be fixed at the upper limit because only the upper limit is regulated.
- Discriminated tariffs may be set up between competitive and non-competitive markets.
- It is difficult to set the rate of productivity increase in industries with rapid innovations in technology and fierce competition.
- Service quality for users may be lowered because of competition for tariff reductions larger than the limit.
- Investments which will not lead to increased revenue may be restricted, and raising funds for long term and large scale investments will be difficult

b. ENR

Thorough review is urgently needed for the passenger tariff structure to cope with the market economy. For this purpose, present pricing principles like "Full Costing" principle and "What The Traffic Will Bear" principle must be revised.

(a) What the traffic will bear principle
Seat classes seem to be based on this principle as already mentioned. Transport cost for each class should be assessed accurately. It seems that train tariffs, especially 2nd and 3rd class, do not reflect accurately their costs. The significance of these classes has diminished greatly as the road network rapidly expanded. Seat classes should be abolished in the following steps :

- Step 1: 2nd and 3rd classes should be combined and their tariffs unified.
- Step 2: 1st A/C and 2nd A/C should combined.
- Step 3: Finally all classes will be combined into only two classes : "normal" and "deluxe with A/C". The tariff structure should then be reformed according to these two classes.

(b) Full cost pricing principle
It is necessary to continue applying this principle until privatization. This is because an urgent task for ENR is balancing its revenue and expenditure. In other words, ENR needs a cost recovery ratio equal to 100 to be financially independent, government without subsidy.
First of all, ENR must list up clearly the items composing total costs as a basis for tariffs. It is especially important that an appropriate scale of investment is planned, because excessive investment will lead to increase costs and higher tariffs. As a result, ENR will lose railway users who switch to competing modes with lower tariffs.

(c) Individual cost pricing method
Individual cost pricing is urgently needed for ENR's passenger tariff structure according to the characteristics of cost generation. Principles for dividing overhead costs like depreciation and track maintenance cost between freight and passengers, must be established.

(d) Review and reclassification of range of haul
As road network expanded, trips by bus and taxi have become longer. ENR must compete with bus and taxi for long trips. To cope with this situation, the distances on tariff tables need revision. The revisions should focus on rational tariff levels for short and long trips. Tariff/km for long trips should be relatively lower than for short trips.
The tariff per km of trips from 1 to 300 km for 1st class (both normal and A/C) is same level. The tariff/km for trips of 41 to 100 km, and 101 to 300 km, must be lower than for trips from 1 to 40 km. The same thing can be recommended for tariffs for trips of 41 to 100 km, and 101 to 300 km, in 2nd class and 3rd class. These tariffs are now the same level.

(e) Flexible tariff system
The tariff level of ENR is now controlled by the Ministry of Transport. This control or regulation must be reduced or deregulated gradually to set tariffs more flexibly. Regulation of the upper limit of tariffs experienced by Japanese railway companies, and the price cap method in other countries mentioned above are very instructive for ENR.

**2) Freight**

a. Experience of Japan

(a) Abolishment of class system for commodities
The class system for commodities based on the value of commodities, which was useful when railway monopolized transport, became less appropriate and was abolished. This is because truck transport rapidly developed and is highly competitive with railways. Therefore the tariff system of Japanese railway companies is not based on "What The Traffic Will Bear" principle, but on the weight of commodities.

(b) Independence of freight transportation service
After privatization, freight transportation service was separated from passenger transportation service. The Freight Railway Company was established. It operates freight trains on tracks owned by passenger companies and pays fees for track usage based on avoidable costing.

b. ENR

(a) Simplification of commodity classification
Many commodities in ENR's commodity classification table are not now handled by ENR. This causes inefficiency. Commodity classifications should be limited to ones actually handled by ENR. A more simplified classification table is necessary for efficient work.
The committee to simplify freight tariffs was established in ENR on July 16, 1995. The committee is composed of managers from ENR departments of Finance, Operations, and Commercial. The committee studied the freight tariff structure in detail. The study result is summarized as follows:

i. Reduce the number of categories from 11 (3 to 13) to 6 (3,5,7,9,10, and 12). Combine tariffs by category of commodity, adding 100% or 120% (for additional charges). By simplification of categories, raise tariffs of many commodities substantially by raising the category.
ii. Reduce the categories of animals "non-express" to 3 classes instead of 4. Reduce "express" animals to 2 classes instead of 3. Reduce the category of cars "with express" and "without express" to 1 class instead of 2, including cars with 2 wheels and 4 wheels. All of them are combined, plus additional charges.

This reform of freight tariff will be a significant improvement of freight tariff structure. But this cannot be a fundamental reform because this simplified tariff structure will still be based on the principle of charging "what the traffic will bear", which is already outdated.

(b) Abolishment of commodity categories
After simplification of commodity categories, the next step is to transform the pricing principle from "What The Traffic Will Bear" principle to "Individual Cost Pricing" principle. Then existing commodity categories based on the value of cargo should be abolished as soon as possible. Cost pricing principle which is already applied to iron ore must be extended to other commodities like phosphate.

(c) Review of degree of car load density
The quality, weight, and shape of commodities have changed through technological innovation. In this context, car load density of freight seems to have changed with innovation. The degree

of car load density with symbols F, G, H, and K needs to be reviewed and reevaluated by scientific methods. The laboratory of chemical research in ENR must be facilitated with more modern tools for experiment and more specialized staff.

(d) Review and reclassification of haul distance
Simplification of freight tariffs by the committee mentioned above does not include the revision of haul distances : 1 ~ 250 km, 251 ~ 500 km, and over 501 km. To compete with trucks, the range of 1 ~ 250 km should be divided into shorter ranges like 1 ~ 100 km, 101 ~ 150 km, and 151 ~ 250 km. More competitive tariffs must be set.

(e) Individual cost pricing principle
An individual cost pricing system is also urgently needed for ENR's freight tariff structure according to the cargo characteristics. The costing system of iron ore seems to be a kind of model case. Principles for dividing common costs like depreciation or track maintenance between freight and passengers must be established.
Reform of pricing principles and tariff structure are closely related to other institutional problems, such as management form, accounting system, and so on. Figure 4.2.1.1 shows the tentative implementation schedule of pricing principles and tariff structure in relation to other institutional reforms.

**(2) Establishment of criteria for rational tariff level**

Criteria for rational tariff level is composed of seven items as follows :

**[Criteria for rational tariff level]**

i. Effective Distribution of Resources
ii. Profitability
iii. Public nature and Social Welfare
iv. Paying Ability of Users (Willingness to Pay)
v. Management Incentives
vi. Influence on Consumer Price Level
vii. Degree of Cross Subsidization

**[Criterion 1] - Effective distribution of resources**
It should be stressed that the railway is a transport mode which is most cost saving and has the least damage on the environment of all transport modes, particularly with regard to air pollution and noise, if its characteristics as a mass transit system are fully utilized. Therefore, the resources of railway transport must be effectively utilized for a sustainable and harmonious transport system.

What is the best tariff level for scarce resources to be most effectively distributed? In economic principle, the most effective distribution of resources is attained only when demand equals supply. The reason why the tariff level must be fixed to distribute ENR resources effectively is because the social surplus is maximized when demand equals supply. The social surplus is composed of the consumer surplus and producer surplus.

Demand decreases as price rises, but the supply, which is assumed to be produced at marginal cost, increases as price (cost) increases. Then the effective distribution of resources is realized when the demand is equal to the marginal cost (Marginal Cost Pricing).

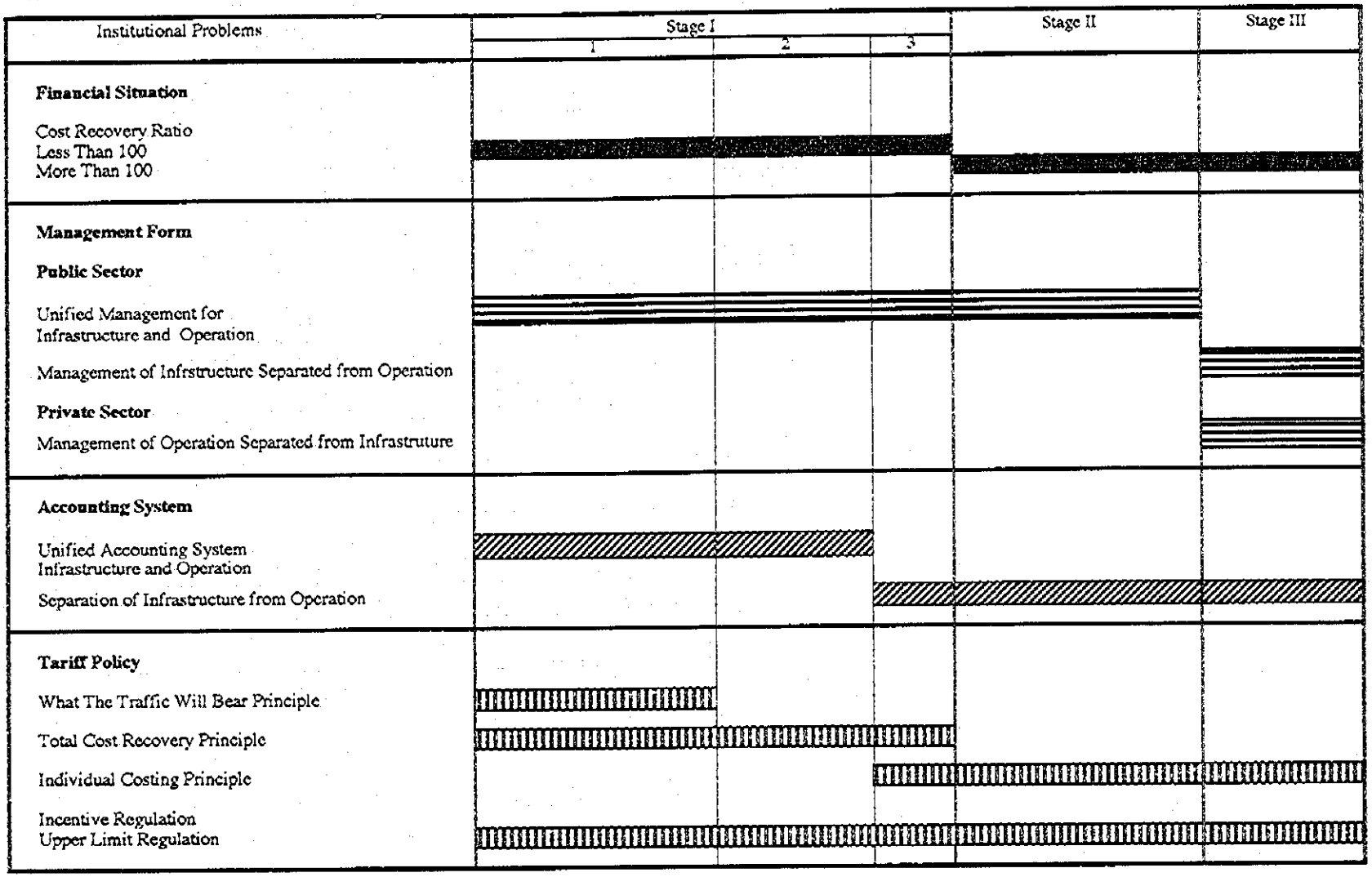



**Fig. 4.2.1.1 Tentative Implementation Schedule for Reform of Pricing Principle and Tariff Structure**

But it is generally recognized that the average cost of railway industry decreases as traffic volume increases, through economies of scale, so its marginal cost also decreases and is less than the average cost (see Figure 4.2.1.2). In this situation, even if the tariff level is set up so the marginal cost equals the demand price, and the effective distribution of resources is attained, equilibrium between revenue and expenditure is not always secured and operational losses are usually generated because the marginal cost is less than the average cost.

Figure 4.2.1.2 has variables $P_4$ (tariff) and $V_4$ (traffic volume), where demand equals marginal cost. If the tariff is set at $P_5$, below marginal cost, traffic demand increases from $V_4$ to $V_5$, so resources will be wasted and a price war or dumping will occur. So marginal cost should be the minimum level of tariffs. Tariffs to secure equilibrium between expenditure and revenue are $P_1$, and to make profits tariffs are $P_2$.

To cope with this situation, there are two alternatives. One is to set the tariff equal to marginal cost, and the loss is subsidized by the Government. But the subsidy can have many negative effects such as negligence of strict management by easy dependence on the subsidy, low morale, lack of competition with other modes, and low incentives to innovate.

The other alternative is to set the tariff equal to average cost, which includes marginal/variable cost and also fixed costs mainly for infrastructure (Average Cost Pricing or Full Cost Recovery Pricing). This creates equilibrium between revenue and expenditure without the subsidy from the Government.

Criterion 1 [effective distribution of resources] is a basic and important principle from an economic point of view but must be modified to apply to the actual tariff policy. Therefore, this criterion is not as important as other criteria.

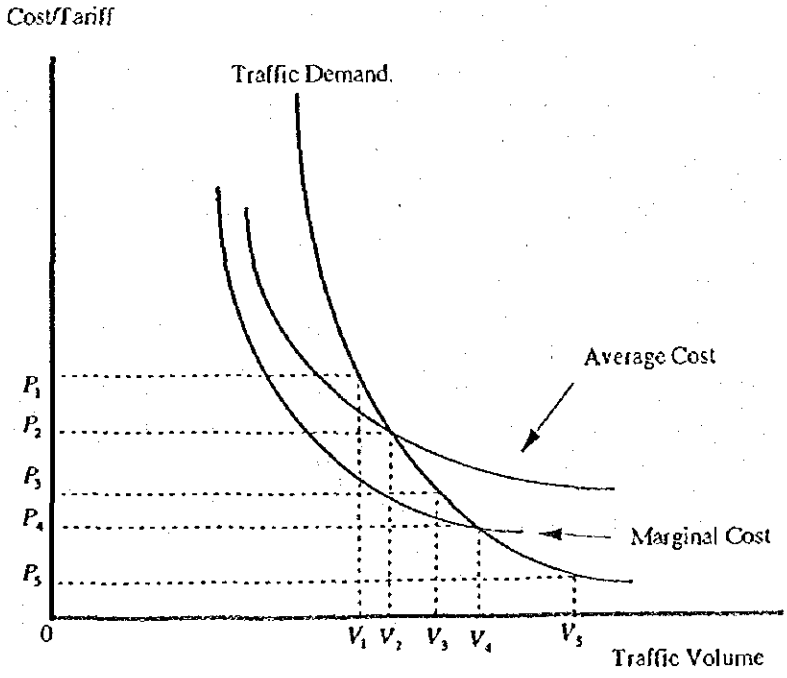



Fig.4.2.1.2 Principle of Marginal Cost Pricing

**[Criterion 2] - Profitability**

Profitability is the most important criterion for a rational tariff level of ENR. ENR is striving to balance revenue and expenditure (cost recovery ratio = 100%) to be independent from the Government. From a market orientated viewpoint, the transport industry is mostly competitive.

In the railway era, the ENR could decide at any level of tariff because of its character as a monopolistic transport mode, and acquire monopolistic profits. But that era is over and now the railway is exposed to severe competition with other modes, so ENR cannot freely decide its tariff level.

To make profit, there are three major factors to set tariffs: (i) price elasticity of traffic demand; (ii) market situation (competitive or monopolistic); (iii) cost recovery based on average cost pricing. With regard to price elasticity, both the elasticity of railway traffic demand and cross-elasticity of competitive modes must be considered. With regard to market situation, first of all, whether the market is competitive or monopolistic should be clarified for each market segment and the degree of competitiveness must be researched.

In a competitive market, price elasticity is generally high. If the service level of ENR is the same as other modes, ENR cannot easily raise its tariffs because its railway traffic demand will divert to other modes because price elasticity is greater than one. ENR will be forced to set up tariffs the same or cheaper than other modes, and strive to reduce costs. But if ENR wants to raise tariffs more than other modes, ENR must raise service quality more than other modes.

The basic strategies for tariff level set by criterion of profitability is as follows :

i. Passenger

(i) Main lines

ENR on main lines competes with airlines, inter-city bus, and inter-city taxi for long trips, and with bus and taxi for short trips. ENR competes with other modes on almost the entire network. ENR traffic demand is very sensitive to tariffs. ENR should strive to reduce costs and raise service quality by improving accommodation, increasing frequency, introducing new cars, and keeping tariffs as low as possible. When ENR's service level is raised higher than other modes, ENR should raise tariffs the minimum possible, to avoid diverting railway passengers to other modes. But the tariff level should be set by taking account of the price elasticity and willingness to pay of passengers.

(ii) Branch lines

ENR's branch lines compete with bus and taxi in short trips, but service is weak and has not been improved aggressively. Even if the tariff level of ENR is lower than other modes, the overall competitive ability of ENR including service quality is weaker than other modes. Almost all branch lines are "lifelines" for local poor inhabitants. ENR is the only means of transport and there is no other alternative means even if the railway tariff is increased. Its price elasticity is very low.

To cope with this situation, three alternatives can be considered : (i) keep the tariff low and subsidized by the Government; (ii) raise service quality but keep the tariff low and subsidized by the Government; (iii) raise tariffs corresponding to the cost of better service, because the price

elasticity is low. Among these three alternatives, alternative (ii) is most desirable. But tariffs should be set by taking account of the price elasticity and passenger willingness to pay.

(iii) Suburban lines (including urban line and Metro underground)
ENR's suburban lines compete with bus and taxi. ENR has a wide variety of passengers with high and low income levels, public and private sector workers, students, shopping housewives, etc. Almost all passengers are accustomed to use the railway because of its cheap tariff, safety, frequency, mass transit character, etc. But now railway passengers have become very sensitive to the tariff level, because there are competitive modes. Therefore, the price elasticity of ENR's suburban lines seems to be higher than on its main lines.

To cope with this situation, three alternatives can be considered: (i) keep the tariff low and subsidized by the Government; (ii) raise service quality but keep the tariff low and subsidized by the Government for the cost of better service; (iii) raise tariffs corresponding to cost of improving service, by taking account of the tariffs of other modes. But the lines should not be closed because the suburban lines cannot be substituted by any other modes for their important roles as mass transit. Among these three alternatives, alternative (iii) is most desirable. But tariffs should be set by taking account of the price elasticity and willingness to pay of passengers. Moreover, it should be taken into consideration that the railway can perform very well on suburban lines, where it can supply large demand if its service and fare are appropriate. Its large transport density could sharply decrease its unit cost and thus its fare.

ii. Freight

As long as the freight tariff is based on the principle of charging "what the traffic will bear", it will not have a market oriented tariff. As already mentioned, fundamental reform of tariff structure is indispensable. But now most ENR tariffs are decided by contract with consignors based on the basic tariff, but contracted tariff is usually higher than the basic tariff. ENR's freight lines compete with waterways and trucks, mainly on long hauls.

The fundamental differences between the passenger and freight tariff systems come from different weight and loading densities. The weight of one passenger is almost the same on average. Therefore, passenger tariffs cannot be based on the weight of each person, because one more passenger does not increase marginal transport cost. But freight is different with regard to weight and car load density of commodities like cotton and sand, so their costs are set by ton, and differ by weight and carload density. So freight tariff should be based on the cost accrued from the differences of weight and carload density.

The price elasticity of freight traffic is closely related to the price of commodities. If the tariff is a relatively large percentage of the product price, the tariff elasticity is also high because the higher tariff will be reflected in higher product cost and the competitive power of the products will be lost. Higher tariffs will force them to switch to other modes.
First, ENR should clarify for each commodity whether its market is competitive or monopolistic, and then the degree of competitiveness must be researched. If the market is monopolistic and its price elasticity is low, the tariff can be fixed high based on the average cost.

To cope with a competitive market, three alternatives can be considered: (i) keep the tariff low and subsidized by the Government; (ii) raise service quality but keep the tariff low and

subsidized by the Government for the higher cost; (iii) raise tariffs corresponding to the cost of improving service, by taking account of the tariffs of other modes. The third alternative is most desirable. But the tariff should be set by taking account of the price elasticity and willingness to pay of consignors.

**[Criterion 3] - Public nature and social welfare**

Even if transport becomes a free and competitive market, ENR should play an important role to help the poor and to promote industry and education by keeping tariffs low, especially for season tickets. ENR will continue to play its public role as a common carrier, and cannot throw away completely and easily this long historical role. But ENR's public nature is steadily decreasing.

In this context, the weight of this criterion (Public aspect and social welfare) is still high but will diminish in the future.

i. Passenger

(i) Main lines

The public nature of main lines can decrease because these lines already compete with other modes, and more market oriented management is strongly needed. These lines can no longer continue to provide transport service only for the sake of public benefit. Then ENR cannot keep their tariffs extremely low, only for public benefit.

(ii) Branch lines

ENR's branch lines are more strongly required to provide service for public service goals, rather than for business goals, because most of its lines have been suffering from large deficits but cannot be easily closed because they are "lifelines", especially for poor passengers and students. On branch lines, the criterion of social welfare is highest of all ENR lines.

(iii) Suburban lines (including urban lines and Metro)

Although less than branch lines, the provision of transport service by suburban lines is strongly needed for public benefit, for example transporting low income workers and students. A business oriented benefit is also required, but less than the importance of social welfare.

ii. Freight

One of the reasons for cheap tariffs of ENR freight transport seems to come from transporting the freight of the public sector "Big Five", like cereals for the Ministry of Supplies, cement, iron ore, coal/coke and sugar for the Ministry of Industry, and petroleum for Ministry of Petroleum. These consignors have contracted with ENR at a low tariff. This low tariff contributes to keep the price of the products low. Consumer enjoying cheap products at the cost of ENR. Basically, ENR transports some freight for public benefit.

Since this freight is inter-governmental, it has the same fiscal result for any agency to suffer losses if tariffs are below costs. There is no reason why ENR should take responsibility for subsidizing the eventual market price of these commodities. If the Government wishes to sell wheat below cost, then the best place to record the subsidy is in the agency producing or selling the product, and not in the transport middleman. This would allow accurate attribution of reason and cost of the subsidies, and permit one of the agencies involved, ENR, to make decisions based on a reasonable relationship between costs and tariffs.

The national economy has already been changed into a free market. The public sectors will be privatized and the market price of products of privatized sectors will be fixed by market mechanism. As freight transport for the private sector increases, the significance of keeping the ENR tariff low will diminish, and the requirement of transport for public benefit will obviously decrease in the future.

**[Criterion 4] - Ability of users to pay (Willingness to pay)**
The ability or willingness of customers to pay is the maximum level of tariff for customers, but is not directly related to transport cost. In other words, it is the value of transport service as evaluated by customers themselves, which creates the price of demand for the service. If the willingness to pay is higher than the tariff, ENR will continue to provide the service and can afford to raise its tariff. But if the willingness to pay is lower than the tariff, customers will change their transport means from ENR to other modes with cheaper tariffs.

Therefore, criterion is relatively important.

i. Passenger

The ability/willingness of passengers to pay is mainly based on the service quality of transport, and their income level.

(i) Main lines
On main lines, the willingness to pay seems to be relatively higher than on other lines, because main lines run through urban areas where big cities are located, and the average income level seems to be higher than on other lines. If the service quality is improved, the tariff can be raised.

(ii) Branch lines
On branch lines, willingness to pay seems to be lower than on other lines, because they are mainly operated in rural areas where average income is lower. Even if service quality is improved, the tariff cannot easily be raised.

(iii) Suburban lines (including urban lines and Metro)
On suburban lines, willingness to pay seems to vary widely because suburban lines are situated in the vicinity of Cairo and Alexandria, and many poor have come to these cities to find work. Even if service quality is improved, tariffs will not easily be raised, but can be set higher than on branch lines. On the contrary, thanks to the higher density of transport, the unit cost on suburban lines should be lower than on branch lines.

ii. Freight

The ability or willingness to pay of consignors seems to be mainly based on the service quality of transport, and not based on their income levels, unlike passengers. The important factor is the ratio of tariff/(product price). Tariff is one component of distribution cost, like cost of package, storage etc. A detailed survey is needed for total production and distribution cost of each commodity.
If service quality is improved, the affordability of higher tariffs corresponding to the improved service depends largely on the relative importance of transport cost for consignors in total

production and distribution cost. If the weight of transport cost is small (i.e. less than 10%), and the tariff is raised by 10%, the product price will be raised less than 1% (0.1 x 0.1 = 0.01), so it is not difficult to raise the tariff.

**[Criterion 5] - Management incentives**

Tariff policy is important to improve management efficiency. Developed countries have introduced tariff systems to give management incentives to public utilities, like the "Yard Stick Method" and "Price Cap Method" already mentioned.

In the yard stick method, cost as a basis of tariff is compared to the cost of more efficient regions or enterprises, and the incentives to compete by cost savings and efficient management are provided to enterprises. Under the full cost recovery pricing principle, the Government as a regulator closely checks the items of cost as a basis of tariffs, with attention paid to efforts to increase revenues, decrease personnel costs by improved productivity, and save maintenance costs by reducing operation expenditures.

In the price cap method, the increase of productivity required by the regulator is taken into account when setting the maximum tariff. The enterprise can freely set its tariffs within the maximum. If the enterprise can save costs more than the required productivity increase, the enterprise can gain the profit of the difference between reduced cost and increased productivity. The benefits of improved management are given to the enterprise.

i. Passenger

If yard stick method is applied to ENR, then when ENR proposes a tariff increase, the Government can compare costs among lines like main lines, branch lines and suburban lines, and use the cost of the most efficient lines as a basis of tariff revision. Less efficient lines have incentives to improve their management. Or the Government can compare the cost of passenger transport of ENR with the cost of competitive modes like bus and taxi. If ENR is less effective than other modes then ENR will be motivated to make their management more efficient.

If the price cap method is applied to ENR, the upper limit of tariff can be fixed for a "service basket", like main lines, branch lines, or suburban lines (or smaller service baskets by class or by line), based on increased productivity, because productivity is different for each service basket.

ii. Freight

In case the yard stick method is applied to ENR, when ENR proposes a tariff increase, the Government can compare the cost by commodity and by line to the cost of the most efficient line as a basis of tariff. Then lines with less efficiency have incentives to improve their management. Or the Government can compare the cost of ENR freight transport with the cost of competitive modes like truck and waterway, so ENR will have incentives to strive for efficient management.

If the price cap method is applied, the upper limit of tariff can be fixed by commodity and by line, based on the percent productivity increase, because productivity is different on each category and line.

This criterion is very important to improve management efficiency. But this criterion can only be introduced into ENR's tariff structure is ENR overcomes several obstacles : (i) establish a

cost accounting system as a basis of tariffs set by the yardstick method; (ii) set up a more objective consumer price index; (iii) establish a more accurate measurement of productivity, for the price cap method.

**[Criterion 6] - Influence on consumer price level**

Transport tariffs are one component of consumer prices, and the beneficiaries of transport service are nation wide. Therefore, tariff changes have a significant influence on the daily life of people, especially low income passengers and consignors of products which have high tariffs relative to product cost.

This is especially sensitive because Egypt is midway in its conversion to a market economy, and has experienced drastic inflation caused by the market mechanism in the past several years. Now drastic price rises have become rarer and the Government reported publicly a policy to stabilize prices. But after moving toward a market economy, the price has the potential to increase. With regard to transport, the cost of maintenance, wages, and fuel have constantly risen.

In this economic situation, keeping ENR tariffs low will impact competitive modes as follows.

i. They will not be able to raise tariffs because of low ENR tariffs.
ii. They must strive to cut waste or compensate for deficits by diversification, without subsidy by the Government.

On the contrary, ENR's deficits have been subsidized by the Government because of its low tariffs.

But this situation is not desirable from the viewpoint of effective distribution of resources. More of the cost of transport by ENR must be paid by customers, not by general tax payers. If so, ENR can take "price leadership". If ENR raises tariffs, other modes will follow and also raise their tariffs. But the upper limit of tariff increases must be controlled or regulated by the Government.

By taking account of the present economic situation and tariff level of ENR, this criterion of "influence to price level" is very important, but customers have limited ability to pay higher tariffs. Therefore the overall weight of this criterion is relatively low.

**[Criterion 7] - Degree of cross subsidization**

Cross subsidization is when an enterprise compensates losses from one activity by surplus from other activities. Cross subsidization is considered to be a type of price discrimination, and its applicability depends on the market situation.

Cross-subsidization over a rational limit will weaken the competitive strength of the railway in areas where it has natural advantages in competition with other modes. Cross-subsidization can preserve the ineffective areas where the railway has disadvantages and fails to take necessary measures to improve management, ultimately reducing its overall efficiency. Japan National Railway Corporation (now JR) was accused of such "over cross-subsidization" as one of reasons which caused its management crisis.

Generally speaking, tariffs of lines which subsidize the deficits of other lines are higher than their costs. In other words, customers of subsidizing lines compensate the deficits of subsidized lines by paying unnecessarily high tariffs. So the degree of cross-subsidization is one factor to consider when setting a rational tariff level.

From the viewpoint of rational tariff level, the less the degree of cross-subsidization, the more rational the tariff level is. But cross-subsidization within the same line is not a problem because the customer can select any train on the same line, based on his preference. But

cross-subsidization among lines with no close relation with regard to service level, location and so on is not desirable.
Cross-subsidization can be permitted within a line as follows :

i. High and low traffic densities
ii. Short and long distances
iii. Peak and off-peak services
iv. Normal and season tickets

The tariff level of subsidizing lines must be carefully set to avoid eliminating the competitive power of ENR by setting up large differences between costs and tariffs.
With regard to ENR, one important problem is that it is not clear where and how cross subsidization exists, mainly because there is no distinct information regarding profits and losses by line, and the Government subsidy is given to ENR not by line, but by gross amount of deficit.

i. Passenger

Part of the deficits of branch lines is subsidized by revenue of main lines, although main lines are not actually profitable, because the same tariff system is applied to both main lines and branch lines, except 1st A/C (which is not provided by branch lines), but the basic tariff of 2nd class and 3rd class are same.
Furthermore, there seems to be implicit cross-subsidization from profitable lines like turbo trains to inefficient trains like without A/C trains between Cairo and Alexandria. This type of cross-subsidization is desirable only as long as the tariff of turbo trains is rational to subsidize lower class trains between Cairo and Alexandria. But the tariff of turbo trains seems to be considerably higher than its cost. Therefore, the cross subsidization by turbo trains seems to be "over cross-subsidization", which is not desirable.

ii. Freight

There seems to be no explicit cross subsidization among lines of freight transport by commodity of ENR. For example, the tariff level of iron ore on El Wahat - Tebeen line is relatively higher than tariffs of other commodities, because the tariff of iron ore is based on its transport cost. On the contrary, tariffs of other commodities are set lower than their costs.
It is not apparent that iron ore transport is subsidizing other freight, because it is not clear yet if the iron ore tariffs are extremely higher than costs.
If the iron ore transport is based on a rational level of tariff, this line cannot be said to subsidize other lines because it has no ability to subsidize other lines. Further detailed investigation and analysis with regard to the relation between tariff and cost for each commodity by line is indispensable.

**[Integrated Criterion]**
For the purpose of fixing the rational level of tariff, an overall integrated judgment of the criteria mentioned above is indispensable, taking account of the importance or weight and priority of criteria from a viewpoint of management improvement on the basis of detailed marketing research, statistical analysis, etc. Some functions or formulas for measuring rationality of tariffs must be developed by further study.

### (3) Tariff increase policy

#### 1) Restructure of decision making process

Fundamental reform of the decision making process for tariff revisions including tariff increases, is an urgent task for ENR.
The decision making for permission of tariff revisions of ENR is conducted by very limited governmental agencies of the Ministry of Transport and Policy Committee headed by the Prime Minister. The process of council and discussion has not been publicly announced. The reasons for revision of tariff increases, for example reducing a 20% request to 15%, have not been announced to customers. To avoid this situation, the right for decision making on tariff revisions should be assigned to some other agencies.

**[First Step]**
First, a more scientific checking system for tariff increase proposals should be established, and the proposals should be checked by this system. The checking system must include: (i) establishment of an independent committee from the Government; (ii) establishment of criteria of judgment for a rational tariff; (iii) establishment of the most suitable pricing principle; (iv) detailed cost breakdown as a basis of tariff increase.

**[Second Step]**
Second, permission from the Government should only be required for tariff increases for normal tickets (1st, 2nd, and 3rd class). Special charges for A/C for 1st class and 2nd class should be decided by ENR itself.

**[Final Step]**
Finally, tariff revisions should be independently conducted by ENR alone without any interference by the Government, same as for other modes like bus, taxi, truck and waterways. But the Government should control ENR in a manner that gives ENR ex post facto approval, and checks the rationality of tariff raise after actual tariff raise.
Fig. 4.2.1.3 shows the procedure for tariff revisions of Japanese Railway Company (JR). It will be informative for restructuring the decision making process for ENR tariff revisions.

#### 2) Practical tariff raise policy

The discussion above shows that tariff increase policy is closely related to the criteria of the rational tariff level, because there are many factors and reasons to raise tariffs in the light of criteria of rational tariff level. Therefore, actions to establish a practical, rational tariff level must start as soon as possible.

For practical tariff increase, three scenarios can be drawn up

**[Scenario 1]**
i. Tariff structure is not reformed
ii. Tariff increase is implemented for passenger and freight.

In this scenario, a tariff increase is carried out with the goal of 100% cost recovery ratio at ENR as soon as possible.

The tariff raise can be conducted by type of service (1st A/C, 2nd A/C, 2nd, and 3rd), by type of train (normal train, express train, Turbo train, Sleeping car, etc.) and by line (main lines, branch lines, urban lines, suburban lines, and Metro underground) for passenger and by category of commodity for freight. But to accurately calculate the impact of tariff increase on ENR finances, a sophisticated model of traffic demand forecast must be developed.
Factors for increasing tariffs are as follows :

(i) Rational tariff level, which needs more detailed study
(ii) Improvement of service level
(iii) Impact on consumer price level
(iv) Higher operating expenditures from higher consumer prices
(v) Cost of investments to strengthen transport capacity
(vi) Tariffs of other modes
(vii) Past results of tariff increases

**[Scenario 2]**

i. Tariff structure is reformed.
ii. Tariff revision (raise or reduction) is only implemented to reform tariff structure.

In this scenario, the criteria for rational tariff level will also be important factors for reform of tariff structure, because restructure of the tariff system is an important factor for establishment of criteria of a rational tariff level. Tariff revision for passengers can be executed with regard to simplification of classes, pricing principle by line, modification of tariff ranges to include shorter distances, etc. The tariff level is not only increased, but can also be reduced, depending on the class and line, according to the policy of the tariff restructuring.
Tariff revisions for freight can be executed with regard to simplification of commodity categories, based on commercial values of commodities. Reforms can include combination or elimination of categories, degree of car load density, pricing principle, modification of price structure for range of haul, and so on. Individual tariffs may be increased or reduced, according to the structure of tariff reform.

**[Scenario 3]**

Scenario 3 is a combination of scenarios 1 and 2.

i. Tariff structure is reformed.
ii. Tariff raise is implemented based on the discussion in scenarios 1 and 2.

In this scenario, the tariff increase described by scenario 1 is conducted at the same time as tariff restructuring is implemented. Actual tariff increase is likely to be highly complex.

By comparing the three scenarios, scenario 1 is the most practical in the short term.

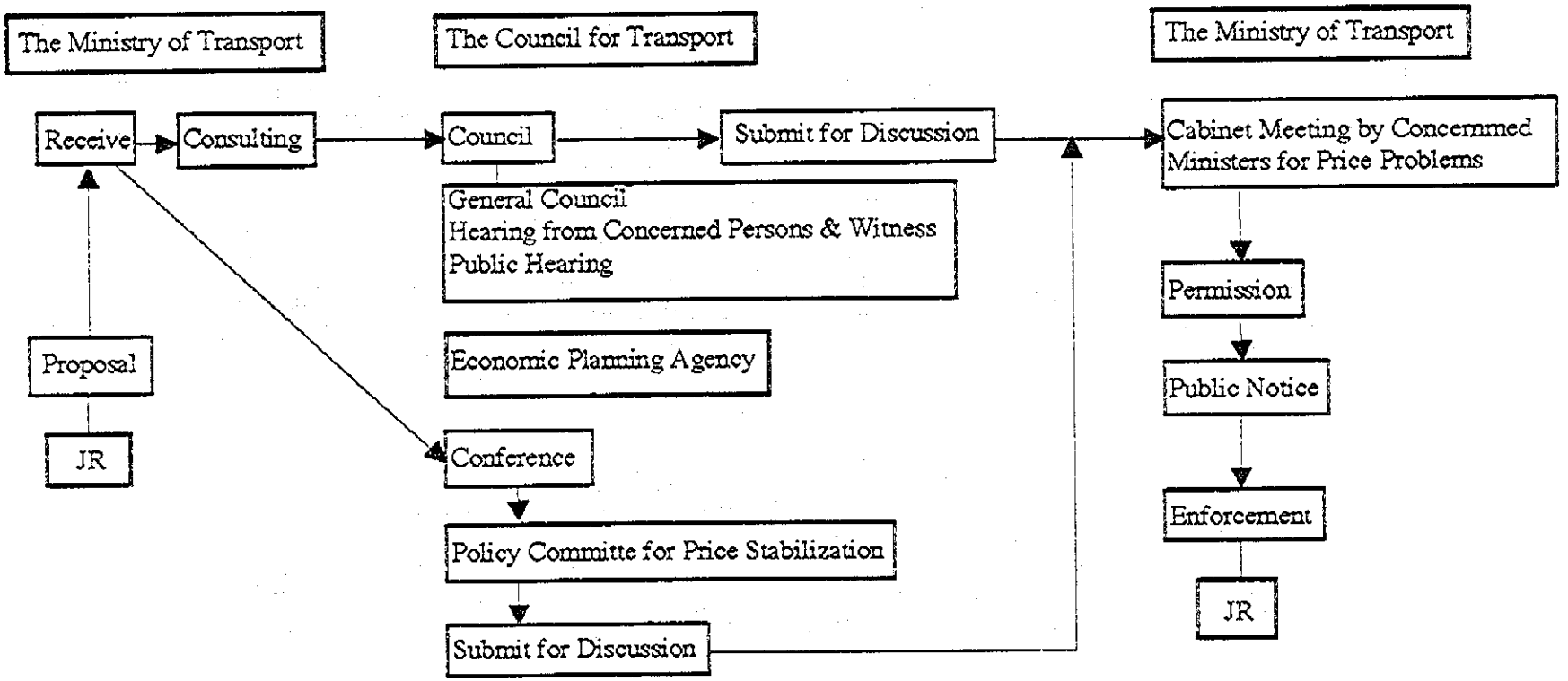



**Fig. 4.2.1.3 Flow Chart of Procedure of Tariff Revision for JR**

### 4.2.2 Strengthen Ticket Checking System

ENR has been suffering from huge losses from passengers without tickets. To avoid this loss, the following tactics should be executed as soon as possible. Passengers without tickets are estimated at about 4 million passengers per month. Intensification of the ticket checking system is one of the simplest and effective ways to increase ENR revenue.

**(1) Building fences around stations**

Many stations have not completely enclosed their areas from the outside. Passengers can freely enter the platform and get on trains without tickets. If these passengers are not checked by conductors and get off without tickets, they will become accustomed to get on trains without tickets and will try to ride crowded trains to avoid checking by conductors.

The first step to eliminate free riders is to build fences around stations to shut out free riders, or strengthening the security system.

**(2) Extend ticket office hours**

Ticket offices of most stations are open only less than 30 minutes before arrival of trains. If passengers want to get tickets from the ticket office, they must miss trains because 30 minutes are not enough to issue many tickets. So passengers must get on trains without tickets. ENR cannot forbid this behavior of passengers because ENR creates the problem. Issuing tickets is a very basic function, but it is not working properly. If there is not enough time, there is no good reason these riders must pay a fine in addition to the ticket price. The fines are a large penalty for passengers, only because they do not have enough time to get tickets at the ticket office. These passengers do not intentionally get on trains without tickets.

Criteria for discrimination between intentional free riders and Unintentional free riders should be established. Only intentional free riders should pay penalties. Unintentional free riders should only pay a small fee for conductor service, in addition to the normal price. All fines for intentional free riders and charges for conductors for unintentional free riders should be allocated to the cost of building fences around stations. Payment of construction cost of fences is based on the principle of payment by users.

**(3) Portable ticket machine**

About 70 portable machines for conductor are introduced into trains between Cairo and Alexandria as a pilot study. Finally 220 machines will be introduced on this line. Approximately 1,000 to 1,500 machines are estimated necessary for all ENR. To effectively collect fares from passengers, more efficient conductor machines and a more rational inspection system should be positively introduced from foreign countries which have experience of intensive and sophisticated inspection systems, like in Japan.

**(4) Incentives for conductors**

It will take time to build fences around all stations. Until then, effective fare collection from

passengers without tickets are indispensable.

**(5) Thorough investigation**

It is a fact that ENR is partially responsible for the problem of free riders, because of its insufficient service. But it is also true that there are intentional and accustomed free riders. Regular and thorough investigation of free riders by ENR staff seems to have potential to increase collection of fares from free riders. This will also make use of idle ENR staff.

**(6) Business improvement alternatives**

In the analysis of business improvement alternatives, revenue increase from intensifying the ticket checking system by conductors is assumed in the "With Cases" as follows.

Non-paying passengers are estimated to be 15% to 25% of passengers for normal 2nd and 3rd class. It is assumed that collection of fares from non-paying passengers in these classes will improve 5% by 1997/98, and 15% by 2001/2002 from the current level, by strengthening ticket inspection.

### 4.2.3 Reduce the Travel Time for Passengers on Main lines

Inter-city Transport and urban transport are becoming the main areas for the passenger transport service of railways. This phenomena is clearly revealed in ENR transport data, as shown in Chapter 3.10.
Road transportation on Egypt's highways is suffering from serious congestion in big cities along the Nile, which lowers the road transport capacity and increases the social cost of transportation.
The attractive aspects of railroad transport, above mentioned, will also contribute to road capacity. The utilization of railway capacity should be promoted for the healthy development of society, by introducing attractive railway transport service, but should not be realized by regulation and law.

Further efforts should be concentrated on the improvement of Railway Passenger Transport on main inter-city lines and urban areas of Cairo and Alexandria.

**(1) Measures for reducing travel time**

① Increase hauling force of locomotives
② Increase passing speed on curves
③ Increase passing speed on switches
④ Increase the provisory limiting speed
⑤ Improve passing speed for operation by tablet block system
⑥ Simplify track alignment of terminal stations

**(2) Measures for reducing travel time by line**

**1) Trunk lines between Cairo and Alexandria**

As shown in the track figure in Chapter 7, the line facilities of Cairo - Alexandria are very suitable for higher speed operation, but the actual traction capacity of trains is not sufficient to utilize the very valuable track facilities.
We can say that the potential of its track alignment is a very valuable asset of ENR and Egypt. These track facilities should be utilized as far as possible.
The effect of introducing pendulum type rolling stock is not very large, because few sections limit train speed.

The line facilities of Cairo - Alexandria are suitable for 160 Km/h operation, and the section between 112 Km and 200 Km might be suitable for 200 Km/h operation. By introducing the special safety device of ATC, 200 Km/h operation can be realized by reducing speed at Qalyub, Benha, Birket El Sab, Tanta, near Kafr El Zayat, and on the Sidi Gaber - Alexandria section in the future.
The following two trunk lines are essentially different from the other two trunk lines along the Nile. These lines are confronting severe competition with road transport, because of the relatively low speed of train operation among cities, and because of the completed highway network connecting directly to Greater Cairo.

**2) Trunk line between Cairo, Benha, Zagazig, Ismailia and Port Said**

Zagazig should have better connections to Greater Cairo by increasing train speed. The road traffic between Ismailia and Cairo runs in 2 hours by desert road. Railway traffic should be set up to provide inter-city transport to Cairo, and regional traffic among cities between Benha and Ismailia, by utilizing the double track line.

Although the trains arrive at Benha station running approximately 75 Km/h from Cairo station, the average speed decreases to 50 - 60 Km/h in Benha - Zagazig - Ismailia, because of the low speed on the Benha - Zagazig - Ismailia line, although the section is constructed as a double track line.

**3) Trunk line between Cairo, Tanta, Mansura and Damietta**

Shortening of travel time between Cairo and Mansura can be achieved drastically by elevating maximum speed, reducing the stopping time at Tanta station, etc. 140 Km/h operation can be realized by enforcing the safety system between Tanta and Mansura, and by introducing more powerful locomotives.

The train average speed between Tanta and Mansura is 65 - 78 Km/h. The current train set still has a possibility of 120 Km/h operation, although current limiting speed of rapid trains is 90 Km/h.

**4) Trunk line between Cairo and Aswan**

Trains between Cairo and Aswan, which are the most important for ENR revenues, can run in less than 11 hours in the near future, after completion of the double tracking project between Idfu and Aswan. 9 hours 30 minutes can be achieved after completion of the signal modernization project.
The train sets of night sleeper luxury cars can be utilized for day time medium distance transport between Aswan and Luxor or between Cairo and El Minya. Passengers who use the night trains can enjoy a full day in the destination, because the trains depart at 19:00 - 21:00 and will arrive at 6:00 - 8:00 in the morning at the destination station.
By utilizing these locomotives by day, train operation service between Aswan and Luxor and between Cairo and El Minya, etc. can be improved.

The passengers who use the night trains can enjoy a full day at the destination, because the trains which depart at 19:00 - 21:00 will arrive at 6:00 - 8:00 in the morning at the destination station. The more powerful rapid train can run at 140 Km/h between Cairo and Asyut or Luxor. Achieving that speed is a very difficult job. 9 hour 30 minute travel may become possible between Cairo and Aswan when the signal improvement project is completed. Then the train can start after peak hours in the evening, and before rush hour in the morning can arrive at its destination.

**5) Facilities for quick return use at terminal stations**

The facilities for efficient rotation of train sets will demand appropriate facilities for passenger service and for operation work at both terminal stations.

### 4.2.4 Improve the Freight Transport System

#### (1) Current problems of freight transport

**1) Small scale of freight stations**

In ENR, more than 300 freight stations handle freight cargoes, as shown in Table 4.2.4.1. Among these stations, the loading and unloading tonnage of 192 stations are below 10,000 tons per year (daily 28 tons or 1 - 2 wagons). Although these small stations account for more than 60% of all stations, the total tonnage handled by these stations is less than 2%.

**Table 4.2.4.1 Number of Station and Tonnage by Category**

| Tons handled | Number of stations | | Total loading/unloading tons/year | |
|---|---|---|---|---|
| More than 100,000 tons | 39 | 12.3% | 22,859,000 | 86.9% |
| 20,000 - 100,000 | 56 | 17.7% | 2,515,000 | 9.6% |
| 10,000 - 20,000 | 29 | 9.2% | 433,000 | 1.6% |
| 0 - 10,000 | 192 | 60.8% | 509,000 | 1.9% |
| Total | 316 | 100% | 26,313,000 | 100% |

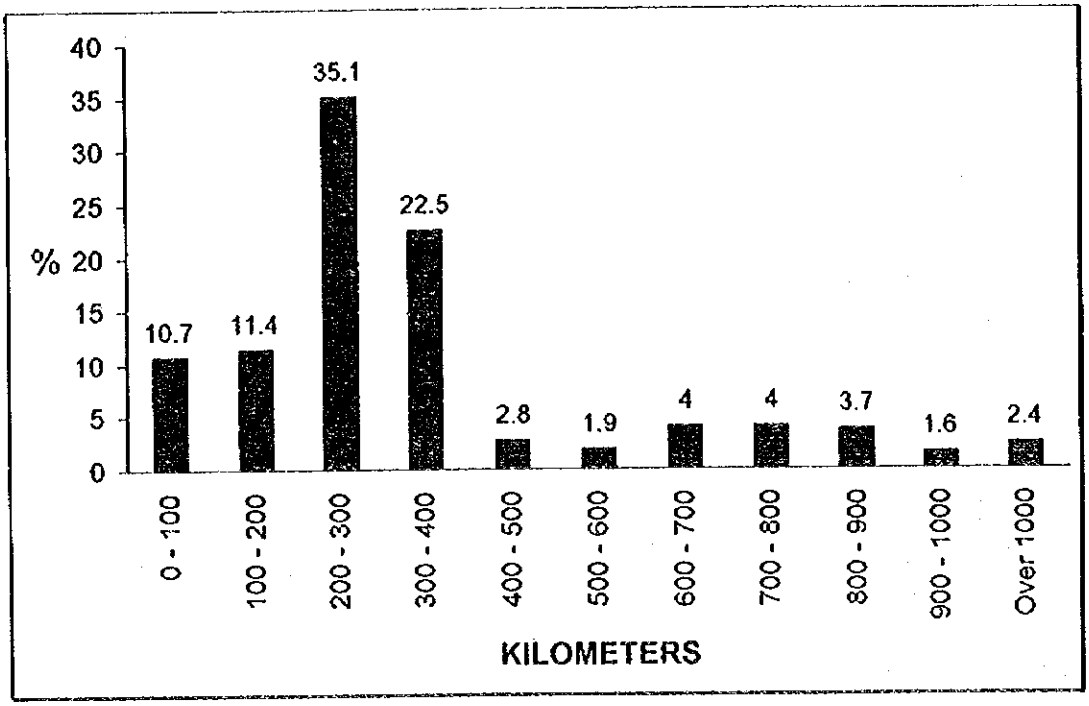
**2) Short distance between adjacent freight stations**

The average distance between freight stations is about 13 km.

**3) Short transport distance**

Because of the geographical features of the land, the average hauling distance of ENR cargoes is about 330 km, rather short compared with other countries. Over 80% of cargoes are transported less than 400 km, as shown in Figure 4.2.4.1.

**Figure 4.2.4.1 Freight Traffic Distance Breakdown**




**4) Commodity share**

8 commodities out of the total 30 categories account for 91% of total loading/unloading tons and ton-kilometers, as mentioned in Chapter 3.3.

**5) Freight train operation**

There is not any pre-scheduled freight train schedule. Freight trains are operated in accordance with cargo booking.

Therefore, freight trains are frequently forced to wait at crossing stations for a long time. As a result, transport time is lengthened, and receiving customers cannot get any information about the arrival time of their cargoes.

Moreover, due to the lack of brakes on some wagons, freight trains are generally very slow. Thus the track capacities of certain lines are restricted by their slow freight trains, and the freight trains can run only during night.

**(2) Customers requirements**

As previously mentioned in the section of "Railway Freight Customers' Opinions for Railway Freight Service", railway freight customers have comments on ENR's freight services. According to customers, the following are required from ENR :

- Provide more freight wagons in proper condition
- Improve the general conditions of freight wagons (i.e. cleaner wagons)
- Provide more freight train operations
- Distribute freight wagons in accordance with customers' required timing ("Just in Time")

### (3) Direction to improve the freight transport system

As mentioned above, there are many proposals and customer requirements for improving freight transport. So the freight transportation system should be improved to be more market oriented, as follows.

#### 1) Rearrangement of freight stations

In view of the development of the vehicles between customers and railway freight stations, the distance between adjacent freight stations is too short, significantly reducing the efficiency of railway freight transport. Moreover, some freight stations are very small. Long freight trains have to stop at small stations to uncouple or couple only a few wagons. This hinders the efficiency of rail freight transport very much.

Because of the reasons mentioned above, the Study Team strongly recommends closing small scale freight stations which have small cargo volume. ENR should consider various factors of each station, including seasonal tonnage variation, possibility of future development, user opinions.

Let us assume that all of the 192 stations with less than 10,000 tons per year are closed, and all cargo handled by these closed stations divert to other transport modes. Even in this extreme case, ENR will lose only 507,000 tons of cargo per year (only 1.9% of total ENR cargo). Of course, if adequate countermeasures are taken, most of this cargoes will not divert to other transport modes, and shift to adjacent larger railway stations.

As a result, only 124 freight stations will remain, significantly raising the efficiency of both freight and passengers train operations.

These 124 remaining major freight stations should be modernized with adequate loading/unloading equipment and facilities such as folk lifts, gantry cranes, and storage to attract customers.

#### 2) Improvement of freight train operation

Both the running speed and average speed from origin to destination of freight trains is very slow, and should be raised. For this purpose, the freight trains should operate according to a pre-scheduled train diagram, and wagons must have brakes installed. Furthermore, a freight information system as mentioned below should be established.

#### 3) Establishment of freight information system

It is necessary to develop an adequate information system which can trace the position of freight trains and the type/number of wagons. Then, freight train operation can be managed on a real-time basis.

Also, dispatching the adequate type and number of empty wagons to customers as soon as possible is one of the important service factors for railway freight business. To carry out this work smoothly, the development of an appropriate information system is indispensable.

#### 4) Promote containerization

Nowadays, bulk cargo such as iron ore and phosphate account for most of railway freight. Relatively little general cargo is carried by railways. Almost all general cargo transport is carried out by trucks.

General cargo is increasingly transported by container throughout the world. Containerization has the merit of transporting general cargoes without troublesome loading and unloading at the freight station, saving labor time and avoiding damage.

In Egypt, transportation of containers are mostly transported by truck, and container transport by rail is very limited to situations such as transshipment from port to port (see Appendix 3.3.3 in the section "Railway Service").
Taking account of the above mentioned merits of containerization in rail freight transport, it is worthy to study a full-scale railway container system for ENR. A relevant study was conducted in 1987 ("Rail Container Feasibility Study, prepared for ENR, Transmark & El Hawary, 1987"). A summary of this Study is shown in Appendix 4.2.4.

**5) Marketing development by effective utilization of freight agents**
Freight agents can function as intermediaries between ENR and freight customers. In order to make close contact with customers, and to attract more freight, effective utilization of arrangement by freight agents is essential, together with providing proper services to customers.

Freight agents have potential to increase volume for ENR, and also to function as coordinators of a future intermodal transportation system (transport system combining several modes) as containerization develops.

**6) Marketing development by introducing joint operations/joint ventures with other transport modes**
The critical disadvantage of railway transport, especially for freight, is the lack of "Door to Door" service. On the contrary, the largest advantage of truck transport is "Door to Door" service. Customers largely rely on trucks to access the railway. Therefore, a system of joint operation or joint venture with other transport modes (trucking companies) is proposed.

The functions of this system are as follows:
- Transport freight by railway, with access by trucks owned by the joint venture company.
- Function as an agent for freight customers (function same as the above "Freight Agent").
- Function as a coordinator of future intermodal transportation system, in accordance with containerization trend.
- Function as a storage operator, with its own storage facilities.

ENR should hold over 50% of the shares in this joint venture, to retain control.

**7) Scrap unused wagons**
About 200 wagons designed for vegetables and livestock are now unused. They should be scrapped.

### 4.2.5 Improve Passenger Service

The Egyptian economy is generally progressing towards a market-oriented economy. In the transport sector, bus, truck, and inland waterway companies are in process of privatization, although some delays are anticipated. It can be said that also the demands of transport business are changing rapidly, reflecting the general trend towards a market-oriented economy. ENR's competitors are already responding to these changes.
ENR also must become more marketing oriented in accordance with the changing transport market.
The following are some proposals regarding ENR's passenger transport :

**(1) Marketing purpose and realization**

The purpose of marketing is to attract more railway passengers. To realize this purpose, the following should be considered.

- Improvement of services in accordance with service class.
- Enhancement marketing attitude and functions in ENR, emphasizing customer satisfaction.

**(2) Improvement of services according to service class.**

Tariff increase is one way to increase revenues. However, without improvement of service level, tariff increase is considered impossible.
According to the interview survey results about railway passenger comments on railway services, several severe comments were revealed, as previously shown in Appendices of 3.6.17 ~ 3.6.21. However, if these comments are interpreted in reverse, it can be understood that when these problems are resolved properly, even if gradually, ENR can attract more passengers.

**1) For First A/C and Second A/C Classes**
The interview survey results show that the characteristics of railway passengers of the first and second A/C classes especially for the Main Line is mainly "business purpose" passengers. Furthermore, considering the interview survey results about the railway passengers' free comment on railway services, and the existing services of the competitive mode (High-deck type buses with higher level services; i.e. A/C, video, toilet and food/drink service), it is required for ENR to provide a rather higher level services, for instance:

- More telephones on coach.
- Isolate smokers.
  For the convenience of non-smoking passengers, it is recommended to introduce a non-smoking coach in the same train, to isolate smokers.
- Cleaner coaches.
- Improve quality of food sold in coaches.

**2) For 2nd and 3rd Classes**

The interview survey results show that the number of "workers" and "students" are a larger share of 2nd and 3rd class passengers, than in 1st and 2nd A/C. Furthermore, considering the interview survey results about railway passenger comments on railway services, the following service improvements should be stressed :

- Basic improvement and maintenance of coaches, such as windows, doors, seats, toilets, and lights, and more cleaning.
- Punctuality.
- More trains.
- More coaches.
- Adjusting train schedule to meet passenger needs.

**3) Common improvement policy**

As previously mentioned in the section "Railway Service", there are some problems regarding ticket windows at stations. Improvements are required for the ticket window system.

### (3) Enhancement marketing attitude and functions in ENR, emphasizing customer satisfaction

To improve passenger service, it is important to enhance ENR's customer service attitude.
It is important to understand passengers' needs, and reflect these needs in actual service improvement.
For this purpose, it is recommended to introduce a monitoring system. In this system, there are some monitors who are railway users outside ENR, and who will report regularly their comments about the railway service as railway users.
The related section/department in ENR (Commercial Department) will collect their comments and use these comments to upgrade service.

### 4.2.6 Require the Compensation to the Government

#### (1) Compensation for amounts discounted by social and political policy

**1) Necessity of compensation**

There are two categories of discount policy for passenger ticket. The first is for marketing policy and the second is for social/political policy. Discount rates for social policy are considerably high. The main reasons for these high discount rates are (i) promotion of industries and education; (ii) support for low income people. These reasons are mostly from Government policy.

These socially discounted tariffs are a kind of "public burden" which is paid by ENR for the Government. In this context, the loss of these discounted amounts should not be indirectly subsidized. It should be directly compensated by the Government. The actual payments of these discounted amounts should be rationally shared between ENR and the Government.

In the European Union (EU), the Governments and railways make contracts on the basis of principles of civil law with regard to compensation for discounted provided for national or social policy goals. Railways are responsible to execute their obligation to transport the passengers who benefit from these discounts. The Government is responsible to pay for part of the transport cost, because governments require provision of cheap transport service. Thus Governments and railways have completely equal status in respect to civil law.

But unfortunately ENR has not been put in an equal position with the Government with regard to transport for the sake of national policy. ENR has one-sidedly been given the obligation to play a role in social welfare policy by the Government. The Government has neither responsibility nor accountability for compensation. Instead, the Government has subsidized deficits of ENR, losses from large discounts for social policy should not be considered to be deficits, because this loss is not generated by management, but by national policy of the Government.

**2) Basic assumption for compensation**

a. Discount Rate

(a) Normal ticket

For normal tickets, the discount rate for soldiers and blind people is 50%.

(b) Seasonal ticket

For seasonal tickets, the weight average discounts are estimated by class on the basis of assumptions as follows.

a) Validity period

Validity period of seasonal ticket is set at six month for workers and students, and 3 months for kilometer tickets, by taking account of the revenues of these tickets out of all revenues.

b) Average travel distance

There is no available data for average distance of seasonal tickets, so 20 km is assumed in this study. But the average distance for kilometer tickets is regulated at 100km.

c) Number of trips per month
The number of trips per month for normal tickets is assumed to be 60 for 30 days. The number of trips per month for discounted tickets is set up by type of line (main/branch lines and suburban lines), and the type of job/discount, according to ENR regulations for seasonal tickets.

d) Weighted average discount rates
By taking account of the above factors a) to c), and weighting discount rates by the revenue of each class, type of job, and the type of line, weighted average discount rates were derived. The highest discount rate is shown for students (98.9% discount), caused by an incredibly low tariff level, unchanged since 1942. Second largest discount is received by public sector workers and governmental officials (85.9% discount), private sector workers (73.5%), and kilometer tickets (73%).
It is notable that the discount rate of kilometer tickets is rather high, considering their purpose is for marketing.

b. Discount rate to be compensated
The maximum level of discount rate that ENR should bear is assumed to be 50%. The discount rates of public bus companies are 15% for all kinds of workers, and 40% for students (see Appendix 4.2.61). These are very small discount rates in comparison with ENR discounts, because these bus companies are already operated commercially, not subsidized by the Government for their losses. So they must strive to cover their cost by passenger tariffs.
The discount rates of these buses are not suitable for setting the maximum level of discount rates of ENR, because ENR also has public policy goals. The discount rate to be compensated by the government is assumed to be the difference between the actual discount rate, and the maximum level of discount rate which ENR should bear (50%).

**3) Amounts to be compensated by the Government**
First of all, the normal revenue, which is considered to be the non-discounted price of normal tickets, is calculated by a formula, (actual revenue)/(1-average discount rate). Second, the discounted amount is calculated by subtracting actual revenue from normal revenue. Finally, the amount to be compensated by the Government is calculated by multiplying the discount rate to be compensated (actual discount rate minus 50%) by the discounted amounts.
The result is shown in the **Table 4.2.6.1**. All kinds of discount rates of normal ticket is 50% and are equal to the maximum level of discount rate to be paid by ENR as 50%. So the amount to be compensated is zero for normal tickets. Kilometer tickets are a part of marketing policy, so are not counted for compensation. Total amount of appropriate compensation would be 36.3 million LE for 1994/95.

The largest amount to be compensated is for students at 19.5 million LE (53.7%), followed by public sector workers and governmental officials at 15.2 million LE (41.9%), and private sector workers at 1.6 million LE (4.4%).
Compensation from the Government is requested only with regard to ENR excluding Metro. The tariff of Metro is higher than that of other suburban lines. The amounts to be compensated mentioned above are included in this study's proposals to ENR. These compensations are assumed to increase in proportion with the increase of passenger traffic.

**(2) Compensation for deficits of Branch Lines for passenger and freight lines**

Most of passenger and freight lines are unprofitable because of tariffs considerably lower than their costs. Especially, branch lines for passengers are operated for social and political goals, regardless of their profitability. Freight lines transport commodities which are necessary for basic industries like construction and mining, and agricultural products, for very low tariffs. Most consignors are in the public sector, such as the Ministry of Supply and the Ministry of Industry. Therefore, freight transport is considered to be operated for national industrial policy.
In this context, the responsibility of deficits of these lines should not be wholly borne by ENR, but shared by ENR and the Government. The Government should pay for ENR deficits in the form of compensation. After 2001/02, by taking account of ENR's financial situation, a more concrete compensation policy should be established.

The criteria for compensation should be studied in detail by line with regard to: (i) contribution to local community; (ii) traffic density; (iii) cost performance; (iv) cost recovery ratio; (v) existence of alternative transport means; (vi) comparison of cost efficiency between railway and other modes, etc.

**(3) Compensation for construction cost of new lines**

The new line between Ismailia and Rafah in Palestine is planned to be constructed for the development of Sinai peninsula. But this project is planned for national goals, and is out of scope of our study. The construction cost of this new line should be financed from the Government. This study's proposals do not include this construction cost in the "With Cases", assuming that this cost should be covered by the Government. The "Without Case" assumes ENR bears the burden of this construction expense.

**Table 4.2.6.1 Estimated Amounts to be Compensated for Passengers by Type of Ticket**

[Period : 1994/95]

| Ticket Type | Type of Job/Discount | Type of Class | Revenue (1,000 LE) (A) | Average Discount Rate(%) (B) | Normal Revenue (1,000 LE) (A)/{1-(B)}=(C) | Discounted Amounts (1,000 LE) (C)-(A)=(D) | Amounts to be Compensated (1,000 LE) (D)x{(B)-50/(B)} |
|---|---|---|---|---|---|---|---|
| Normal & Discount | Return Ticket | 1~3 | 1,439.6 | 17.5 | 1,745.0 | 305.4 | 0.0 |
| | Special Group Discount | 1~3 | 406.8 | 50.0 | 813.6 | 406.8 | 0.0 |
| | Soldiers | 1~3 | 2,551.2 | 50.0 | 5,102.5 | 2551.2 | 0.0 |
| | Blind People | 1~3 | 18.3 | 50.0 | 36.7 | 18.3 | 0.0 |
| | Total | | 4,416.0 | 42.6 | 7,697.8 | 3,281.8 | 0.0 |
| Season | Workers of Public Sector and Government Officials | 1 | 151.7 | 86.0 | 1,083.4 | 931.7 | 384.6 |
| | | 2 | 1,994.4 | 85.8 | 14,067.8 | 12073.4 | 4,994.1 |
| | | 3 | 3,825.5 | 86.0 | 27,252.9 | 23427.4 | 9,674.8 |
| | Sub-total | | 5,971.5 | 85.9 | 42,404.1 | 36,432.6 | 15,053.5 |
| | Workers of Private Sector | 1 | 72.6 | 73.0 | 268.8 | 196.2 | 63.2 |
| | | 2 | 582.0 | 73.5 | 2,196.2 | 1,614.2 | 516.1 |
| | | 3 | 1,149.3 | 73.5 | 4,336.9 | 3,187.6 | 1,019.2 |
| | Sub-total | | 1,803.8 | 73.5 | 6,801.9 | 4,998.0 | 1,598.4 |
| | Students | 2 | 430.6 | 98.9 | 39,863.8 | 39,433 | 18,736.0 |
| | Kilometer | 1 | 239.9 | 73.0 | 888.3 | 648.5 | 0.0 |
| | | 2 | 614.5 | 73.0 | 2,275.9 | 1,661.4 | 0.0 |
| | Sub-total | | 854.3 | 73.0 | 3,164.2 | 2,309.9 | 0.0 |
| | Total | | 9,060.2 | 90.2 | 92,234.0 | 83,173.8 | 35,387.9 |
| Grand Total | | | 13,476.2 | 86.5 | 99,931.8 | 86,455.5 | 35,387.9 |

Source : Revenue and basic discount rates were provided from the ENR Commercial Department.

Notes : 1) The discounted amounts to be compensated are limited to the amounts discounted from the viewpoint of social policy.
2) Discount rates for seasonal tickets are based on the ticket price of 6 months with 20km travel distance.
3) Discount rates by type of job for seasonal ticket are weighted averages with regard to revenue of main/branch line and suburban line.
4) Amounts to be compensated are assumed to be the amounts based on the discount rate over 50%.

### 4.2.7 Reducing the Number of Staff

#### (1) Productivity

Within this Study we explored the possibility of making specific Productivity comparisons using the World-wide comparison data obtained from the World Bank.

The warnings have been that it would be necessary to take great care before drawing specific conclusions from this data because of the difficulty of validating the real comparability of differing organizations.

As the Master Plan Study has progressed and the information and data available on ENR has become more detailed and meaningful, the value of this point has become even clearer.

The nuances of Railway practice and organizations make it extremely difficult to directly compare any two Railway systems with any real confidence, and the best they can do is to provide pointers as to the areas where improvement may be possible.

Taking the current situation of ENR, all anecdotal and observational evidence indicates there is considerable scope for staff reductions. This view has recurred frequently throughout the Progress and Interim Reports and there appears to be a general acknowledgment that Egyptian Government Organizations pursue a deliberate policy of underemployment, and that this problem is prevalent within ENR.

The real questions that are being asked are in relation to current traffic levels, not whether ENR should be reducing its staff, but by how much and in which specific areas.

In order to attempt to get a fix on this issue we have returned to the World Bank Productivity Indicators to compare ENR to other railway companies. The first point to be noted is that ENR has reasonable productivity, partly due to Egypt's dense population (living on only 4% of Egypt's territory). But comparison with railways in developed countries indicates that ENR has room for improvement. The following method was used :

Approximately 72,184 ENR employees are estimated to have transported 56,431 million traffic units (TU) in 1995/96 (excluding Metro). This averages to 781,766 TU per ENR employee. Regression analysis of 26 developed countries in the World Bank railway database results in the following formula for calculating the number of employees needed to operate a railway (see figure 4.2.7-1):

$$94.187 \times (\text{annual traffic units} \div 1{,}000{,}000)^{.5571} = \text{employees needed}$$

Similar regression for railways in Africa and the Middle East results in the following regression :

$$79.902 \times (\text{annual traffic units} \div 1{,}000{,}000)^{.6243} = \text{employees needed}$$

To show what these equations mean, we take the number of Traffic Units ENR transported in 1994/95, and calculate the number of staff required by the average developed country or Africa/Middle Eastern railway.

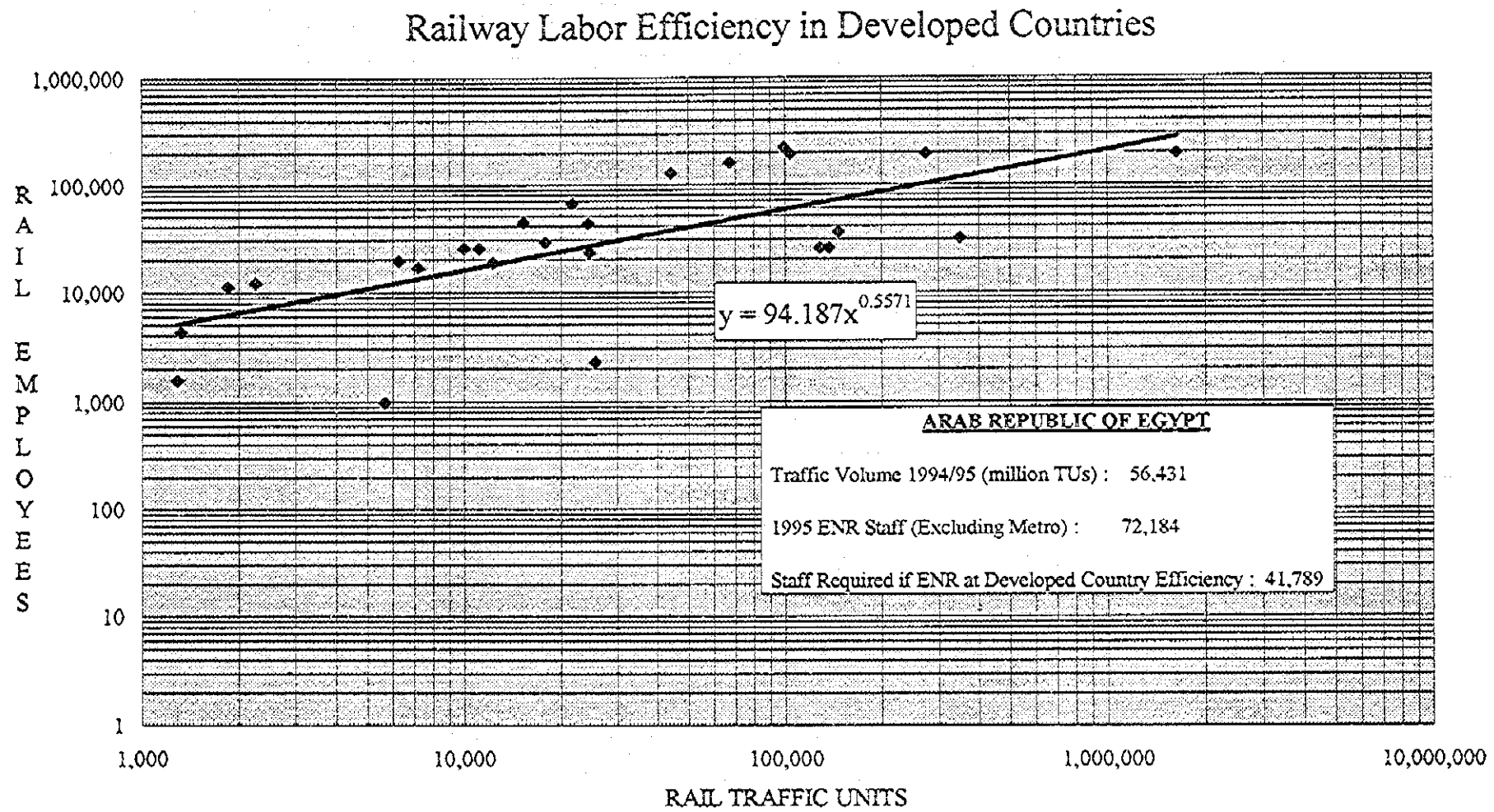
Staff Required to transport 56,431 million traffic units

| ENR in 1994/95 | Developed country railways | African & Middle Eastern railways |
|---|---|---|
| 72,184 | 41,789 | 73,949 |

To raise productivity, ENR will either have to significantly increase its traffic levels or effect a large staff reduction. The issue of expanding traffic levels is examined separately within this Study. This section concentrates on staffing levels.

This approach provides a very broad look at what it might be reasonable to anticipate in terms of staff savings. In order to plan for systematic reductions throughout the system it is probably necessary to take a more formalized approach to individual functional staffing levels and for these to be linked to specific schemes or developments that can be seen to be reducing the need for manpower.

**FIGURE 4.2.7-1**


Railway Labor Efficiency in Developed Countries
1,000,000
100,000
10,000
1,000
100
10
1
RAIL EMPLOYEES
y = 94.187x^0.5571
ARAB REPUBLIC OF EGYPT
Traffic Volume 1994/95 (million TUs) : 56,431
1995 ENR Staff (Excluding Metro) : 72,184
Staff Required if ENR at Developed Country Efficiency : 41,789
1,000
10,000
100,000
1,000,000
10,000,000
RAIL TRAFFIC UNITS

**(2) Staff wastage (Retirements, etc.)**

The strategy for staff downsizing and redeployment within ENR will inevitably be subject to a degree of influence exerted by the Government on job creation policies within the Public Sector.

However, in the absence of any specific current proposals for major staff reductions in particular activities, this paper will concentrate on looking at the approaches and opportunities that could be available to ENR to deal with either systematic reduction in staff numbers or specific schemes for termination, reduction or transfer of particular activities.

**The general approach to downsizing**

Earlier, this Study examined the use of Productivity Indicators and drew initial conclusions as to what they might mean to ENR.

These Indicators point to the need to review staffing levels throughout the organization, but they do not address the most difficult issue of how, in practice, staff reductions could be achieved without a major challenge to job security or a disruption of the current procedures.

It is considered that the two key ingredients in producing an acceptable, non-controversial approach to reducing staff numbers will be **Staff Recruitment** and **Staff Wastage.**

If recruitment can be regulated to provide a significantly lower annual figure than natural staff wastage, then it should be possible to effect acceptable staff and establishment reductions without causing insurmountable problems to either individuals or Trade Unions.

This approach would need to be coordinated under the umbrella of an integrated Annual Manpower Plan which would need to anticipate all the pre-planned factors affecting Manpower and a method for dealing with the re-deployment of staff displaced by the Plan.

So, using this approach , what are the opportunities for ENR to reduce their staffing levels over the period of the Master Plan?

The first step is to examine how accurately it is possible to forecast natural staff wastage within ENR over the coming years, and then to try and strike a sensible balance between that and the need for selective recruitment.

**Forecasts of Staff Recruitment and Staff Wastage**

The historical data obtained so far has revealed the following picture :

| | |
|---|---|
| Recruitment | 1,250 per annum approx. (1995 figures) |
| Natural Wastage | 2,200 per annum approx. (1992/3 figures) |

which would tend to suggest that staff numbers in ENR should be falling year on year.

The real picture of staff actually employed is however different as shown :

| | |
|---|---|
| 1992/1993 | 71,653 |
| 1993/1994 | 72,890 |
| 1994/1995 | 74,123 |

Whilst no specific explanation for these differences has been provided, the suspicion is that the increases have arisen, at least partly, due to the Governmental influence referred to in the first sentence of this memorandum, and to the impact of staff returning from the Military, Maternity Leave, Returning from Abroad etc.

So, leaving aside these influences, we have tried to examine what opportunities should emerge within the existing system that would reduce staff numbers naturally.

The **Wastage** figures that we have are for the 12 month period November 1, 1992 to October 31, 1993 and these indicate the position as set out below :

**Table 4.2.7-1 Wastage Figures, 1/11/92 to 31/10/93**

| | | |
|---|---|---|
| Retired | 1,125 | |
| Died | 516 | |
| Early Retirement | 140 | (55 Years) |
| Early Retirement | 345 | (No loss of Pension) |
| Resigned | 138 | |
| **Total** | **2,264** | |

*Source: ENR*

This data is only in respect of one year and might in normal circumstances be regarded as an insufficient sample. However, when the data is analyzed it becomes clear that because the majority of the wastage is directly related to retirements and as such directly forecastable, it provides an accurate guide as to what is likely to happen over the life of the Master Plan.

**To emphasize this point, there can be an extremely high level of confidence in the wastage forecast because approximately 70% of the total is preplanned and can be forecast with considerable accuracy in that it represents normal and special retirements.**

Taking each of the Wastage categories, the following forecasts can be made :

**Deaths** : Using the 1992 figures, the ENR death rate when set against the total workforce equaled 0.72%. Assuming that the improvement in life expectancy continues at the levels indicated during the period 1960 to 1990, then it would be conservative to apply a figure of 0.6% to the 17 Years of the Plan Period.

*Note : To try and validate this figure, which represents some 20+% of the total ENR Wastage, we examined the trend in Egyptian Life Expectancy over the past 30 years.*

**Table 4.2.7-2 Life Expectancy in Egypt**

| *Year* | *Male* | *Female* |
|---|---|---|
| *1960* | *51.6* | *53.8* |
| *1976* | *52.7* | *57.7* |
| *1986* | *60.5* | *63.5* |
| *1991* | *62.9* | *66.4* |

*(Source: CAPMAS, 1995 Statistical Year Book)*

*These figures show an 11.3 year (18%) improvement in male life expectancy over a 31 year period and when applied to the 17 year period of the current Study this would adjust the percentage figure to 0.65%. A similar analysis of the last 6 years of the statistical period produces a marginal reduction to 0.64%. This analysis increases confidence that the use of the 0.6% figure is in fact conservative.*

**Notes :**
- Again using the 1992 figures the percentage level of resignations stood at **0.19%** and it is reasonable to use this figure for future projections.

*- This is already a small percentage figure and whilst the potential improvement in an ENR remuneration package could mean that fewer staff will resign from the service, because of the small numbers involved this will not significantly affect the Manpower Plan.*

**Special Retirements** : Again using the 1992 figures for both the categories, the percentage figure stood at **0.68%.** Part of this figure is a result of special inducements, and given the right incentives it should be possible to attract a larger number of 'volunteers' should the need arise.

*Note : These figures are largely controlled by ENR management and they will be a small but significant part of the 'balancing' that will be necessary around the margins of the Manpower Plan to ensure that Manpower targets are achieved.*

**Normal Retirements** : This is a more specific calculation as it relates directly to the age of the employee. We can calculate with some degree of certainty the numbers of staff who will retire each year. We need of course to be aware that potential retirees could also fall into all the previous categories in that they could die, or resign, or decide to retire early, and it would be sensible to reduce the anticipated figure by say 5% to take account of these factors.

Retirement age for ENR staff is when they attain the age of 60 years. The only exception to this is for laboring staff who were recruited prior to June 1st 1963. These staff were recruited on daily rates of pay and are still paid under these conditions. They are not allocated to specific grades and they have the right to remain in the service until they reach 65 years of age. They can however be persuaded to retire voluntarily from the service after they reach 60 years of age.

*Note : For the purpose of this exercise, we estimated the number of staff in this category who are entitled to work until they reach the age of 60 using the following assumptions:*
*- All current ENR staff over 60 years of age are able to work until age 65.*
*- The current ENR staff age structure is similar to the age structure in 1963.*

Using these projections, we tested many different assumptions on the levels of recruitment that ENR will need over the life of the Master Plan.

Some of the assumptions tested were :

CASE 1-1 & 2-1: No new recruitment until year 2003.
CASE 1-2 & 2-2: Annual recruitment reduced to a minimum (1%) until year 2003.
WITHOUT CASE: Annual recruitment equal to growth in Traffic Units, with a 1% productivity increase each year.

The results of Case 1-1 are shown in Table 4.2.7-3.

**Table 4.2.7-3 : Natural Wastage based on Recruitment at 0%**
Case 1-1 (Rail+Metro)

| Year | Employees | Retire | Deaths | Resign | Special retire | Total wastage |
|---|---|---|---|---|---|---|
| 1996 | 74,965 | 1,294 | 450 | 142 | 510 | 2,396 |
| 1997 | 72,569 | 1,563 | 435 | 138 | 493 | 2,630 |
| 1998 | 69,939 | 1,738 | 420 | 133 | 476 | 2,766 |
| 1999 | 67,173 | 2,316 | 403 | 128 | 457 | 3,303 |
| 2000 | 63,870 | 2,740 | 383 | 121 | 434 | 3,679 |
| 2001 | 60,191 | 2,589 | 361 | 114 | 409 | 3,474 |
| 2002 | 56,717 | 2,147 | 340 | 108 | 386 | 2,980 |

Source: JICA Study Team

Under this plan, employees are steadily reduced by zero recruitment. Under this scenario, ENR reduces staff from 1996 to 2002, and then begins to increase staff to meet growing demand.

**Initial Conclusions**

**Making changes by natural wastage and recruitment control**

Table 4.2.7-3 shows that, assuming constant traffic levels and limited recruitment and using the processes of natural wastage it would be possible to reduce staff to 56,717 by the year 2002.

Using this projection it is possible to see that there is considerable scope for making substantial staffing reductions by means of natural wastage, without dramatically affecting ENR's current practices apart from reducing recruitment.

Whilst it is tempting to conclude that recruitment should not be an issue when the objective is to reduce numbers, the reality is likely to be that there will still be a need to recruit into positions requiring particular skills or qualifications that are not likely to be available via redeployment and retraining. This means that before adopting this model this aspect should be considered in more detail and against a more detailed examination of the retirement profiles of key grades such as

detail and against a more detailed examination of the retirement profiles of key grades such as Locomotive Drivers, Fitters etc. as well as making a detailed examination of Management Succession and the need for a proper Management Development strategy.

The other issue that should not be totally discounted is the possibility of increasing natural wastage by promoting early retirement. This would clearly be a feasible proposition but the issues to be addressed are those of the cost of persuading more staff to retire early and the knock-on effects that this might produce.

**The use of work measurement**

Whilst all this data points to the need for a serious re-examination of overall staffing levels within ENR it does not in itself provide sufficient detail of where, and by how much, manpower should be reduced or in some cases even possibly increased.

As is made absolutely clear at the outset of this section of the Report, the best that broad Productivity Indicators can do is to provide a pointer on comparative manpower levels and provide an impetus for possible closer examination of areas where savings might be identified.

What is now required is more detailed examination to determine exactly what are the appropriate staffing levels for particular activities within the organization.

One of the recommendations contained in Chapter 4.2.11 of the Business Improvement Proposal is the creation of a Productivity Section within ENR.

This recommendation is specifically to facilitate production of work measurement data at selected locations and for selected activities.

The intention would be to produce appropriate staffing standards for a whole range of activities that were tailored specifically to the circumstances of ENR.

It would then be possible to use these standards to check their comparability with current staff levels and produce a revised staffing level for each activity in which there would be confidence.

Before finally determining an appropriate establishment it would be necessary to check whether or not there were future developments or likely changes in work-load that were likely to influence the figures.

**(3) Personnel reduction plan**

To do this the Study Team devised a format that should be capable of adaptation to the varying functional circumstances of ENR.

It is suggested that if the proposals on reforming the current organization are processed, then it may well be sensible that this process be overseen by the Change Manager (See section 4.2.11)

**Manpower Planning Steps to be taken to review Functional Staffing Levels**

Step 1 **Identify the precise point at which the exercise is to start.**
For the purpose of producing an overall ENR manpower policy is sensible that specific manpower budgeting periods are confirmed. It is also necessary to analyze any circumstances in which staff may be currently on the books without authorized posts. Basically there needs to be a clear identification of the status of each position currently in existence.

At this stage it would be sensible to establish some agreed Performance Indicators for each function against which their current and subsequent progress could be measured. These indicators should be developed with and agreed by the functions in order that 'ownership' is established at an early stage. The Indicators can take whatever form is considered appropriate providing that they are seen as a reasonable indication of the movement in functional productivity. Examples that could be considered are attached as an Appendix to this paper.

Whilst some of these examples are simple indicators they should chart the productivity progress of the particular function. It is of course possible to make them more sophisticated but care needs to be exercised that they do not become too complicated to produce.

Step 2 **Determine the period over which the Manpower Plan will operate.**
This again needs to be consistent for all functions and would normally follow the periodicity of the Financial Budget. However, there may well be a case for the Manpower Plan to stretch over a number of years to cover the gradual implementation of a particular policy or strategy. In this case it would be sensible to have a detailed action plan-driven budget for the first year but this could be set within a 5 year overall plan containing the departmental goals.

Step 3 **Determine the global factors that are likely to influence Departmental staffing levels.**
In the case of ENR these are likely to fall into the following categories :

- Changes in Traffic levels within ENR
- Changes in Employment conditions within ENR
- Changes in organization levels within ENR
- Changes in authority levels within ENR

All of these factors could significantly affect staffing levels throughout the organization and as such any plans that impinge upon the following years budget need to be promulgated in sufficient time for them to be included.

Step 4 **Review the existing working methods within the Department.**
This should be a continuous exercise for Departmental management. The benefit of making it a defined step in a budgeting process is that it encourages Managers to periodically review the working practices within their own Departments and challenge the efficiency of the current methods. There can be real benefits to be gained from fundamental questioning of the value of particular activities.

Questions to be answered could be :

Why is this work done ?
What purpose does it serve ?
What value does it add to the business ?
What would happen if we stopped doing it altogether ?
What would happen if we didn't do it so often ?
Can we do it more efficiently ?
Could someone else do it more efficiently ?

Step 5 **Review the impact of current Investment Plans.**
This will relate to agreed projects that have been authorized and included within the overall Investment Plan for ENR. Some of these may have already been covered by the considerations given as part of Step 3, but this step should provide a useful check that the implications of all the overall plans for ENR have been taken into account.

Step 6 **Review the opportunity for further Investment.**
The scope for this will clearly vary between functions. If the overall Investment Plan has been prepared and evaluated in a systematic way with all Departments being given the opportunity to make bids for the available funds, then this step may not produce a significant number of new schemes.

Step 7 **Examine the scope for 'Contracting-Out' activities.**
This aspect is partly covered in the Step 4 process but particularly in the early stages of an organization contemplating major changes like ENR it is worth maintaining this as a separate process in order to ensure that contracting-out is considered as a regular option.

This issue is dealt with in more depth in Chapter 4.3 of this report. In using this approach it would be sensible to look at both the opportunities for 'contracting - out' and also the establishment of Joint Venture Companies

Step 8 **Examine the opportunities for Computerization.**
This is an issue that is particularly relevant to ENR. In the early stages of change this could provide the greatest scope for making quick and easy reductions in staffing levels, particularly in support departments. The Master Plan Study provides for an overall information systems strategy for ENR but this should not inhibit the development of individual applications providing they conform to the general framework being recommended. Certainly within the administrative activities of most functions there will be considerable scope to computerize systems to provide greater efficiency in the service and to reduce staffing levels.

Step 9 **Examine the history of the constituent parts of the organization.**
The purpose of this exercise is to ensure that the original justification for the activity is still valid. An examination of this kind will often establish that the purpose of the particular part of the organization has, over the years, changed or even in some cases disappeared altogether. Armed with this information it is then possible to objectively review what changes need to be made to fit it more appropriately for its current role.

**Step 10 Examine what changes could be made if it were possible to either reward current staff more appropriately or to recruit better qualified staff.**

This is a fundamental step towards greater productivity. If sufficient evidence is collated that there are significant cost/efficiency benefits to be obtained from improving staff conditions then the case will become ever stronger and the pace of change more rapid.

Step 11 **Identify what additional training is required.**
This should be a practical exercise which identifies the overall costs and benefits of introducing new training as a means of increasing efficiency and reducing costs.

Step 12 **Recheck the cycle.**
This involves rechecking each of the steps to make sure that everything has been covered , all the opportunities have been identified, there has been no double counting and that the Plan is realistic.

If this process were followed we would have a Manpower Plan geared to meet the needs of ENR and we could then examine the issue of how to effectively use it to reduce actual bodies.

### 4.2.8 Raise the Availability of Rolling Stock

As the availability of Passenger Cars (PC) and Freight Cars (FC) is normally high, this discussion focuses on the availability of Diesel Electric Locomotives (DEL). However, ENR should also study why there is low availability of some FCs such as hoppers, FCs for iron ore, and brake vans.

In order to increase the availability of DELs, ENR needs to take the following measures: reduce locomotive breakdowns; reduce idle time waiting for spare parts by using a computerized inventory control system covering related workshops and depots; mechanize maintenance facilities to decrease the cycle time from entering to exiting the facility; and emphasize designs which are maintenance-free to prolong the time between maintenance. These measures are also useful to decrease the total number of locomotives. The total number of necessary locomotives is the number of locomotives in daily operation, plus locomotives not operating for regular maintenance and reserved for unexpected breakdowns. ENR may require 15% of its locomotives to be in repair and reserve (Japan's average is 10%). Thus locomotive availability should be more than 85 %. The 632 examples of locomotive breakdowns listed in this report were analyzed from various viewpoints. The data provided by ENR for analysis of locomotive breakdowns covers April 1994 to December 1995, as follows :

- Table 4.2.8-1-1 of Appendix 4.2.8 Locomotive Breakdown Table (by locomotive age)
- Table 4.2.8-1-2 of Appendix 4.2.8 Locomotive Breakdown Table (in alphabetic order)
- Table 3.11.11 of Appendix 3.11 History of Each Locomotive

**(1) Relation between locomotive breakdown rate, total and annual average running km per locomotive, and locomotive age**

Table 4.2.8-2 "Trouble shooting by age group", which is derived from Tables 4.2.8-1-1 and 3.11.11 described above, show a relationship between locomotive age, production unit, number of breakdowns, and total running km per locomotive. Figure 4.2.8-1 shows the breakdown rate and total and annual average running km per locomotive by age group, based on Table 4.2.8-2. When calculating average total running km per locomotive, abnormal values were excluded (Locomotive numbers: 3016, 3021, 3117, 3223, 3241, 3453, 3459, 3602, 3603, 3646, 3894, 3931, and 3999).

1) It seems that total running km per locomotive by age group has no relation to the breakdown rate. However, running km per year may have some relation to the breakdown rate.

2) Breakdown rate and locomotive age

a. Locomotive breakdowns peak at 7 years of age. Younger and older locomotives have a decreasing trend of breakdowns, except 3271-3299 of age 16 for Baharia Line. Locomotives 3271-3299 have rather small running km, but it is said that Baharia Line has severe train operating conditions. It is to be appreciated that maintenance quality in Tebien Workshop is very high.

## Table 4.2.8-2 Trouble Shooting by Age Group

| No. | Age 1995-12-31 | Locomotive Number | (a) No. on Book | (b) No. of B.Down | B.D. % (Unit) | B.D. % (Age) | Worse Order | Total Running km per Loco × 10 mean | Total Running km per Loco × 10 Age Group mean | Remarks (more than 4B.D) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 19 | 3241-3263 | 22 | 6 | 27 | 27 | 24 | 1,632 | 1,632 | |
| 2 | | 3016-3036 | 20 | 6 | 30 | | 22 | 1,123 | | |
| 3 | 18 | 3264-3270 | 7 | 2 | 29 | 43 | 23 | 1,678 | 1,732 | |
| 4 | | 3801-3832 | 31 | 27 | 87 | | 14 | 2,099 | | |
| 5 | 17 | 3037-3050 | 13 | 7 | 54 | 54 | 19 | 1,307 | 1,307 | |
| 6 | 16 | 3271-3299 | 29 | 3 | 10 | 10 | 26 | 789 | 789 | |
| 7 | 15 | 3051-3075 | 25 | 15 | 60 | 66 | 18 | 1,364 | 1,344 | |
| 8 | | 3833-3897 | 63 | 43 | 68 | | 17 | 1,337 | | 3857,96 |
| 9 | | 3076-3084 | 9 | 20 | 222 | | 3 | 1,826 | | 3080,82,83 |
| 10 | 14 | 3120-3131 | 12 | 6 | 50 | 124 | 20 | 1,583 | 1,405 | |
| 11 | | 3898-3917 | 20 | 16 | 80 | | 16 | 1,108 | | |
| 12 | | 3085-3090 | 6 | 9 | 150 | | 8 | 1,975 | | 3090 |
| 13 | 13 | 3132-3171 | 39 | 67 | 172 | 146 | 7 | 1,787 | 1,432 | 3151,54,56,57,58,59,68,69 |
| 14 | | 3601-3602 | 2 | 1 | 50 | | 20 | 1,209 | | |
| 15 | | 3918-3999 | 81 | 110 | 136 | | 12 | 1,219 | | 3922,32,41,60,83,84,91,98 |
| 16 | | 3091-3094 | 4 | 9 | 225 | | 2 | 1,897 | | 3091 |
| 17 | 12 | 3201-3212 | 12 | 24 | 200 | 152 | 5 | 2,030 | 1,068 | 3211 |
| 18 | | 3603-3661 | 59 | 81 | 137 | | 11 | 1,220 | | 3613,23,25,36,55,56 |
| 19 | 11 | 3213-3240 | 27 | 49 | 181 | 169 | 6 | 1,280 | 1,208 | 3216,21,27 |
| 20 | | 3445-3459 | 15 | 22 | 147 | | 10 | 1,064 | | 3451,59 |
| 21 | 10 | 3095-3115 | 21 | 46 | 219 | 188 | 4 | 1,676 | 1,453 | 3095,98,100,114 |
| 22 | | 3460-3470 | 11 | 14 | 127 | | 13 | 1,027 | | 3464 |
| 23 | 7 | 3116-3119 | 4 | 6 | 150 | 280 | 8 | 1,541 | 1,618 | |
| 24 | | 3172-3182 | 11 | 36 | 327 | | 1 | 1,639 | | 3172,77,79,81 |
| 25 | 5 | 3183-3188 | 6 | 5 | 83 | 83 | 15 | 1,301 | 1,301 | |
| 26 | 3 | 3001-3011 | 11 | 2 | 18 | 18 | 25 | 222 | 222 | |
| 27 | 2 | 3012-3015 | 4 | 0 | 0 | 0 | 27 | 191 | 165 | |
| 28 | | 3189-3197 | 9 | 0 | 0 | | 27 | 154 | | |
| 29 | 1 | 3198-3200 | 3 | 0 | 0 | 0 | 27 | 149 | 149 | |
| Total | | | (c) 576 | (d) 632 | | | | | | |

Break Down Rate : (b/d) ÷ (a/c) × 100

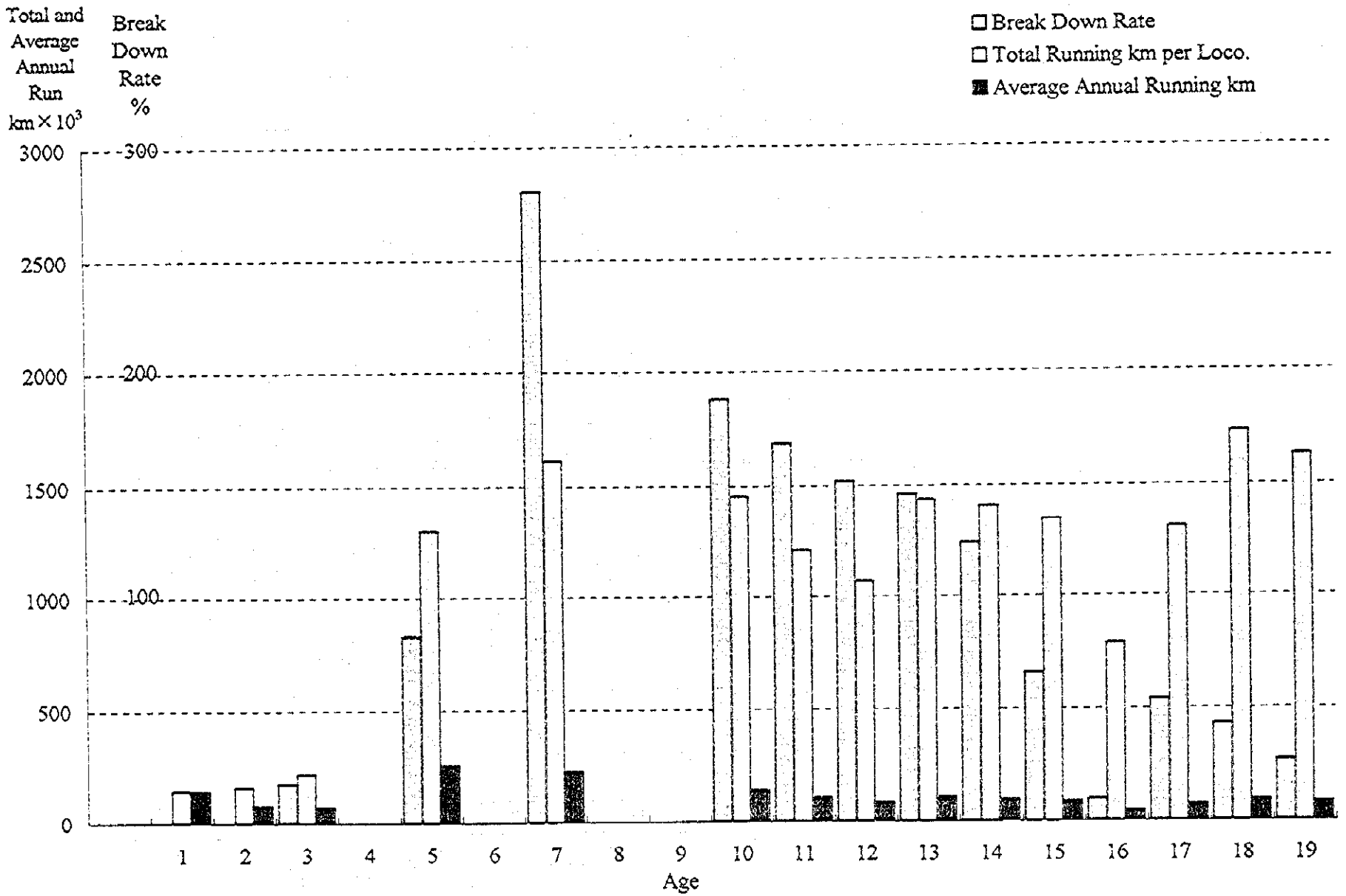



Fig. 4.2.8-1 Break Down Rate and Total Running km per Loco by Age Group

b. The sudden increase in breakdowns from age 5 to age 7 seems to be caused by the first overhaul maintenance, and by long running km per year, which may require repeat maintenance. It is said that dismounting or disassembling can cause rolling stock breakdowns later. Dismounting or disassembling of equipment and parts is to be avoided as much as possible.

c. A gradually decrease in breakdowns from age 10 to 19 seems to show stabilization of locomotives, partly from short running km per year.

**(2) The worst locomotives: No. 3172-3182 (7 years in service)**

Table 4.2.8-2 shows that the 7 year old locomotives (numbers 3172-3182) have the worst breakdown rate. 11 out of the total 12 locomotives had more than 2 breakdowns. Locomotive 3179 broke down 7 times, and 3172 broke down 6 times. However, there is no common cause of breakdowns in these locomotives, except for 10 engine-related breakdowns and 6 repair errors, out of a total 36 breakdowns. The analysis was performed, as shown below in (3) "Analysis of locomotives with multiple breakdowns", and (5) "Troubleshooting by cause".

**(3) Analysis of locomotives with multiple breakdowns** (Table 4.2.8-1-1 of Appendix 4.2.8)

1) 7 breakdowns

- Locomotive 3179 : This broke down 3 times in 2 months, because of carbon brush problems related to the fuel pump motor. This may be caused by poor maintenance skills. Education and training are necessary.

2) 6 breakdowns

- Locomotive 3080 : There are no notable points. However, the traction motor earth problem on 2-9-95 might be caused by the missing traction motor cover on 7-5-95. Careful inspection is necessary.
- Locomotive 3083 : There were 3 breakdowns related to the voltage regulator in several months. Careful maintenance is necessary.
- Locomotive 3091 : There were 2 breakdowns related to test valves in two months after the first breakdown. There were also 4 engine-related breakdowns.
- Locomotives 3095, 3100, 3114, 3158 and 3169 : There are no notable points.
- Locomotive 3172 : There were 3 engine-related breakdowns.

3) 5 breakdowns

- Locomotive 3154 : There were 2 breakdowns related to the test valve within two months. More careful maintenance is necessary.
- Locomotives 3156, 3157, 3168, 3221, 3636, 3655, 3922 and 3944 : No notable points.

4) 4 breakdowns

- Locomotive 3082 : 2 breakdowns related to the auxiliary generator within 1 month, due to poor maintenance.
- Locomotives 3090, 3098, 3151, 3159, 3177, 3181, 3211, 3216, 3227, 3451, 3459, 3464, 3613, 3623, 3625, 3656, 3857, 3896, 3984, 3991 and 3998 : No notable points.
- Locomotive 3932 : 2 breakdowns of fuel circuit choke within 2 months. More careful maintenance is necessary.
- Locomotive 3960 : 3 breakdowns related to low battery voltage within about 40 days. At the second breakdown, this battery should have been examined in detail.
- Locomotive 3983 : There are 2 breakdowns from overheated water within one month. More detailed troubleshooting is necessary.

5) Less than 3 breakdowns

Peculiar breakdowns are analyzed as follows

- Locomotive 3072 : There were 2 breakdowns related to traction motor earth in only one week. More careful inspection is necessary.
- Locomotives 3864 and 3883 : Both locomotives had 2 breakdowns from battery box cracks.
- Locomotive 3905 : Fuel pump motor cable earth breakdowns happened twice in two days. This is a large and careless mistake.
- Locomotive 3908 : Battery discharge twice in 20 days.

**(4) Locomotive breakdown and responsibility**

Table 4.2.8-3 shows some analysis of the relation between locomotive breakdowns and responsibility. Re-education and retraining of related staff are required. Especially for drivers, this Table may show differences in drivers' skills.

## Table 4.2.8-3 Trouble Shooting by Responsibility

| | No.of Responsible Break Down (a) | No. of Staffs (b) | a / b (%) |
|---|---|---|---|
| Depot | | | |
| Aswan | 57 | 1,648 | 3.46 |
| Hadra, Kabary | 57 | 1,164 | 4.90 |
| Farz | 142 | 2,881 | 4.93 |
| Mansura | 27 | 399 | 6.77 |
| Menya | 42 | 764 | 5.50 |
| Tanta | 44 | 1,490 | 2.95 |
| Zagazig | 56 | 1,650 | 3.39 |
| Driver | | | |
| Aswan | 5 | 819 | 0.61 |
| Hadra, Kabary | 12 | 611 | 1.96 |
| Farz | 26 | 1,420 | 1.83 |
| Mansura | 1 | 200 | 0.50 |
| Menya | 22 | 671 | 3.28 |
| Tanta | 13 | 617 | 2.11 |
| Zagazig | 4 | 677 | 0.59 |
| Workshop | | | |
| Diesel Bulak | 67 | 2,047 | 3.27 |
| Tebien | 3 | 747 | 0.40 |

**(5) Troubleshooting by cause**

Table 4.2.8-4 shows breakdown rate by cause, classified as follows.

Group 1 : More than 31 breakdowns
Group 2 : 11 to 22 breakdowns
Group 3 : 1 to 9 breakdowns

Meanings of abbreviations in the "cause" column are shown in Table 4.2.8-5. The number of breakdowns of Group 1 amounts to 54.3 % of total breakdowns. Figure 4.2.8-2 shows breakdown rate by cause for Group 1, and the breakdown rate for Groups 2 and 3.

1) Analysis of Group 1

a. Analysis of FX (Repair error)

Repair error is the most notable cause of locomotive breakdowns, amounting to 13.9 % of total breakdowns. Figure 4.2.8-3 "Analysis of Fixation Error" shows that FXC (Cable or wire connection) and FXBT (Bolting) are common. Repair errors resulted from disassembling machines, apparatus and parts for maintenance. A double-checking system, using painting marks which confirm completion of the maintenance and inspection work by the worker himself, is necessary. For bolting, use of a torque wrench is indispensable.

b. Analysis of E (Engine breakdown)

Although there were 80 engine-related engine breakdowns as shown in Table 4.2.8-4, this analysis of engine breakdowns added the 8 gear breakdowns related to engines, including 7 governor gear defects. Thus there were 88 engine-related breakdowns (same number as for repair errors). Figure 4.2.8-4 "Analysis of Engine Breakdown" shows the engine breakdown rate classified into "Engine Itself", "Attached Devices". There is also a category for "Result Caused by Unknown Reason" (overheating, excess speed, etc.) because the cause of engine breakdown is widely distributed. However, the number of breakdowns of pistons, cylinders, test valves, governors, and governor gear totals 13, 11, 10, 9 and 7, respectively. These total to 50 breakdowns, equal to 57 % of total engine-related breakdowns. Analysis by production unit shows that the following locomotives have the worst breakdown rates: 3091-3094 of age 12 (125% breakdown), 3172-3182 of age 7 (91%), and 3095-3115 of age 10 (62%). The breakdown rate is the number of breakdowns divided by the number of locomotives in ENR's books. A clear relation between breakdowns and age or running-km per year was not found. For maintenance of engines, non-disassembling examination should be developed. According to analysis of engine lubricating oil, the type and degree of part wear can be estimated. Then it can be decided if the engine should be disassembled. It is said in Japan that engines with less than 500,000 running km do not need to be disassembled. According to Table 4.2.8-2, running km per year of new locomotives seems to average about 100,000 km. Therefore, disassembling of engines before the 4 year overhaul should be avoided. Based on ENR experience, ability to do engine maintenance without disassembling should be developed, because engine condition depends on the engine itself and the locomotive operating conditions of each railway. The working environment of engine maintenance is also an important factor against engine breakdown. In all the engine maintenance workshops of ENR, engine overhaul is carried out in a dirty environment. The engine shop should be separated from other shops to maintain cleanliness.

## Table 4.2.8-4 Cause-wise Break-down Rate

| Group | Cause | No.of BD | % |
|---|---|---|---|
| 1 | FX | 88 | 13.9 |
| | E | 80 | 12.7 |
| | BS | 69 | 10.9 |
| | W | 42 | 6.7 |
| | FN | 33 | 5.2 |
| | BT | 31 | 4.9 |
| | Sub-Total | 343 | 54.3 |
| 2 | FL | 22 | 3.5 |
| | BG | 19 | 3.0 |
| | GD | 17 | 2.7 |
| | SFOW | 16 | 2.5 |
| | O | 14 | 2.2 |
| | RY | 14 | 2.2 |
| | NSP | 14 | 2.2 |
| | NDFT | 12 | 1.9 |
| | ST | 12 | 1.9 |
| | TM | 12 | 1.9 |
| | BH | 11 | 1.7 |
| | Sub-Total | 163 | 25.8 |
| 3 | GR | 9 | 1.4 |
| | FPES | 8 | 1.3 |
| | CB | 7 | 1.1 |
| | LR | 7 | 1.1 |
| | FR | 6 | 0.9 |
| | MDL | 6 | 0.9 |
| | RD | 6 | 0.9 |
| | CTT | 5 | 0.8 |
| | HR | 5 | 0.8 |
| | MG | 5 | 0.8 |
| | SSW | 5 | 0.8 |
| | Y | 5 | 0.8 |
| | ATC | 4 | 0.6 |
| | FRS | 4 | 0.6 |
| | HL | 4 | 0.6 |
| | TFT | 4 | 0.6 |
| | AG | 3 | 0.5 |
| | INSP | 3 | 0.5 |
| | MV | 3 | 0.5 |
| | COLP | 2 | 0.3 |
| | DMS | 2 | 0.3 |
| | U | 2 | 0.3 |
| | X | 1 × 9 | 1.4 |
| | Z | 1 × 12 | 1.9 |
| | Sub-Total | 126 | 19.9 |
| Total | | 632 | 100.0 |

Remarks :

As for abbreviation of cause column, Please refer to Table 4.2.8-5.

## Table 4.2.8-5 Explanatory Table of Abbreviation

| | |
|---|---|
| AG | Auxiliary Generator |
| AGBW | Auxiliary Generator Binding Wire |
| ATC | Automatic Train Control |
| BGAX | BearinG - Axle Box |
| BGCP | BearinG - ComPressor |
| BGCR | BearinG - CRank shaft |
| BGFN | BearinG - cooling FaN |
| BGRD | BearinG - connecting RoD |
| BGTM | BearinG - Traction Motor |
| BHAG | Brush Holder - Auxiliary Generator |
| BHFM | Brush Holder - Fuel Motor |
| BHMG | Brush Holder - Main Generator |
| BHOP | Brush Holder - Oil Pump motor |
| BHTM | Brush Holder - Traction Motor |
| BS | Brake System |
| BSBV | Brake System - Brake Valve |
| BSCP | Brake System - ComPressor |
| BSDR | Brake System - DRain |
| BSDT | Brake System - DirTy |
| BSFL | Brake System - oil FiLter |
| BSFX | Brake System - FiXation |
| BSGT | Brake System - GasketT |
| BSP | Brake System - Pipe |
| BSRH | Brake System - Rubber Hose |
| BSSC | Brake System - Switch CCS |
| BSSP | Brake System - Switch PCS |
| BT | BaTtery |
| BTBX | BaTtery - BoX |
| BTCT | BaTtery - CircuiT |
| BTLS | BaTtery - Liquid Shortage |
| BTLV | BaTtery - Low Voltage |
| CB | Circuit Breaker |
| COLP | COmpressor Low oil Pressure switch |
| CTT | ConTacTor |
| DMS | Dead Man System |
| ECR | Engine - CRank shaft |
| ECY | Engine - CYlinder |
| ECYL | Engine - CYlinder Liner |
| EEXH | Engine - EXHaust valve |
| EFR | Engine - FiRe |
| EGPT | Engine - Governor Plunger Trip |
| EGV | Engine - GoVernor |
| EHP | Engine - High Pressure |
| EIJ | Engine - InJection |
| ELAD | Engine - Lash ADjuster |
| EOH | Engine - Over Heat |
| EOPV | Engine - Oil Pressure Valve |
| EOS | Engine - Over Speed |
| EOSL | Engine - Over Speed Lever |
| EP | Engine - Pipe |
| EPRD | Engine - PRotection Device |
| EPST | Engine - PisTon |
| ES | Engine - Supercharger |
| ESGT | Engine - Supercharger GasketT |
| ESRD | Engine - Supercharger RoD |
| ESTP | Engine - STop |
| ETV | Engine - Test Valve |

| | |
|---|---|
| FLCT | FueL CircuiT |
| FLPM | FueL Pump Motor |
| FN | FaN |
| FPES | Fuel Prime Engine Start |
| FR | FiRe |
| FRAL | FiRe - ALtornator |
| FRS | FiRe alarm System |
| FXAM | FiXation - misAllignMent |
| FXBG | FiXation - BearinG |
| FXBH | FiXation - Brush Holder |
| FXBT | FiXation - BolT |
| FXBV | FiXation - Brake Valve |
| FXC | FiXation - cable Connection |
| FXFU | FiXation - FUse |
| FXRH | FiXation - Rubber Hose |
| FXSK | FiXation - SocKet |
| FXZ | FiXation - Z (others) |
| GD | GrounD |
| GRES | GeaR - between Engine and Starter |
| GRGV | GeaR - GoVernor drivng |
| GRRD | GeaR - RoD (main shaft) |
| GRWP | GeaR - Water Pump |
| HL | Head Light |
| HR | HoRn |
| INSP | INSPection |
| LR | Load Regulator |
| MDL | MoDuLe |
| MG | Main Generator |
| MV | Magnetic Valve |
| NDFT | No DeFecT |
| NSP | No SPeed |
| OGT | Oil - GasketT |
| OP | Oil - Pipe |
| OPM | Oil - Pump Motor |
| RDAG | RoD - Auxiliary Generator |
| RDCE | RoD - between Compressor and Engine |
| RDCP | RoD - ComPressor connecting rod |
| RDFX | RoD - FiXation |
| RY | Relay |
| SFOW | Supply Fuel, Oil and Water |
| SSW | Small SWitch |
| STCT | STarting CircuiT |
| STM | STarter Motor |
| TFT | Tread of wheel FlaT |
| TM | Traction Motor |
| TMBW | Traction Motor - Binding Wire |
| TMGB | Traction Motor - Gear Box |
| TMGD | Traction Motor - GrounD |
| U | Unknown reason |
| WGT | Water - GasketT |
| WH | Water - Hose |
| WOH | Water - Over Heat |
| WP | Water - Pipe |
| WR | Water - Radiator |
| X | eXternal reason |
| Y | Y (short circuit) |
| Z | Z (others) |

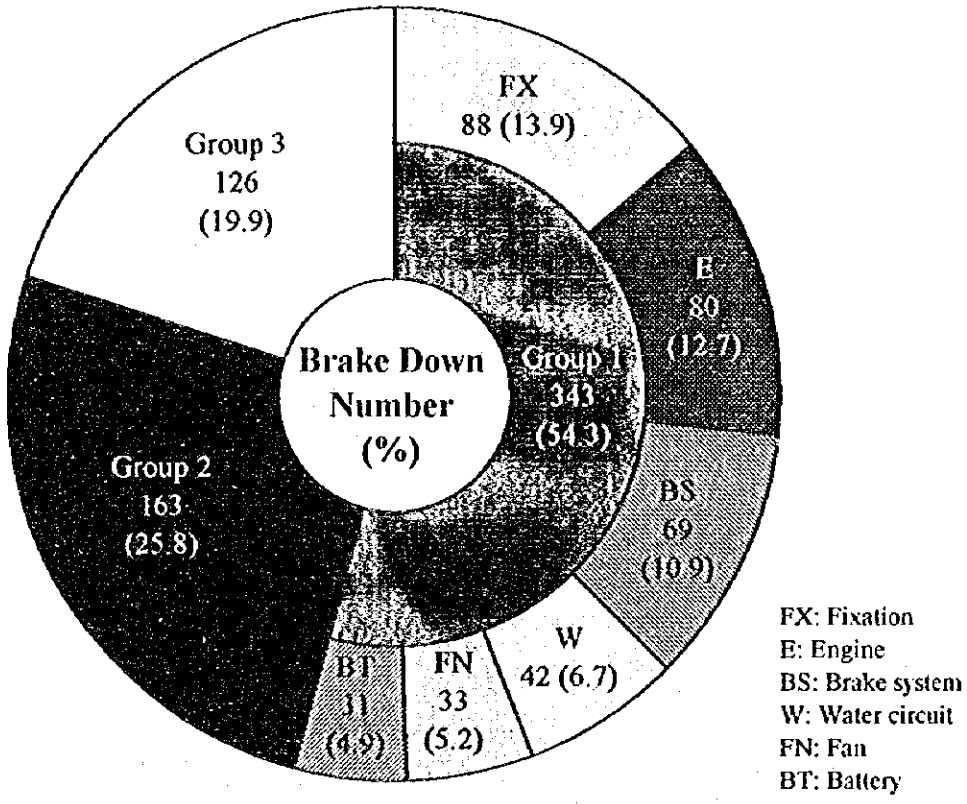



**Fig. 4.2.8-2 Cause-wise Break Down Rate**

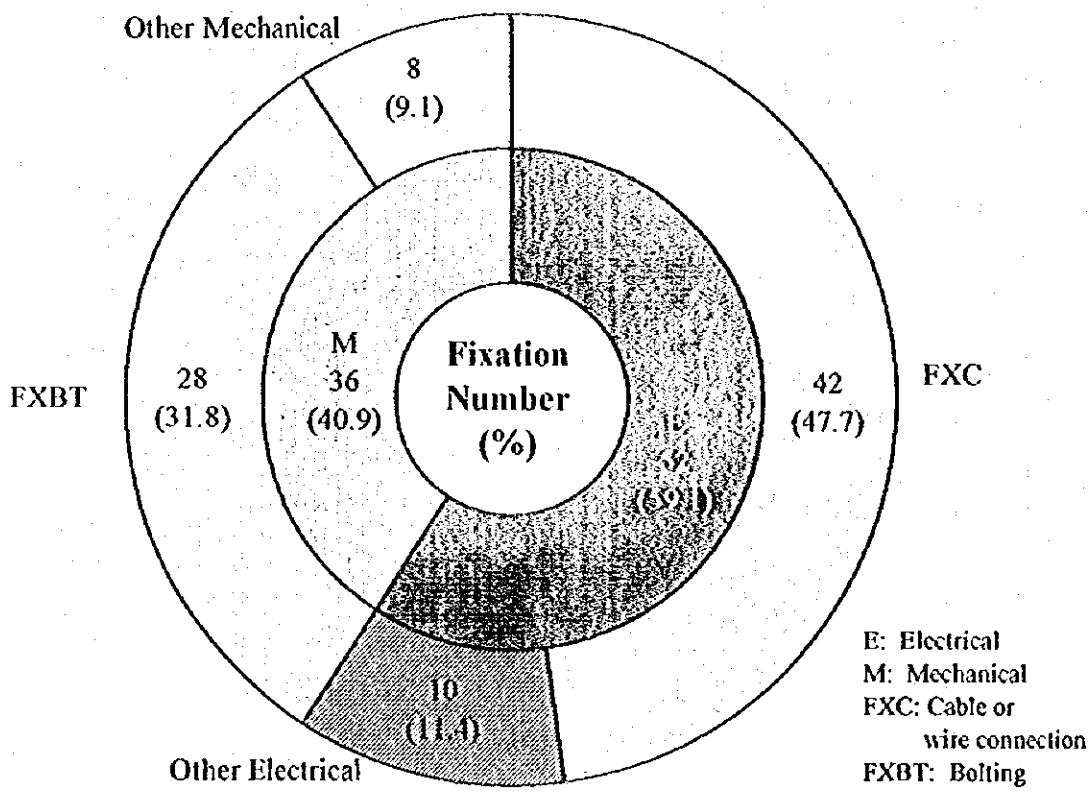



**Fig. 4.2.8-3 Analysis of Fixation Error**

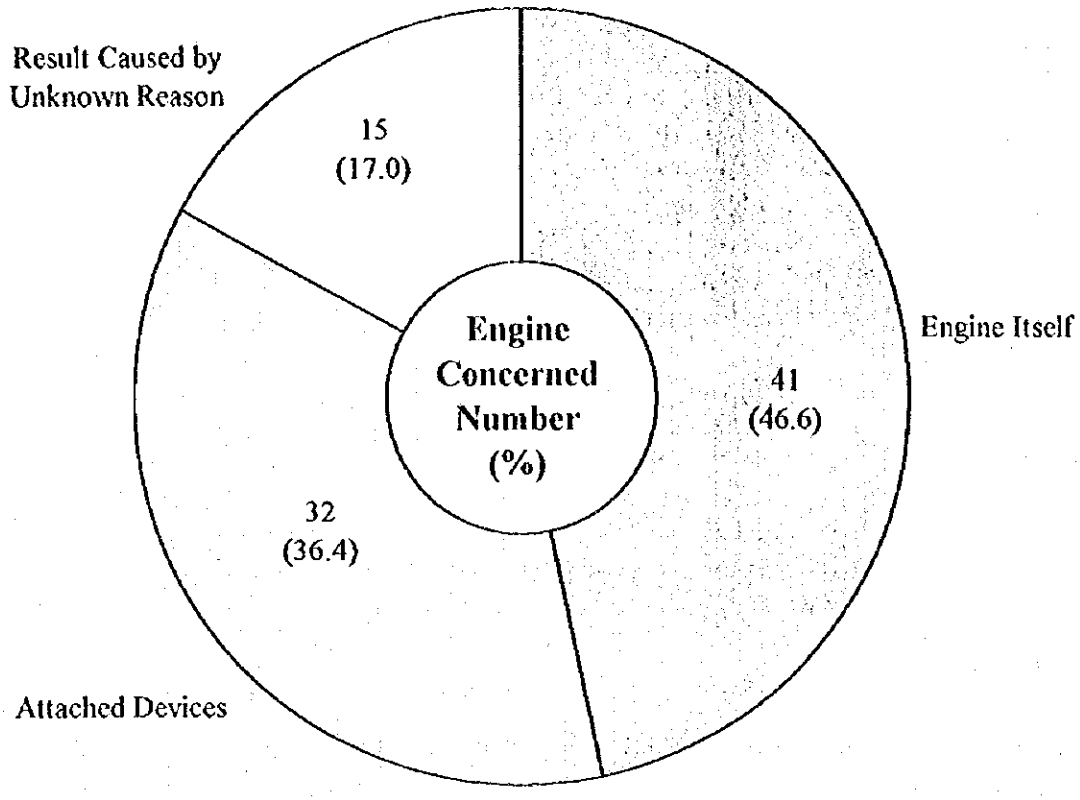



**Fig. 4.2.8-4 Analysis of Engine Break Down**

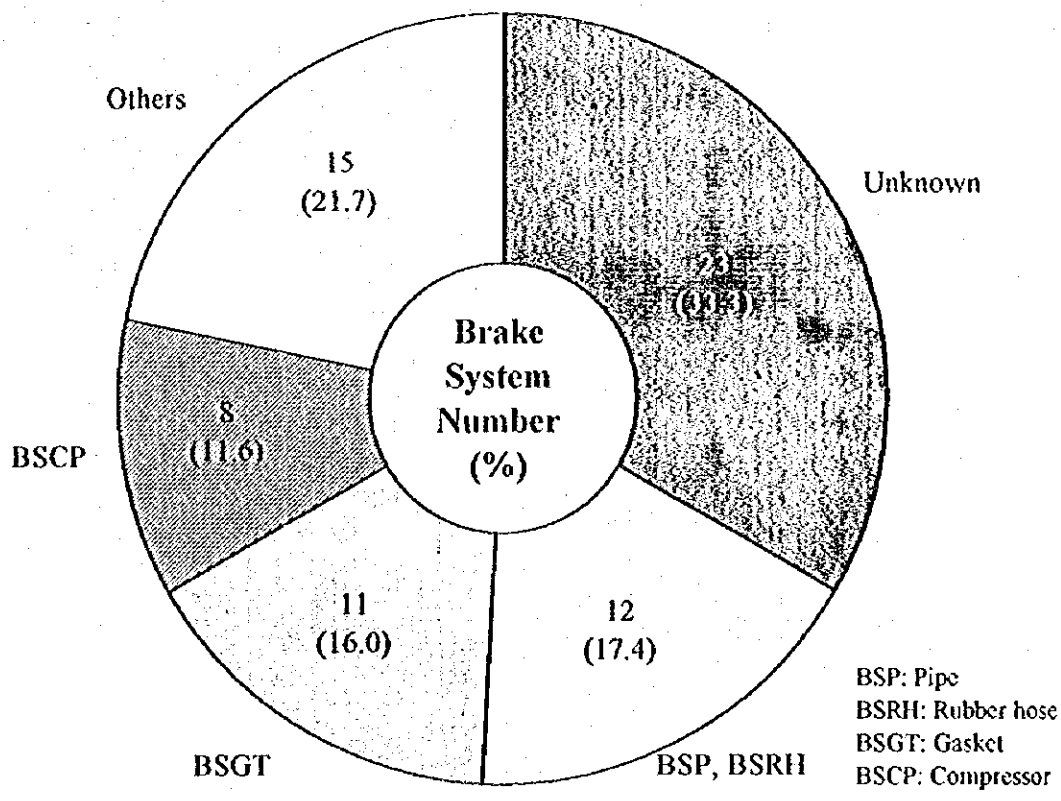



**Fig. 4.2.8-5 Analysis of Brake System Break Down**

c. Analysis of BS (Break system breakdown)

Fig. 4.2.8-5 "Analysis of Brake System Breakdown" shows that there are many unknown causes of brake system failure. Brake system failure can create serious train accidents in spite of a fail safe system. Faulty parts and causes should be clarified through education and training for drivers. Possible air leaks from air pipes and rubber hoses should be prudently inspected through periodical air leak tests. ENR had brake problems 9 times when the gaskets were age 13. The gasket is generally to be exchanged at the time of disassembling related parts, but gaskets not exchanged for more than 10 years should be periodically exchanged.

d. Analysis of W (Cooling water system) and FN (Fan)

Cooling water system breakdown including fan breakdown accounted for 11.9 % of total breakdowns. Although there were 12 breakdowns of unknown reasons from water overheat, it was from fan defects and water leaks or stoppage in cooling water circuits. Fig 4.2.8-6 "Analysis of Cooling Water System Breakdown" shows that fan defects accounted for 44 % or more of total cooling water system breakdowns.

(a) Fan

Fan breakdowns are widely distributed in locomotives of more than 10 years old. 44 % of total cooling water system breakdowns were from a fan defect. A common problem is excess current caused by single phase operation of a three phase motor. The cause of fan breakdowns may derive from poor original design, but the use of NFB (no fuse breaker) which trips by thermostat detecting excess current and its duration, in place of ordinary fuses, is desirable to avoid serious damage to the fan. The NFB is re-settable. As for mechanical breakdown of fans, mechanical balancing is important.

(b) Cooling water circuit

Cooling water circuit defects are also widely distributed in most locomotives. Gasket damage (especially water pump gaskets) cause 31 % of cooling water system breakdowns, distributed in locomotives of various ages. The same recommendations as proposed in item C are appropriate here.

e. Analysis of BT (Battery)

Fig. 4.2.8-7 "Analysis of Battery Breakdown" shows that 55% of all battery breakdowns are from low battery voltage, widely distributed among locomotives of more than 11 years old. A periodical exchange system for batteries should be established, possibly every 10 years.

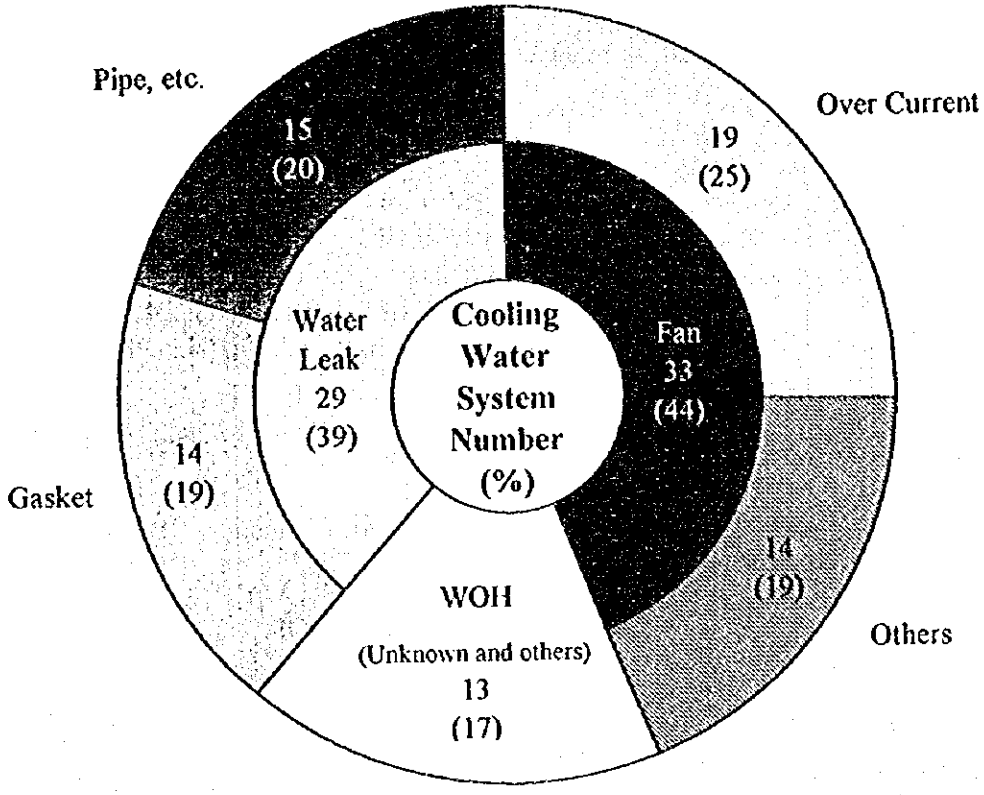



**Fig. 4.2.8-6 Analysis of Cooling Water System Break Down**

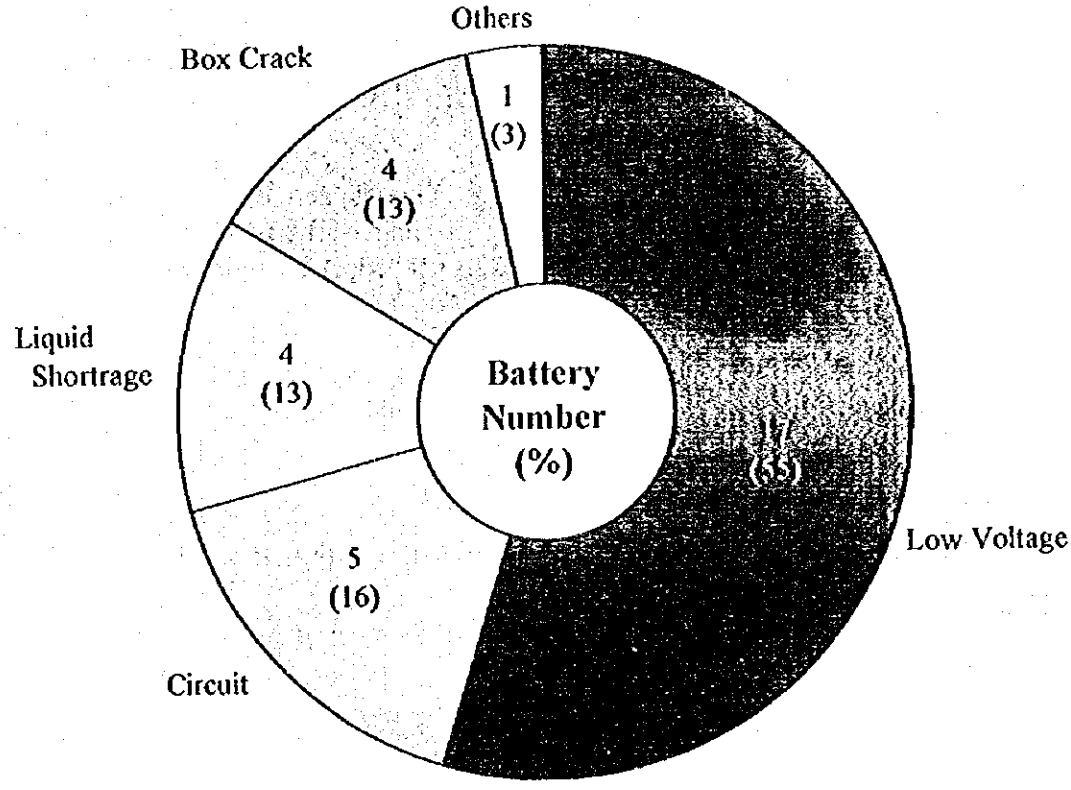



**Fig. 4.2.8-7 Analysis of Battery Break Down**

2) Analysis of Group 2 and Group 3
Only notable points are described, as follows.

a. FL (Fuel circuit)

There were 10 fuel circuit stoppage defects and 10 fuel pump motor damages out of 22 breakdown of the fuel circuit. They were widely distributed among all locomotives of more than 7 years age. At the time of regular maintenance, cleanness of filters should be strictly maintained through by working in an independent clean room. As for fuel pump motor damage, in case there is the same situation as for fan motors, NFB should be also used for protection of fuel pump motors.

b. BG (Bearing)

Breakdown of bearings is widely distributed in locomotives of all ages. Bearing maintenance should be carried out in a separated clean room.

**(6) Recommendations**

Breakdowns derived from repair errors, engine, brake system, and cooling water system, including fans and batteries, amounted to 54.3 % of total breakdowns.

Recommendations mentioned above, and additional recommendations, are arranged below, which could reduce the number of breakdowns by 50% or more.

1) Dismounting and disassembling should be avoided as much as possible.

2) There are significant differences in the skills of drivers. Retraining and re-education are necessary for resolving locomotive problems on the line, and for decreasing unknown causes of brake system breakdown.

3) There are many wiring and bolting errors. This is derived from dismounting or disassembling. A double-checking system, using painting marks to confirm completion of maintenance and inspection by each worker himself, is needed. A torque wrench for bolting is indispensable.

4) A clean maintenance environment should be provided in an independently separated shop. Disassembling of engines before the 4 years overhaul should be avoided. Non-disassembling examination technology should be developed.

5) For the brake system, besides retraining and re-education for drivers, as mentioned in item 2) above, periodical exchange of gaskets and periodical air leak tests should be carried out.

6) For fan damage, NFB (No Fuse Breaker) should be used, instead of ordinary fuses, to avoid single phase operation of three phase motors.

7) For cooling water circuit, a periodical system of gasket exchanges should be established.

8) For battery breakdown, periodical exchange system, for example every 10 years, should be

established.

9) For the fuel circuit, cleanliness of the filter should be strictly maintained through work in an independent clean room. NFB should be used for protection of fuel pump motors.

10) For bearings, maintenance should also be carried out in independent clean rooms.

11) Maintenance manual including work procedure, and visual boards in related working places, indicating important working points for maintenance, should be prepared to avoid the above-mentioned common breakdowns and repeats of the same breakdown.