6.3 Numbering Plan

6.3.1 The Present Condition of Cambodia's Numbering Plan

(1) Overall composition

The complete international number consists of the country code, area code, exchange code and subscriber number.

(2) Country code and prefix

Country code of Cambodia is 855.
The international prefix is 0 0.

(3) Area code and prefix

Area code consists of two digits as shown in Table 6.3-1. The trunk prefix is 0.

Table 6.3-1 Present Area Code of Cambodia

OA	B								
	2	3	4	5	6	7	8	9	0
02	Phnom Penh			Kan dal		Komp. Chhang	Komp. Speu		
03	Takeo		Kampot	Komp. Som	Koh Kong				
04	Kompong Cham			Prey Veng		Svay Rieng			
05	Pursat		Battambang			Bantay Mean			
06	Kompong Thom		Siem Reap		Preah Vihear				
07	Kratie		Mondol Kiri		Stung Treng		Ratann akiri		
08	reserve								
09	reserve								
00	international								

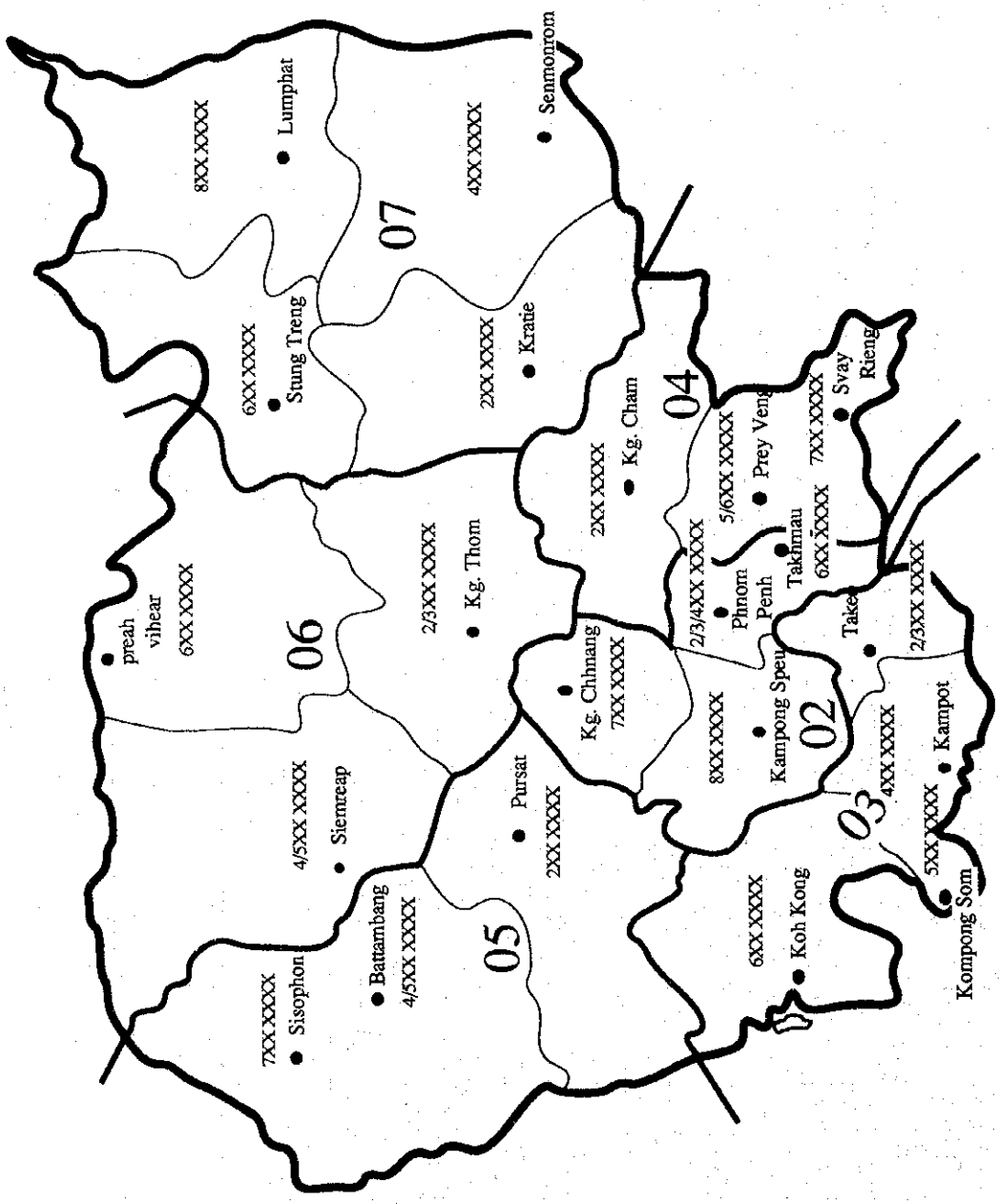


Figure 6.3-1 The Existing Area Codes of Cambodia

(4) Exchange code

The exchange code consists of two digits in Phnom Penh.

(5) Subscriber number

The subscriber number consists of three digits.

(6) Present Numbering Plan for Phnom Penh City

Table 6.3-2 shows the numbering plan of Phnom Penh.

Table 6.3-2 Present Numbering Plan for Phnom Penh City

Area Code	Exchange Code	Subscriber Number	Exchange Name	Capacity of Exchange
23	22	XXX	Penta Conta	1,000
	23	XXX	Penta Conta	1,000
	24	XXX	Penta Conta	1,000
	25	XXX	Penta Conta	1,000
	26	XXX	AXE 104 A	1,000
	27	XXX	AXE 104 B	1,000
	28	XXX	AXE 104 A	1,000
	29	XXX	AXE 104 A	1,000
	6X	XXX	CAMSHIN	

(7) Special service numbers

Table 6.3-3 shows the present special service numbering plan.

(8) Mobile service code

Mobile services are using "0" and "1x" as the prefix and company code respectively. The present condition of each numbering usage of mobile service operations is shown in Table 6.3-4.

Table 6.3-3 The Existing Numbering for Special Service

Code	Special Service
12	Domestic & Long Distance Call Inquiries
13	Directory Assistance
17	Emergency -- Police
18	Emergency -- Fire Station
19	Emergency -- Hospital
151	ITMC Phnom Penh

Table 6.3-4 The Existing Numbering for Mobile Service

Prefix - Code	System
011	Reserve
012	Reserve
013	UNTAC
014	Reserve
015	SAMART
016	Reserve
017	TRI
018	CAMTel
019	Reserve
010	Reserve

6.3.2 Proposed Numbering Plan

(1) National Plan for Phnom Penh City and its Surrounding Areas

The proposed numbering plan for Phnom Penh City and its surrounding areas will be set up with the following principles.

(a) The area code will continue to be the same as the present number, which is 23.

(b) The exchange code will be composed of 2 digits.

(c) The subscriber number will be composed of 4 digits, because the existing 3 digit subscriber number will not be sufficient for the telephone demand in the future.

Based on the above principles, the telephone number for subscribers accommodated by newly installed exchanges will be 023-nX-XXXX. Figure 6.3-2 and Table 6.3-5 show proposed exchange codes for new local exchange areas. n: 2 ~ 9, X: 0 ~ 9.

Table 6.3-5 Proposed Exchange Code

First Digit of Exchange Code	Exchange Area
2	WEST, AIRPORT
3	NORTH, C.C. REH, P. PHNOU
4	CENTRAL, RUSSEI
5	C. AMPOU, TAKHMAU

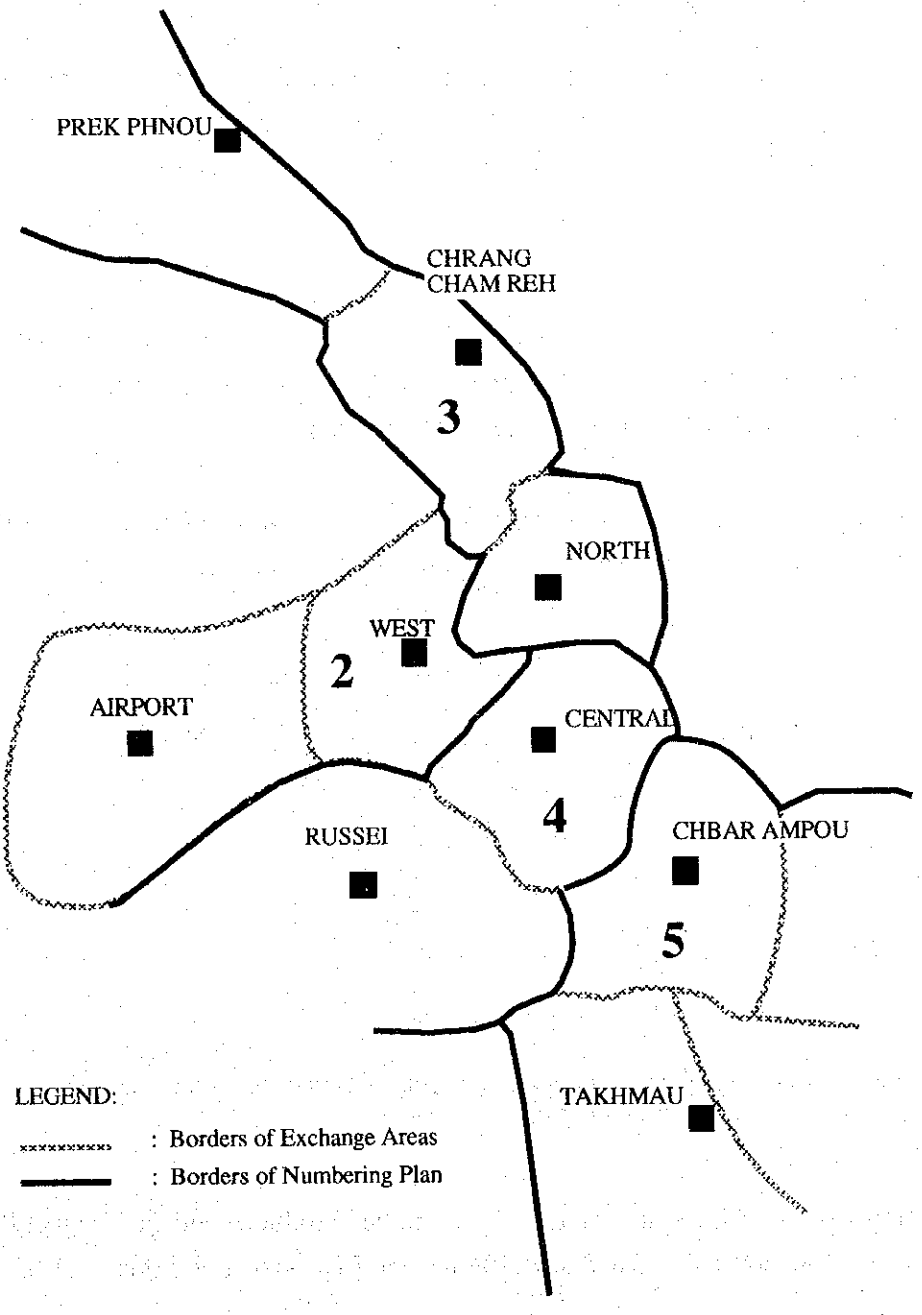


Figure 6.3-2 Numbering Plan in Phnom Penh City and its Surrounding Areas

(2) Special service numbers

For special services, a small numbering series is appropriate. Emergency numbers should be easy to remember, and the special service numbers should be uniform throughout the country.

(3) Mobile telephone service code

In order to avoid useless confusion of numbering, for the present, it is not necessary to change the present numbering plan for this mobile telephone service code.

6.4 Signaling System

The CCITT CCS No. 7 is applied to the signaling system between digital exchanges. In the first stage of the introduction of digital exchange, an associated mode is used as the mode of signaling link as shown in Figure 6.4-1.

In this Study, the associated mode will be applied to the Emergency Project. The Telephone User Part (TUP) will be applied as the User Part.

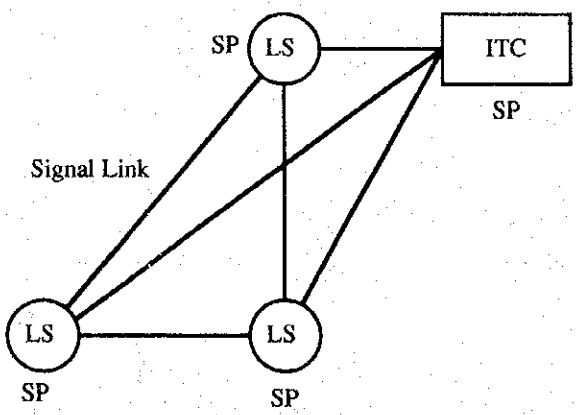


Figure 6.4-1 Signal Transfer Mode (associated mode) in Objective Area in the Emergency Project

In the future, a quasi-associated mode will be introduced and each Signal Point (SP) will belong to two Signal Transfer Points (STP) as shown in Figure 6.4-2.

In this Study, the quasi-associated mode will be applied to the Essential Project.

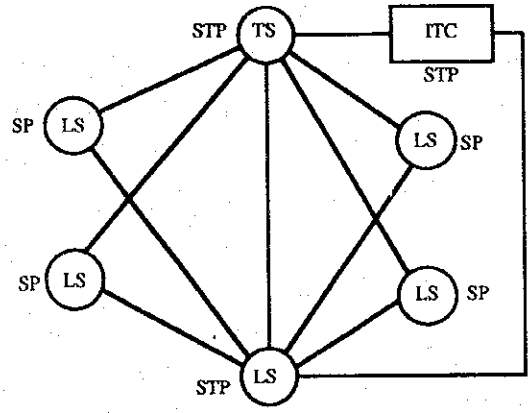


Figure 6.4-2 Signal Transfer Mode (quasi-associated mode) in Objective Area in the Future

6.5 Charging System

The present charging systems are shown in the following table.

Table 6.5-1 Present Charging Systems

Category of Call	Charging System	Charging Point
Local call	*1 None	-
Long distance call	*2 None	-
International call	Automatic Message Accounting (AMA) System	Local Switch

*1 Flat rate system *2 Per minute system

In this Study, the present charging systems will be used.

6.6 Synchronization Plan

For the telecommunication network of Cambodia, a master slave synchronization method will be introduced. For the time being, the existing international exchange which has cesium oscillators with a stability of 10^{-12}/life time will be the master exchange. Local exchanges to be introduced will be slave exchanges. Local exchanges will have oscillators with stability of 10^{-8}/life time as back up oscillators in free run. RSU will have oscillators with stability of 10^{-6}/life time as back up oscillators in free run. Master clock distribution network for the time being is shown in Figure 6.6-1.

When a new trunk exchange is introduced in Phnom Penh City, it will be a sub-master exchange and will have cesium oscillators with stability of 10^{-12}/life time as back up oscillators. Master clock distribution network in the future is shown in Figure 6.6-2.

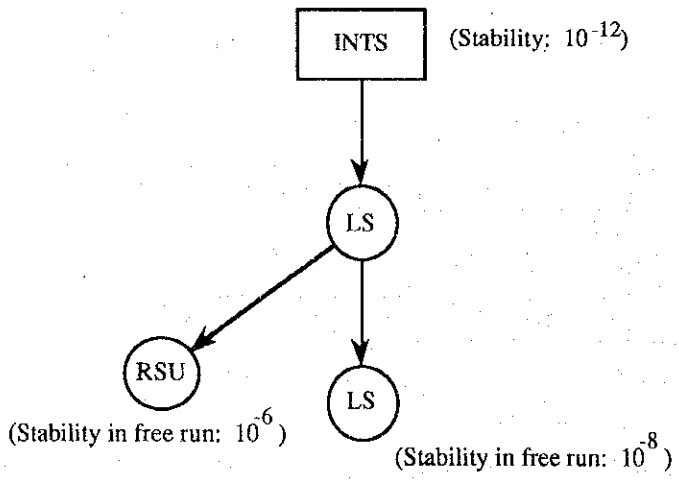


Figure 6.6-1 Master Clock Distribution Network for the Time Being

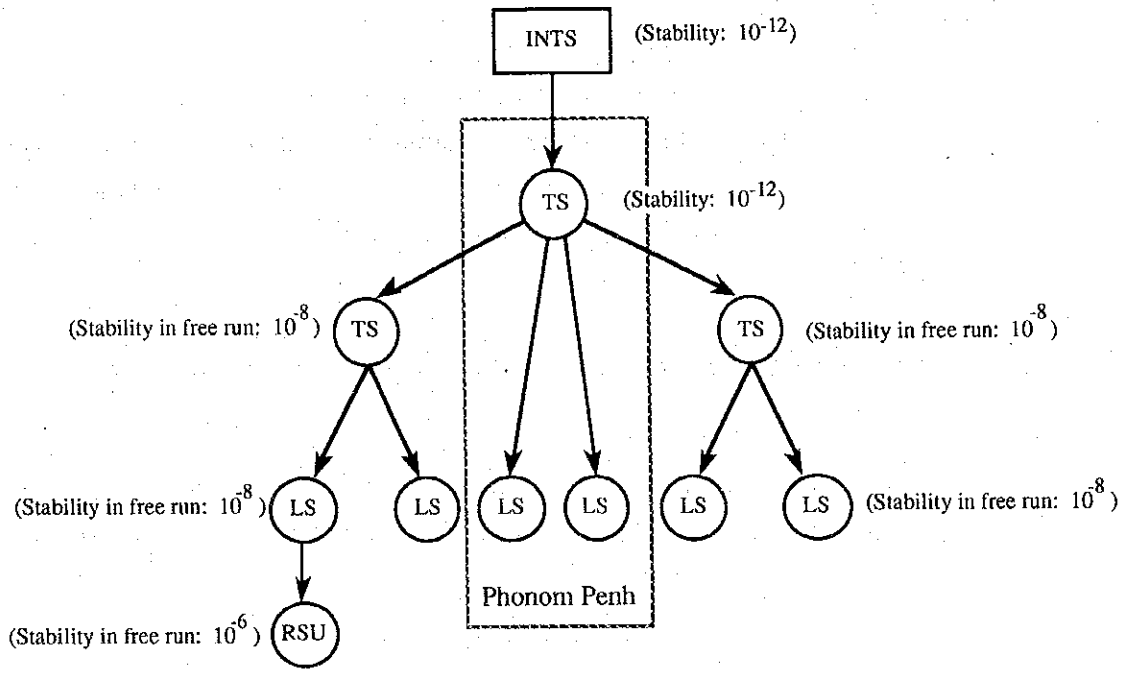


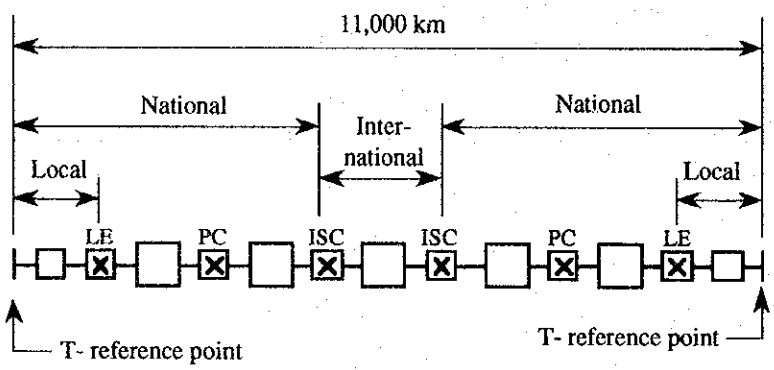
Figure 6.6-2 Master Clock Distribution Network in the Future

6.7 Technical Standard of Network Quality

In order to design an appropriate network, the design work should be done so as to satisfy each target value of the connection performance, the transmission performance and the availability performance for the network. Table 6.7-1 shows the target values for the quality of each network between subscribers through connections of Figure 6.7-1 and Figure 6.7-2.

(1) Standard Digital Hypothetical Reference Connection (HRX) for Digital Networks

A digital HRX is a model in which studies relating to overall performance may be conducted, thereby facilitating the formulation of standards and objectives.



LE Local exchange
PC Primary center
SC Secondary center
TC Tertiary center
ISC International switching center

Digital link

Digital exchange

Figure 6.7-1 Standard Digital Hypothetical Reference Connection (moderate length)

(2) National Transmission Loss Allocation

Figure 6.7-2 shows a typical national transmission loss allocation between subscribers.

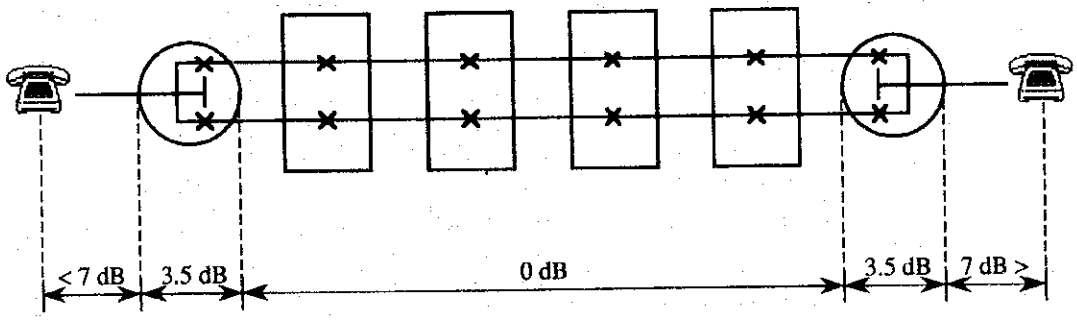


Figure 6.7-2 National Transmission Loss Allocation

The transmission loss allocated to the two wire subscriber lines does not exceed 7 dB, and its direct current loop resistance does not exceed 1500 Ω in this Study. The losses for digital sections and hybrid portions are 0 dB and 3.5 dB.

(3) Target Values for Network Quality

Table 6.7-1 The Target Values for Network Quality

Network Quality	Grade of Service	Target Values		Related CCITT Recom-mendations
Connection Performance	Initial address message delay (for signaling system No. 7 networks)	Total delay International National	4 sec. 1.5 sec. 2.5 sec.	Rec. E723
	Answer message delay (for signaling system No. 7 networks)	Total International National	2.5 sec. 1.0 sec. 1.5 sec.	Rec. E723
	Probability of end-end blocking	Local connection Toll connection International connection	2% 3% 5%	Rec. E721
Transmission Performance	Transmission Loss for Digital Links	Total loss	0 dB	
	Bit Error Ratio for Severely Errored Seconds of Digital Network	Fewer than 0.2% of one second intervals to have a bit error ratio worse than $1 \cdot 10^{-3}$		Rec. G821
Availability Performance	A 2,500 km hypothetical reference circuit in one direction (Analog cable transmission systems and associated equipment)	> 99.6% for one year duration		Rec. G602

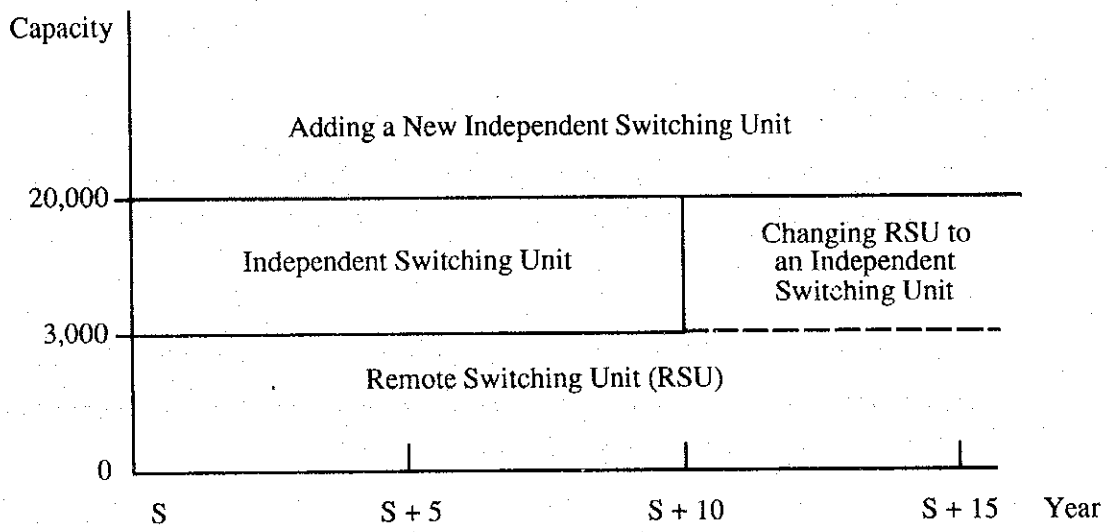
CHAPTER 7

System Selection

CHAPTER 7 SYSTEM SELECTION

7.1 Exchange System

Selection criteria of exchange systems is shown in the Figure 7.1-1.



(1) In the case of establishing an RSU, an independent switching unit to accommodate it is necessary in the same local area.

(2) If there is not an independent switching unit to accommodate RSU, an independent switching unit will be installed even though it has small exchange capacity.

Figure 7.1-1 Selection Criteria of Exchange Systems

7.2 Transmission Network System

For the provision of the transmission system for the junction network in the Study, an optimum system should be selected considering not only the requirement to meet traffic density estimated in the year targeted, but also the requirement that it be an economical system for the whole network which takes into account the world technology trend.

7.2.1 Selection of System

A digital transmission system should be applied to the networks in the study area. The Synchronous Digital Hierarchy (SDH) system is to be introduced to the networks for the following reasons.

- SDH has been standardized and recommended by ITU-T as a worldwide unified digital hierarchy system in 1988, and approved by the World Telecommunication Standardization Conference (WTSC) in March, 1993.

- The PDH system might become globally obsolete telecommunications technology in the near future. Therefore, it is presumed that the equipment and materials for PDH will become difficult to obtain for maintenance and operation of the system.

- It is an advantage of SDH system that the management system for transmission networks utilizing either micro-wave links or optical fiber links, can be adopted easily.

- The system interface is unified as 155.52 Mb/s, and can connect with inter networks among other countries, so the multi-venderization of equipment is possible.

7.2.2 Interface of SDH

The interface of the SDH system in the Study is shown in Figure 7.2-1.

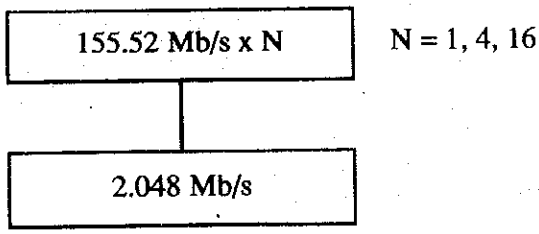


Figure 7.2-1 Interface for SDH

7.2.3 Selection of Transmission Network for the SDH System

The SDH system can be applied to the transmission network (media) utilizing either the micro-wave link or optical fiber link systems. Therefore, the optimum transmission network to be applied in the Study is determined by the cost comparison between the above 2 systems. The cost comparison was made for the 3 conceivable systems (media) in the Study, i.e., the digital micro-wave transmission system (155 Mb/s), the optical fiber system (155 Mb/s) and the optical fiber system (600 Mb/s), and the results are shown in the Figure 7.2-2. An applicable range for optimum systems given in the figure in terms of distance between the terminal exchanges and capacities to be transmitted as parameters.

In accordance with the cost comparison, the SDH system using optical fiber transmission system is an appropriate medium for the transmission network when the distance between exchanges is less than 20 km and when the capacity of transmission is less than 126 systems (calculated in terms of 2 Mb/s).

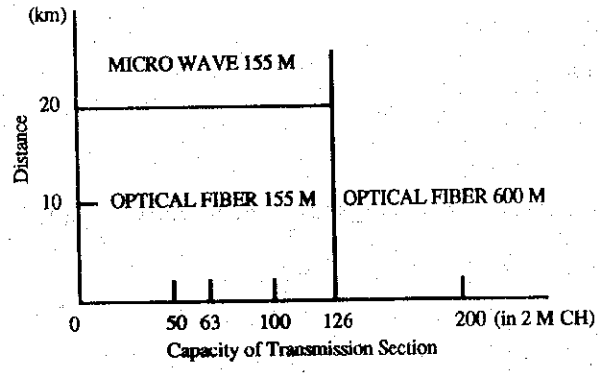


Figure 7.2-2 Standard of System Selection for SDH

7.3 Subscriber System

7.3.1 Potential Subscriber Systems

For the establishment of the subscriber network in the study areas, the following subscriber systems are considered. The features of these subscriber systems are shown in Table 7.3-1.

Table 7.3-1 Features of Subscriber Systems

Category			Features	Remarks
Cable Subscriber System	Metallic Cable System		As a basic telephone service, the metallic cable systems are generally utilized in the world.	
	Optical Cable System		For the specific subscribers and/or services, the optical cable systems are utilized due to their wide-band transmission capability.	
Radio Subscriber System	Fixed Radio System	Point-to-Multipoint (P-MP) System	For the sparsely scattered demand such as in the rural area, this system is most efficient.	
		Point-to-Point (P-P) System	For the specific subscribers such as dedicated lines, P-P system is effective system.	
	Mobile Telephone System		For the mobile communications, the mobile telephone system is used. In addition, the modified system such as fixed cellular system is also used for the subscriber system.	

Among the above subscriber systems, the following potential subscriber systems are preliminarily selected considering the objectives of the Project and the conditions of the study areas.

- Metallic Cable System
- P-MP System
- Mobile Telephone System

These potential subscriber systems are conceptually designed and compared with each other.

7.3.2 Application of Subscriber System

The above potential subscriber systems are applied to the study areas as follows:

(1) Application of Metallic Cable System

The metallic cable systems are connected to the telephone office in each exchange areas. In this case, there is little restriction regarding the construction of the cable system compared the other countries. Also, the application of the metallic cable system can comply with the numbering plan, which corresponds to each exchange area.

(2) Application of P-MP System

A P-MP system can not accommodate all of the subscribers in the study areas, because its system capacity is smaller than the number of demand. Therefore, the P-MP system can be used as a supplemental system of the other subscriber systems. In addition, the P-MP system requires the power supply system not only at the base station, but also at each subscriber station.

(3) Application of Mobile Telephone System

To cover the study areas, the number of the base stations may be more than that of the telephone offices, so the new sites are required for the mobile telephone system. An antenna tower and an approach link from / to the mobile telephone exchange are required in each base station. In addition, the power supply system is required not only for the base station, but also each subscriber.

7.3.3 Selection of Subscriber System

The subscriber system to be applied in the study areas is selected among the above systems considering the following conditions:

(1) Request by Cambodian Side

The Cambodian side requests the application of the metallic cable system in the study areas due to the following reasons:

- To rehabilitate the cable subscriber network as a basic telephone service
- To avoid competition with the existent joint venture companies
- To provide affordable public services
- To manage the subscribers by the easiest means as far as possible
- To solve the difficulty of subscribers to get commercial power supply for terminals

(2) Required Service Menu

The subscriber system to be applied in the study areas requires only a basic service menu such as ordinary telephone functions and facsimile communications.

(3) Application Conditions

In the study areas, the conditions of the AC commercial power are very poor. If the radio subscriber systems are applied to the ordinary subscribers (not specific subscribers such as important subscribers), the provision of the power supply system is required. Besides, the cable subscriber system can be constructed easily due to little restriction in the study areas compared with the other countries.

From the above considerations, the metallic cable system is selected for subscriber systems in the study areas.

CHAPTER 8

Development Strategy

CHAPTER 8 DEVELOPMENT STRATEGY

8.1 Demand Fulfillment Plan

Public telephone network service in the study areas is remarkably insufficient in terms of both quantity and quality. Hence most subscribers are affected by the high cost of acquiring a telephone line and poor quality of services. Telephone penetration in terms of Plain Ordinary Telephone Service (POTS) in Phnom Penh City is 0.6 per 100 inhabitants which is very low compared to the 5.4 per 100 inhabitants on the average of capital cities of surrounding countries, namely Manila, Bangkok, Jakarta, Vien chan, and Ho chi minh. A recommendation had been made to introduce a mobile communication system as an urgent measure for easement of the issue and then the system could be combined with fixed telecommunication systems to be developed later.

Currently, the cellular telephone services are provided only for select key subscribers who can afford it as compensation for insufficient public telephone network facilities supplied by the foreign private sectors. The number of subscribers of these services reached almost 10,000 in 1994.

In order to improve the public telephone network conditions stated above, the following basic concepts are to be applied:

To improve the services in both quantity and quality for supporting and enhancing the socio-economic activities of the area.

The year of 2007 is determined as the target year for the development of the public telephone network in the Study. The target year is determined by the consideration of the policies stated in the "Telecommunications Sector Investments Program for 1994 - 1998" as a part of "Public Investment Program for Physical Infrastructure" formulated by the MPTC, and the "Policies and Programs for Rehabilitation and Development for the Kingdom of Cambodia" issued by the government of Cambodia. In accordance with the Investments Program, the penetration ratio of Phnom Penh City will improve to more than 2 to 3 telephones per 100 inhabitants by the year 1997.

MPTC should therefore, take necessary action for the network before 1997, and an additional 10 years are considered as a period for expansion and development of the network. During this 10 year period, trunk networks to connect Phnom Penh and

other cities in provinces, should also be improved and expanded in conformity with the total telecommunication network in Cambodia.

Targets for the development of public telephone network up to the year 2007 which is 10 years after the expected commissioning of the initial provision are set as follows:

- To provide a fully digitized network,
- To provide sufficient capacity of facilities to meet the telephone demand in that year,
- To provide a network in which the function of the trunk network can be added in the future.

To realize the target mentioned above, the following strategies will be applied to telephone supply and network development.

8.1.1 Telephone Supply Strategy

At the initial stage, a large sum of investment might be required for installing subscriber lines to meet the telephone demand fully at once. Therefore, the supply of telephones other than public pay phones is made taking into consideration the priority given to respective subscriber category groups as listed below:

GROUP	PRIORITY
Administrative group	Highest
Public group	↑
Industrial / Business group	↓
Commercial group	
Residential group	Lowest

For the area within an exchange, telephone lines are provided to all waiting applicants in accordance with the priority orders and those who play an important role in the community and more public pay phones are provided.

It is necessary to provide proper telecommunication services to subscribers located outside the exchange area.

For the area outside exchange areas, telephone lines are provided to all waiting applicants belonging to the highest priority group such as administrative offices, hospital/clinics, police stations, and public pay phones.

8.1.2 Provisioning Period

(1) Initial provision of telecommunications facilities shall be made to meet the immediate requirement at the expected commissioning year for these exchange offices which are planned in the Study. However, capacities of respective systems to be introduced, such as exchange buildings, cable/radio transmission equipment, civil facilities, and power supply equipment, shall be decided considering not only the immediate requirements but also future requirements to economically establish the network in total. Such an arrangement might be inevitable for expanding the telecommunication services smoothly in the areas without heavy financial constraints.

(2) It is recommended that provisioning for further expansion be implemented every 5 years so as to avoid frequent expansion which may increase the total costs for expansion work over the long period as labor and material costs may increase for completing such expansion. In addition to that, the total capacities of the facilities should increase gradually in proportion to the substantiality of MPTC's ability in terms of manpower and management for maintaining and operating the facilities.

(3) Provision of telecommunication facilities to meet the 2007 year demand for each area as the fundamental network is made a total of 2 ~ 3 times for the Project, considering the criteria stated in (1) and (2) above. For instance, if the initial provision in 1997 is made based on the demand in the same year, then its expansion in 2002 and 2007 are made based on 2002 and 2007, respectively.

However, new subscriber's line connection is provided gradually afterwards to meet applications for telephone connection. A reference figure is shown in Figure 8.1-1.

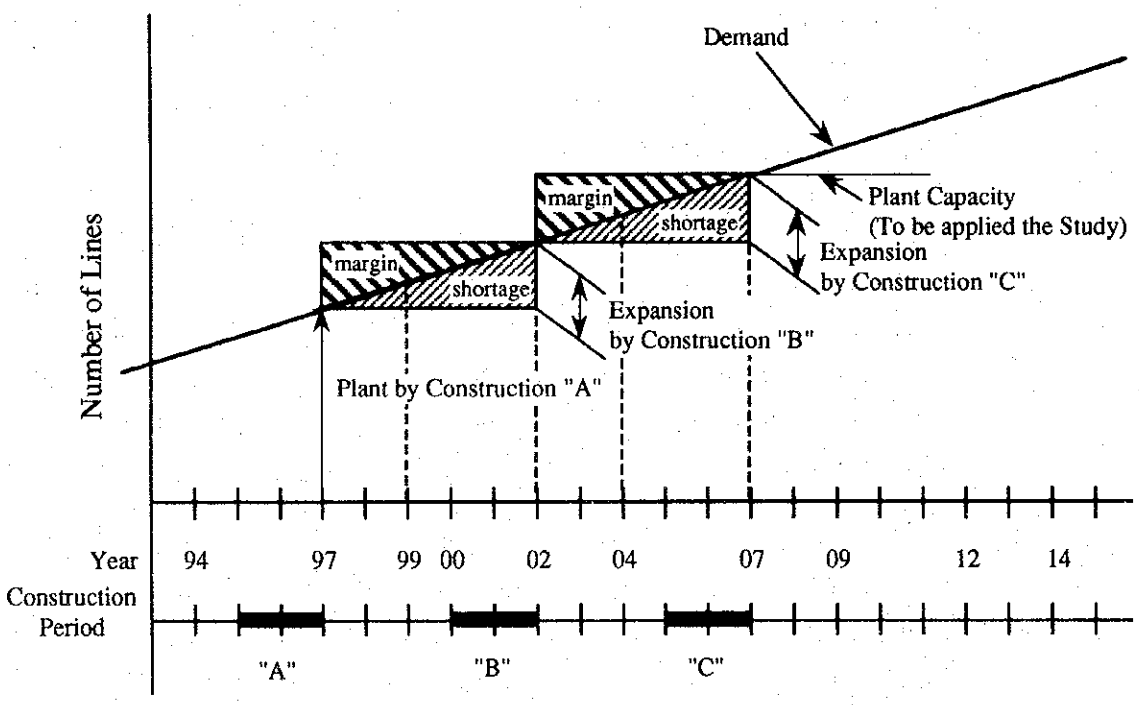


Figure 8.1-1 Provisioning Plan

8.2 Provisioning Plan in the Study Areas

Facilitating telecommunication facilities in an economical manner as well as in a balanced manner with demand, sizing and expansion timing is dependent on the telephone demand forecasted.

8.2.1 Phnom Penh City and its Surrounding Area

The objective area of this study is defined as greater Phnom Penh City including the city area, 3 districts outside the city and part of 2 districts (Prek Phnou, Takhmau), since the municipality of Phnom Penh City governs administratively all areas mentioned above and moreover, between respective areas is a close relation socially and economically.

(1) Telephone Demand for Greater Phnom Penh City

The telephone demand for the greater Phnom Penh City is forecasted by the Study in the preceding Chapter 5 where the results summarized are shown in Table 5.4-1.

(2) Exchange Area Determination

In order to determine proper size of the exchange area, the following items have been taken into consideration for the establishment of an economical network and easiness of the maintenance and expansion of the network in future:

a) The size of telephone demand (density)
b) The area size in square kilometers (km^2)
c) The exchange area boundary, which should be designated to match the administrative boundary as much as possible, and a big river or railway line should be considered to be a boundary as well. A barren area is also taken into consideration to designate the exchange area boundary.
d) Application of the unigauge system, which is determined by the following reasons:
   - To reduce the type of spare materials, tools/equipment and spaces for keeping them as well as the procurement costs for those materials by mass procurement effect,
   - To avoid the impedance of miss matching affecting data transmission,
   - To make it easy to manage the subscriber network.

The cable subscriber system in which 0.4 mm conductor diameter of cable is applied can reduce the number of ducts, since the cable can contain a large number of pairs, for instance 2,400 pairs in one cable. Therefore, in the Project 0.4 mm diameter conductor cable is applied as a unigauge system, and accordingly the exchange area is determined within almost 3 km radius from a center of demand density. Due consideration of the limitation of linc loss value (7.0 dB) is to be specified by the national transmission loss allocation.

The greater Phnom Penh City is divided into 3 exchange areas in the city and 6 exchange areas in surrounding areas by the Study. Proposed exchange areas are shown in Figure 8.2-1.

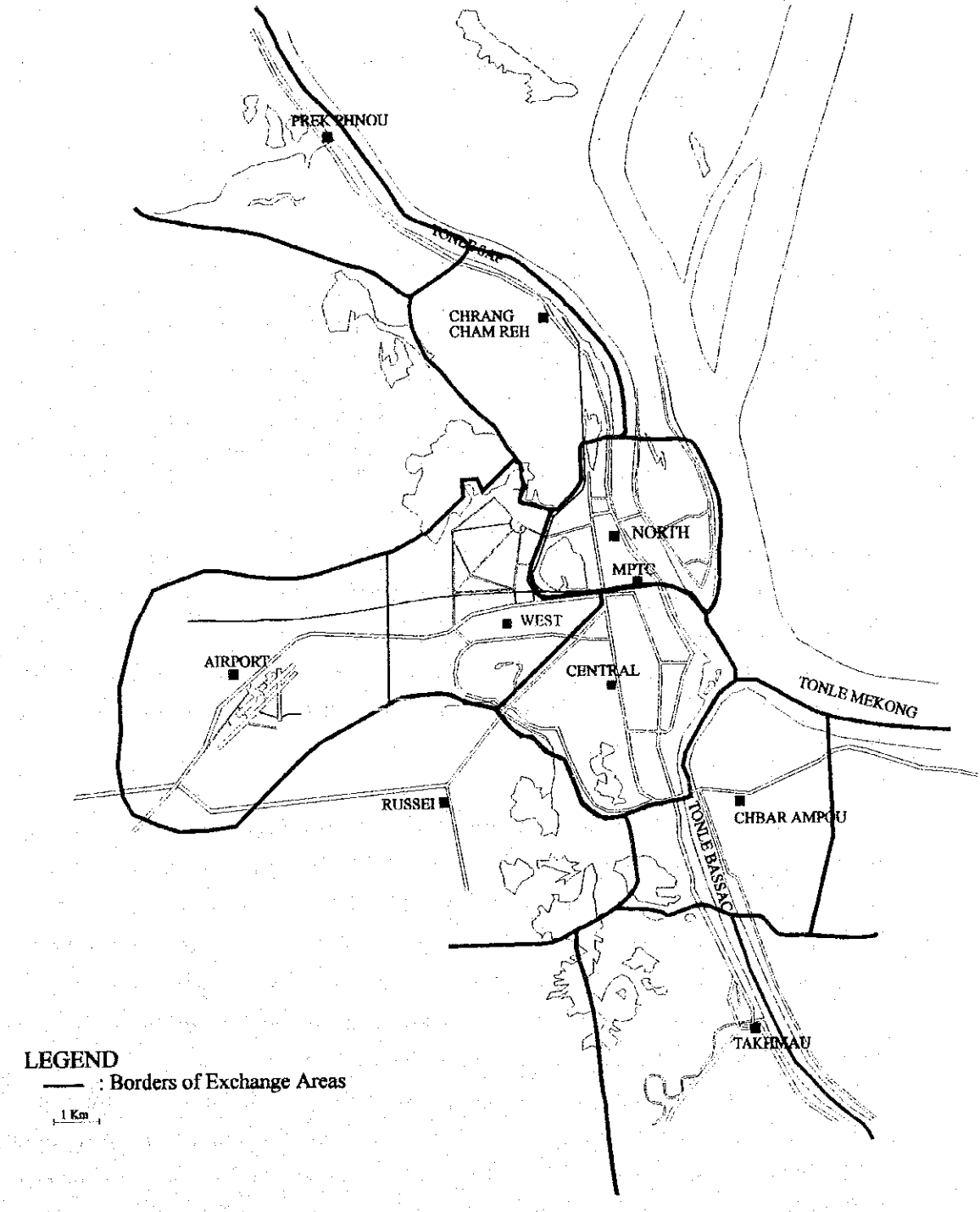


Figure 8.2-1 Exchange Areas in 2007

8.2.2 Telephone Demand of Each Exchange

Telephone demand forecasted in preceding Chapter 5 of each proposed exchange is shown in Table 8.2-1 below.

Table 8.2-1 Telephone Demand (Exchange base)

Exchange Office	North (MPTC)	Central	West	Charang Cham Reh	Prek Phnou	Airport	Takhmau	Chabar Ampou	Russei	Other Areas	Total
1994	1,300	8,200	4,400	300	50	500	900	930	40	1,830	18,450
1997	1,600	9,600	5,300	400	80	600	1,700	1,500	60	2,740	23,580
2002	2,700	13,400	8,300	900	180	1,400	3,300	3,000	110	5,090	38,380
2004	3,300	15,200	10,000	1,200	260	1,900	4,300	4,000	150	5,490	45,800
2007	4,400	19,800	13,900	1,800	420	2,900	6,700	6,200	240	10,760	67,120

All exchange offices except North Exchange Office are proposed to be establish newly and to cover respective area telephone demand. However, in consideration of future network in Cambodia, it is recommended to shift the location of North Exchange Office which is currently in the MPTC Head Office building, and that existing buildings should be utilized as a headquarters office of MPTC which plays the role of a regulatory body.

For the subscribers in the other areas listed in the above Table, the exchange areas are not determined by the application of the cable subscriber system in this plan, due to the distance between an exchange office and subscribers which is far over the limitation of services to be provided by the system. Also, from the economical view-point the area is not as sufficiently developed as the other exchange areas for the establishment of new exchange office. However, as the public telecommunication services are considered one of the most important infrastructure for BHN, it is important to provide proper telecommunication services to the area. On the other hand, at the initial stage, a large sum of investment might be required for installing subscriber lines to meet the telephone demand fully at once for the vast area. Such an investment may impose heavy financial constraints on the MPTC. Therefore, the supply of telephones other than public pay phones is to the subscribers who are categorized as high priority groups located in the area. High priority groups mean the important subscribers who play an important roll in the area, such as Administrative offices, Hospital/clinics, Police stations, organization offices to be subordinate to the Government and/or non governmental organizations (NGO), etc. In accordance with

the MPTC's request and the survey results based on the concept stated above by the Team, the number of important subscribers is to be more than 100 in the area which is not covered by the cable subscriber system. The most applicable system recommended for the important subscribers mentioned above is radio subscriber system.

8.3 Project Formation

The project formation of the fundamental network plan is formulated for each exchange area. The optimum systems to be applied in the Essential Project are studied and selected in the preceding Chapter 6 and 7.

8.3.1 Telephone Network in Phnom Penh City and Surrounding Areas

Based on the results of the Study in preceding 8.1and 8.2, the telephone network in the Study areas will be realized in the year 2007 as shown in Figure 8.2-1, and capacity for main equipment of each exchange office is listed below in Table 8.3-1:

Table 8.3-1 Capacities of Main Equipment

Exchange Office	Switching Unit	Exchange Capacity	MDF Termination	Transmission Media
NRT (MPTC)	LS	3,600 lu.	4,000 pairs	F/Optic
CNT	T/LS	21,000 lu.	24,800 pairs	ditto
Other Area	(incl. Central)	(100 lu.)	(-)	digital MAS
WST	LS	15,000 lu.	17,600 pairs	F/Optic
CCR	RSU	1,300 lu.	1,600 pairs	ditto
PPN	RSU	500 lu.	600 pairs	ditto
APT	RSU	3,000 lu.	3,600 pairs	ditto
TKM	LS	4,800 lu.	5,000 pairs	ditto
CAP	LS	4,400 lu.	4,600 pairs	ditto
PRS	RSU	300 lu.	350 pairs	ditto
Total	-	54,000 lu.	62,150 pairs	-

Note: Host exchange of RSUs in Prek Phnou, Charang Cham Reh, and Russei is Central exchange,
Host exchange of RSU in Airport exchange is West exchange,
T/LS means Toll Local Switching,
F/Optics means optical fiber cable (junction cable system).

8.3.2 Project Implementation Plan

In order to realize the public telecommunications network in the year 2007, the implementation plan for the provision of facilities should carefully be established considering the effective provision of the services to be well-balanced with the investment costs. The exchange offices planned in the Study for the objective area are divided into 3 groups by priority order, and the Project should be implemented by

each group considering the mass procurement effect. The groups are made based on the following criteria:

- An area which shall be a high telephone demand area,
- An area which shall include socially and economically important subscribers,
- An area which has no telecommunication facilities or the existence of obsolete facilities,
- An implementation which can afford the maximum contribution to the future network in Cambodia,
- Total system for each group which can be completed within MPTC's capabilities in terms of the mobilization of staff and utilization of budget.

The exchange offices selected in the groups by above criteria are as follows:

1st, the first priority group includes 3 exchange areas, i.e., Central Exchange Office area, West Exchange Office area, and Airport Exchange Office area and the other areas to be covered by radio subscriber system. These exchange areas include the highest telephone demand area and socially and economically important subscribers, as well as the international airport and the lands for developments. This also includes the services to the important subscribers located in the other areas.

Therefore, implementation of this 1st priority group is required urgently considering not only subscribers in the area, but also as a foundation of the total public telecommunication services in Cambodia.

This project to reconstruct the telecommunications facilities in the first priority group for the first stage is categorized as the Emergency Project.

Telecommunication facilities to be constructed by the Emergency Project are only planned for provision of the initial stage of which the target is to meet the demand in the year 1997, and the expansion plan of facilities will be made afterward by the Essential Project in accordance with the 8.1.2 hereinabove.

2nd, the second priority group includes 4 exchange areas, i.e., North Exchange Office area, Charang Cham Reh Exchange Office area, Takhmau Exchange Office area and Chabar Ampou Exchange Office area. The telephone demand of these areas is rather small compared to the 1st priority group in the early stage.

As for the areas of North and Takhmau Exchange Offices, the area includes some of the important subscribers, and a telephone demand of 4,400 and 6,700 respectively is estimated. However, additional subscribers can utilize existing facilities for expansion while new exchange offices are established and rehabilitation of facilities is made later. For important subscribers located in the areas other than those of these 2 exchange offices, the services are provided by the radio subscriber system to be established in the 1st priority group, until the exchange offices are established in their own area.

This is categorized as the Essential Project.

3rd, the third priority group includes 2 exchange areas, i.e., Prek Phnou Exchange Office area and Russei Exchange Office area. Telephone demand in the areas are rather small at present.
The services for important subscribers in the area will be provided by radio subscriber system to be installed in 1st priority group until the new exchange offices are established.

This is categorized as the Essential Project.

8.3.3 Project Implementation Schedule

The overall time schedule of the project implementation is shown in Table 8.3-1.

For implementation of the Project, employment of a consultant is recommended for execution of detailed design including field survey, preparation of tender specification, assistance in evaluation of tender proposals and contract negotiation, methodical work progress management, and proper solution of problem causes in the course of implementation.

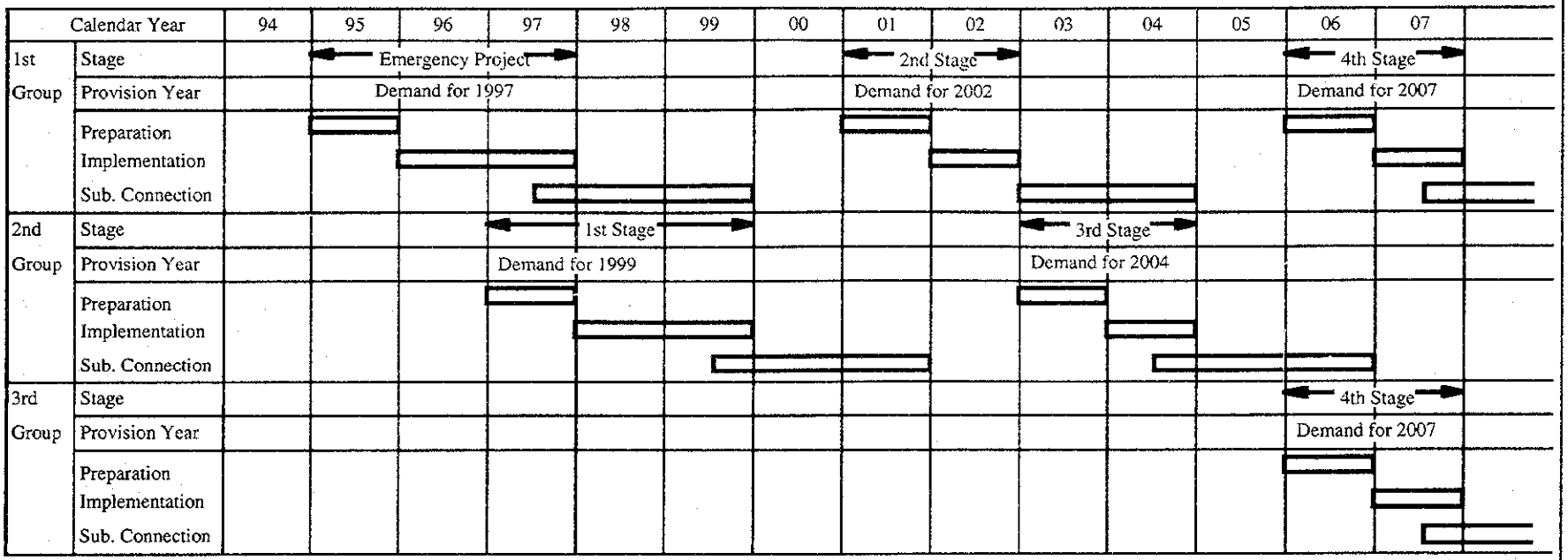
The following preconditions are taken into consideration in formulating the time schedule:

1) Implementation of the Emergency Project is required urgently. Therefore, the detail of implementation is studied in the study of the said project as a supplemental report of this Study.
2) Equipment and materials are to be provided by the same contractor for all areas in the groups to ease operation and maintenance, and also to reduce cost

required for spare units. Therefore, the selection of a contractor by competitive bidding is to be made.

3) Construction work is to be carried out by the contractor on turn-key basis. However, the construction of exchange buildings required for the Essential Project and the connection of subscriber lines in each area are to be carried out by MPTC at its own cost.

Table 8.3-2 Implementation Schedule



Note: Exchanges consisted in each group are as follows
1st Group - Central Exchange, West Exchange, Airport Exchange
2nd Group - North Exchange, C.C. Rey Exchange, Takhmau Exchange, C. Ampou Exchange
3rd Group - P. Phnou Exchange, P. Russei Exchange

CHAPTER 9

Traffic Forecast and Circuit Calculation

CHAPTER 9 TRAFFIC FORECAST and CIRCUIT CALCULATION

9.1 Method of Approach for Traffic Forecast and Circuit Calculation

(1) Determination of outgoing calling rate

Actual traffic data of outgoing calls per subscriber at the busiest time was acquired based on the data from the existing digital exchange AXE 104 during the field survey, and taking into consideration the changing rate as well as the rate of increase in the future, the outgoing calling rate of the new exchange was determined.

(2) Determination of traffic rate

The local and long distance traffic rates (including international calls) were determined after acquiring the traffic data for the destinations regarding the existing digital exchange AXE 104 and AXE 105.

(3) Presumption of traffic volume per each local exchange

The quantity of the traffic rate depending on the local calls and long distance calls (including international call) per each unit of the local exchange was presumed based on the outgoing calling rate and the traffic rate which are determined in the preceding clause.

(4) Preparing traffic matrix

The traffic matrix was prepared according to the quantity of outgoing traffic. The matrix was prepared on the assumption that the affinity rate among exchange offices is equal and it is not affected by the distance between exchange offices. The traffic rate depending on the destinations, is designated by the capacity rate of each exchange.

(5) Calculation of the number of junction circuits among exchanges

Based on the traffic matrix, the number of the junction circuits was calculated as in the case of "Loss Probability of 0.01". The calculation is carried out by Erlang's B formula as the calls among exchanges are generated at random.

(6) Calculation of number of circuits to international exchanges from new exchanges

The number of the circuits to the international exchange from the new exchanges was calculated according to the amount of the international call traffic.

9.2 Traffic Forecast

9.2.1 Basic Data for Traffic Forecast

(1) Outgoing Traffic Measurement

In this study, to identify characteristics concerning busy hour traffic concentration and traffic distribution by routes (or traffic inter flow) in existing local telephone networks, analytical study was carried out based on the latest data collected from OTCI. The useful traffic data collected at local exchange AXE 104 A, AXE 104 B and international exchange AXE 105, could be obtained. Data resulting from analysis of calls are as follows;

(a) Weekly traffic fluctuation (one week) measurement : Monday had the most heavy traffic.

(b) Daily traffic fluctuation measurement : The busy-hour was one hour between 10 to 11 o'clock in the morning.

(c) Traffic measurements of outgoing & incoming calls at the busy hour :

Traffic of outgoing & incoming calls	:	68.7 erl
Number of subscribers	:	951 subscribers
Coefficient of variation	:	1.2
Outgoing calling rate estimated from above data	:	68.7 x 1/2 x 1.2 /951= 0.043 erl

(d) Traffic measurement for international calls :

Outgoing traffic	:	20.1 erl
Number of subscribers	:	10,000 subscribers
Outgoing calling rate estimated from above data	:	0.002 erl

(2) Outgoing Calling Rate by Subscriber Categories

A well known fact is that outgoing calling rates vary greatly according to subscriber categories, i.e., between household subscribers and business office subscribers.

However, in Cambodia and Phnom Penh, due to the effects of civil war and the fact that existing telecommunications facilities are old and obsolete, there are many troubles of facilities and a lack of facilities' capacity. At present, most existing telephone subscriptions are only for business use. For the present, business office use will be given priority, because of the shortage of telephone facilities.

(3) Outgoing Calling Rate by Type of Call

Types of outgoing traffic are mainly threefold. They are the local call, the long distance call (include international call) and the special service call.

(a) Outgoing Long Distance Calling Rate

In Phnom Penh, outgoing long distance calls except for international calls are few, because almost all trunk links between Phnom Penh and provincial cities are out of order. On the other hand, for the recovery of Cambodia's economic activities, many countries are assisting Cambodia with infrastructure rehabilitation. Therefore, international calls are rapidly increasing. In the future, with the recovery and new installation of domestic trunk links, the total outgoing long distance call rate will change.

(b) Outgoing Special Service Calling Rate

At present in Phnom Penh, police and fire station lines are out of order and only some emergency lines are alive, but most hospitals do not have telephones. Under this situation, it was impossible to get useful data for

telephone traffic. Referring to other countries calling rates, a special service calling rate of 0.001 erl was estimated.

(c) Outgoing Local Calling Rate

Outgoing local calling rate is the remainder after subtraction of the outgoing long distance calling rate and the outgoing special service calling rate from the outgoing gross calling rate.

9.2.2 Traffic Forecast Procedures

The preceding results are mainly used as basic data for junction network planning for objective Phnom Penh City and surrounding area of the Study. Junction circuits are generally installed as individual circuit groups according to type of call and local exchange.

(1) Traffic Forecast by Type of Call

(a) Local call
(b) Long distance call (including international call)
(c) Special service call

As basic data for outgoing traffic forecast by exchange and by type of call, the outgoing calling rate by exchange and by type of call and number of subscriber circuits by exchange must be given for each forecast year.

(2) Inter-Local Exchange Traffic Forecast

The foregoing (b), (c) items are established as one junction circuit group for each type of call at each exchange. For item (a), junction circuits to make traffic routing from one local exchange to all other exchanges possible must be established. This is to say, local call traffic for each forecast year must be further distributed to other local exchanges concerned.

9.2.3 Traffic Forecast by Type of Call

(1) Outgoing Calling Rate by Type of Call in Future

(a) Total Outgoing Calling Rate

Total outgoing calling rate by exchange depends mainly upon household subscribers versus business office subscribers ratio at each exchange for each forecast year. As mentioned above, Phnom Penh is in the first stage of the program for rehabilitation and development of telecommunications facilities. Therefore, for the present, the ratio of business use to that of all subscribers will take an absolute majority.

(b) Outgoing Long Distance Calling Rate

From the short term viewpoint, the major assumption is that as domestic long distance service expands regionally, calling rate also grows. However, with the increase of subscribers, international calls will decrease. So, the total outgoing long distance calling rate is estimated at a constant 0.002 erl.

(c) Outgoing Special Service Calling Rates

With the expansion of trunk networks, delayed call acceptances, etc., will decrease. However, as the number of subscribers increases, calls to directory operators, etc., will increase. By reason of those mutually conflicting factors, the special service calling rate in the future is assumed to be at the same level as at present.

(d) Outgoing Local Calling Rate

The outgoing local calling rate is the remainder after subtraction of the outgoing long distance calling rate and outgoing special service calling rate from the total outgoing calling rate.

(e) Forecast results for outgoing calling rates by types of calls are as follows ;

Outgoing Subscriber Calling Rate		0.043 erl
(i)	Local Calling Rate	0.040 erl
(ii)	Long Distance Calling Rate	0.002 erl

(iii) Special Service Calling Rate 0.001 erl

(2) Traffic Forecast by Call Category

Outgoing local traffic (in-unit and out-unit), the outgoing long distance traffic and the outgoing special service traffic volume are respectively expressed by the product of the calling rate of each category call and the number of subscriber circuits. Calculation results of outgoing traffic by category in 1997, 1999, 2002, 2004 and 2007 are shown in Table 9.2-1. As an assumption, the ratio of in-unit to out-unit traffic is equal to the ratio of the number of the installed exchange unit terminals to the total number of all local exchange unit terminals in the city.

Table 9.2-1 Traffic Forecast by Call Category

(erl)

Year	Exchange Name	Local Traffic			Long Distance Traffic	Special Traffic
		Total	In-unit	Out-unit		
1997	CNT	400	84	316	20	10
	WST	272	39	233	13	7
	ITC#1	200	21	179	10	5
	ITC#2	800	335	465	40	20
	*CNT#1	240	30	210	12	6
1999	CNT	432	94	338	22	11
	WST	272	37	235	14	7
	NRT	88	4	84	4	2
	TKM	96	5	91	5	2
	CAP	88	4	84	4	2
	ITC#1	200	20	180	10	5
	ITC#2	800	324	476	40	20
2002	CNT	592	151	441	30	15
	WST	460	91	369	23	12
	NRT	88	3	85	4	2
	TKM	96	4	92	5	2
	CAP	88	3	85	4	2
	ITC#1	200	17	183	10	5
	ITC#2	800	275	525	40	20
2004	CNT	612	145	467	31	15
	WST	460	82	378	23	12
	NRT	144	8	136	7	4
	TKM	192	14	178	10	5
	CAP	176	12	164	9	4
	ITC#1	200	15	185	10	5
	ITC#2	800	248	552	40	20
2007	CNT	924	271	653	46	23
	WST	720	164	556	36	18
	NRT	144	7	137	7	4
	TKM	192	12	180	10	5
	CAP	176	10	166	9	4
	ITC#1	200	13	187	10	5
	ITC#2	800	203	597	40	20

* CNT#1 exchange will be replaced to CNT in 1999.

9.2.4 Local Traffic Distribution Matrix

Local traffic is distributed to each exchange. The results of this local traffic distribution are shown in Table 9-2 ~ 9-6. These tables are prepared on the assumption that the affinity rate among exchanges is equal and is not affected by the distance between exchanges.

Table 9.2-2 Local Traffic Matrix in 1997

(erl)

	CNT	WST	ITC#1	ITC#2	CNT#1
CNT		57	42	167	50
WST	57		28	114	34
ITC#1	42	28		84	25
ITC#2	167	114	84		100
CNT#1	50	34	25	100	

Table 9.2-3 Local Traffic Matrix in 1999

(erl)

	CNT	WST	NRT	TKM	CAP	ITC#1	ITC#2
CNT		59	19	21	19	44	175
WST	59		12	13	12	28	110
NRT	19	12		4	4	9	36
TKM	21	13	4		4	10	39
CAP	19	12	4	4		9	36
ITC#1	44	28	9	10	9		81
ITC#2	175	110	36	39	36	81	

Table 9.2-4 Local Traffic Matrix in 2002

(erl)

	CNT	WST	NRT	TKM	CAP	ITC#1	ITC#2
CNT		117	22	24	22	51	204
WST	117		17	19	17	40	158
NRT	22	17		4	3	8	30
TKM	24	19	4		4	8	33
CAP	22	17	3	4		8	30
ITC#1	51	40	8	8	8		69
ITC#2	204	158	30	33	30	69	

Table 9.2-5 Local Traffic Matrix in 2004

(erl)

	CNT	WST	NRT	TKM	CAP	ITC#1	ITC#2
CNT		109	34	45	42	47	189
WST	109		26	34	31	36	142
NRT	34	26		11	10	11	45
TKM	45	34	11		13	15	59
CAP	42	31	10	13		14	54
ITC#1	47	36	11	15	14		62
ITC#2	189	142	45	59	54	62	

Table 9.2-6 Local Traffic Matrix in 2007

(erl)

	CNT	WST	NRT	TKM	CAP	ITC#1	ITC#2
CNT		211	42	56	52	59	234
WST	211		33	44	40	46	183
NRT	42	33		9	8	9	37
TKM	56	44	9		11	12	49
CAP	52	40	8	11		11	45
ITC#1	59	46	9	12	11		51
ITC#2	234	183	37	49	45	51	

9.2.5 Traffic between Host Exchanges and RSUs

The Central Exchange Office has three RSUs, or C.C. Reh RSU, Prek Phnou RSU and Russei RSU. The West Exchange Office has the Airport RSU. Table 9.2-7 shows the traffic between host exchange offices and its RSUs. The traffic is outgoing traffic from each RSU to its host exchange offices.

Table 9.2-7 Traffic between Host Exchanges and RSUs

(erl)

Year	APT	CCR	PPN	RRS
1997	34			
1999	34	34		
2002	63	34		
2004	63	55		
2007	124	55	21	13

9.3 Circuit Calculation

For the number of circuits required in the local networks, calculations are made for junctions, long distance networks and special service circuits according to categories of calls.

(1) Calculation Formula

The calculation is carried out by Erlang's B formula as the calls among exchanges are generated at random. In this Erlang's B formula, loss probability (En) is the function of traffic (in erl) and numbers of circuits required in channel. Loss probability indicates probability of call connections to fail. In this study, as loss probability, En = 0.01 is used.

(2) Circuit Calculation Results for the Number of Junction Circuits

Based on the traffic matrix in 9.2.4, calculation results for the number of the junction circuits required are in Table 9.3-1 ~ 9.3-5.
For long distance and special service, only outgoing channels are shown in each table. In order to design actual connection lines, twice the numbers of each

outgoing channel should be used as shown by numbers in parenthesis for long distance and special columns of 30 ch /unit row in these tables.

Table 9.3-1 Number of Junction Circuits among Exchanges in 1997

(ch)

	Exchange	Local					Long Distance	Special
		CNT	WST	ITC#1	ITC#2	CNT#1		
ch/Unit	CNT		71	55	188	64	30	18
	WST	71		40	132	46	22	14
	ITC#1	55	40		100	36	18	11
	ITC#2	188	132	100		118	53	30
	CNT#1	64	46	36	118		20	13
15ch / Unit	CNT		90	60	195	75	30	30
	WST	75		45	150	60	30	15
	ITC#1	60	45		105	45	30	15
	ITC#2	210	135	120		120	60	30
	CNT#1	75	60	45	120		30	15
30ch / Unit	CNT		90	60	210	90	30 (60)	30 (60)
	WST	90		60	150	60	30 (60)	30 (60)
	ITC#1	60	60		120	60	30 (60)	30 (60)
	ITC#2	210	150	120		120	60(120)	30 (60)
	CNT#1	90	60	60	120		30 (60)	30 (60)

Table 9.3-2 Number of Junction Circuits among Exchanges in 1999

(ch)

	Exchange	Local							Long Distance	Special
		CNT	WST	NRT	TKM	CAP	ITC#1	ITC#2		
ch / Unit	CNT		74	29	31	29	57	195	32	19
	WST	74		21	22	21	39	128	22	14
	NRT	29	21		10	10	17	48	10	7
	TKM	31	22	10		10	18	52	11	7
	CAP	29	21	10	10		17	48	10	7
	ITC#1	57	39	17	18	17		97	18	11
	ITC#2	195	128	48	52	48	97		53	30
15ch/ Unit	CNT		90	30	45	30	60	195	45	30
	WST	90		30	30	30	45	135	30	15
	NRT	30	30		15	15	30	60	15	15
	TKM	45	30	15		15	30	60	15	15
	CAP	30	30	15	15		30	60	15	15
	ITC#1	60	45	30	30	30		105	30	15
	ITC#2	195	150	60	60	60	105		60	30
30ch/ Unit	CNT		90	30	60	30	60	210	60 (120)	30 (60)
	WST	90		30	30	30	60	150	30 (60)	30 (60)
	NRT	30	30		30	30	30	60	30 (60)	30 (60)
	TKM	60	30	30		30	30	60	30 (60)	30 (60)
	CAP	30	30	30	30		30	60	30 (60)	30 (60)
	ITC#1	60	60	30	30	30		120	30 (60)	30 (60)
	ITC#2	210	150	60	60	60	120		60 (120)	30 (60)

Table 9.3-3 Number of Junction Circuits among Exchanges in 2002

(ch)

	Exchange	Local							Long Distance	Special
		CNT	WST	NRT	TKM	CAP	ITC#1	ITC#2		
ch / Unit	CNT		135	33	35	33	65	225	41	24
	WST	135		27	29	27	52	178	34	20
	NRT	33	27		9	9	15	42	10	7
	TKM	35	29	9		9	16	45	11	7
	CAP	33	27	9	9		15	42	10	7
	ITC#1	65	52	15	16	15		84	18	11
	ITC#2	225	178	42	45	42	84		53	30
15ch/ Unit	CNT		135	45	45	45	75	240	45	30
	WST	135		30	30	30	60	180	45	30
	NRT	45	30		15	15	15	45	15	15
	TKM	45	30	15		15	30	45	15	15
	CAP	45	30	15	15		15	45	15	15
	ITC#1	75	60	15	30	15		90	30	15
	ITC#2	240	180	45	60	45	90		60	30
30ch/ Unit	CNT		150	60	60	60	90	240	60 (120)	30 (60)
	WST	150		30	30	30	60	180	60 (120)	30 (60)
	NRT	60	30		30	30	30	60	30 (60)	30 (60)
	TKM	60	30	30		30	30	60	30 (60)	30 (60)
	CAP	60	30	30	30		30	60	30 (60)	30 (60)
	ITC#1	90	60	30	30	30		90	30 (60)	30 (60)
	ITC#2	240	180	60	60	60	90		60 (120)	30 (60)

Table 9.3-4 Number of Junction Circuits among Exchanges in 2004

(ch)

	Exchange	Local							Long Distance	Special
		CNT	WST	NRT	TKM	CAP	ITC#1	ITC#2		
ch / Unit	CNT		127	46	59	55	61	211	43	24
	WST	127		37	46	43	48	162	34	20
	NRT	46	37		19	18	19	58	15	9
	TKM	59	46	19		22	24	74	17	11
	CAP	55	43	18	22		22	69	16	10
	ITC#1	61	48	19	24	22		77	18	11
	ITC#2	211	162	58	74	69	77		53	30
15ch/ Unit	CNT		135	60	60	60	75	225	45	30
	WST	135		45	60	45	60	165	45	30
	NRT	60	45		30	30	30	60	15	15
	TKM	60	60	30		30	30	75	30	15
	CAP	60	45	30	30		30	75	30	15
	ITC#1	75	60	30	30	30		90	30	15
	ITC#2	225	165	60	75	75	90		60	30
30ch/ Unit	CNT		150	60	60	60	90	240	60 (120)	30 (60)
	WST	150		60	60	60	60	180	60 (120)	30 (60)
	NRT	60	60		30	30	30	60	30 (60)	30 (60)
	TKM	60	60	30		30	30	90	30 (60)	30 (60)
	CAP	60	60	30	30		30	90	30 (60)	30 (60)
	ITC#1	90	60	30	30	30		90	30 (60)	30 (60)
	ITC#2	240	180	60	90	90	90		60 (120)	30 (60)

Table 9.3-5 Number of Junction Circuits among Exchanges in 2007

(ch)

	Exchange	Local							Long Distance	Special
		CNT	WST	NRT	TKM	CAP	ITC#1	ITC#2		
ch / Unit	CNT		233	55	71	66	73	257	60	34
	WST	233		45	57	53	59	203	48	28
	NRT	55	45		16	15	17	49	15	9
	TKM	71	57	16		19	21	62	17	11
	CAP	66	53	15	19		19	58	16	10
	ITC#1	73	59	17	21	19		65	18	11
	ITC#2	257	203	49	62	58	65		53	30
15ch/ Unit	CNT		240	60	75	75	75	270	60	45
	WST	240		45	60	60	60	195	60	30
	NRT	60	45		30	15	30	60	15	15
	TKM	75	60	30		30	30	75	30	15
	CAP	75	60	15	30		30	60	30	15
	ITC#1	75	60	30	30	30		75	30	15
	ITC#2	255	210	60	75	60	90		60	30
30ch/ Unit	CNT		240	60	90	90	90	270	60 (120)	60 (120)
	WST	240		60	60	60	60	210	60 (120)	30 (60)
	NRT	60	60		30	30	30	60	30 (60)	30 (60)
	TKM	90	60	30		30	30	90	30 (60)	30 (60)
	CAP	90	60	30	30		30	60	30 (60)	30 (60)
	ITC#1	90	60	30	30	30		90	30 (60)	30 (60)
	ITC#2	270	210	60	90	60	90		60 (120)	30 (60)

(3) Circuit Calculation Results for the Number of Circuits between host exchange offices and its RSUs

The number of circuits between host exchange offices and its RSUs are shown in Table 9.3-6. In order to install connection lines between them, considering incoming calls, twice this channel number should be used as shown by numbers in parenthesis of 30 ch / Unit row in this table.

Table 9.3-6 Number of Circuits between Host Exchange Offices and RSUs

(ch)

Unit	Year	APT	CCR	PPN	RRS
ch / Unit	1997	46			
	1999	46	46		
	2002	78	46		
	2004	78	69		
	2007	143	69	32	22
15 ch / Unit	1997	60			
	1999	60	60		
	2002	90	60		
	2004	90	75		
	2007	150	75	45	30
30 ch / Unit	1997	60 (120)			
	1999	60 (120)	60 (120)		
	2002	90 (180)	60 (120)		
	2004	90 (180)	90 (180)		
	2007	150 (300)	90 (180)	60 (120)	30 (60)

CHAPTER 10

Telecommunications Facility Provision Plan of Essential Project

CHAPTER 10 TELECOMMUNICATIONS FACILITY PROVISION PLAN OF ESSENTIAL PROJECT

10.1 Exchange Facilities

The number of subscriber lines of new local exchanges for each facility provision year is shown in the Table 10.1-1.

Table 10.1-1 The Number of Subscriber Lines of New Local Exchanges

Exchange Name	Year				
	1997	1999	2002	2004	2007
Central	*1 9,600	10,600	13,400	15,200	19,800
CNT	*2 10,000	10,000	14,000	14,000	21,000
Airport	600	900	1,400	1,900	2,900
APT	800	800	1,500	1,500	3,000
C.C. Reh	400	600	900	1,200	1,800
CCR		800	800	1,300	1,300
Prek Phnou	80	120	180	260	420
PPN					500
Russei	60	70	110	150	240
PRS					300
West	5,300	5,900	8,300	10,000	13,900
WST	6,000	6,000	10,000	10,000	15,000
North	1,600	2,000	2,700	3,300	4,400
NRT		2,200	2,200	3,600	3,600
Takhmau	1,700	2,200	3,300	4,300	6,700
TKM		2,400	2,400	4,800	4,800
C.Ampou	1,500	2,000	3,000	4,000	6,200
CAP		2,200	2,200	4,400	4,400
AXE-105ls					
ITC#1	5,000	5,000	5,000	5,000	5,000
AXE-105int					
ITC#2 *3	20,000	20,000	20,000	20,000	20,000

Note: *1 : Demand *2 Number of telephone installations
*3 : Number of telephone in ITC#2 includes cellular networks to be connected to AXE105 int.

10.2 Transmission Facilities

The transmission system for the junction network in Phnom Penh City and its surrounding area will be supported by the SDH system which is complied with the latest relevant ITC-T Recommendations. The comparison of systems between SDH and PDH are mentioned in Chapter 7.2.

10.2.1 Capacity of Transmission Systems

The transmission system is planned based on the circuit calculation in Chapter 9.3 to connect five (5) local exchange offices, four (4) RSUs and International Telephone Center with each other in the 4th stage of the Essential Project. CEPT system will be applied to the transmission system to be introduced, because it has been used between the ITC and the MPTC buildings. The connection diagram and the required capacity of the transmission system at the time of the implementations are shown in Figure 10.2-1.

Required capacity of the transmission system at each exchange office at the time of the implementation completion is summarized in Table 10.2-1.

Table 10.2-1 Required Transmission Capacity (1997 - 2007)

Exchange Office		'97	'99	'02	'04	'07
Airport	(RSU)	4	4	6	6	10
West	(LS)	32	34	44	50	62
Central	(TLS)	64	152	168	190	212
North	(LS)	0	22	24	28	32
ITC	(LS/INT)	36	62	70	74	78
Russei	(RSU)	0	0	0	0	2
CH Ampou	(LS)	0	36	38	42	50
Takhmau	(LS)	0	20	20	24	26
C. C. Reh	(RSU)	0	4	4	6	10
Prek Phnou	(RSU)	0	0	0	0	4
Total Unit/2 Mbps		136	334	374	420	486

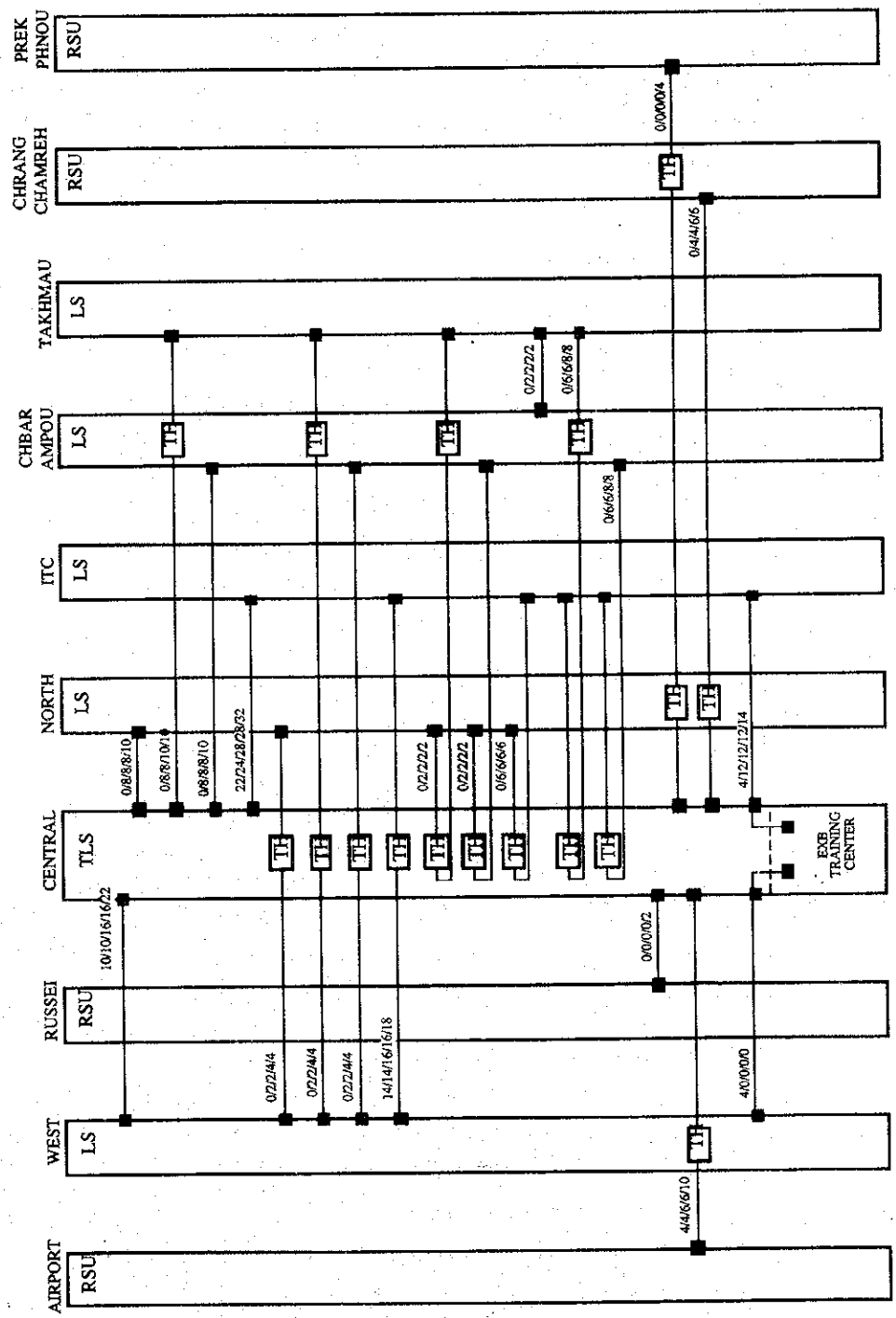


Figure 10.2-1 Connection Diagram for Transmission System

10.2.2 Cores of Optical Fiber Cable

In order to match the required capacity of the transmission system by 2007 in the Table 10.2-1, the optimum number of optical fiber cable cores were calculated. In this project, six (6) cores optical fiber cable will be applied. Figure 10.2-2 shows the cable route for junction network, the number of cores and rough length of the optical fiber cables.

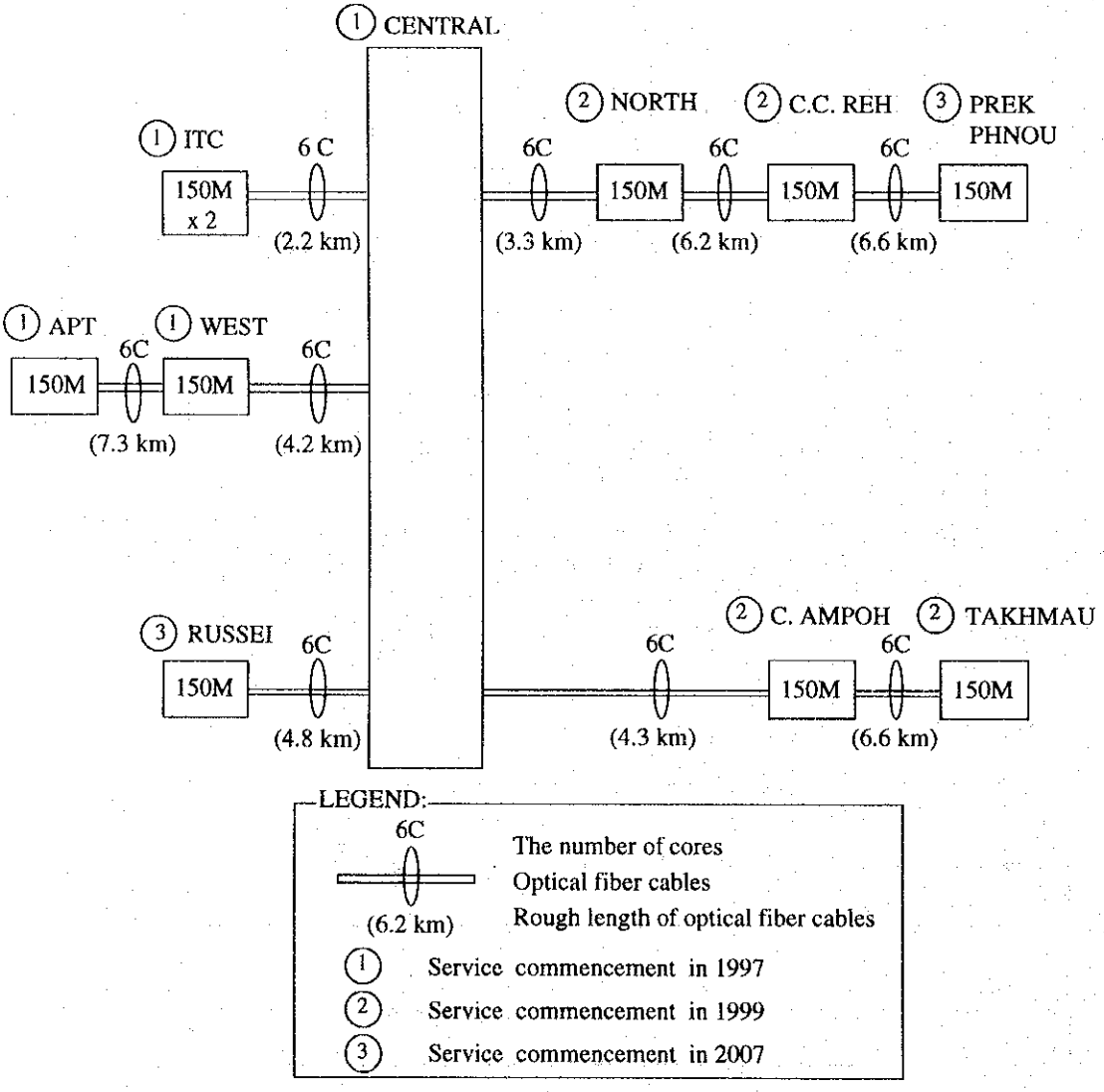


Figure 10.2-2 Cable Route of Junction Network

10.2.3 Provision of Transmission System

As mentioned in Chapter 8, two projects will be formulated based on the Study, namely the Emergency Project and the Essential Project. The Essential Project following the Emergency Project will be divided into four stages.

The block diagrams of the transmission system in all projects are shown in Figure 10.2-3 (1) to Figure 10.2-3 (5).

Since the details of the Emergency Project, in which the block diagram of the system configuration is shown in Figure 10.2.3 (1), are mentioned in the Emergency Project part of the interim report of the Study, only the details of the Essential Project in each stage are described as follows.

1) 1st stage of the Essential Project

The transmission system will be established for four (4) sections between Central, ChabarAmpou, Takhmau, North and Charang Cham Reh exchanges to connect them with each other. In addition, one (1) system of SDH (150 M) will be expanded between the Central and ITC Exchange Office because of lack of capacity of the transmission system in this stage. The block diagram of the system configuration is shown in Figure 10.2-3 (2).

2) 2nd stage of the Essential Project

No new sections of the transmission system will be established nor will package units of the existing transmission systems be added at Central Exchange Office. The block diagram of the system configuration is shown in Figure 10.2-3 (3).

3) 3rd stage of the Essential Project

No new sections of transmission system will be established either in this stage. Package units of the existing transmission system will be expanded at Central, West, North, Chabar. Ampou and Takhmau Exchange Offices. The block diagram of the system configuration in this stage is shown in Figure 10.2-3 (4).

4) 4th stage of the Essential Project

In the 4th stage of the Essential Project, the transmission system will be newly established for two (2) sections of Central-Russei and Charang Cham Reh-Prek Phnou routes. The block diagrams for system configuration are shown in Figure 10.2-3 (5).

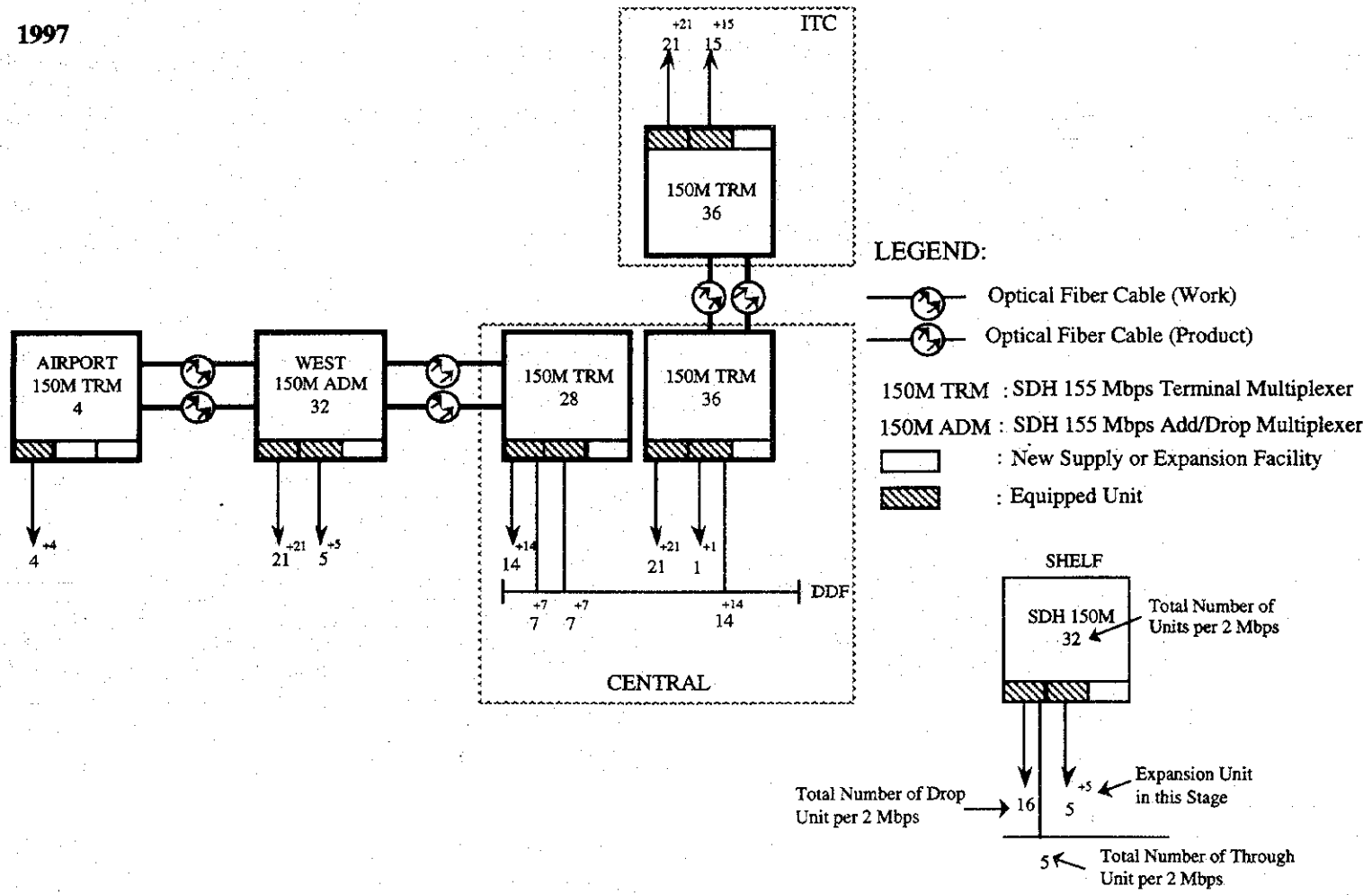


Figure 10.2-3 (1) Block Diagram of Transmission System for the Emergency Project

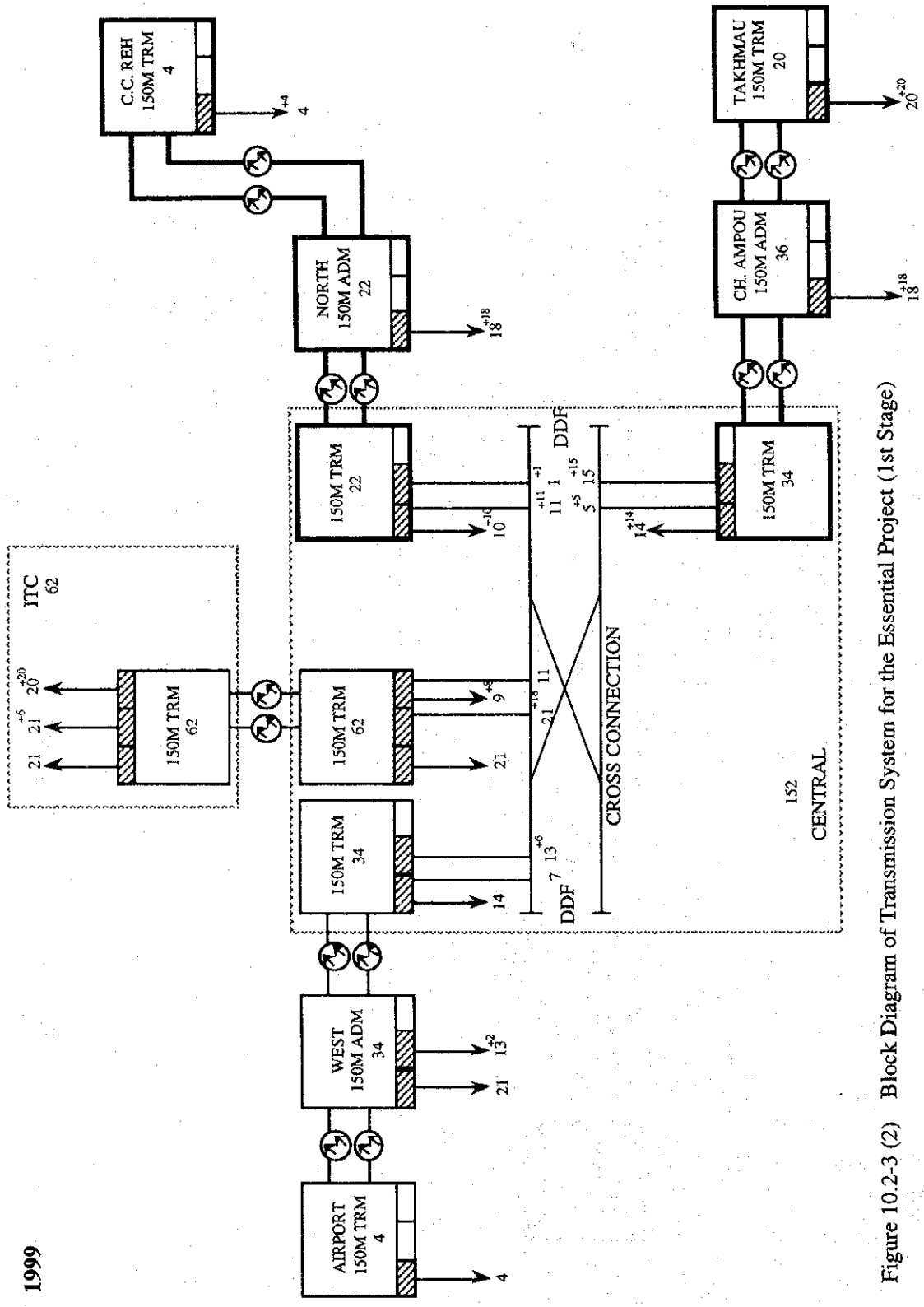


Figure 10.2-3 (2) Block Diagram of Transmission System for the Essential Project (1st Stage)

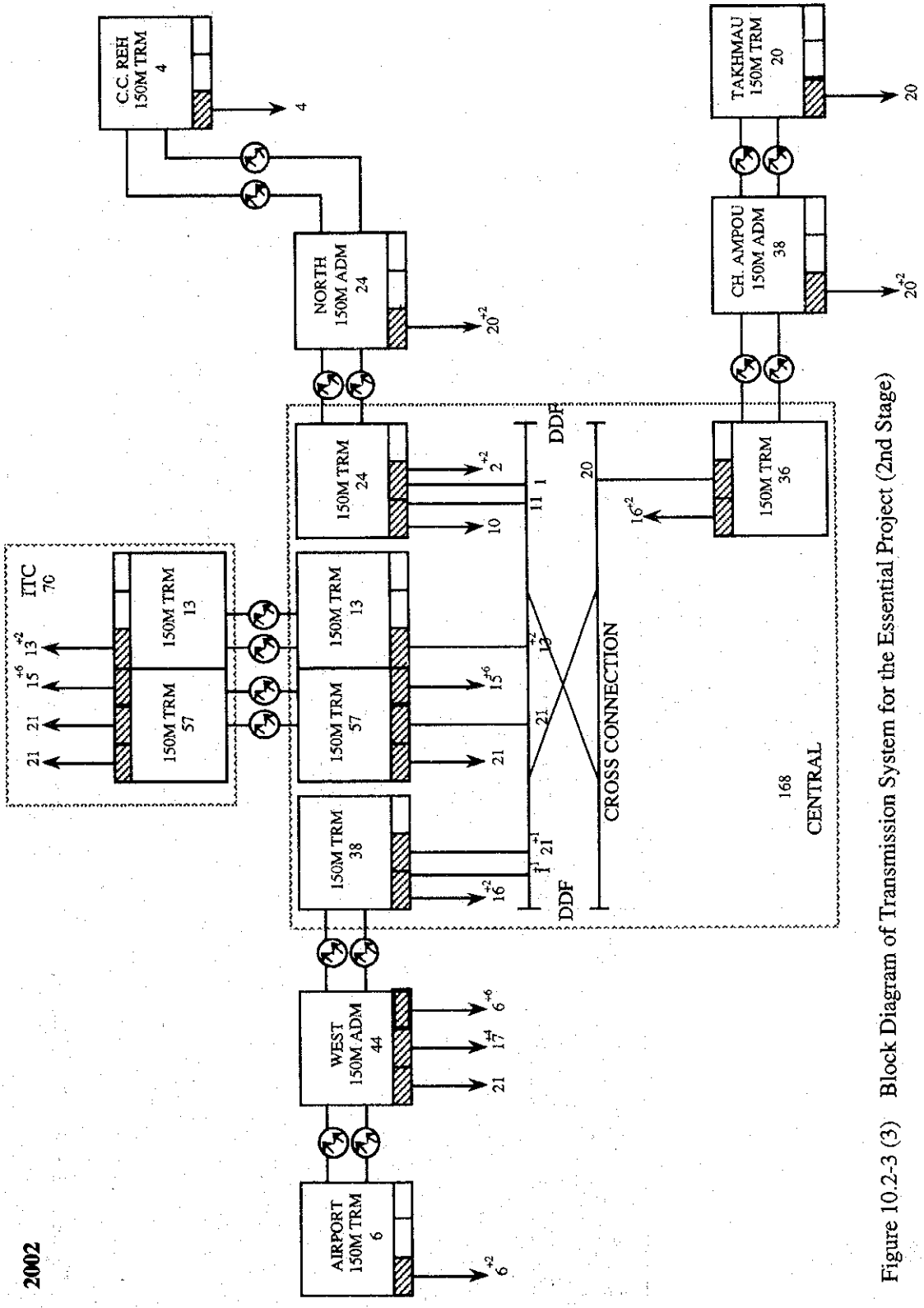
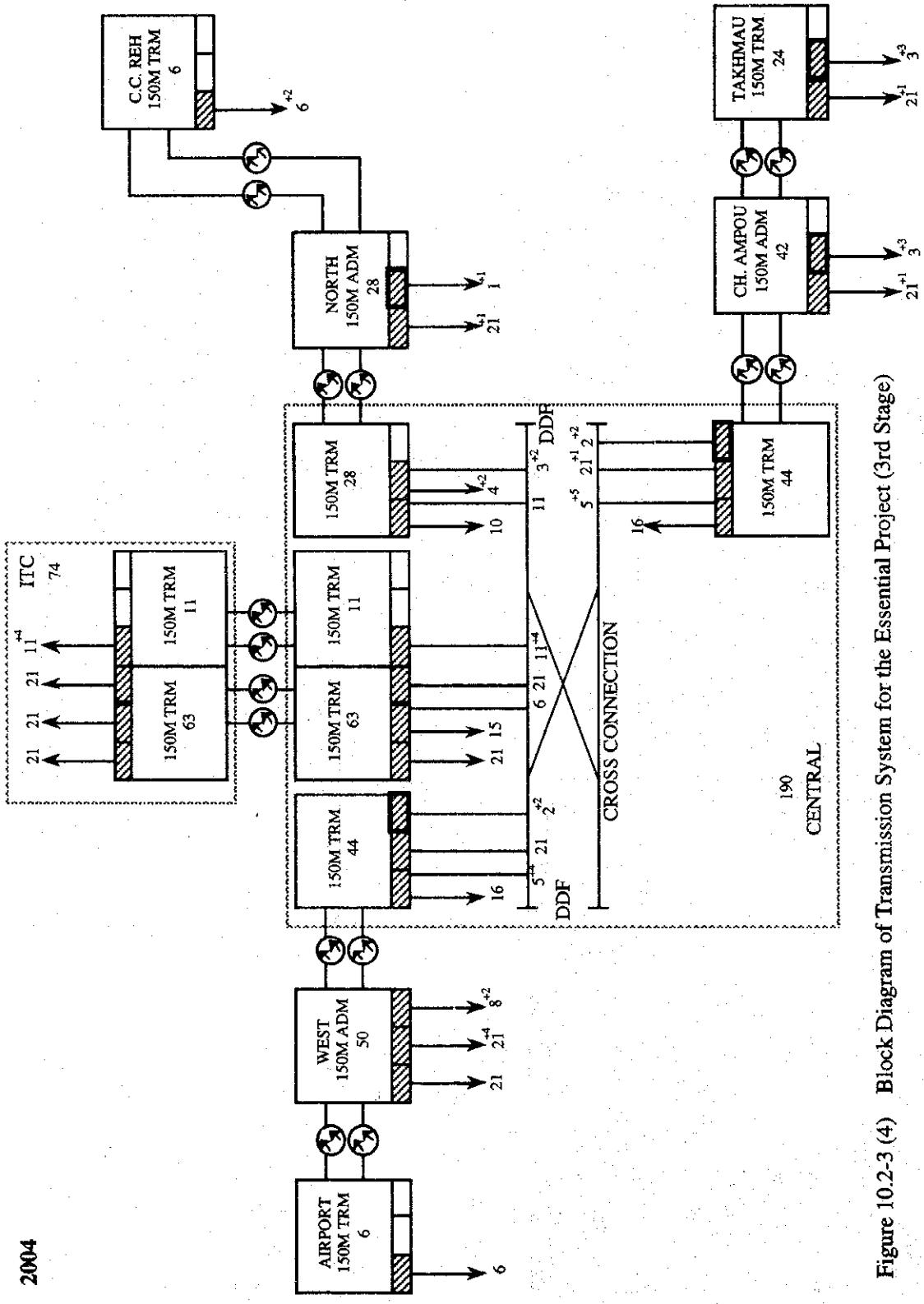


Figure 10.2-3 (3) Block Diagram of Transmission System for the Essential Project (2nd Stage)



2004

Figure 10.2-3 (4) Block Diagram of Transmission System for the Essential Project (3rd Stage)

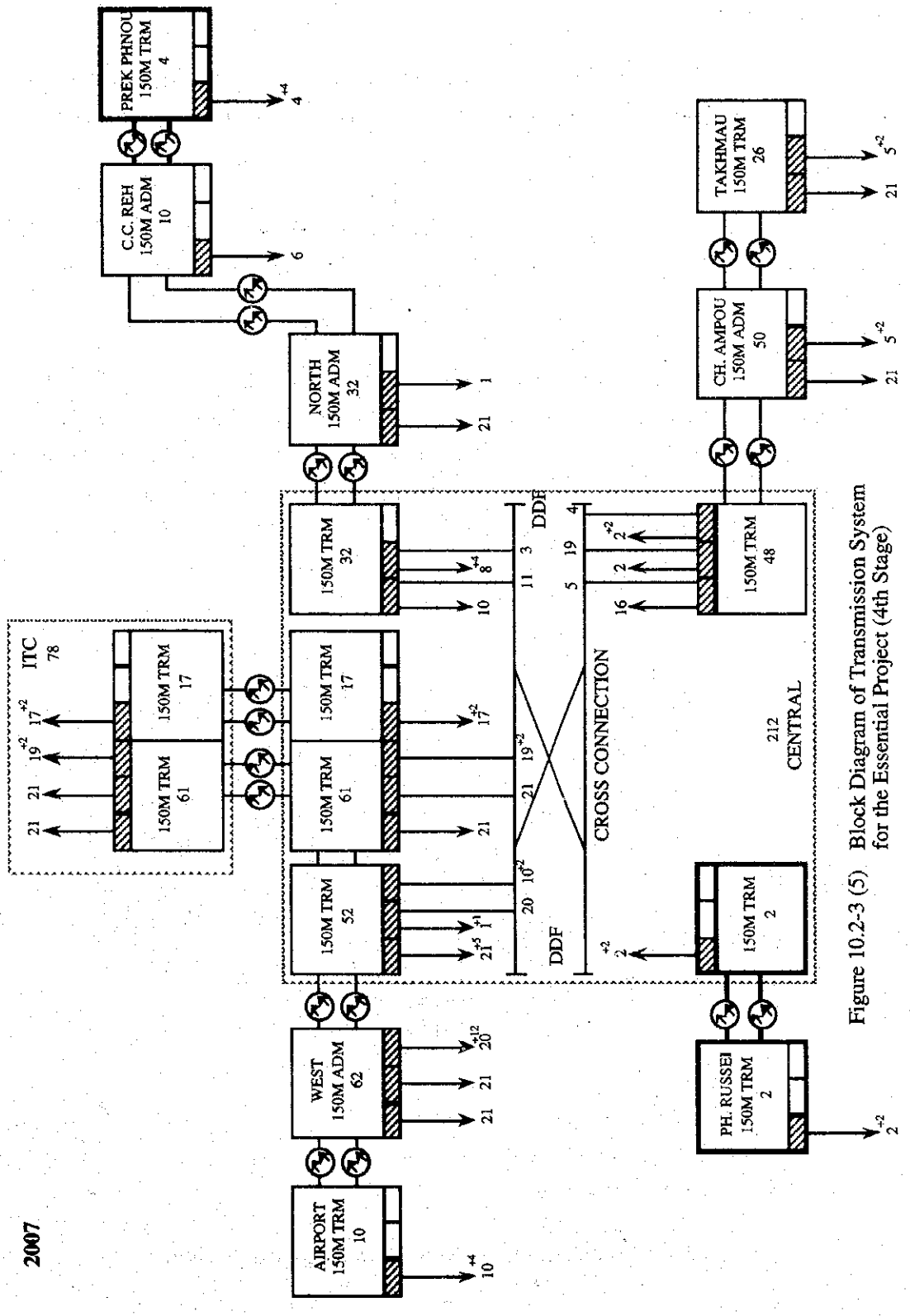


Figure 10.2-3 (5) Block Diagram of Transmission System for the Essential Project (4th Stage)

10.2.4 Network Management System

In order to facilitate the introduced SDH system's operation and maintenance, the network management system consisting of local management and central management systems will be adopted in both Projects.

Basically, one portable local network management system will be provided in the Emergency Project and used to monitor the status of SDH operation, and change of SDH parameters.

The central network management system will be provided in the 1st stage of the Essential Project. This system which is a fixed type will be installed in the Central Exchange Office, and can monitor the status of SDH system in all the exchange offices in operation and can change SDH parameters. The configuration of the network management system is shown in Figure 10.2-4. Major functions of the network management system are shown in Table 10.2-2.

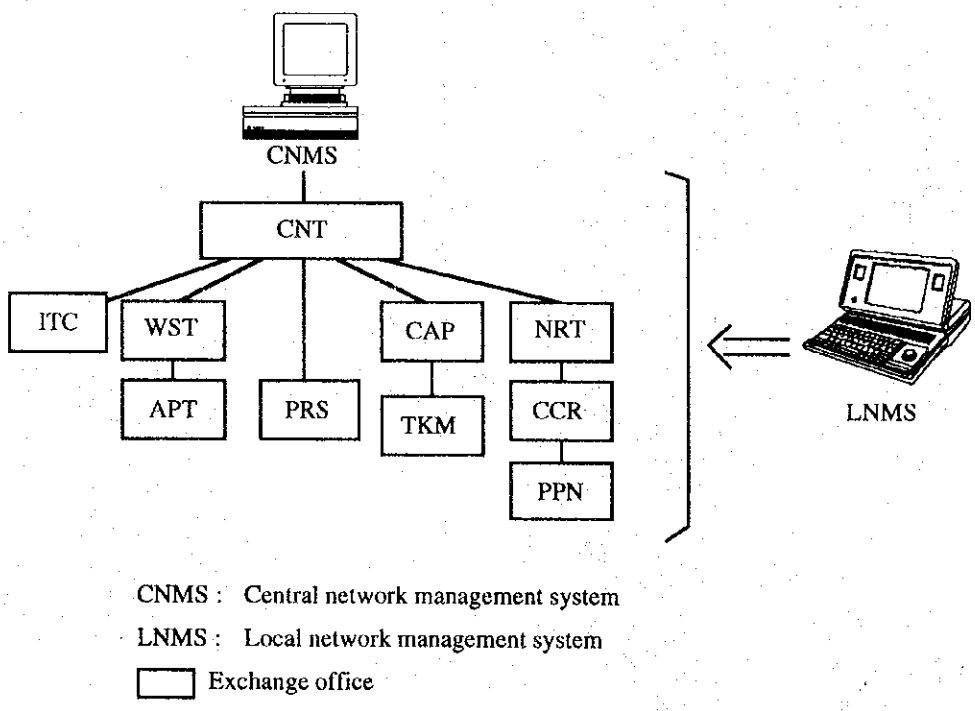


Figure 10.2-4 Configuration of Network Management System

Table 10.2-2 Function of Network Management System

	Major Functions	Local	Central
1	Alarm and status monitor	x	x
2	Provisioning setting	x	x
3	Performance monitor	x	x
4	Control	x	x
5	Security	x	x
6	Configuration management		x
7	Network route indication		x
8	History data log		x

10.3 Outside Plant

On the basis of the facility provision policy mentioned below, the facility provision plan for construction of outside plants is formulated to meet the demand fulfillment plan in each stage of the Essential Project of the Feasibility Study period which is divided into 4 stages as described in Chapter 8.

Regarding the major work volume of the first stage, the cable length, duct length etc. are calculated with the results of the rough design based on the field survey, demand forecast and map study. After the first stage, the major work volume which consists of primary cable pairs is estimated on the basis of the demand forecast and the results of the design of the first stage of the Essential Project and the Emergency Project.

10.3.1 Subscriber Network

(1) The Facility Provision Policy

(a) Subscriber Network System

The flexible distribution system will be applied to the subscriber network of the Essential Project. This system can provide cable pairs effectively to meet the fluctuation of demand. The existent network in Phnom Penh has adopted this system, therefore the Cambodian staff can easily maintain the subscriber network to be installed by the Essential Project and the Emergency Project. The configuration of this system is shown in Figure 10.3-1.

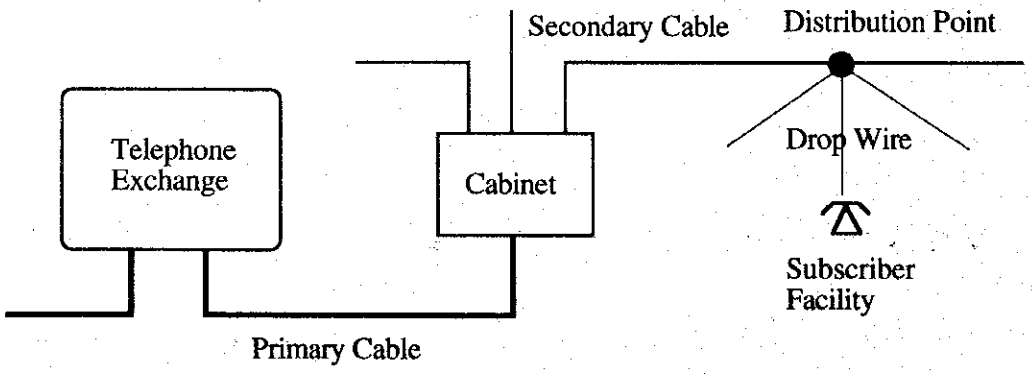


Figure 10.3-1 Configuration of Flexible Distribution System

(b) Primary Cable

Phnom Penh City suffers from floods frequently in the rainy season. Jelly filled cable is therefore applied to the primary cable which will prevent cable troubles caused by the infringement of water.

The primary cables are installed into ducts in order to protect main cables of the subscriber network as well as to enable easy maintenance and easy expansion of the cable.

(c) Secondary Cable

The direct buried cable is applied for the secondary cable taking the request from the Cambodian side for the reliability of the cable into consideration. The cable is jelly filled and steel armored.

(d) Type of Cable

The diameter of the cable conductor is calculated from the transmission loss allocated to the subscriber network, the direct current loop resistance limitation and the extent of each exchange area. Based on the proposed exchange locations described in Chapter 8, the cable conductor which is used for the essential project is 0.4 millimeters in diameter.

The electrical characteristics of cable and the number of the cable pairs used for the Essential Project are shown in Table 10.3-1 and Table 10.3-2 respectively.

Table 10.3-1 Electrical Characteristics

Diameter (mm)	Direct Current Loop Resistance (Ω/km)	Transmission Loss (dB/km)
0.4	148.0	1.84

Table 10.3-2 Number of the Cable Pairs

Kind of Cable	Number of Pairs
Primary Cable	400, 600, 800, 1000, 1200, 1300, 1400, 1600 1800, 2000, 2200, 2400
Secondary Cable	10, 20, 30, 50, 100, 200

(e) Civil Work

i) Number of Duct Lines

The number of duct lines will match the number of the primary cables to be installed for the Essential Project. In order to avoid digging up the road frequently, one duct line for maintenance (replacement of damaged cable) and one spare duct line for fluctuation of the demand are added.

The duct line for the transmission cable is added on the cable section where the transmission cable runs on the same route as the primary cable route.

ii) Type of Duct

Polyvinyl chloride (PVC) duct with 100 millimeters in inner diameter will be applied for the project.

The steel duct will be used on the section where the duct line route runs across the road, railway to protect the cable from the heavy load to the duct.

iii) Space between Manholes

The space between manholes is determined in consideration of cable branch, cross connecting cabinet location and road condition. The maximum limitations of the space are given by the cable weight, friction coefficient between cable and duct, and curvature radius of installed duct line. The maximum space is;

Straight Section ---------- 200 meters,
Curved Section ---------- 150 meters.

(2) Major Work Volume

On the basis of the facility provision policy mentioned above, the major work volume of the subscriber network for the Essential Project is calculated. Summaries for the major work volume for the first stage and for each stage after the second stage are shown in Table 10.3-3 and Table 10.3-4.

Table 10.3-3 Major Work Volume for the First Stage (Provision Year: 1999)

Work Item	Exchange Office			
	North	Charang Cham	Takhmou	Chabar Ampou
Primary Cable (km)	3.7	1.5	2.6	2.5
Secondary Cable (km)	22.5	6.7	27.0	19.6
Duct Line Length (km)	3.7	1.5	2.6	2.5
Manhole (piece)	20	9	16	12

Table 10.3-4 Primary Cable Pairs for each Stage after the Second Stage

The Stage of the Project	Exchange Office	Primary Cable Pair
The Second Stage (Provision Year: 2002)	Central	4,800
	West	3,800
	Airport	1,000
The Third Stage (Provision Year: 2004)	North	1,600
	Charang Cham Reh	800
	Takhmau	2,600
	Chabar Ampou	2,400
The Forth Stage (Provision Year: 2007)	Central	8,000
	West	7,000
	Airport	1,800
	Prek Phnou	600
	Russei	350

10.3.2 Transmission Cable Facility

(1) Facility Provision Policy

(a) Type of Cable

Jelly filled single mode optical fiber cable is applied for the Essential Project.

The transmission cable will be laid directly under the ground, but will be installed into the duct in the section where the transmission cable route runs on the same route as the primary cable route of the subscriber network.

(b) Number of Fiber Cores

The number of fiber cores in each stage will meet the transmission capacity estimated in each stage.

(2) Major Work Volume

The summary for the major work volume based on the facility provision policy mentioned above is shown in Table 10.3-5.

Table 10.3-5 Major Work Volume of the Transmission Cable

Provision Year	Transmission Section	Cable Length (km)	Duct Section (km)	Buried Cable Section (km)	No. of Core
1999	Central - North	3.3	3.3	0	6
	North - C. Cham Reh	6.2	2.2	4.0	6
	Central - C. Ampou	4.3	2.1	2.2	6
	C. Ampou - Takhmau	6.6	1.8	4.8	6
2007	C. Cham Reh - P. Phnou	6.6	0.8	5.8	6
	Central - Russei	4.3	0	4.3	6

10.3.3 Public Pay Phones

(1) Standards for placement

In principle, public pay phone terminals are installed along the sidewalk of main roads with 1,000 meter distances and they should not obstruct pedestrians. Furthermore, they are installed at the following places where many persons gather in Phnom Penh city.

i) Markets
ii) Hospitals
iii) Bus Stations
iv) Big Hotels
v) Railway Stations
vi) Pagodas
vii) Ports
viii) City halls, Theaters
ix) Airport

(2) Number of public pay phone terminals

According to the standards for placement mentioned above and by the necessary number of public pay phone terminals forecast at the above location, the required number of public pay phone terminals are determined as shown in Table 10.3-6.

Table 10.3-6 Number of Necessary Public Pay Phone Terminals

Locations	Number of Locations	Necessary Number of Terminals	Total
Along the Roads	56 Km	1 terminal / Km	54 terminals
Big Markets	3 sites	20 terminals	60 terminals
Small Markets	8 sites	5 terminals	40 terminals
Big Hospitals	15 sites	3 terminals	45 terminals
Bus Stations	6 sites	3 terminals	18 terminals
Big Hotels	20 sites	3 terminals	60 terminals
Railway Stations	1 site	3 terminals	3 terminals
Pagodas	30 sites	1 terminal	30 terminals
Ports	1 site	5 terminals	5 terminals
City halls, Theaters	5 sites	3 terminals	15 terminals
Airport	1 site	30 terminals	30 terminals
Total	-----	-----	360 terminals

360 public pay phone terminals in total will be installed by 2007 in Phnom Penh City and airport area.

At present there is an agreement between MPTC and OTCI which stipulates the installation of 175 public pay phone terminals by 2000. After completing the installation based on the agreement, there are 185 public pay phone terminals remaining. Regarding the remaining public pay phone terminals, the number of public pay phone terminals to be installed at each above location is determined. They will be installed during and after the second stage of the Essential Project. The number of public pay phone terminals to be installed for each stage is shown in Table 10.3-7.

Table 10.3-7 The Number of Public Pay Phone Terminals for Each Stage

Stage	Terminals to be installed
The second stage (Provision Year: 2002)	150
The third stage (Provision Year: 2004)	35

10.4 Power Supply System

10.4.1 Design Criteria of Power Supply System

The power supply systems in the objective exchange offices are designed considering the present conditions of the commercial power and the future plan of the telecommunications facilities to be introduced.

(1) General

(a) Composition of Power Supply System

The power supply system at the exchange office consists of the following components:

- Engine generator
- UPS (Uninterruptible Power Supply)
- Rectifier and batteries

(b) Design Period

The power supply systems are designed to correspond to the following periods:

- AC Mains	: Capacity at the ultimate stage (Capacity for the contract is to be that at the initial stage.)
- Engine Generator	: Capacity at the ultimate stage
- UPS	: Capacity at the ultimate stage
- Rectifier	: Capacity at the initial stage
- Batteries	: Capacity at the initial stage

Note: initial stage : year of service commencement (S + 0)
ultimate stage : 10 years later from the initial stage (S + 10)

(2) AC Mains

The AC commercial power excluding at the Central Exchange Office and the Airport Exchange Office is to be low tension commercial power (AC 380 V, 50 Hz, 3 ϕ).

(3) Engine Generator

(a) Type of Engine Generator

In the study area, the conditions of commercial power are very poor, so the following engine generator will be provided to each exchange office.

- Dual stand-by diesel engine
- Continuos operation type
- Cooling system : Radiator system
- Output : AC 380 V, 50 Hz, 3 ϕ

(b) Capacity of Fuel Tank

Considering the condition of operation and maintenance, the fuel tank will be, in principle, capable of storing one (1) or more weeks worth of fuel.

(4) UPS

In case of commercial power interruption, the engine generator requires a moment for start-up and stabilizing. Therefore, the UPS will be provided to prevent power supply interruption.

- Holding time : 10 minutes
- Function of UPS : Stabilizing output voltage
- Input voltage : AC 380 V, 50 Hz, 3 ϕ
- Output voltage : AC 220 V, 50 Hz, 1 ϕ

(5) Rectifier

Most facilities and equipment work by providing DC power (DC-48V), so the following rectifier will be applied:

- Input voltage : AC 380 V, 50 Hz, 3 ϕ
- Output voltage : DC-48 V
- Function of charging for batteries (floating type)

(6) Batteries

To prevent a DC power supply interruption, sets of batteries will be provided under the Essential Project. The back-up time of the batteries is established to be three hours considering the reliability of commercial power and the other power supply system provided by the Essential Project.

- Back-up time : Three (3) hours
- Output voltage : DC-48 V
- Type of batteries : Maintenance free type

(7) Miscellaneous Equipment

As miscellaneous equipment, the following equipment will be provided:

- MTR (Meter)
  Low tension commercial power (AC 380 V, 50 Hz, 3ø) is lead in through the MTR.
- BRK (Breaker)
  Low tension commercial power is connected with the BRK.
- MDP (Main Distribution Panel)
  MDP divides the commercial power into two streams, one is to directly supply AC power to the load, another is to be connected with engine generators, UPS and rectifier/batteries.
- LBP (Low tension branch panel)
  Low tension power is distributed to the various load through the LBPs.
- LTP (Low tension change-over panel)
  LTP has a function of change-over from commercial power source to output of engine generator, vice versa.
- MTS (Mobile transfer switch)
  MTS has a function of switch-over from internal power source such as commercial power or output of engine generator to external power source in case the internal power source fails.
- MB (Mobile box)
  The external power source is connected to the MB.

10.4.2 System Diagram of Power Supply System

The power supply system at the exchange office is designed considering the accommodation plan of the telecommunications systems. The typical system diagram of the powers upply system at the exchange offices is indicated in Figure 10.4-1.

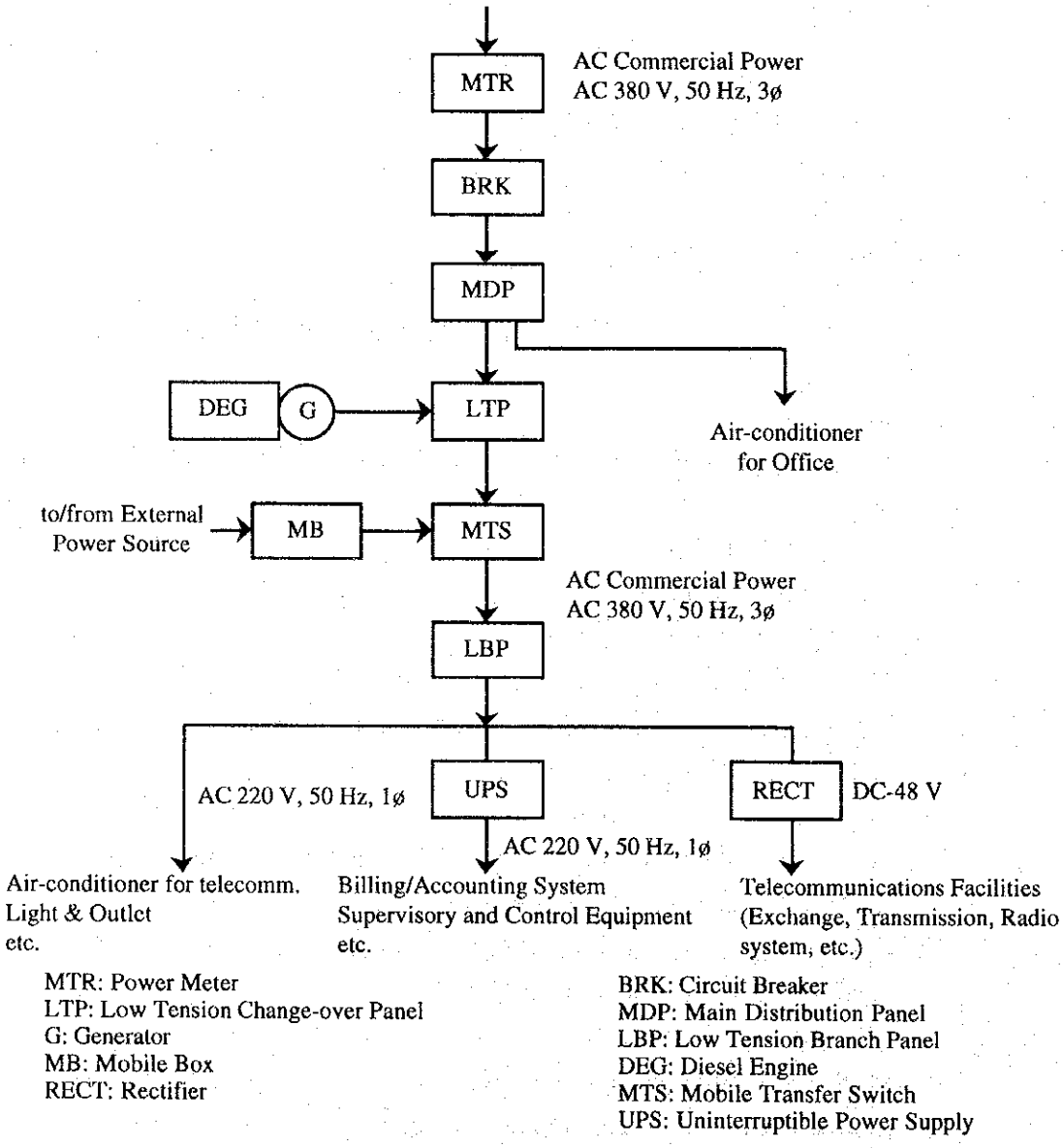


Figure 10.4-1 System Diagram of Power Supply System at the Exchange Office

The power supply systems at the Central, West and Airport Exchange Offices will be introduced under the Emergency Project. Therefore, the additional power supply

systems for the above three exchange offices are designed, and the power supply systems for the other six stations are newly designed as follows:

10.4.3 Power Consumption

To design the power supply systems, the power consumption at each exchange office is estimated based on the introduction plan of the telecommunications systems as follows:

Table 10.4-1 Power Consumption at Exchange Offices

Telephone Office	S + 0				S + 10				Remarks
	AC direct	E/G direct	UPS	RECT	AC direct	E/G direct	UPS	RECT	
	1997				2007				
Central*	234	217	15	611	234	217	16	1,980	
West*	4	18	1	312	4	18	1	712	
Airport*	4	18	1	87	4	18	1	247	
	1999				2009				
North	4	18	1	187	4	18	1	367	
C. C. Reh	4	18	1	87	4	18	1	252	
Takhmau	4	18	1	207	4	18	1	587	
C. Ampou	4	18	1	242	4	18	1	712	
	2007				2017				
Prek Phnou	4	18	1	37	4	18	1	127	
Russei	4	18	1	27	4	18	1	67	

Note * : The power supply systems at the marked exchange offices will be introduced under the Emergency Project, so the additional power supply systems will be only prepared at these stations under the Essential Project.

10.4.4 System Capacity of Power Supply System

The capacity of the power supply system at each exchange office is established based on the power consumption estimated in clause 10.4.3.

The ultimate capacity of the power supply system is shown in Table 10.4-2.

Table 10.4-2 System Capacity of Power Supply System at Ultimate Stage

Exchange Office	AC Mains	Engine Generator	Rectifier	Batteries	UPS	Remarks
Central	AC 15 KV* 680 KVA	400 KVA*	2,600 A*	9,000 AH*	20 KVA*	
West	AC 380 V* 105 KVA	90 KVA*	1,000 A*	3,000 AH*	1 KVA*	
Airport	AC 380 V* 55 KVA	50 KVA*	400 A*	1,200 AH*	1 KVA*	
North	AC 380 V 65 KVA	60 KVA	500 A	2,000 AH	1 KVA	
C. C. Reh	AC 380 V 55 KVA	50 KVA	400 A	1,200 AH	1 KVA	
Takhmau	AC 380 V 90 KVA	70 KVA	800 A	3,000 AH	1 KVA	
C. Ampou	AC 380 V 105 KVA	90 KVA	1,000 A	3,000 AH	1 KVA	
Prek Phnou	AC 380 V 50 KVA	40 KVA	300 A	600 AH	1 KVA	
Russei	AC 380 V 40 KVA	30 KVA	200 A	300 AH	1 KVA	

Note *: The marked systems are to be initially provided under the Emergency Project.

10.4.5 Facility Provision Plan

Based on the above design and the introduction plan of telephone exchanges, the facility provision plan of the power supply systems is established as shown in Table 10.4-3.

Table 10.4-3 Facility Provision Plan of Power Supply system

Exchange Office	1st Stage (1999)	2nd Stage (2002)	3rd Stage (2004)	4th Stage (2007)
Central	-	BATT: +5000 AH RECT: +1500 A MAINS:+120 KVA	-	BATT: +1000 AH RECT: +300 A MAINS:+20 KVA
West	-	BATT: +1000 AH RECT: +200 A MAINS:+15 KVA	-	RECT: +300 A MAINS:+25 KVA
Airport	-	RECT: +100 A MAINS:+10 KVA	-	BATT: +600 AH RECT: +100 A MAINS:+5 KVA
North	E/G: 60 KVA BATT: 1000 AH RECT: 300 A UPS: 1 KVA MAINS: 50 KVA	-	BATT: +1000 AH RECT: +200 A MAINS: +15 KVA	-
C. C. Reh	E/G: 50 KVA BATT: 600 AH RECT: 200 A UPS: 1 KVA MAINS: 40 KVA	-	BATT: +600AH RECT: +200 A MAINS:+15 KVA	-
Takhmau	E/G: 70 KVA BATT: 1000 A RECT: 400 A UPS: 1 KVA MAINS: 55 KVA	-	BATT: +1000 AH RECT: +200 A MAINS: +20 KVA	-
C. Ampou	E/G: 90 KVA BATT: 2000 AH RECT: 400 A UPS: 1 KVA MAINS: 55 KVA	-	RECT: +200 A MAINS: + 20 KVA	-
Prek Phnou	–	–	–	E/G: 40 KVA BATT: 300 AH RECT: 200A UPS: 1 KVA MAINS: 40 KVA
Russei	–	–	–	E/G: 30 KVA BATT: 300 AH RECT: 200 A UPS: 1 KVA MAINS: 40 KVA

Note *1 E/G: Engine Generator, BATT: Batteries, RECT: Rectifier, UPS: Uninterruptible Power Supply, MAINS: AC Mains, +: Equipment to be added
*2: Capacity of AC Mains means only the capacity for the contract with EDC.

10.5 Building

For the buildings for new exchange offices, total floor space of building is shown in the Table 10.5-1.

All the buildings are considered as newly constructed buildings.

Table 10.5-1 Total Floor Space of Buildings for New Exchange Office

Exchange Name	Year			
	1999	2002	2004	2007
Central	3,060 m^2	3,060 m^2	3,060 m^2	3,060 m^2
Airport	180 m^2	180 m^2	180 m^2	180 m^2
C.C. Reh	180 m^2	180 m^2	180 m^2	180 m^2
Prek Phnou				36 m^2
Russei				36 m^2
West	216 m^2	216 m^2	216 m^2	216 m^2
North	216 m^2	216 m^2	216 m^2	216 m^2
Takhmau	180 m^2	180 m^2	180 m^2	180 m^2
C.Ampou	180 m^2	180 m^2	180 m^2	180 m^2

CHAPTER 11

Operation and Maintenance Plan

CHAPTER 11 OPERATION AND MAINTENANCE PLAN

After the completion of the construction, the operation and maintenance plan consisting of, for example, the following items will be established by the MPTC to cope with the increase of the number of new subscribers.

(1) For operation

- Plant record arrangement
- Subscriber arrangement
- Patrol
- New subscriber connection, desk and field work
- Procurement

(2) For maintenance

- Fault repair on site
- Workshop for repairing equipment/contract with local agent
- Manufactures' repair contract

Table 5.4-1 shows the assumption of number of subscribers under the Essential Project. The first stage of the Project includes the construction of new North Telephone Office which at the time of operation commencement will have the area of around 1,200 subscribers connected to existing exchange who are to be converted to new exchange under the Essential Project. This makes the increment of the number of subscribers 1,200 less than that of the capacity of new exchange under the Essential Project.

Where the MPTC has carried out new subscriber connection work since 1985 of about 200 subscribers annually, the MPTC is required to set up such work structure and procedure to implement thousands of new subscriber connection work after completion of both the Emergency and the Essential Projects.

11.1 Operation and Maintenance Body

To meet the expansion of telecommunications network in Phnom Penh City and its surrounding areas under the name of the Emergency Project, MPTC has a plan to establish a telephone office organization which covers overall operation and

maintenance of telecommunications network in the areas. Figure 11.1-1 shows the telephone office organization.

Figure 11.1-1 shows that the MPTC has the plan that a section for transmission facility operation is necessary for the West Exchange Office, but considering the volume of facility and simple network configuration, transmission operation work in the West Exchange Office can be centralized to the Central Exchange Office and the MPTC can make the exchange office unattended regarding transmission operation work.

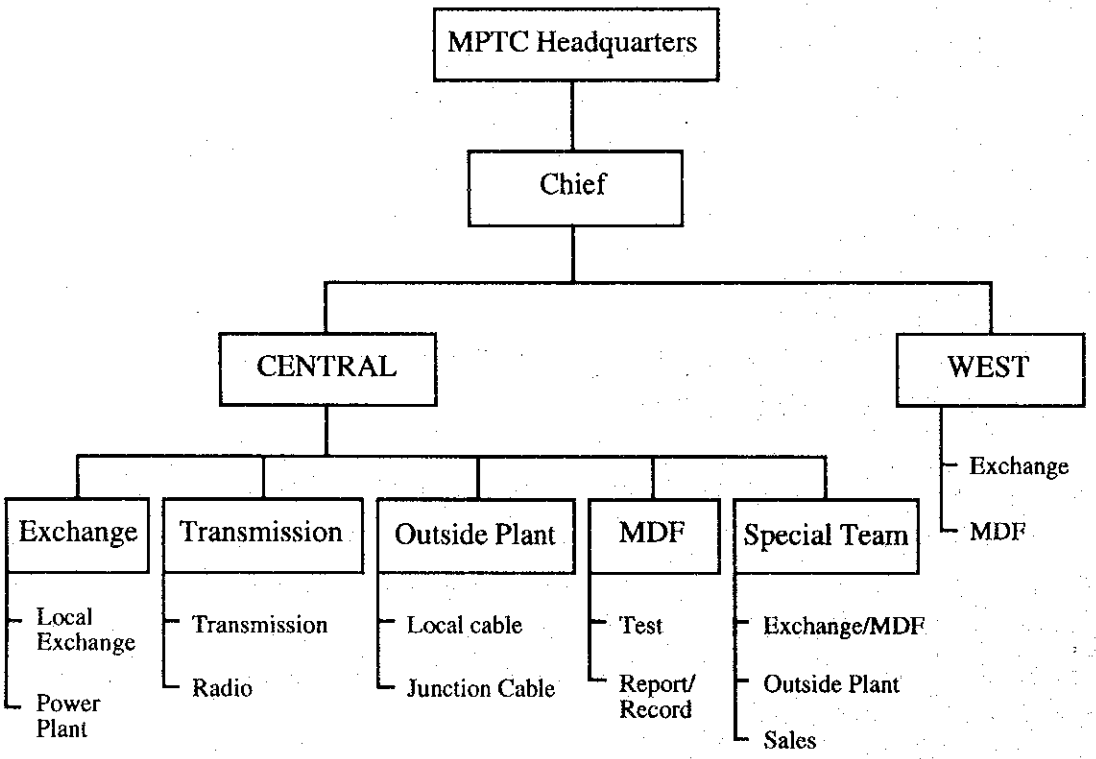


Figure 11.1-1 Telephone Office Organization

Given that the forecasted demand in 2007, the last year of the Essential Project, will be around 50,000 as described in 5.4, it is possible for MPTC to centralize the employees to operate and maintain all the equipment in each exchange office at night. In accordance with the expansion plan under the Essential Project, new exchange offices will be established other than Central, West and Airport Exchange Offices which are established under the Emergency Project. As shown in Chapter 7, two kinds of exchanges will be introduced, namely, independent type and RSU in proportion with their capacity. The independent type exchange will be introduced to the exchange offices of more than 3,000 subscribers and RSU will be introduced to

those of less than 3,000 subscribers. Concerning the operation and maintenance structure, it is tentatively determined that the operation and maintenance employees will be stationed during the daytime at exchange offices using the independent type exchange, except the Central Exchange Office which will be an attended office.

The operation and maintenance organization of newly established exchange offices using the independent type exchange under the Essential Project will be similar to that of West Exchange Office.

An organization can operate and maintain those exchange offices established under the Essential Project together with those established under the Emergency Project in terms of telecommunications facilities. The main force will be stationed at the Central Exchange Office. Installation work employees belonging to the special team for new subscriber connection under the Emergency Project will be transferred to operation and maintenance section of each telecommunications facility.

During the re-organization, the force for outside plant operation and maintenance formerly being stationed in the Central Exchange Office will be transferred to the below-mentioned outside plant maintenance center (OPMC).

The more volume of telecommunications facilities operated and maintained by the organization increases, the more work volume to be carried out by the telephone office organization. The telephone office organization then will be enlarged by each function of the special team established under Emergency Project to carry out a number of new subscriber connection work orders in individual sections such as the billing section and sales section and by the force which formerly carry out such works as are commonly executed for both MPTC headquarters and the telephone office, namely, workshops for repairing equipment, material control, billing and accounting who will be transferred partly from those of MPTC headquarters.
It results that an organization succeeding that shown in Figure 11.1-1 can handle all the exchange offices established under the Essential Project in total without establishing additional organization in parallel. The chief of the telephone office shown in Figure 11.1-1 will manage the telephone office organization including those employees being stationed there.
Figure 11.1-2 shows the proposed telephone office organization as of the year 2007.

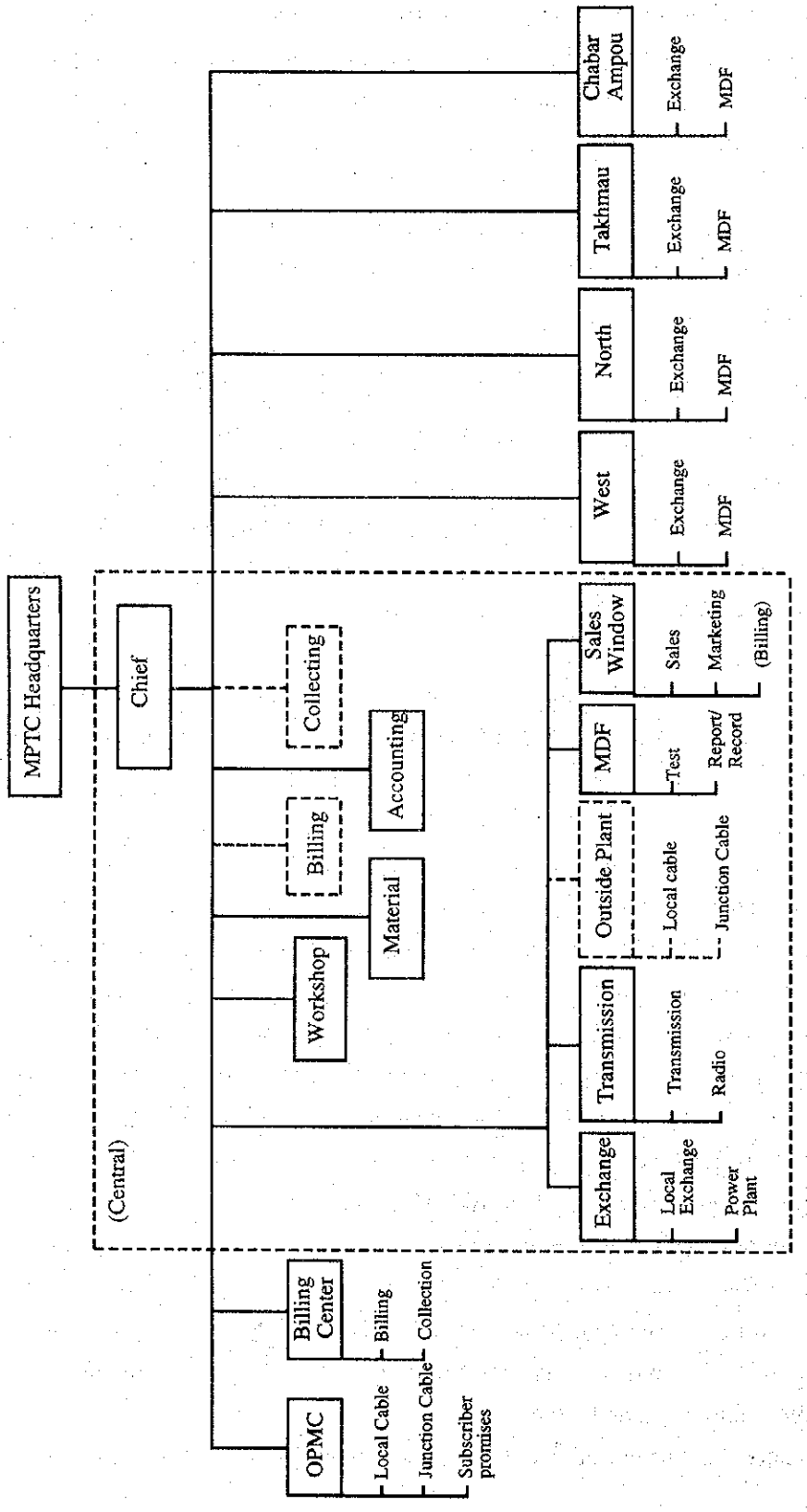


Figure 11.1-2 Proposed Telephone Office Organization as of 2007

11.2 Staffing

(1) Necessary number of employees

Figure 11.2-1 shows the macroscopic assumption of necessary number of employees in future.

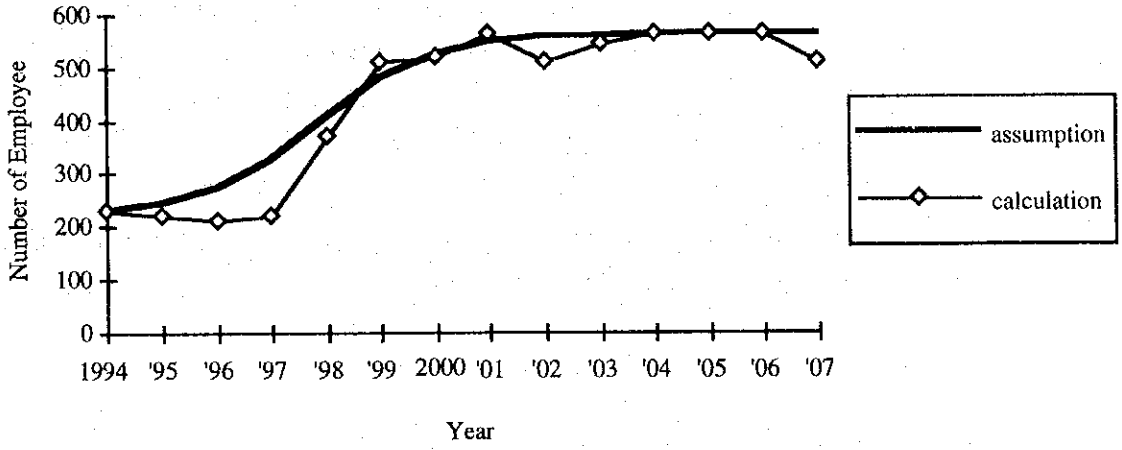


Figure 11.2-1 Number of Employees for Domestic Telecommunications Operation and Maintenance

Figure 11.2-1 was made given the following conditions.

- That the actual conditions of the MPTC concerning domestic telecommunications services, 230 employees operate and maintain 4,700 subscribers, which means an employee operates and maintains an average of 20.4 subscribers and during the Essential Project period, the efficiency in terms of the number of subscribers operated and maintained by an employee increases by 10 percent annually where 10 percent increment is estimated based on other countries experiences.
- That the capacity of the telecommunications network will increase according to Table 5.4-1 in each stage of construction.
- Provided the two conditions above, the necessary number of employees can be calculated dividing the number of subscribers by the work efficiency in terms of the number of subscribers operated and maintained by an employee.
- The thick line which follows logistic function and will be used for the Study is introduced for smoothening the change of calculation results because the number of employees calculated by the number of subscribers and the work efficiency drastically increasing in years of 1996 through 1999 and fracturing

year by year in years of 2000 through 2007 seems not to be suitable for a realistic manning schedule.

- The saturation in the Figure 11.2-1 means the balance of the increase of work efficiency with the increment of the number of subscribers.

About one tenth of these employees are assumed to be administrative division who are in charge of overall management, budget control, manning control and so on. The remaining are roughly divided into those of desk work and field work and most of the personnel to be increased will be those doing desk work for subscriber management including sales window work and billing work and those of field work for outside plant operation and maintenance. The number of operation and maintenance employees in charge of inside plant, i.e. exchange and transmission equipment and so on is not so many in comparison with that of outside plant due to technology renovation.

(2) Recruit and human resource development

To meet the requirement for personnel increment above, MPTC needs a recruitment plan and a human resource development plan.

11.3 Tools and Equipment for Operation and Maintenance

It will be necessary to procure, store and maintain measuring equipment, tools, vehicles, spare parts/packages for operation and maintenance work. The necessary tools and equipment for each plant are described as below:

(1) Inside Plant

(a) Network management system

Regarding items such as exchange equipment and transmission, the network management systems respectively are to be introduced under the scope of the Project to monitor, manage and control them from consoles at the same time as system construction. Operation and maintenance employees monitor the console which, in the case of trouble, indicates the position and situation of trouble instantly.

(b) Spare package

Necessary spare packages selected by the determination of both importance of the function and fault rate are provided by contractor(s) at the completion of the Project and kept by the MPTC.

When a fault occurs, following the diagnosis by the network management system, the deteriorated package(s) will be replaced by the spare package(s) and will be sent to the manufacturer to be fixed.

(c) Vehicle

As mentioned above, exchange offices of RSU type exchange are unattended exchange offices all day, operation and maintenance employees are to be stationed at the exchange office of independent type in daytime and at night are to be centralized to and stationed at only the Central Exchange Office so that the vehicles for patrol and for dispatch of fault repair employees to unattended exchange offices will be necessary. The number of vehicle equivalent to the number of exchange offices will be required.

(2) Outside Plant

As the outside plant group have to do their work outside exchange offices, they require vehicles having measuring equipment and/or tools necessary.
Aspects required in the vehicle are, for example,

(a) Equipment and tools

i) measuring equipment;

- grounding measuring set and insulation tester for operation work
- buried cable locator and cable pair checker for maintenance work
- gas detector for common work

ii) working tools

- cable cutter for maintenance work
- manhole blower and submergible pump for common work

(b) Safety

- safety belt
- helmet
- facilities enclosing working site from third party

(c) Vehicle

- for patrol and light duty preventive as well as corrective maintenance work, van type vehicle with the capacity of 4 to 5 passengers and 500 kg payload
- for heavy duty preventive and corrective maintenance work, a truck with 1 to 2 ton capacity to carry cable drum and/or pole

While aspects mentioned above are required in the vehicle, aspects which make desk work efficient will also be necessary to control outside plant facilities, subscribers, fault record and so forth. For example;

- plant record management system which stores and proceeds records in terms of drawing of area wise spreading outside plant
- cable pair assignment sheets which record every terminal block number and cable pair number of each subscriber

- fault record/analysis system which controls each step of fault repairing work flow from complaint reception until repair work completion, analyzes the fault cause, location and situation to make suitable preventive measures in future

11.4 Supporting System

To operate the telecommunications facilities constructed under the project and in consideration of the MPTC's lack of experienced engineers, prompt human resource development plan preparation and prompt improvement of work efficiency are required.
To realize the above and sustain the project, the following are to be recommended.

(1) Establishment of the following:

(a) New Training Center to be a center of human resource development

Following the plan to construct a new Central Telephone Office using the land of the existing training center of the MPTC and to solve the problem that there is no training facility for practice in the existent training center, it is necessary for the MPTC to program the establishment of the new training center. The MPTC needs not only construction of a training center building but also rehabilitation of the training program and reinforcement of the training center with practical training materials as well.
Though the training center is not only for domestic telecommunications services but for international telecommunications services and postal services, the demand by the domestic telecommunications services division of the MPTC will become more than that for the current training center because the number of trainees from the division of an initiation training as the number of the MPTC's employees for domestic telecommunications services will increase rapidly as shown in Figure 11.2-1 and needs for human resource development program of the division to raise individual efficiency for the period of saturation to balance the increment of the number of subscribers with the increase of individual work efficiency.

(b) Outside Plant Maintenance Center

The Study Team assessed the present operation and maintenance conditions of MPTC and found out that the fault rate of outside plant was bigger than that of inside plant and it can be pointed out, referring to the operation conditions of other countries, that most of the faults of newly constructed telecommunications facilities will concentrate on outside plant, especially drop wire, indoor wire and telephone sets. This means, in the future, maintenance work force of the MPTC will have to mainly focus on that of outside plant and the MPTC may be required to prepare a special taskforce to meet such a situation from the two aspects of providing services of good quality to its customers and operating its services in a cost-conscious manner.

To operate and maintain outside plant in high quality with suitable cost, it is necessary to utilize the tools, equipment and manpower for corrective maintenance work which is the repair work promptly carried out in response to each subscribers' complaint and, adding to that, to promote preventive maintenance work utilizing the tools, equipment and manpower which rehabilitates outside plant prior to total deterioration and will prevent losses in corrective maintenance work to respond to each complaint randomly occurring in time and place.

While there needs to be the above-mentioned measures to improve outside plant operation and maintenance work, in proportion with the increase of volume of telecommunications facilities, the necessary quantity of operation and maintenance tools, vehicles and materials as well as number of outside plant operation and maintenance employees will increase and the division will become a center having an individual premises, buildings for the work to fulfill the above requirements. A maintenance area of around 20,000 subscribers will be the criterion establishing the center.

(c) Billing Center

In line with the increase of the number of subscribers, work volume of billing and collecting increase. It is necessary for the MPTC to win subscribers' confidence for invoice if the MPTC wants to reduce the ratio of arrearage. Concerning the collection work, the more the number of subscribers increase the greater possibility of arrearage becomes and the employees for collection will be necessarily reinforced. The sooner a

subscriber who has his circuit cut by the MPTC as punishment pays for his arrearage the better the MPTC can recover the circuit.

A billing center having a more capable billing system than that installed in the Central Telephone Office under the Emergency Project and being able to communicate with customer service system will be required.

These three centers will be established in 1999 under the Project.

(2) Introduction of fellowship to send employees to study abroad

To fulfill the lack of experienced engineers of MPTC at present, it is strongly required for MPTC that it will look for the available funding and foreign counterpart who responds to MPTC's request for human resource development. Long and short term planning, design and their execution, facilities management, maintenance plan and its implementation are, for example, required.

(3) Introduction of technical assistance as follows

(a) Foreign experts for management

The MPTC requires the Japanese government to dispatch a long-term expert in charge of advising the MPTC on Development Plan and total operation and maintenance and the government of Japan, in response to the requirement, has a plan to dispatch an expert in the telecommunications sector. While the expert will not be able to concentrate on technology transfer for operation and maintenance for the telecommunications facilities, some short-term experts for technical assistances to make MPTC operate and maintain new facilities with those technology firstly introduced under the Essential Projects such as Japanese exchange equipment and SDH transmission technology more smoothly are also required as even though those technologies have been standard at the moment in most countries, there is no experience of operation and maintenance in Cambodia.

The MPTC needs to establish new guidelines for work structures and procedures for smooth implementation of new subscriber connection work

of being suitable for Cambodian condition referring to other countries' experience of rapid growth stage to match the following two situations. One is that the annual increment of the number of subscribers becomes thousands under the Essential Projects. Two is that it can be said in general in developing countries that the considerably high percentage of fault of subscriber network is concentrated on that of outside plant especially that of dropwire, indoor wire and telephone set of which the reason has been clearly analyzed that incorrect installation itself and/or that poor installation quality causes deterioration in shorter term than the materials' lifetime. A short-term expert will also be required to assist MPTC to prepare the said guideline.

(b) Junior volunteers for actual level of know-how transfer

In cooperation with the afore-said experts, junior volunteers will also be required to carry out the technical assistance for new work process in the MPTC to handle facilities constructed under the Essential Project and subscribers connected to them as well.

CHAPTER 12

Implementation Plan

CHAPTER 12 IMPLEMENTATION PLAN

12.1 Policy of Implementation Plan

In order to carry out the Project smoothly and without any delays, the basic items to be considered are shown as follows.

12.1.1 Construction on Turn Key Basis

The Project which will be divided into 4 stages, includes various types of construction works such as civil work for outside plant, installation of cable, exchange/transmission equipment, power facilities, etc. in each stage. The construction work, therefore, is to be carried out on a turn key basis in order to promote the various types of construction work which are related to each other in an efficient and economical manner, and to complete the Project successfully.

12.1.2 Employment of Consultant

The projects in each stage require large scale construction work and take 3 or 4 years until completion including the preparation period. The digital technology and optical fiber system are introduced to the Project. Advanced installation management and knowledge of recent technology for telecommunication facilities are required to carry out the construction of the project mentioned above. An experienced consultant, therefore, will be employed and will perform the preparation of the tender document, tender evaluation, installation supervision, inspection work, etc. in cooperation with the MPTC staff.

12.1.3 Establishment of Project Team

In order to carry out the construction work smoothly and without any delays of the implementation schedule, and to coordinate management among the sections concerned, the MPTC should establish a project team which consists of the MPTC staff and consultant.

12.1.4 Participation in Construction Work

Advanced technologies such as digital exchange/transmission equipment, optical fiber system, etc. will be introduced in the Project. Operation and maintenance staff of the

MPTC, therefore, will participate in the construction work to acquire the necessary knowledge for the operation and maintenance of the systems to be constructed. The MPTC staff will participate in every stage of the project to increase the skilled operation and maintenance staff for increasing facilities.

12.2 Project Implementation

12.2.1 Tasks of the Project Team

The project will be proceeded by the Project Team which consists of the MPTC staff and consultant. The main tasks of the Project Team are described below.

(1) Preparation of tender documents, and its evaluation and negotiation with a contractor

(2) Preparation of implementation schedule and control of overall progress

(3) Supervision work for each system's construction

(4) Factory inspection

(5) Inspection of provisional and final acceptance test

(6) Drawing inspection

12.2.2 Procurement Plan

Taking into consideration the results of the field survey in Cambodia, and the market circumstances and quality of equipment and materials to be procured for the Project, main equipment and materials which will be purchased in Cambodia and in foreign countries are shown respectively as follows.

(1) Equipment and material from Cambodia

- Sand, Gravel
- Crushed stone
- Cement
- Lumber (boards, poles and square lumber)

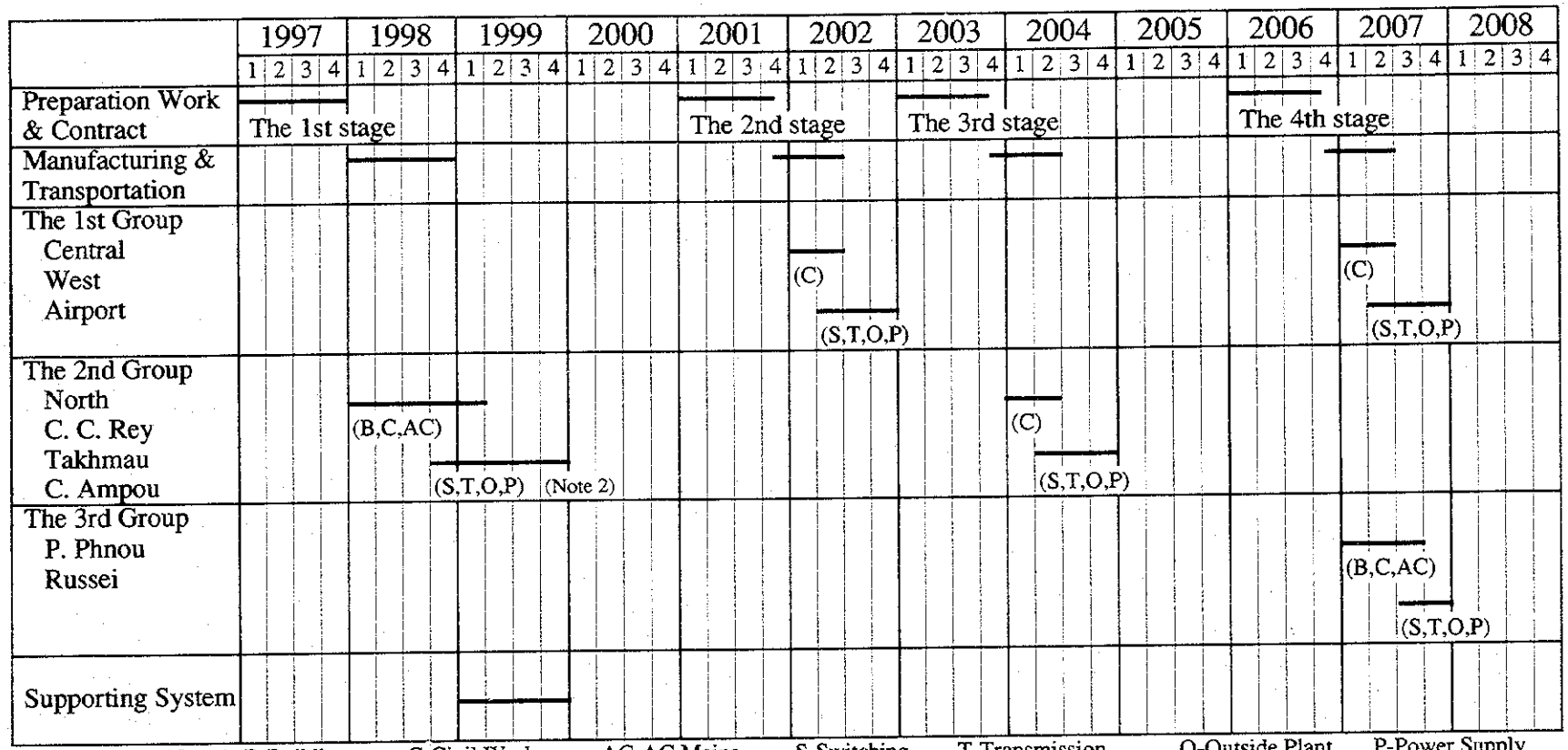
- Bricks, tiles, etc.
- Asphalt
- AC main power receiving facilities

(2) Equipment and materials from foreign countries

- Cables, conduit-pipe and supporting materials for outside plant
- Exchange equipment
- Transmission equipment
- Power facilities such as engine generators, rectifier, batteries, etc.
- Spares, tools and testing instruments necessary for the operation and maintenance

12.3 Implementation Schedule

Considering the effective provision of the telecommunication service, the exchange areas are divided into 3 groups as described in Chapter 8 in detail. The installation of the telecommunication facilities for the first priority group is selected as the Emergency Project. The installation and the expansion of the facilities up to 2007 for the second and the third group, and the expansion for the first group are selected as the Essential Project. The Essential Project will be divided into 4 stages and executed stage by stage, taking into consideration the demand trends up to 2007 and the even distribution of construction work volume. The overall time schedule of the Essential Project implementation and the supporting system construction is shown in Figure 12.3-1. As for the Emergency Project, the time schedule is shown in the Emergency Project part of the report.



Note 1: B-Building C-Civil Work AC-AC Mains S-Switching T-Transmission O-Outside Plant P-Power Supply

Note 2: Installation of Transmission Facilities at ITC are included in the schedule for the first stage.

Figure 12.3-1 Implementation Schedule for the Essential Project

CHAPTER 13

Cost Estimation

CHAPTER 13 COST ESTIMATION

The investment cost of the Essential Project is estimated based on the telecommunications facility provision plan of the essential project in Chapter 10 of this report with the following conditions.

(1) US$ are used as domestic currency.

(2) The classification of procurement from abroad or domestics is shown in the following table.

	Exchange, Transmission Power Plant		Subscriber, & Junction Cable		Building	
	Abroad	Domestic	Abroad	Domestic	Abroad	Domestic
Equipment & Materials	X		X	X	X	X
Design & Installation	X	X	X	X	X	X
Training	X		X		-	-

(3) The investment cost of the project is mentioned in Table 13-1 as US$.

(4) The cost of equipment and materials is C.I.F. (Cost, Insurance and Freight) of 1994.

(5) Rate of foreign exchange is shown below.

US$1 = ¥100.21

Table 13-1 Estimated Investment Cost

(1) Telecommunication Facilities

(US$1,000)

Phase	I		II	III	IV	
Constructed office: Number of subscriber line of exchange to be installed.	North : 2200 C.C. Reh : 800 Takhmau : 2400 C. Ampou : 2200		Central: 4000 West: 4000 Airport: 700	North: 1400 C.C. Reh: 500 Takhmau: 2400 C. Ampou: 2200	Central : 7000 West : 5000 Airport : 1500 P. Phnou : 500 P. Russei : 300	
Item	1998	1999	2002	2004	2006	2007
(1) Equipment & Material						
Subscriber cable	1,351	900	2,649	2,179	0	4,741
Junction cable	0	75	0	0	0	42
Exchange	0	3,034	2,750	2,076	0	4,598
Transmission	0	665	9	24	8	156
Power Plant	0	198	34	14	0	96
Subtotal = a	1,351	4,872	5,442	4,293	8	9,633
(2) Installation						
Subscriber cable	1,339	893	2,598	2,120	0	4,689
Junction cable	0	27	0	0	0	15
Exchange	0	152	138	104	0	230
Transmission	15	125	3	7	0	34
Power Plant	0	11	1	2	0	5
Building	3,189	0	0	0	0	108
Common temporary office	454	121	262	223	0	508
Subtotal = b	4,997	1,329	3,013	2,456	0	5,589
(3) Training						
Subscriber cable	0	21	21	21	0	21
Junction cable	0	11	0	0	0	11
Exchange	0	61	6	42	0	92
Transmission	0	35	0	0	0	35
Power Plant	0	8	0	0	0	8
Subtotal = c	0	136	27	63	0	167
(4) Management d = (a + b) x 0.1	635	620	846	675	1	1,522
(5) Consultant e = (a + b) x 0.1	635	620	846	675	1	1,522
(6) Physical Contingency f = (a+b+c+d+e) x 0.1	762	757	1,022	816	1	1,843
Total (a + b + c + d + e + f)	8,379	8,334	11,245	8,978	11	20,276

(2) Supporting System

Commencement year: 1999 (US$1,000)

Item	Training Center	OPMC	Billing Center	Note
(1) Equipment & Material	3,333	599	2,994	
(2) Installation	2,030	3,194	1,248	
(3) Training	67	200	60	
(4) Management	536	379	424	= [(1) + (2)] x 0.1
(5) Consultant	536	379	424	= [(1) + (2)] x 0.1
(6) Physical Contingency	650	475	515	= [(1) + (2) + (3) + (4) + (5)] x 0.1
Sub total	7,152	5,226	5,665	
Total	-	-	-	18,043