MINISTRY OF POSTS AND TELECOMMUNICATIONS CAMBODIA

THE KINGDOM OF CAMBODIA

BASIC DESIGN STUDY REPORT
ON
THE PROJECT FOR THE DEVELOPMENT
OF
THE TELECOMMUNICATIONS NETWORK
IN
PHNOM PENH CITY, THE KINGDOM OF CAMBODIA

AUGUST 1995

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
NTT INTERNATIONAL CORPORATION
NIPPON TELECOMMUNICATIONS CONSULTING CO., LTD.

BASIC DESIGN
THE BASIC DESIGN STUDY REPORT ON THE PROJECT FOR THE DEVELOPMENT OF THE TELECOMMUNICATIONS NETWORK IN PHNOM PENH CITY, THE KINGDOM OF CAMBODIA
AUGUST 1995

JAPAN INTERNATIONAL COOPERATION AGENCY

MINISTRY OF POSTS AND TELECOMMUNICATIONS CAMBODIA

THE KINGDOM OF CAMBODIA

BASIC DESIGN STUDY REPORT
ON
THE PROJECT FOR THE DEVELOPMENT
OF
THE TELECOMMUNICATIONS NETWORK
IN
PHNOM PENH CITY, THE KINGDOM OF CAMBODIA

AUGUST 1995

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
NTT INTERNATIONAL CORPORATION
NIPPON TELECOMMUNICATIONS CONSULTING CO., LTD.

PREFACE

In response to a request from the Royal Government of Cambodia, the Government of Japan decided to conduct a basic design study on the Project for the development of the telecommunications network in Phnom Penh City and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Cambodia a study team from April 21 to April 28, 1995.

The team held discussions with the officials concerned of the Government of Cambodia, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Cambodia in order to discuss a draft basic design, and as this result, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Royal Government of Cambodia for their close cooperation extended to the teams.

August 1995

Kimio FUJITA
President
Japan International Cooperation Agency

August 1995

Letter of Transmittal

We are pleased to submit to you the basic design study report on the Project for the development of the telecommunications network in Phnom Penh City in the Kingdom of Cambodia.

This study was conducted by NTT International Corporation in association with Nippon Telecommunications Consulting Co., Ltd., under a contract to JICA, during the period from April 17, 1995 to August 24, 1995. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Cambodia, and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

Finally, we hope that this report will contribute to further promotion of the project.

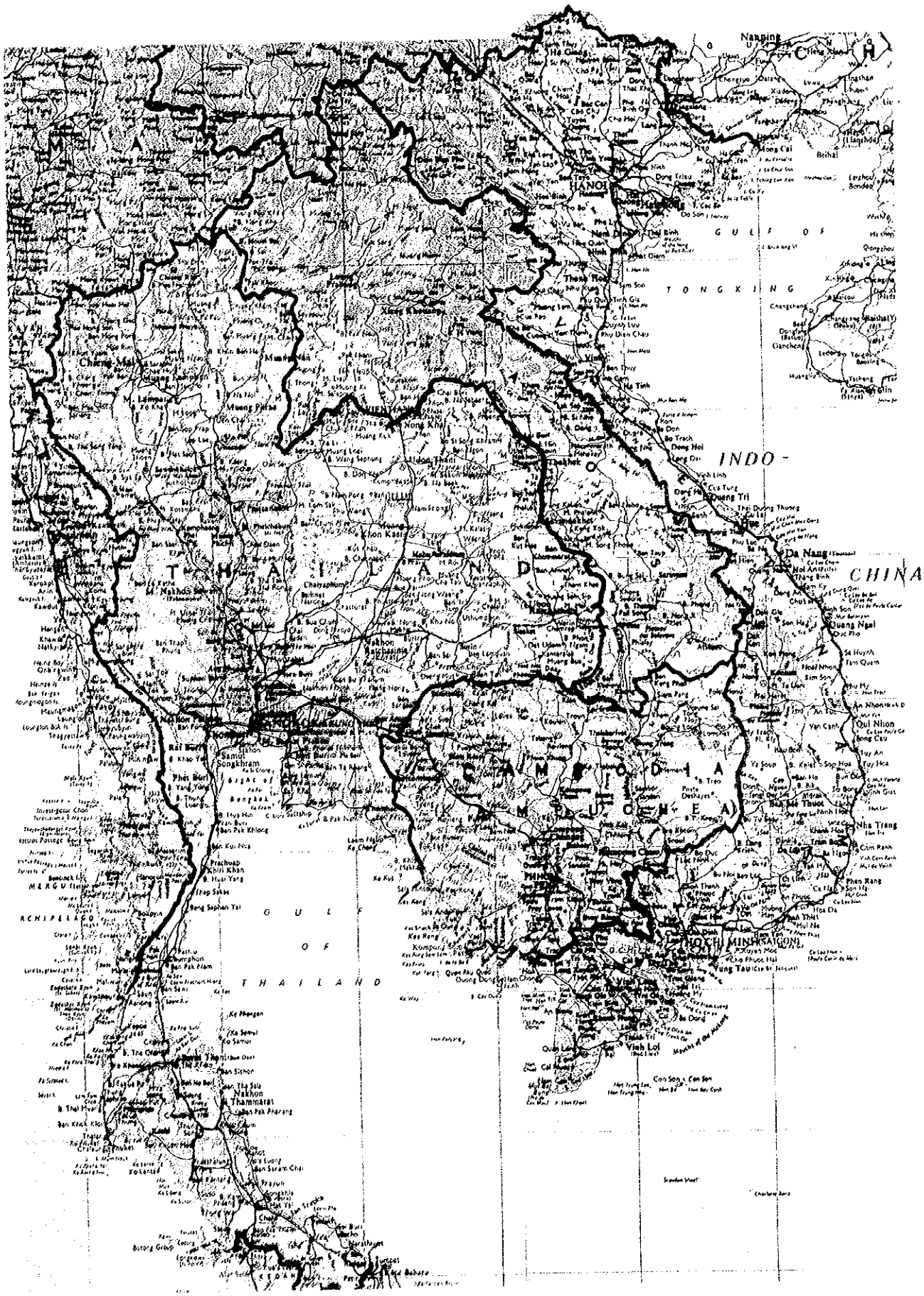
Very truly yours,

梅村靜宏

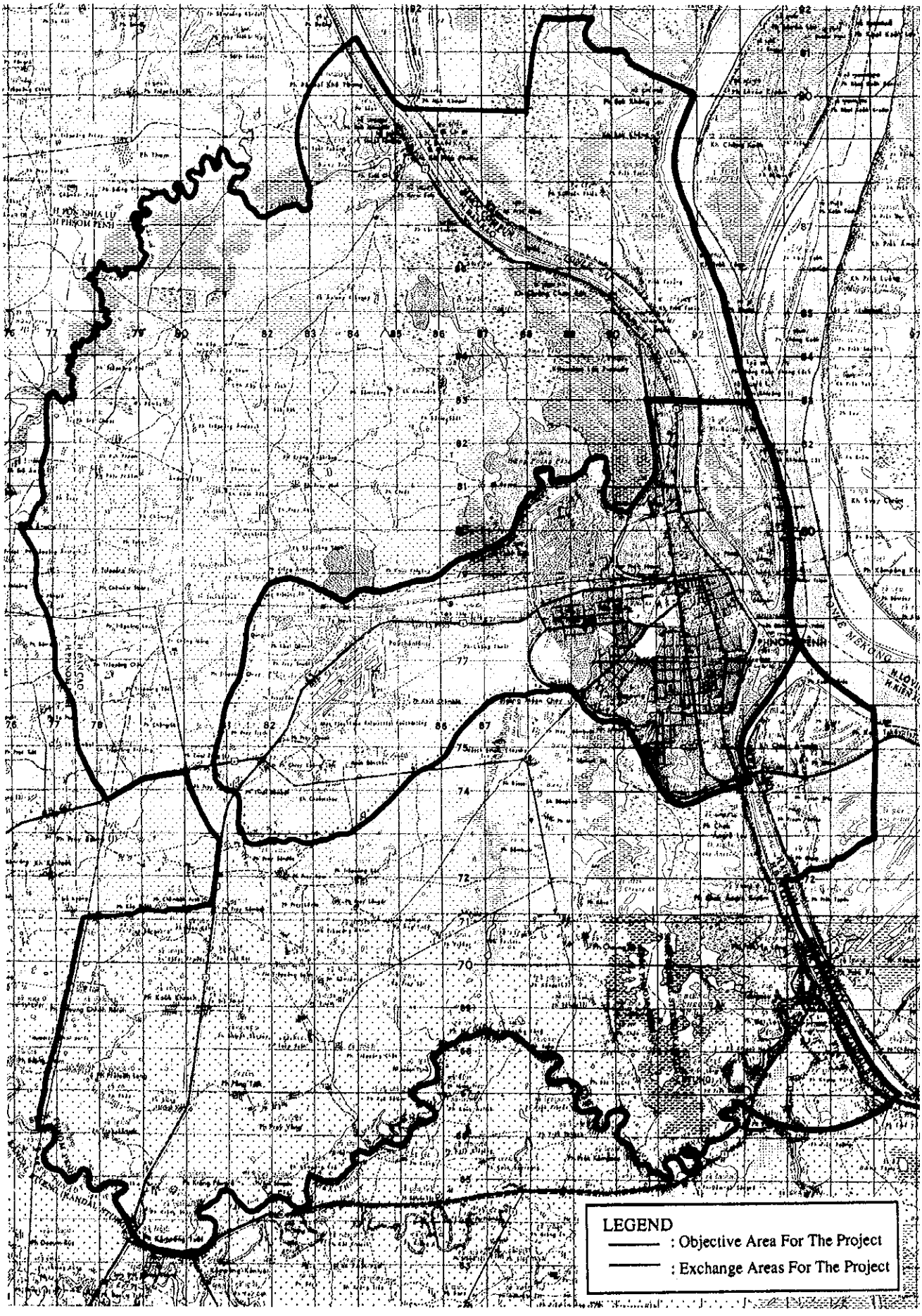
Shizuhiro UMEMURA
Project Manager,
Basic design study team on
the Project for the development of
the telecommunications network in Phnom Penh city
NTT International Corporation

Location Map / Perspective

THE KINGDOM OF CAMBODIA



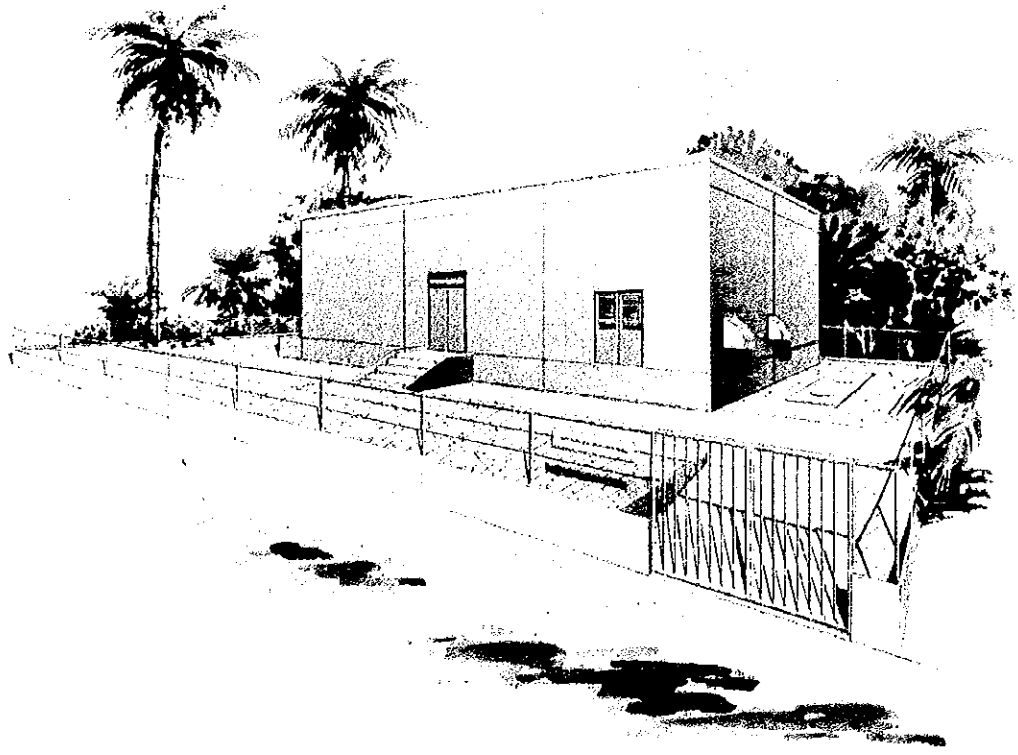
OBJECTIVE AREA



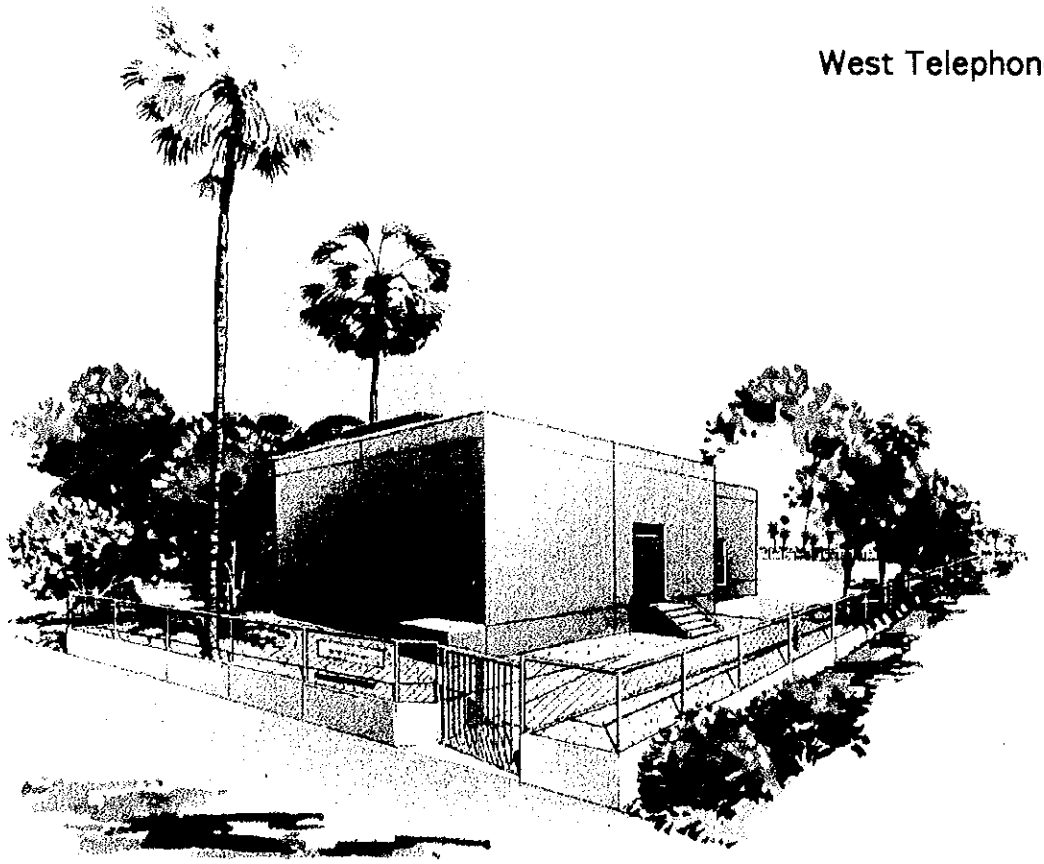
Perspective drawing (As completed) in Phase I

Central Telephone Office

Perspective drawing (As-completed) in Phase II



West Telephone Office



Airport Telephone Office

Abbreviations

Abbreviation

AC	:	Alternating Current
ADB	:	Asian Development Bank
AMA	:	Automatic Message Accounting
AMPS	:	Advanced Mobile Phone System/Service
BCC	:	Business Cooperation Contract
BOD	:	Biochemical Oxygen Demand
CIF	:	Cost, Insurance and Freight
DAMA	:	Demand Assignment Multiple Access
DC	:	Direct Current
DDF	:	Digital Distribution Frame
DP	:	Distribution Point
E/G	:	Engine Generator
ETACS	:	Extended Total Access Communication System
FRP	:	Fiber Reinforced Plastic
FS	:	Feasibility Study
GDP	:	Gross Domestic Product
HF	:	High Frequency Band
IDD	:	International Direct Dialing
INTELSAT	:	International Telecommunications Satellite Consortium
ITC	:	International Telecommunication Center
ITU	:	International Telecommunication Union
JICA	:	Japan International Cooperation Agency
KfW	:	Kreditanstalt für Wiederaufbau
LS	:	Local Switch
MAS	:	Multiple Access System
Mbps	:	Mega bit per second
MDF	:	Main Distribution Frame
MPTC	:	Ministry of Posts and Telecommunications Cambodia
NMT	:	Nordic Mobile Telephone
OJT	:	On the Job Training
OLT	:	Optical Line Terminal
OTCI	:	OTC International Limited
P-MP System	:	Point-to-Multipoint System
P-P System	:	Point-to-Point System
PA	:	Pre-Assignment

PABX	:	Private Automatic Branch Exchange
PDH	:	Plesiochronous Digital Hierarchy
POTS	:	Plain Ordinary Telephone Service
PVC	:	Polyvinyl Chloride
RC	:	Reinforced Concrete
RSU	:	Remote Switching Unit
SDH	:	Synchronous Digital Hierarchy
UNDP	:	United Nations Development Program
UNTAC	:	United Nations Transitional Authority for Cambodia
VHF	:	Very High Frequency Band

Summary

Summary

The Kingdom of Cambodia occupies a territory covering 181,035 km^2, approximately half the size of Japan, and is bordered by Thailand and Laos to the north, and by Vietnam to the east. Since the whole of the country is in the torrid zone and affected intensively by monsoons, there are two pronounced seasons: the rainy season from May to October, and the dry season from November to April. The annual precipitation totals 1,308 mm. In Phnom Penh, the average temperature in January is 25.6°C, and in July 28.9°C, but daily maximum temperatures sometimes exceed 40°C in April to May. People traditionally produce rice in the fertile plains resulting from frequent flooding of the Mekong river and the monsoon climate. The population of Phnom Penh city is approximately nine hundred thousand.

As for the status-quo of the telecommunications, there are 14,000 subscribers including mobile telephone users in a population of 9.76 million, giving a telephone density of 0.15 per hundred inhabitants which is one of the lowest rates in the world. The size of telecommunications networks in the provinces is still small, with radio systems using high or very high frequencies. A national telecommunications network is almost non-existent, and automatic long distance call service is not available.

Phnom Penh city is the capital city and the center of political, administrative and economic activities of the Kingdom of Cambodia. Approximately 90% of total telephone subscribers of the country are concentrated in the city. The telephone density in Phnom Penh city is 1.5 per 100 inhabitants and telephone density in terms of Plain Ordinary Telephone Service (POTS) is 0.6 per 100 inhabitants, which is very low in comparison with the average of capital cities of the surrounding countries. As for the existing telecommunications facilities, apart from some exchanges, most were installed before 1970, and they are more than 25 years old. Since they reach the end of their life, either do not function well or are out of use. Furthermore, twenty years of civil war destroyed and damaged most of the equipment, facilities and cables which were then in operation. After the war, proper expansion and maintenance of facilities has not been implemented because of lack of well-trained engineers, and of capital. The fault rate of subscriber cables is high at 13 per 100 subscribers as of November, 1994 (70 times that of Japan). In addition, there was no service for new subscribers in 1994 due to shortage of subscriber cables.

The telecommunications facilities in Phnom Penh are insufficient not only in quantity but also in quality. People have no choice but to walk or to use motorcycles for distant

communications. Lack of means of communications is a big obstacle for people in emergencies as well as in daily life.

Under these circumstances, the Royal Government of Cambodia requested the rehabilitation of the telecommunications network in the Capital City of Phnom Penh to the Government of Japan in August 1993. In response to this request, the Government of Japan decided to conduct a feasibility study on the telecommunications network for Phnom Penh City and its surrounding area and Japan International Cooperation Agency (JICA) conducted this study from September 1994 to July 1995. In the study, a project implementation program has been formulated, in which the rehabilitation and development of the telecommunications network in Phnom Penh City and its surrounding areas will be executed in five steps by the year 2007. The Government of Japan decided again to conduct a basic design study for those portions which must be implemented most urgently for the rehabilitation among these five steps of the project implementation program, and JICA dispatched a basic study team to Cambodia from April 21 to April 28, 1995. The basic design study team confirmed the contents of the Cambodian request and discussed with the relevant Cambodian authorities the appropriateness of Japan's Grant Aid, and the size of the aid. In addition, the basic study team investigated project sites, the status-quo of telecommunication facilities and services, aid plans by other countries and maintenance and operation systems. Based on the results of these investigations, data collected in Cambodia and the feasibility study, the basic design study team formulated a basic design regarding what kinds of facilities and sizes are appropriate to the telecommunications network to be newly installed, and prepared a draft final report after returning to Japan. From June 6 to June 12, 1995 JICA once more dispatched the basic design study team to Cambodia to explain and discuss the report and both sides basically agreed on the contents of the report.

The project formulated in the basic design study involves the construction of three new telephone office buildings in high demand areas of Phnom Penh, the installation of digital exchanges, subscriber cables, digital transmission equipment, and laying of optical fiber cables to connect telephone offices in Phnom Penh with each other, as well as the installation a digital radio subscriber system to supply telecommunications services to important subscribers in suburban areas of Phnom Penh. The project is planned to be executed in two phases. The contents of the basic design are shown in the table of page S-3

Item	First Phase	Second Phase	
Name of Telephone Office	Central Telephone Office	West Telephone Office	Airport Telephone Office
Building Construction	RC (3,164 m^2) • Cable chamber • Switching room • Transmission Radio room • Manual S/W room • Power room • Staff room • Customer service room • Billing room • Classroom • Ancillary rooms Ancillary building-1 for generators (97 m^2) Ancillary building-2 for watchmen (22 m^2)	RC (226 m^2) • Cable chamber • Switching room • Transmission room • Power room • Staff room	RC (186 m^2) • Cable chamber • Switching room • Transmission room • Power room • Staff room
Digital exchange (including installation)	Local exchange 10,000 line units	Local exchange 6,000 line units	Remote switching unit 800 line units
Digital transmission equipment (including installation)	• Central telephone office ~ ITC 155 Mbps (1 + 1) Optical fiber cable • Central telephone office ~ E-10B 2 Mbps Shielded metallic cable	• Central telephone office ~ West telephone office 155 Mbps (1 + 1) Optical fiber cable • West telephone office ~ Airport telephone office 155 Mbps (1 + 1) Optical fiber cable	
Subscriber cables (including installation)	• Cable termination at MDF 12,000 pairs • Total cable length in pair km 22,798 pair km	• Cable termination at MDF 6,800 pairs • Total cable length in pair km 13,178 pair km	• Cable termination at MDF 800 pairs • Total cable length in pair km 1,803 pair km
Power plant (including installation)	• DC uninterrupted power supply system • AC uninterrupted power supply system	• DC uninterrupted power supply system • AC uninterrupted power supply system	• DC uninterrupted power supply system • AC uninterrupted power supply system
Digital radio subscriber system (including installation)		• 1 base station (in Central telephone office) • 52 subscriber stations (in suburban areas of Phnom Penh) • 117 subscribers (in suburban areas of Phnom Penh) • Power supply systems for subscriber stations - 37 rectifier and battery systems - 15 solar battery systems - 3 portable engine generators (in Central telephone office) • Tower - A guyed tripod tower 35 m (in Central telephone office) - 52 steel poles 15 ~ 23 m (in the subscriber stations)	
Vehicles for maintenance and subscriber connection	• 6 station wagon cars • 2 four wheel driven cars	• 2 station wagon cars • 1 four wheel driven car	

A total cost of US$2,348,500 will be borne by the Cambodian side. The implementation periods of both phases of the Project are scheduled to be 4.5 months for detailed design, tendering and contract awarding, and 12 months for building construction and equipment/facility procurement and installation.

The following benefits can be expected from the implementation of the Project for rehabilitation and expansion of the telecommunication network in the capital city of Phnom Penh.

1) The public telecommunication network to be constructed by the Project (hereinafter referred to as the Network) can provide high quality telephone services to 15,500 subscribers at the initial stage in Phnom Penh city and surrounding areas. Therefore, the population of 120,000 people in the objective area can benefit from this service.
2) The Network can make a great contribution to promoting the Socio-Economic Rehabilitation Plan 1994-1995 which is being implemented by the Government of Cambodia, and to obtaining assistance more effectively from foreign countries and/or international organizations, through the improvement of communication between ministries and relevant administrative offices.
3) There are 10 large-scale hospitals in Phnom Penh city, with 2 telephone lines connected to each of 8 hospitals, one hospital with only 1 line, and the remaining hospital with no telephone line at all. Even these telephone lines are frequently out of order, especially in the rainy season. No proper means of communication is available to patients and hospitals for emergency cases at present. However, the Network will allow patients to utilize the hospitals more effectively in emergency cases, as well as improving operations of hospitals, through the provision of proper means of communication with the public.
4) Most fire stations, police stations and schools in the city are not currently provided with public telephone services. Moreover, areas outside the city of Phnom Penh are not provided with any services at all. There is no choice for the public but to communicate face-to-face, walking or traveling by motorcycle as necessary, even in emergencies. However, the Network can provide proper means of communication to the public.
5) The Network contributes greatly not only to the improvement of the telecommunications network in Phnom Penh city but also to the foundation of a nationwide telecommunications network to be formulated in the future. The quality of the network and the quantity of facilities will be remarkably improved by the Network, and the benefits of Ministry of Posts and Telecommunications Cambodia (hereinafter referred to as "the MPTC") will be expected to increase in accordance with the number of new subscribers. Therefore, the MPTC can apply the cross subsidy mechanism in which the

revenue accrued from profitable areas should be invested for the development and/or improvement of the network of unprofitable areas.

6) The network's total fault rate in the present system is 13.0 per 100 subscribers, due to obsolete facilities in the present network and insufficient spare materials for maintenance. Since 90 % of 4,800 present subscribers should be transferred to the new network, the fault rate can be remarkably reduced to less than 1.0 per 100 subscribers by the Network

Telecommunications equipment and the facilities to be introduced by the Project are superior in terms of expandability. Therefore, the MPTC can implement the expansion of the network and the formulation of the nationwide network in the future by applying the revenue accrued from their own network. Thus, the implementation of this Project contributes to socio-economic improvements not only in the capital city of Phnom Penh but also throughout the whole country, through the establishment of telecommunications network nuclei toward the formation of a total network in Cambodia in the future. Furthermore, it is judged to be appropriate that the Government of Japan provides the grant aid for the implementation of the Project, because the Project will bring widespread benefits to the public and there is no uncertainty regarding operation and maintenance of the facilities after completion of the Project.

For the purposes of smooth and effective implementation of the Project, the following recommendations are made to the MPTC:

1) The Project is planned as the rehabilitation of social infrastructure and the funding for implementation is provided by Japanese grant aid. The MPTC should preferentially provide telephone services to subscribers in accordance with the priority order. The priority order has been given to the persons and/or offices who play an important roll in social activities, such as government authorities, administrative offices, international organizations, hospitals and police stations.
2) The MPTC adopts the flat rate system as the tariff system for the present, and it is expected that the MPTC will change from the flat rate system to the meter pulse system, so that the monthly fee can be reduced and the number of subscribers increased. Following this, the MPTC should increase its own budget to construct the nationwide network in the future.
3) It is expected that the MPTC should positively apply the revenue from the network constructed by the Project to the rehabilitation and expansion of the rural telecommunications network.
4) In order to provide telephone services to the public immediately and to ensure the budget for the management of networks, the MPTC should carry out new subscriber connections

as soon as possible. Therefore, it is suggested that the MPTC puts the incentive system for subscriber connections into practice. The system aims at the promotion of connection work and covers an allowance for technician's over time, special work, etc.

5) In general, the quality of the materials and installation work for the subscriber connection may severely effect the total network and poor quality may cause increments in total failure rate of systems in developing countries. In order to avoid such failure, the MPTC should take the following actions:
   - To prepare appropriate specifications of equipment and materials to be applied for subscriber connections,
   - To prepare appropriate manuals for installation work,
   - To establish the inspection procedure system for subscriber connections to check whether the work is completed according to installation manuals and materials as instructed in the specifications.

6) The subscriber radio system equipment provided by the Project can be moved and reused. Therefore, it is desirable that equipment that becomes unnecessary through service area expansion of the subscriber cable facilities will be moved to areas where subscriber cabling services are unavailable, and be effectively reused.

7) Up to the present, the MPTC has 2 year and 3 year training courses in the telecommunications department. It is desirable that the MPTC will develop the existing training courses further and set up the leader's training course to cope with the new telecommunications facilities introduced by the Project. In order to effectively operate and maintain the facilities established by the Project, it is desirable for the MPTC to train many employees through on-the-job training in order to obtain a large number of qualified people.

CONTENTS

CHAPTER 1

Background of the Project

CHAPTER 1. BACKGROUND OF THE PROJECT

Phnom Penh city is the capital city and the center of political, administrative and economic activities of the Kingdom of Cambodia. Approximately 90% of total telephone subscribers of the country are concentrated in the city. The telephone density in Phnom Penh city is 1.5 per 100 inhabitants and telephone density in terms of Plain Ordinary Telephone Service (POTS) is 0.6 per 100 inhabitants, which is very low compared with the average of capital cities in the surrounding countries. The size of telecommunications networks in the provinces is still small, with radio systems using high or very high frequencies. A national telecommunications network is almost non-existent, and automatic long distance call service is not available.

As for the existing telecommunications facilities, apart from some exchanges, most were installed before 1970, and they are more than 25 years old. Since they reach the end of their life, either do not function well or are out of use. Furthermore, twenty years of civil war destroyed and damaged most of the equipment, facilities and cables which were then in operation. After the war, proper expansion and maintenance of facilities has not been implemented because of lack of well-trained engineers, and of capital. The fault rate of subscriber cables is high at 13 per 100 subscribers as of November, 1994 (70 times that of Japan). In addition, there was no service for new subscribers in 1994 due to shortage of subscriber cables.

Present mobile telephone services, four foreign investors, which have made joint venture companies with the MPTC, commenced their services in Phnom Penh and four local cities. As of November 1994, there are approximately 9,200 mobile telephone subscribers in the country. The service areas of the mobile telephone are limited and the telephone charges are more expensive than those of Thailand. In detail, deposits for the mobile telephone services are 9.7 times, installation fees 2.4 times and call charges per minute 1.4 times in Thailand. They are set up relatively expensively except for monthly fees. Since the subjects of the mobile telephone services are business users such as high rank people in companies and foreigners, it is not said that the mobile telephone services are the basic telecommunications service which should be fairly supplied to the public. In fact, private companies would invest to profitable areas but not to unprofitable areas.

Under these circumstances, the Government of Cambodia has requested to the Government of Japan to carry out the feasibility study for the rehabilitation of the telecommunications network, and in response to the request JICA sent the Study team from September 1994 to July 1995.

As the results of the Study, the project implementation plan (shown in Table 1.1) with priority order based on the exchange areas has been elaborated. JICA is requested to carry out a basic design study for the Project listed in the first priority in the plan to rehabilitate the telecommunications network so that the rehabilitated network can be a nucleus for the future telecommunications network in Cambodia.

Table 1.1 Implementation Schedule for Development Plan

Implementation Stage	1st Stage		2nd Stage		3rd Stage		4th Stage		5th Stage		Total
Implementation Year	1995 ~ 1997		1997 ~ 1999		2000 ~ 2002		2002 ~ 2004		2005 ~ 2007		
Provision Year	1997		1999		2002		2004		2007		
Central Telephone Office	9,600				(13,400)	3,800			(19,800)	6,400	19,800
West Telephone Office	5,300				(8,300)	3,000			(13,900)	5,600	13,900
Air Port Telephone Office	600				(1,400)	800			(2,900)	1,500	2,900
North Telephone Office			2,000				(3,300)	1,300			3,300
C. C. Rey Telephone Office			600				(1,200)	600			1,200
Takhmau Telephone Office			2,200				(4,300)	2,100			4,300
C. Ampou Telephone Office			2,000				(4,000)	2,000			4,000
P. Phnou Telephone Office									420		420
Russei Telephone Office									240		240
New Installation Total	15,500	-	6,800	-	-	-	-	-	660	-	22,960
Expansion Total	-	-	-	-	-	7,600	-	6,000		13,500	27,100
Accumulation Total	15,500		6,800		23,100		12,800		37,260		50,060
Scope of Work	Building x 3 S/W x 3 F/O. Trans. x 3 Sub. Connection D. MAS x 1		Building x 4 S/W x 4 F/O. Trans. x 4 Sub. Connection		Sub. Connection		Sub. Connection		Sub. Connection Building x 2 S/W x 2 F/O. Trans. x 2		
Construction Period	1st		2nd		3rd		4th		5th		
Year	95		97		99		01		03		05		07

Note: The figures in this table show the telephone demand.

( ) figures mean the total demand accumulated in the year.

CHAPTER 2

Contents of the Project

CHAPTER 2. CONTENTS OF THE PROJECT

2-1 Objectives of the Project

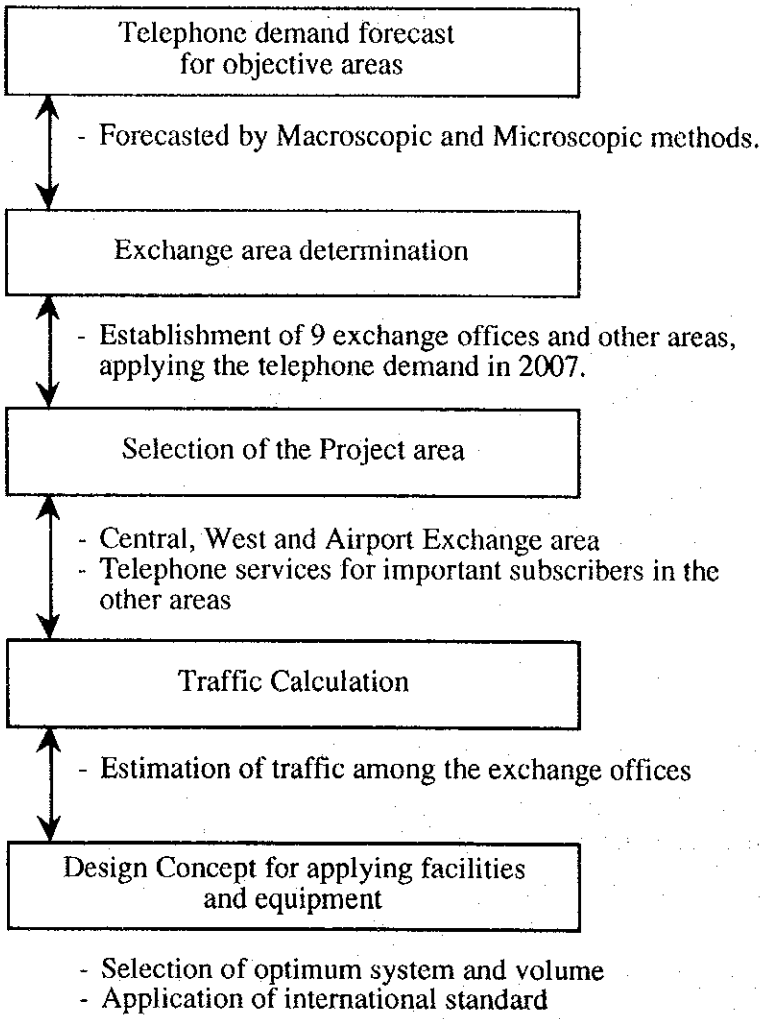
The Project for the Development of the Telecommunications Network in Phnom Penh City (hereinafter referred to as "the Project") aims at constructing new telephone office buildings and installing digital exchanges, transmission equipment and subscriber cables, etc. in order to improve the deteriorated telecommunications network in Phnom Penh and to meet the demand of the construction completion year of the Project, that is the demand of the year of 1997, as well as to provide a telecommunications service to important subscribers located in the surrounding areas of Phnom Penh city and the existing telephone offices by installing a radio subscriber system.

2-2 Basic Concept of the Project

In response to a request of the Government of Cambodia, the Japan International Cooperation Agency (JICA) dispatched the Feasibility Study Team to study viability on Telecommunications Network for Phnom Penh City and its surrounding area in the Kingdom of Cambodia from September 1994 to July 1995.

In this study, the Study team formulated a plan to rehabilitate and develop Telecommunications Network for the area divided into five steps till 2007. (Refer to Table 1.1, Implementation Schedule for Development Plan.) This project selected from this plan should be executed urgently.

Telecommunications facilities to be provided by the Project are designed based on the following: (Details are stated in Chapter 5, 7, 8, 9 and the Emergency part of the Feasibility Study report on telecommunications network for Phnom Penh city and its surrounding area in the Kingdom of Cambodia (hereinafter referred to as FS report).)



2-3 Basic Design (Telecommunications Facilities)

2-3-1 Design Concept (Telecommunications Facilities)

Telecommunications facilities to be provided by the Project are designed based on the relevant ITU-T and R recommendations and standards recognized internationally as well as the MPTC standards, with a view to eliminate probable confusion in operation and maintenance of the network in the future.

(1) Telephone Demand of Objective Areas

1) Telephone demand of telephone office areas

The telephone demand of objective areas have been studied by two (2) methods, namely Macroscopic and Microscopic demand forecast. The

macroscopic demand forecast has been done based on an ITU-recommendation and the microscopic demand has been forecasted by surveying sites. Both of the results were compared and assessed to determine a final demand of the objective area. Then the final demand has been assigned as a demand of each telephone office. The telephone demand in proposed exchange areas are listed below.
(Refer to Chapter 5 in FS. Report.)

Telephone Demand

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

2) Important Subscribers to be covered by the Project

In order to provide the telephone services to the important subscribers located outside these 3 exchange and the existing exchange areas, the cable subscriber system is not applicable due to the fact that the distance between an exchange and subscribers is far over the limitation of the distance to be provided by the cable system. Therefore, a Radio Subscriber system is applied for the important subscribers located outside the 3 proposed exchange areas and the existing exchange areas. The system can cover the whole objective area and the base station is to be established in the Central telephone office. The following table shows the number of important subscribers in each district.
(Refer to Chapter 2, item 2.1.5 in FS. Report Emergency Part.)

The selection of these important subscribers has been decided with the Study team's confirmation for about one hundred subscriber stations requested by MPTC in the subject area except unneeded places such as ruins or spots of which function are stopped. And it is necessary to consider again the detail in installation, and so on, on the implementing design.

Number of Important Subscribers

District Name	No. of Subscriber Stations	No. of Important Subscribers
Dang Kor	21	Administrative office / 14 Hospital/Clinics / 13 Police station / 14 Others / 4 School / 7
Russey Keo	17	Administrative office / 9 Hospital/Clinics / 6 Police station / 7 Others / 5 School / 4
Mean Chey	12	Administrative office / 9 Hospital/Clinics / 3 Police station / 8 Others / 3 School / 4
Prek Phnou	2	Administrative office / 2 Hospital/Clinics / 1 Police station / 2 School / 2
Total	52	117

When the new telephone office has been established in the future according to the implementation schedule for development plan stated in Table 1.1 on the page 1-3 the important subscribers provided telephone services by the digital MAS if any should be transferred to the new telephone office. Then the digital MAS equipment served for these subscribers can be shifted to the other location of outside telephone office area to provide services to other important subscribers even after completion of the said development plan in the year 2007.

(2) Exchange Area Determination

In order to determine the proper size of the exchange area where the cable subscriber system is applied, the following items have been taken into consideration for economical establishment, easy maintenance and expansion of the public telecommunications network:

1) The distribution of telephone demand (density)
2) The area size in square kilometers (km^2)
3) The exchange boundary, 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 boundary.

4) Application of the unigauge system in the subscriber cable network, which is determined by the following reasons:
   - To reduce the type of spare materials, tools/equipment and spaces for keeping them,
   - To reduce 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 with due consideration of the limitation of line loss value (7.0 dB) specified by the national transmission loss allocation.

(3) Selection of the Project

The Project areas are the areas where improvement and/or rehabilitation of telecommunication services is urgently required. Therefore, the following criteria are applied for selection of the areas so as to implement the Project in conformity with the policy of the "Telecommunications sector investment program for 1994-1998" formulated by the MPTC.

1) The areas should be the exchange areas which have been planned in the fundamental plan for 2007.
2) The areas should be the exchange areas where there is a possibility of high revenue by the provision of telephone services (High telephone demand density area).
3) The areas should be the exchange areas where there are important institutions and/or facilities for social and economic activities.
4) The areas should be the exchange areas where no expansion plan using funds from other countries exists.

Three exchange areas have been determined by the study stated above, in the Phnom Penh city and its surrounding areas. Telephone demand of three exchange areas is shown in the table below.

Telephone Demand

Year	Central	West	Airport	Total
1997	9,600	5,300	600	15,500
2000	11,500	6,800	1,000	19,300
2002	13,400	8,300	1,400	23,100
2007	19,800	13,900	2,900	36,600

Although North exchange is not selected in the Project, high benefits will be brought to the North exchange area by the utilization of the existing telecommunication facilities, because some subscribers in North exchange will be accommodated to Central and West exchanges. Therefore, facilities of North exchange will be available to other applicants in North exchange area.

(4) Traffic Calculation

In order to get the necessary number of junction circuits among the exchanges in the Project, the following calling rates have been calculated based on traffic data measured from the existing digital exchanges.
(Refer to FS. Report in chapter 9, item 9.2.1.)

- Local outgoing calling rate : 0.040 erl
- Local distance outgoing calling rate : 0.002 erl
- Special service outgoing rate : 0.001 erl

1) Local traffic distribution matrix

Local traffic is distributed to each exchange based on the Outgoing traffic calculated by the proportion of respective area demand to the total telephone demand in the whole area. The results are shown in the Table below. For preparation of this table, the affinity coefficients are assumed to be equal to each exchange, since all the exchanges are located in the same city.

Traffic calculation formula between exchanges:

$$Tab = Ta \times \frac{Lb}{\sum L - La}$$

where, Tab = distributed traffic from A to B
Ta = all outgoing traffic of A
La = number of subscriber lines of A
Lb = number of subscriber lines of B

Local Traffic Matrix (erl)

	CNT	WST	E10B	ITC#1	ITC#2
CNT		57	50	42	167
WST	57		34	28	114
E10B	50	34		-	-
ITC#1	42	28	-		-
ITC#2	167	114	-	-	

Note: CNT - Central Telephone office
WST - West Telephone office
(Host office of Airport Telephone office)
E10B - Switching Equipment in the former training center
ITC#1 - Local Switching Equipment in the International Telephone Center
ITC#2 - Switching Equipment for Transition of Cellular Telephone Service in International Telephone Center

2) Number of junction circuits

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.

Number of Junction Circuits (CH)

	CNT	WST	E10B	ITC#1	ITC#2
CNT		71	64	55	188
WST	71		46	40	132
E10B	64	46		-	-
ITC#1	55	40	-		-
ITC#2	188	132	-	-	

Note: Erlang's B formula

$$En = \frac{\frac{a^n}{n!}}{1 + \frac{a}{1!} + \frac{a^2}{2!} + \cdots + \frac{a^n}{n!}}$$

where En = less probability

n = number of junction circuits (CH)

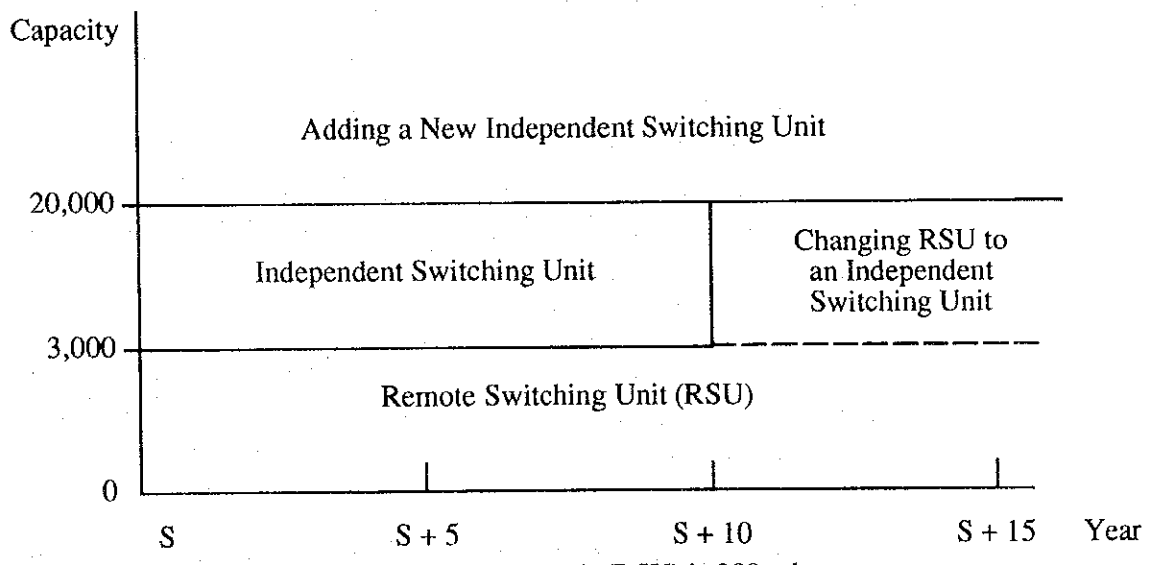
a = traffic (erl)

(5) Design Policy for Applied System

Design policy for the system to be applied in the Project is stated below.

1) Design Policy for Switching System

A switching system to be applied to the Project will be selected in accordance with the selection criteria mentioned in Figure 1.1.



Note: The capability of remote switching unit (RSU) is 300 erl.
Though the average outgoing and incoming calling rate per subscriber is 0.086 erl in this study, the calling rate 0.1 erl is used for the design of RSU equipment.
The reason is that the calling rates in small areas for RSU application have a tendency to become higher than those of ordinary exchange areas and it needs some safety factor.
Therefore the RSU equipment can accommodate 3,000 subscriber's lines.
On the other hand, because the capability of single processor of ordinal exchange is 2,000 erl, this single processor can accommodate 20,000 subscriber's lines.

Figure 1.1 Selection Criteria

The following facilities are included in the switching facilities.

- Exchange
- Simplified network management equipment
- Billing system
- Main distribution frame (MDF)

2) Design Policy for Transmission System

The Synchronous Digital Hierarchy (SDH) system will be introduced to the Project for the following reasons. (Refer to Chapter 7, item 7.2 in FS. Report.)

- 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.

- 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.

The systems to be applied in the Project, two methods i.e., the microwave system and the optical fiber cable system are considered as the transmission medium. By the following reasons, the optical fiber system is selected for the transmission medium of this Project.

- Based on the economical comparison of the construction cost, the optical fiber system is advantageous to the microwave system for the range of distance less than 20 km between a transmission section. The actual distance between exchanges in the Project are only about 7 km.

- Since the optical fiber cable for the system can be installed in the same ducts route constructed for the subscriber cables in the Project, it is possible to reduce its construction cost.

The following facilities are included in the transmission facilities.

- SDH transmission equipment
- Simplified SDH network management equipment
- DDF

3) Design Policy for Outside Plant

The subscriber cable network of this Project is comprised of primary cables, ducts, manholes, cabinets, secondary cables, distribution point boxes (DPs), dropwires, rosettes, house wires and telephone sets as shown in Figure 2.2.

In order to provide the reliable telecommunication services that are economical, easy to maintain and expansible for future with the telecommunication facilities in the objective area, the outside plant design work will be done according to the following design policy. The basic design drawings made by this design policy and the design conditions described in the Feasibility Report, Emergency Project Chapter 3, 3.3.3 are attached in this Chapter, item 2-3-2 .

(a) Application of duct system

Since there are so many pairs of conductors in a primary cable, accidents will inflict damage on a great number of subscribers. The duct system is, therefore, applied to primary cable installation for protection. It is easy to install a new cable for unexpected demand and replacement of the damaged cable by the utilization of a vacant duct.

Therefore, primary cable must be installed into a duct, and the splicing points will be installed in a manhole.

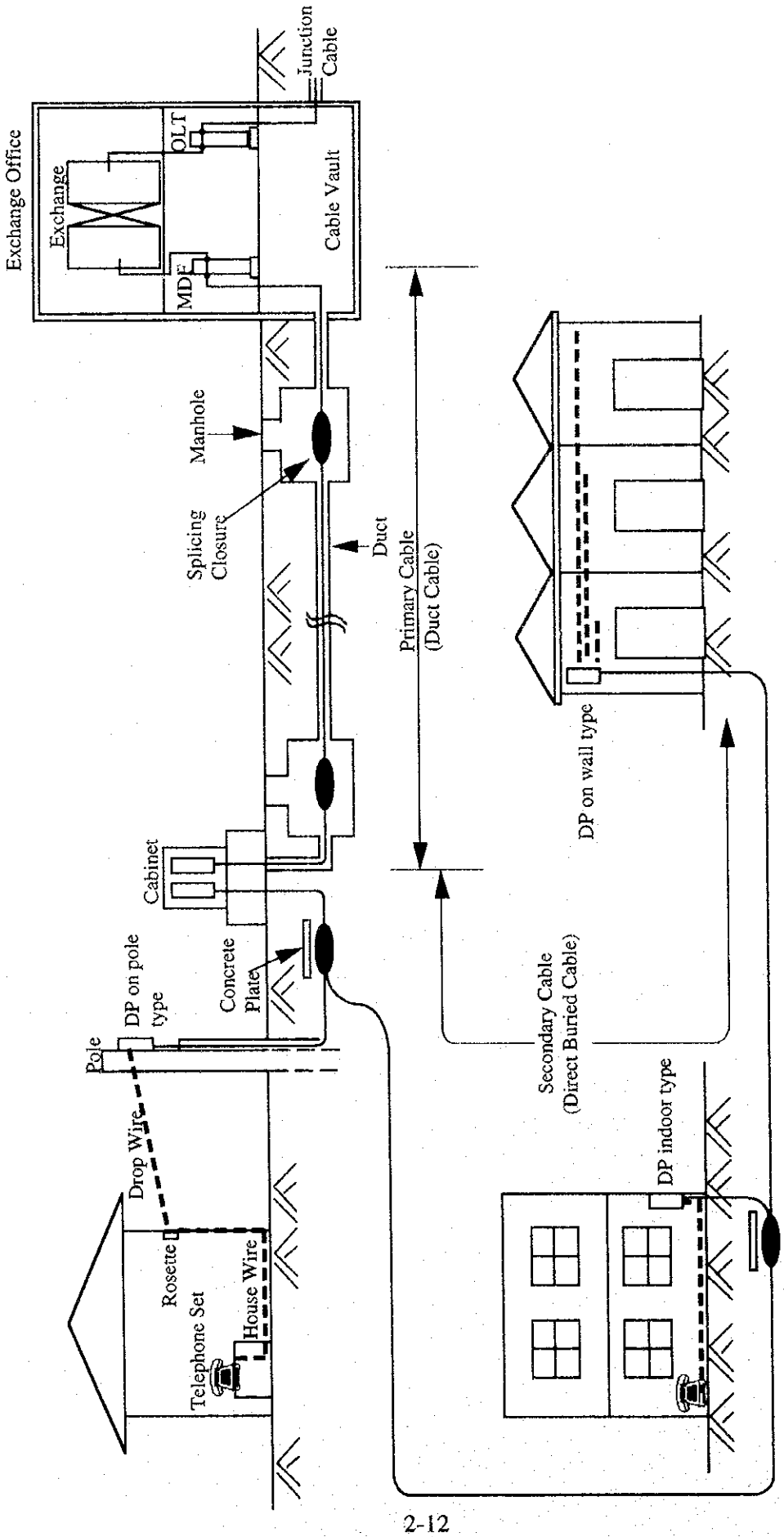


Figure 2.2 Subscriber Cable Network System

(b) Determination of Distribution Block

The distribution block is a unit area to control the telephone demand and subscriber cable networks for effective use and to realize suitable expansion of the telephone facilities. Exchange areas are divided into distribution blocks by using a wide road, a river, railway, etc. as a boundary.
The suitable demand for each distribution block is around 600 based on the forecasted demand in 2007.

(c) Distribution method

A cabinet is installed in a distribution block. A distribution network consists of mainly the primary cable, the secondary cable and the cabinet which connect them. This method is introduced for easy extension of facilities and easy maintenance.

(d) Cable distribution

The primary cable is installed in a duct.
The steel tape armored secondary cable is installed in the soil directly.
The primary cable and secondary cable are jelly filled cable in order to prevent cable trouble from infringement of water and to improve reliability.

(e) Unigauge system

Application of 0.4 mm unigauge system for subscriber cable network in an exchange area is for effectiveness regarding economical network establishment, ease of maintenance and expansion of the network.

(f) Existent outside plant

The existent outside plant such as primary cables, secondary cables, cabinets, poles and DPs are not reused because of poor quality of electrical or physical characteristics.

(g) Junction Cable

The junction cable is installed along the same route as the primary cable and the secondary cable as far as possible. In consideration of the importance of the junction cable network, the junction cable shall be installed under the position of the primary cable or the secondary cable in order for protection from damage by road construction work or other work. In the case of the junction cable installation along the primary cable route, it should be installed separately and in the duct below that of the primary cable.

4) Design Policy for Radio Subscriber System

A radio subscriber system will provide the telecommunications service to the important subscribers located in the surrounding area of Phnom Penh city, so the system should be capable of covering the object area of the feasibility study. The system should have a function of encryption, because the system will be used by the important subscribers. Based on the requirements by the MPTC, the important subscribers have been surveyed by the member of MPTC and the study team, and have been finalized.

The radio subscriber system will provide 117 telephone lines to the important subscribers, and the number of subscriber stations is 52.

(a) System Selection

The following potential three (3) radio subscriber systems can satisfy the above requirements:

- Digital MAS
- Multi-channel Point-to-Point system (Multi-channel P-P system)
- Single channel Point-to-Point system (Single channel P-P system)

The comparison between these systems is summarized in the following table. Based on the comparison, the digital MAS has been selected as a radio subscriber system of the project.

Comparison between Radio Subscriber Systems

Item		Digital MAS	Multi-channel P-P System	Single Channel P-P System
Service		o	o	o
	Designing	Δ	Δ	x
	Procurement	o	o	o
	Construction	o	Δ	x
	Initial Cost	Δ	Δ	Δ
	Cost for Expansion	o	Δ	Δ
	Cost for Terminal	o	o	o
Expandability of System		o	Δ	x
Operation & Maintenance		o	Δ	x
Judgment		o	x	x

Note: o: Good, Δ: Fair, x: No good

(b) Base Station of Digital MAS

The base station of the digital MAS will be established at the Central Telephone Office based on the following reasons:

- The Central Exchange Office is located at the center of the object area.
- Staff for maintenance and operation will be assigned for 24 hours at the Central Telephone Office, so the full-time/centralized supervision and control can be done at the office.
- An antenna tower can be erected effectively on the roof of the new building, so the construction cost of the tower will be reduced.

(c) Subscriber Station of Digital MAS

The locations of the subscriber stations have been selected among the locations of important subscribers' building such as commune office. (Refer to 2-3-1, (1), (b).)

(d) Antenna Tower

The height of an antenna tower is decided to ensure the required clearance factor* (0.6 or more) and to satisfy the system quality stipulated by ITU-R report 380-3.

Note*: The clearance factor is defined as the ratio of the clearance and 1st Fresnel's radius.

a) Base station

The height of the tower at the Central Exchange Office has been calculated to be 50 m above ground. At the Central Exchange Office, a new building will be constructed, so the new 35 m antenna tower can be erected on the roof of the new building. A guyed tower, which is economical has been selected so that the new tower does not significantly affect the structure and strength of the new building.

b) Subscriber station

Height of a tower is also calculated by the above method. The required antenna heights have been calculated to be 15 - 23 m above ground, and the height depends on the location of the subscriber stations.

The possible types of antenna tower which could be considered for the subscriber stations include the following:

- Steel pole: A steel pole is easy to assemble at the site, and is relatively low cost. The installation and mounting of feeder cables and antenna are also easy on the steel pole.
- Concrete pole: A concrete pole is the cheapest antenna pole. However, the weight is considerable, and the maximum length of a concrete pole is in general approximately 15 m. Therefore, a concrete pole is not applicable to the antenna tower of the project. Also, the feeder cable and antenna cannot be installed easily on the concrete pole.
- Tripod tower: The price and construction cost of a tripod tower is high, because considerable manpower for the erection is required and the foundation of the tower must be large.

From the above comparison, a steel pole is the most suitable as the antenna tower for the project.

5) Design Policy for Power Supply System

(a) Power Supply System for Exchange Office

Under this project, power supply systems of high reliability are to be installed at the Exchange Offices. The type and capacity of the systems for each Exchange Office are selected based on the future introduction of telecommunications systems and the other miscellaneous facilities.

(b) Power Supply System at Subscriber Station

To maintain stable telecommunications services, the following uninterruptible power supply systems are selected for the subscriber stations:

a) Rectifier and Batteries

At sites where AC power supply is available, rectifiers and batteries are to be provided for back-up purpose. The AC commercial power in Cambodia has frequent power interruption and the outage duration is long, i.e., the outage ratio is approximately 10% - 95% and may last more than one day. Considering the long duration of outage of the power supply, the back-up time of the batteries is designed to be 48 hours.

b) Solar Power System

At sites where AC power supply is not available, a solar power system is to be used. Considering the average hours of sunshine (average 7.7 hours/day through a year) and average continuous non-sunshine duration (approximately 2 days), the back-up time of the batteries is designed to be 48 hours.

c) Portable Engine Generator

For the back-up of the power supply systems, three (3) portable engine generators are to be prepared and stored at the Central Exchange Office. The number of portable engine generators is calculated based on the following: 1) Two (2) subscriber stations which are located in the Peninsula and south of the object area are isolated or difficult to access during rainy season. Therefore, two (2) portable engine generators are expected to be used mainly at these sites during rainy season. In addition, one (1) portable engine generator is required for back-up of the other subscriber stations. 2) These portable engine generators will be used for the installation and testing of the subscriber station facilities of the digital MAS.

2-3-2 Basic Design (Telecommunications Facilities)

Main facilities in respective system to be provided by this Project are stated below;

(1) Switching Facilities

The switching facilities will be supplied as in shown below.

Switching Capacity

Telephone Office	Type	Line Unit	Remarks
Central	LS	10,000 lines	
West	LS	6,000 lines	Host exchange of Airport RSU
Airport	RSU	800 lines	

(2) Provisioning Plan for Transmission Facilities

The transmission facilities will be supplied as in the following Table.

Transmission Capacity

Telephone Office Name	System	Remarks
Central ~ West	155 Mbps (1+ 1)	Optical Fiber Cable
Central ~ International	155 Mbps (1 + 1)	Optical Fiber Cable
Central ~ E10B	2 Mbps	Tie Cable
West ~ Airport	155 Mbps (1 + 1)	Optical Fiber Cable

(3) Outside Plant Facilities

Work volume in each telephone office is shown below.

Telephone Office	Items	Work
Central office	Primary Cable	2400P x 5 Cables
		Cable length 12 km
		62 Manholes
		Duct length 10 km
		31 Cabinets
	Secondary Cable	Cable length 144 km
		1200 Distribution Point Boxes
West office	Primary Cable	2400P x 2, 1600P x 1, 400P x 1 Cable
		Cable length 8 km
		41 Manholes
		Duct length 7 km
		16 Cabinets
	Secondary Cable	Cable length 87 km
		600 Distribution Point Boxes
Airport office	Primary Cable	800P x 1 Cable
		Cable length 2 km
		11 Manholes
		Duct length 2 km
		2 Cabinets
	Secondary Cable	Cable length 8 km
		40 Distribution Point Boxes
Junction Cable		Conduit Cable length 8 km
		Direct Buried Cable length 4 km

Note: The quantities of each office in this table are the result of design and calculation based on this report 2-3-1, (5), (c) "Design policy for Outside Plant".

Furthermore, in order to calculate all quantities of the second cable item as the first step, the detail design and calculation are made on the selected 5 blocks, and then the estimation is made for all quantities of the second cable item according to the areas and telephone demands of the other blocks by using the above calculated results.

(4) Power Supply Facilities

The following power supply facilities will be installed.

Capacity of Power Supply Facilities

Telephone Office Name	Power Supply System	Capacity
Central	AC-220 V Uninterruptible Power Supply	20 kVA
	DC-48 V Uninterruptible Power Supply	800 A
	Engine generator	400 kVA x 2 sets
West	AC-220 V Uninterruptible Power Supply	1 kVA
	DC-48 V Uninterruptible Power Supply	100 A
	Engine generator	90 kVA x 2 sets
Airport	AC-220 V Uninterruptible Power Supply	1 kVA
	DC-48 V Uninterruptible Power Supply	200 A
	Engine generator	50 kVA x 2 sets
Subscriber Station	Rectifier/Batteries system	37 sub. stations
	Solar power system	15 sub. stations

(5) Digital MAS (Radio Subscriber System)

The following equipment and facilities will be installed for the radio subscriber system.

Capacity of Radio Subscriber System

Telephone Office Name	Power Supply System	Capacity
Base station	Tower for Base station	Guyed tripod angle tower 35 m x 1 (in Central office)
	Omni-directional antenna	1 antenna installed in Central office
	Transmitter/Receiver Equipment	Capacity for 117 subs and more
Subscriber station	Tower for Sub. station	Steel pole (15 ~ 23 m) x 52
	Directional antenna	52 locations
	Radio Equipment	Outdoor type x 52

(6) Spare Parts

The spare parts provided for this Project are shown in the table below. The spare parts of equipment for 2 years are expendable supplies and spare packages considering failure factors of packages. However, the important packages of the latter are provided regardless of the failure factors. The spare parts of the cables for 2 years are provided with the consideration of the initial trouble, the hour by hour inferiority, the failure by external accident and the change of pole installation spot.

List of Spare Parts

Spare Parts	Quantity
Spares for Digital Exchange Equipment	1 set
Spares for Digital Transmission Equipment	1 set
Spares for Power Supply System	1 set
Spares for Radio Subscriber System	1 set
Optical Fiber Cable	1 set
Duct Cable	1 set
Direct Buried Cable	1 set

(7) Vehicles for maintenance

Purposes	Remarks
Maintenance for Switching Transmission and Radio facilities for 3 telephone offices	2 Wagon type, 1 4 Wheel driven car
Maintenance for OSP facilities for 3 telephone offices	6 Wagon type, 2 4 Wheel driven cars

(8) Basic Design Drawings for Outside Plant

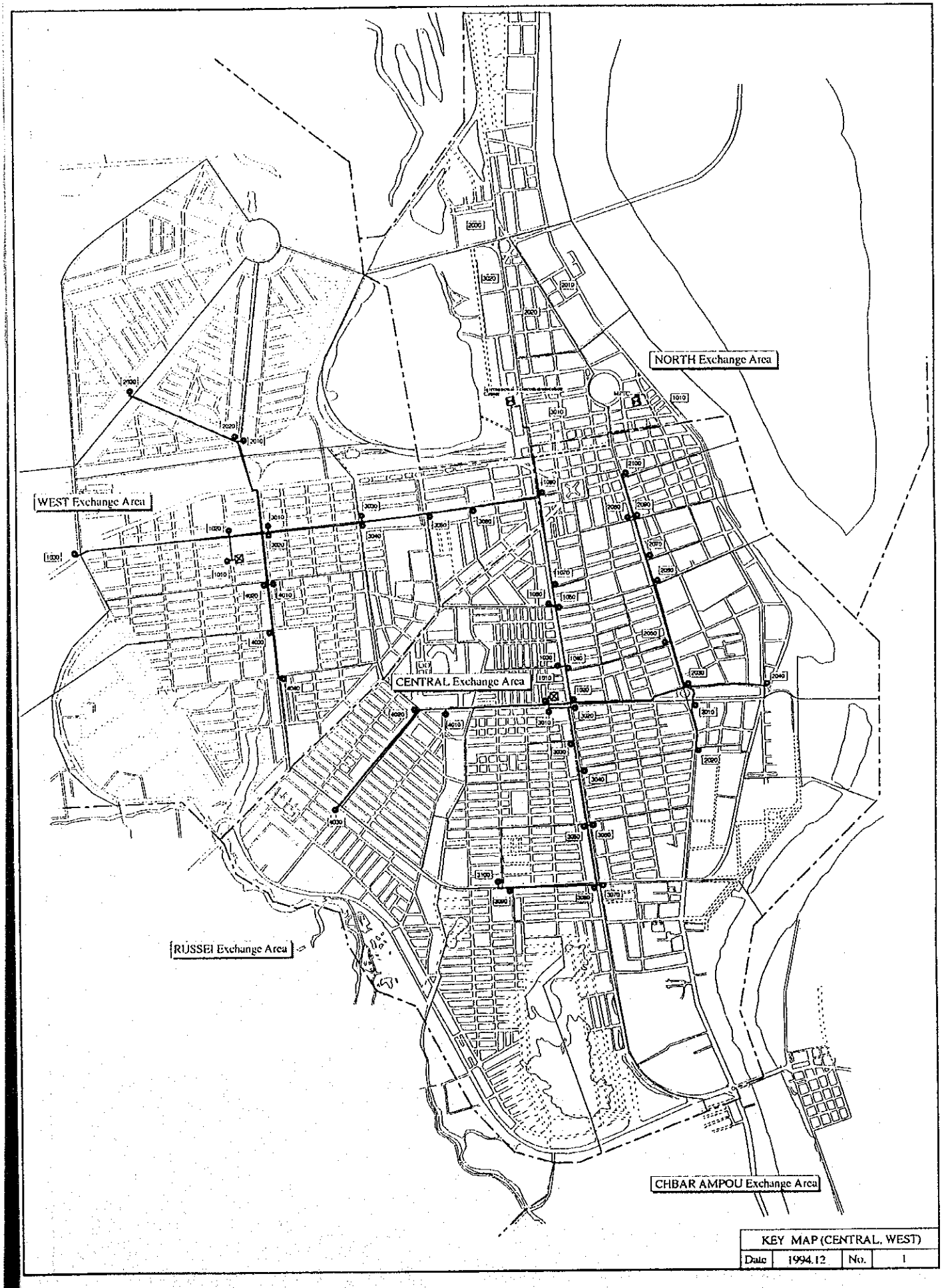
The following basic design drawings are given on the following pages.

No. 1	Key Map of Primary Cable for Central and West Exchange
No. 2	Key Map of Primary Cable for Airport Exchange
No. 3	Primary Cable Diagram for Central Exchange
No. 4	Primary Cable Diagram for West Exchange
No. 5	Primary Cable Diagram for Airport Exchange
No. 6	Duct Diagram for Central Exchange

No. 7	Duct Diagram for West Exchange
No. 8	Duct Diagram for Airport Exchange
No. 9	Key Map of Junction Cable
No. 10	Junction Cable Diagram
No. 11 ~ 16	Secondary Cable Diagram

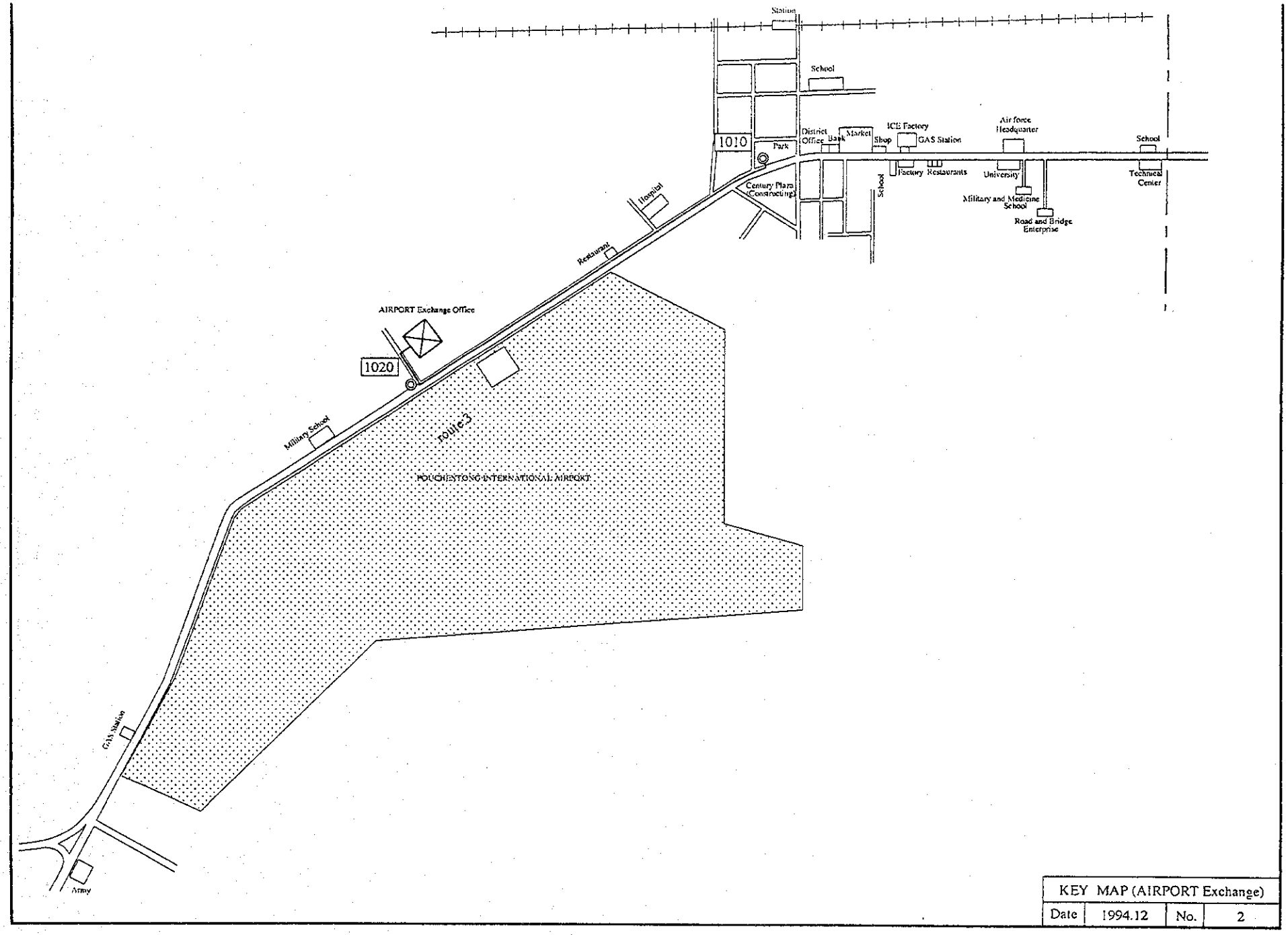
(9) Basic Design Data for Digital MAS

1. Summary of Important Subscribers
2. Location of Subscriber stations and Telephone offices.

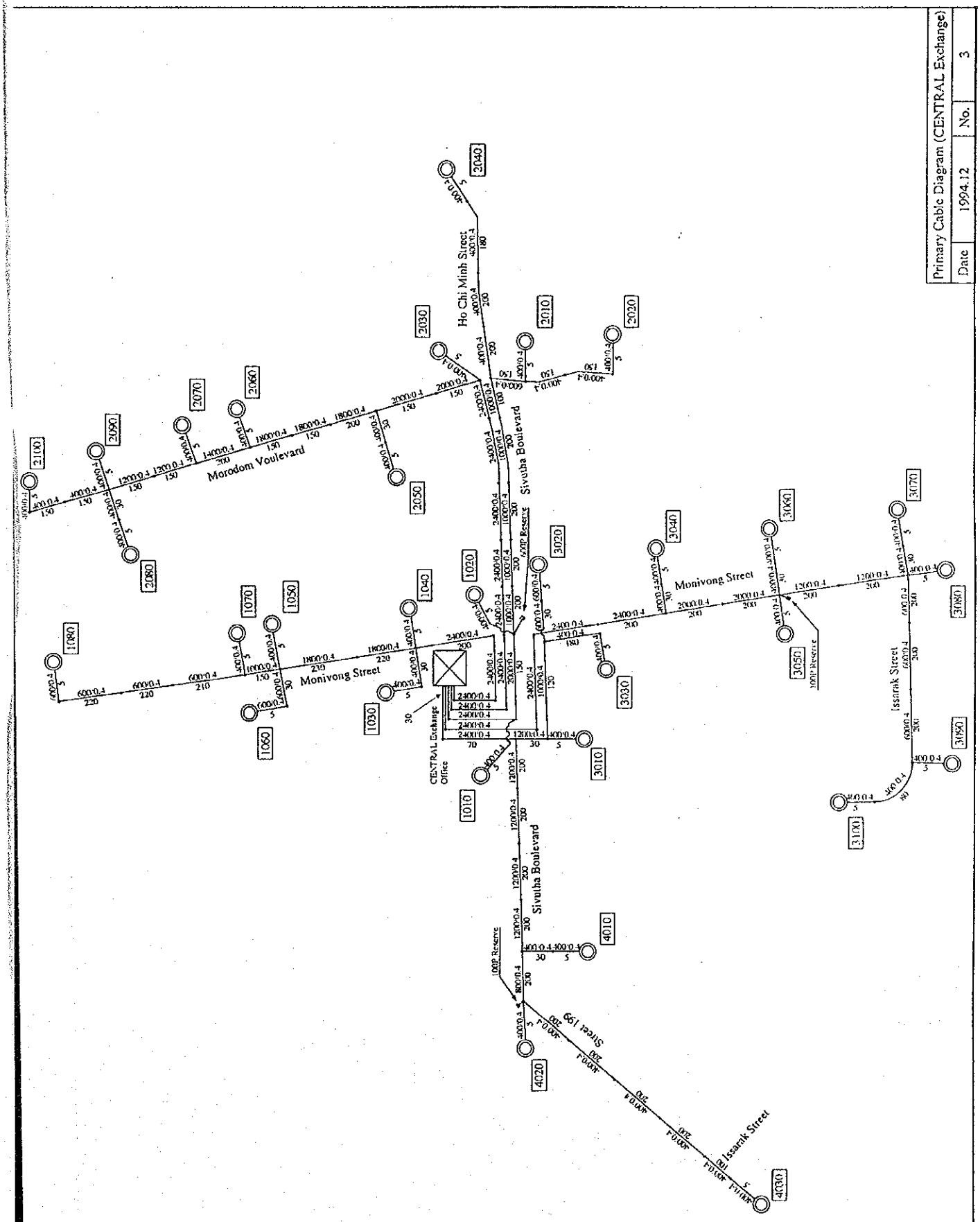


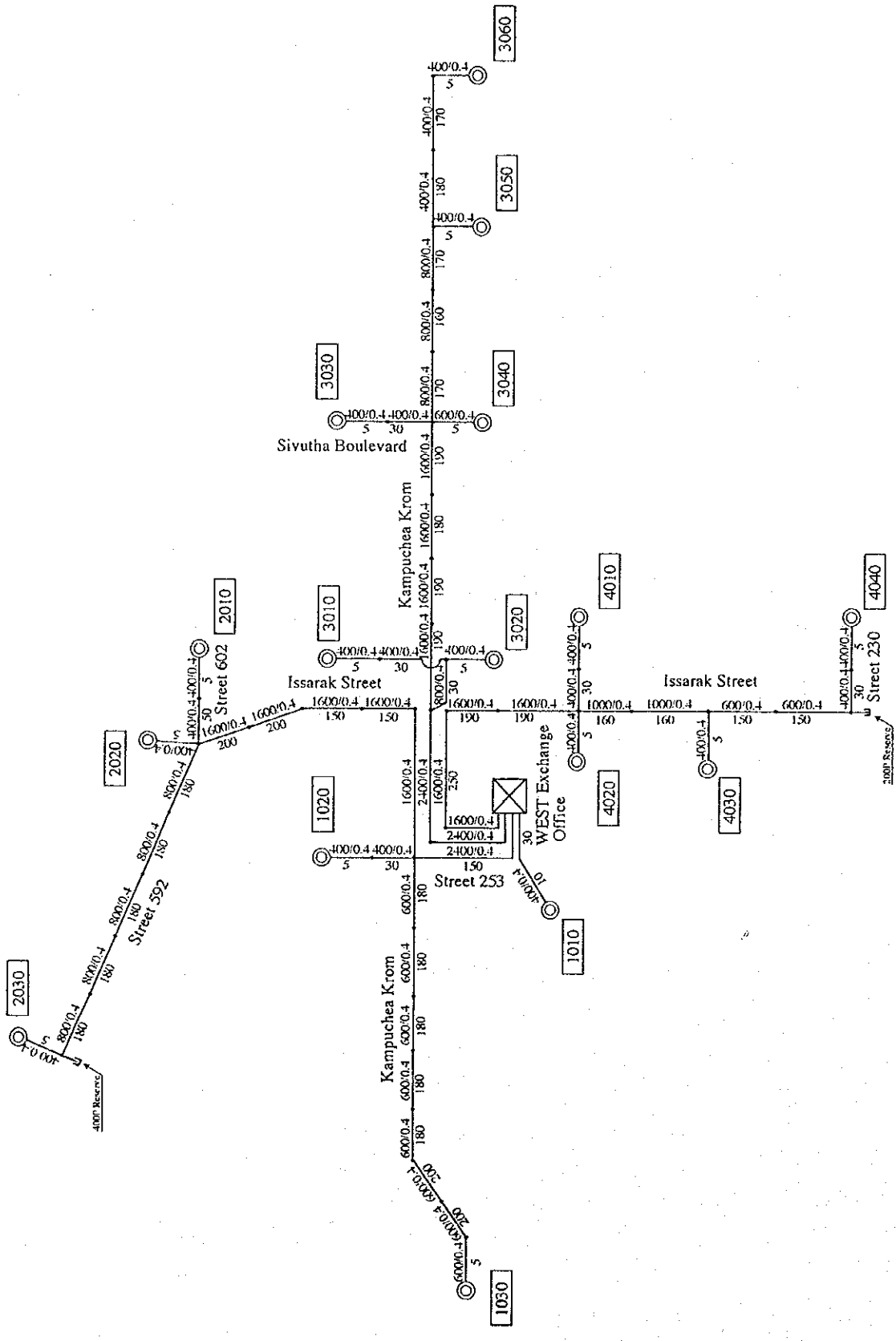
KEY MAP (CENTRAL, WEST)

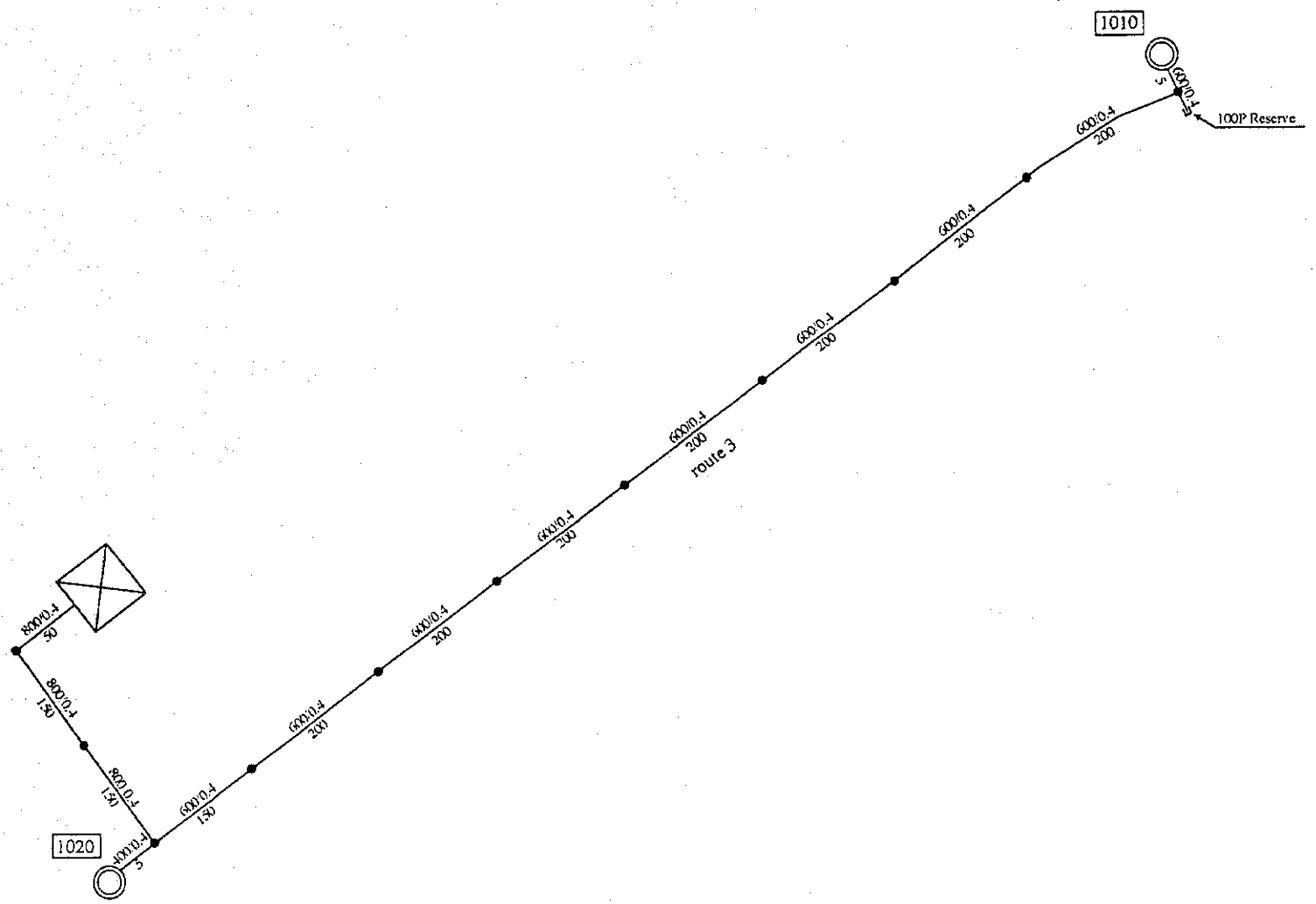
Date	1994.12	No.	1



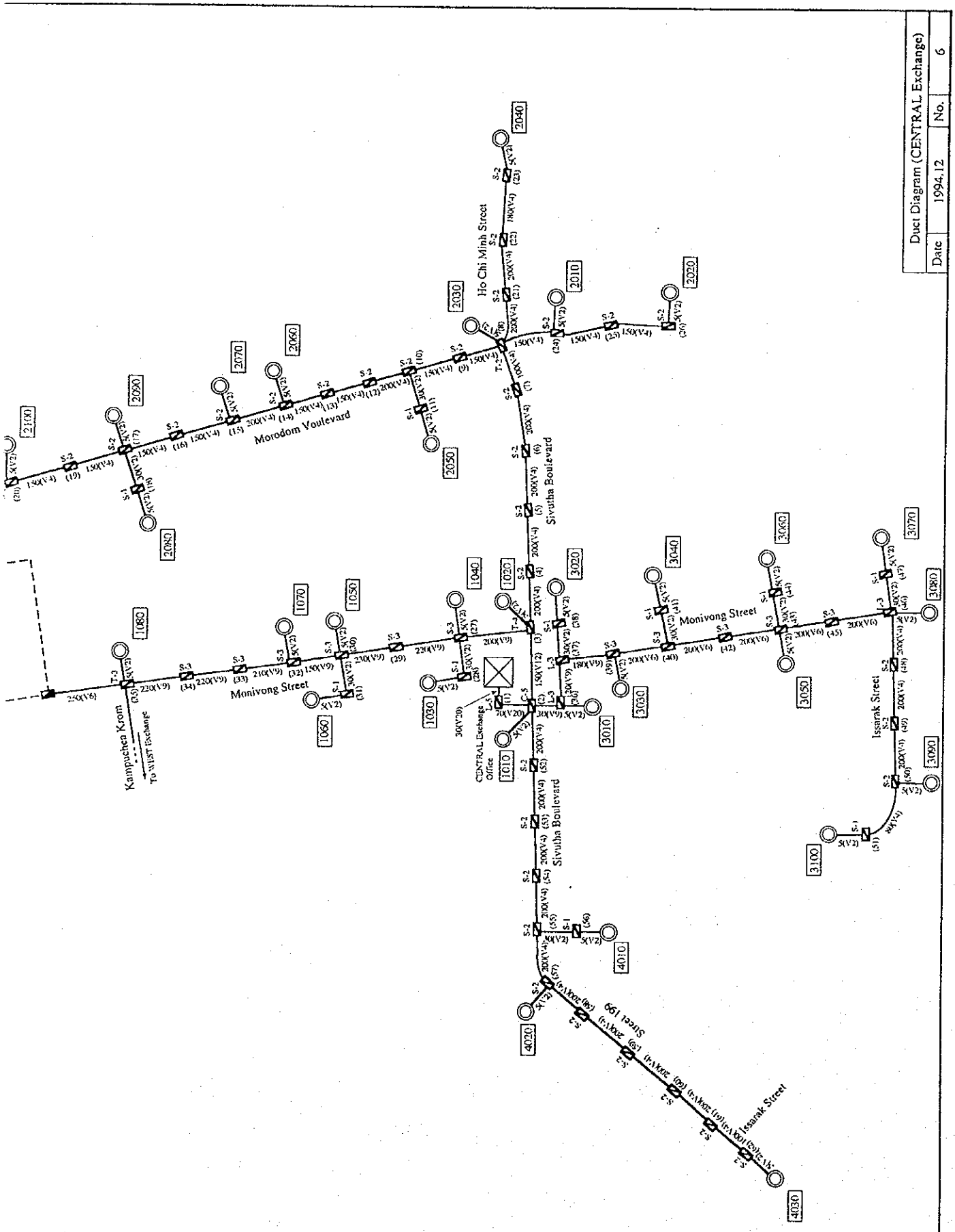
KEY MAP (AIRPORT Exchange)			
Date	1994.12	No.	2

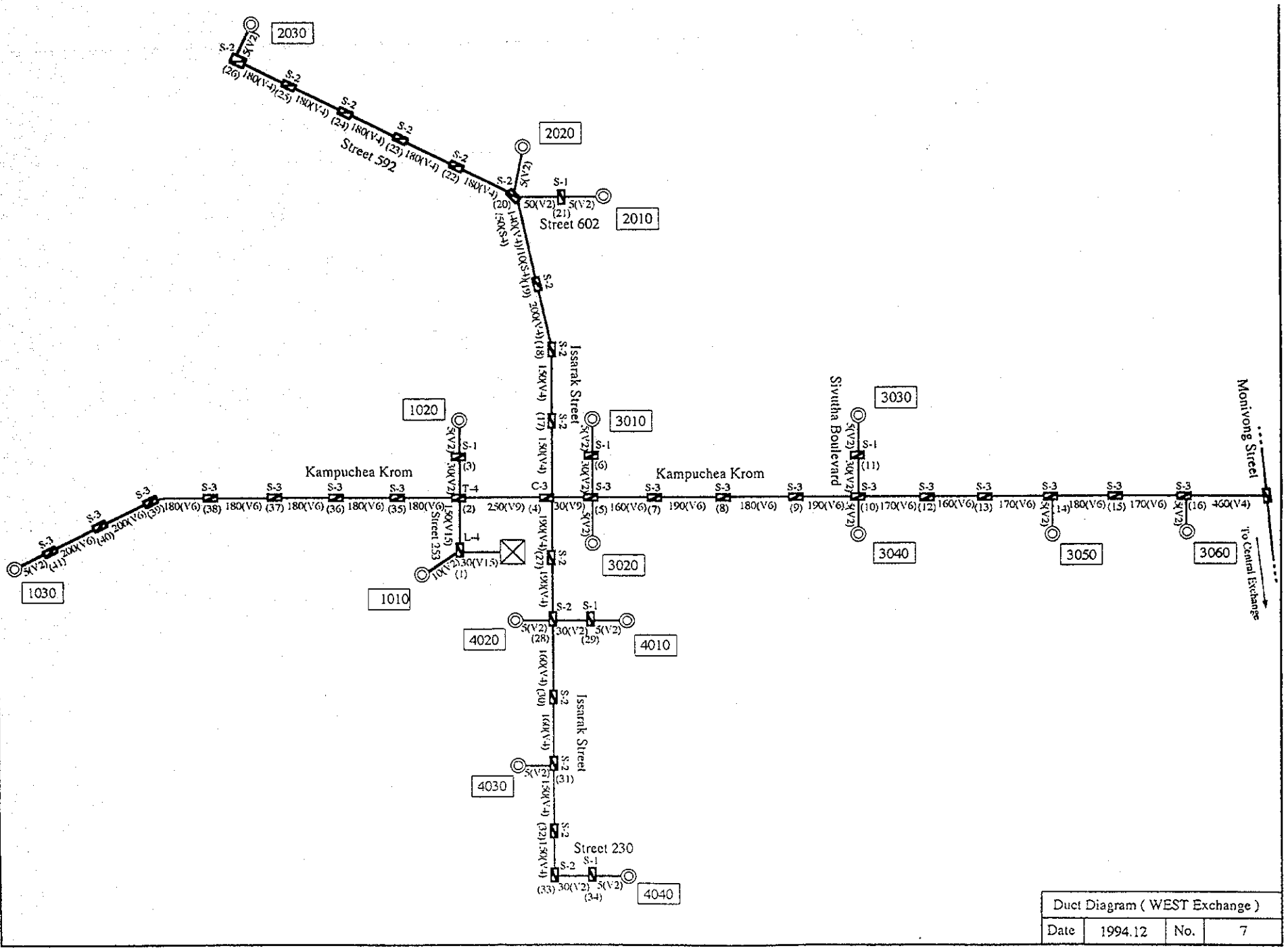

Primary Cable Diagram (CENTRAL Exchange)
Date
1994.12
No.
3
Ho Chi Minh Street
Sivutha Boulevard
Morodom Voulevard
Monivong Street
Monivong Street
Issarak Street
Sivutha Boulevard
Street 199
Issarak Street
CENTRAL Exchange Office
1000 Reserve
600 Reserve
1000 Reserve
1000 Reserve


Primary Cable Diagram (WEST Exchange)
Date 1994.12 No. 4
3060
3050
3040
3030
3020
3010
2010
2020
2030
4010
4020
4030
4040
1010
1020
1030
Sivutha Boulevard
Kampuchea Krom
Issarak Street
Street 602
Street 592
Street 253
Street 230
WEST Exchange Office
Kampuchea Krom
Issarak Street
400/0.4
600/0.4
800/0.4
1000/0.4
1600/0.4
2400/0.4



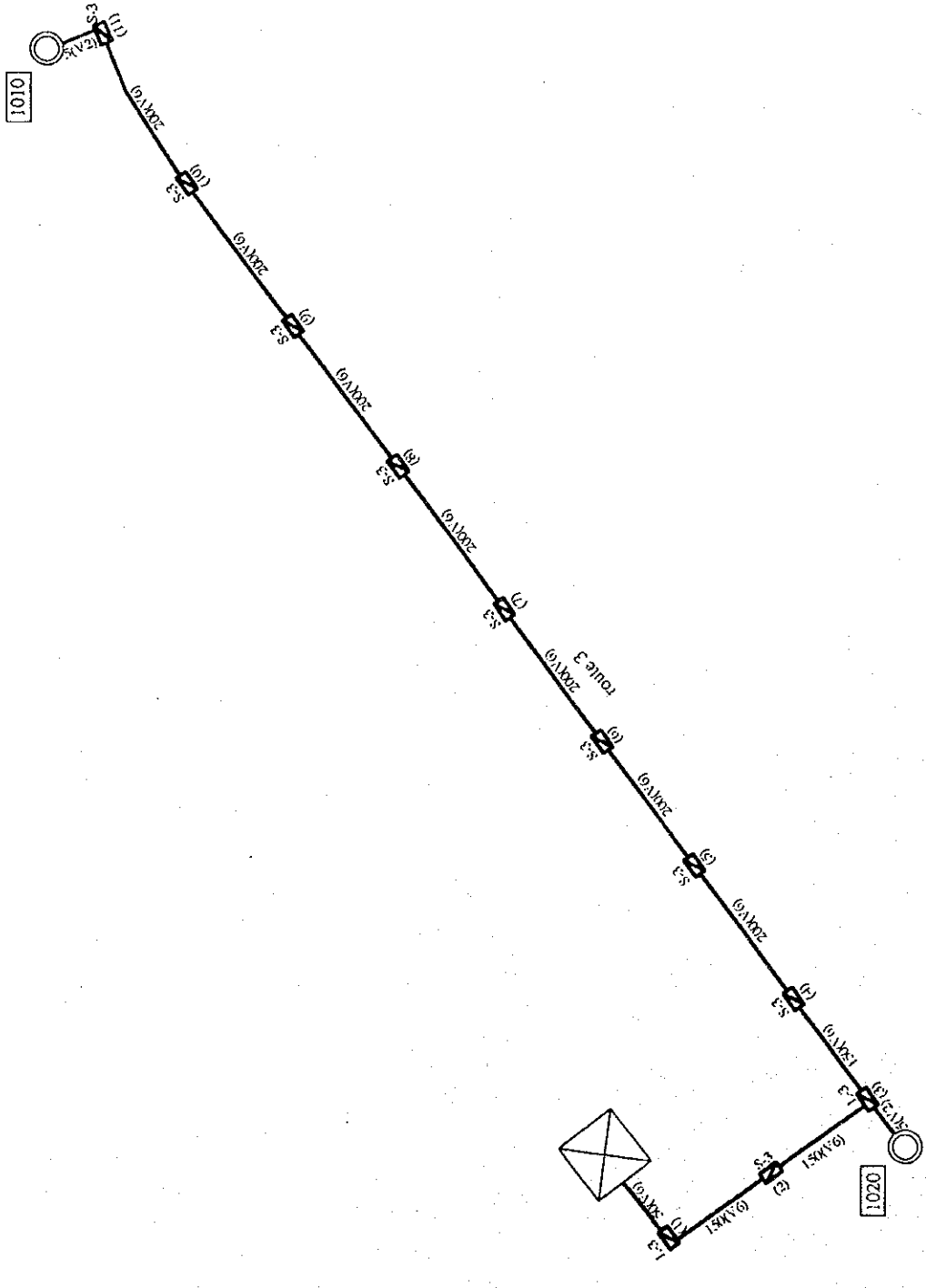
Primary Cable Diagram (AIRPORT Exchange)			
Date	1994.12	No.	5


Duct Diagram (CENTRAL Exchange)
Date 1994.12
No. 6
Ho Chi Minh Street
Sivutha Boulevard
Monivong Street
Monodom Voulevard
Kampuchea Krom
To WEST Exchange
CENTRAL Exchange Office
Issarak Street
Street 199

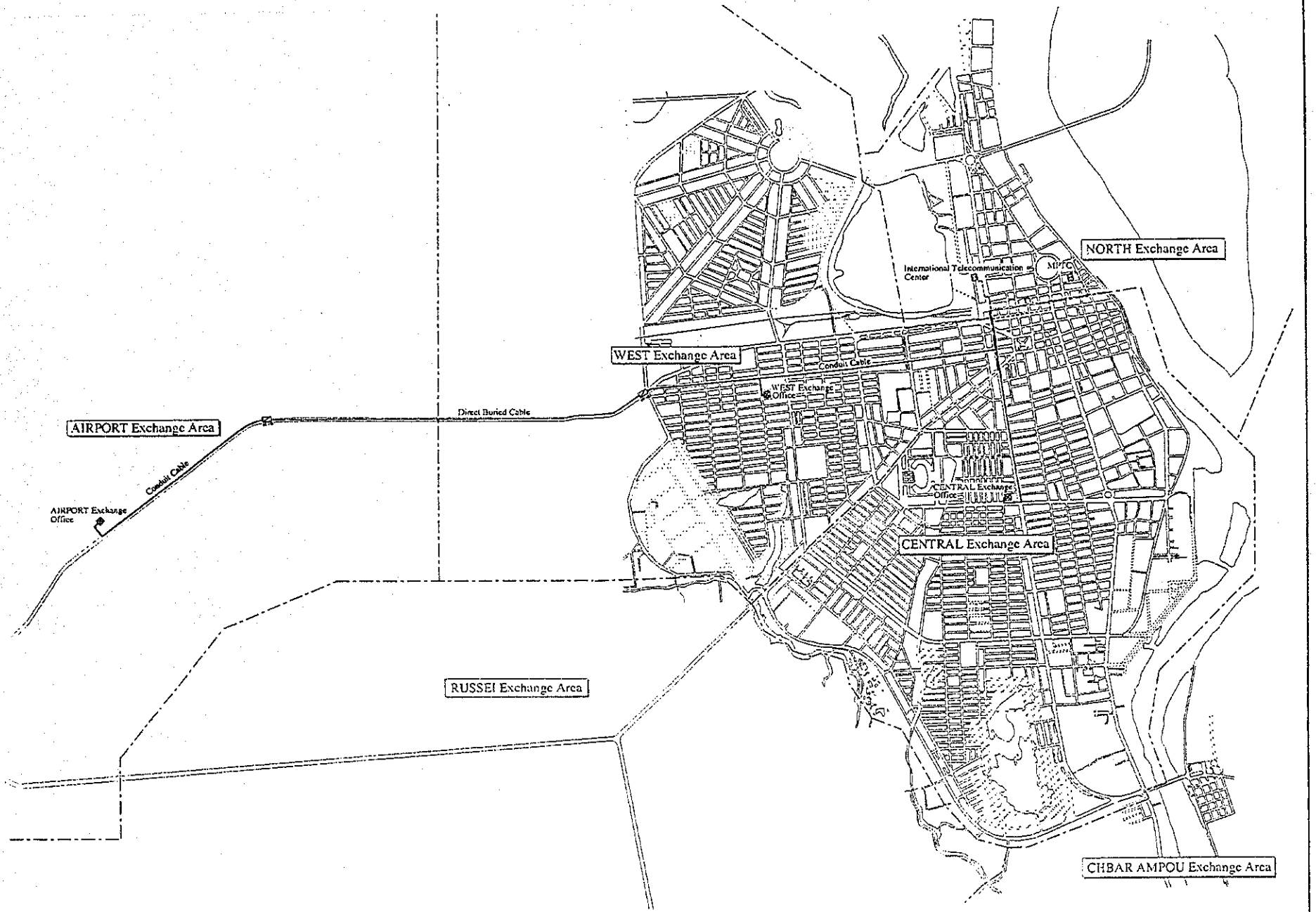


Duct Diagram (WEST Exchange)

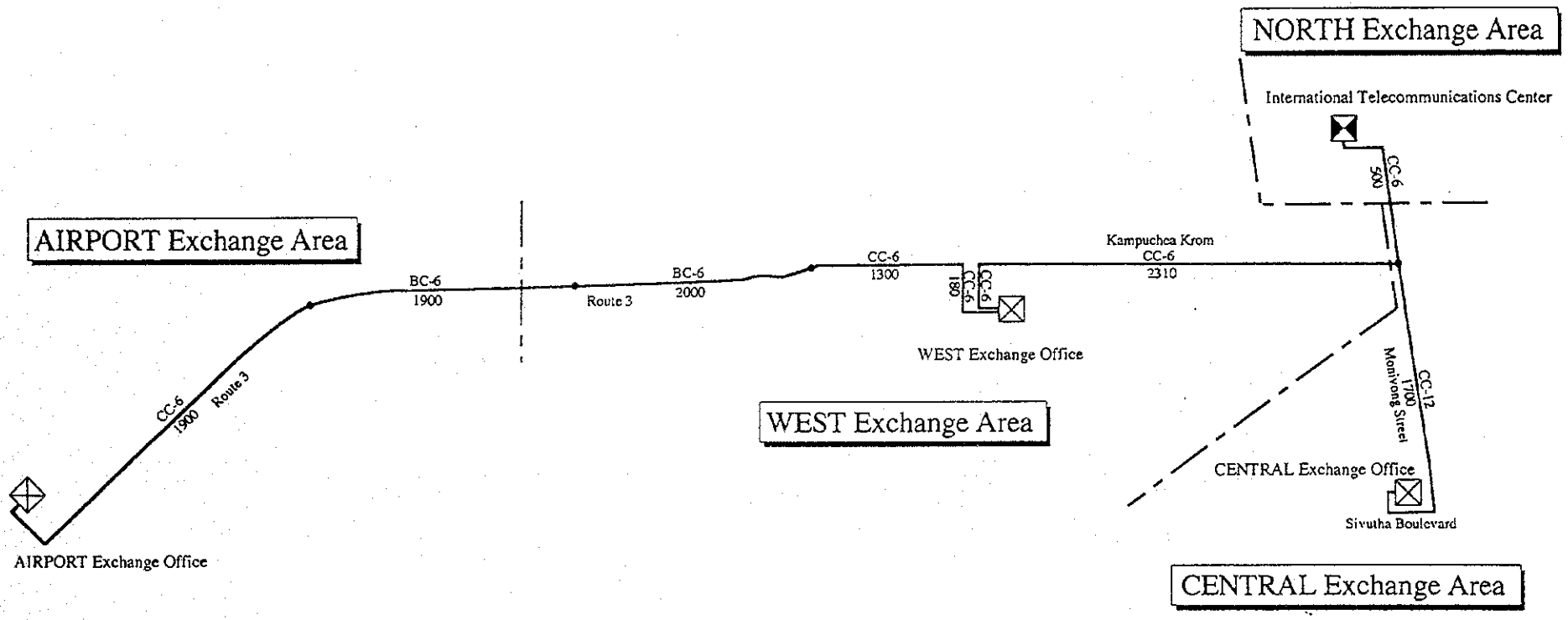
Date	1994.12	No.	7



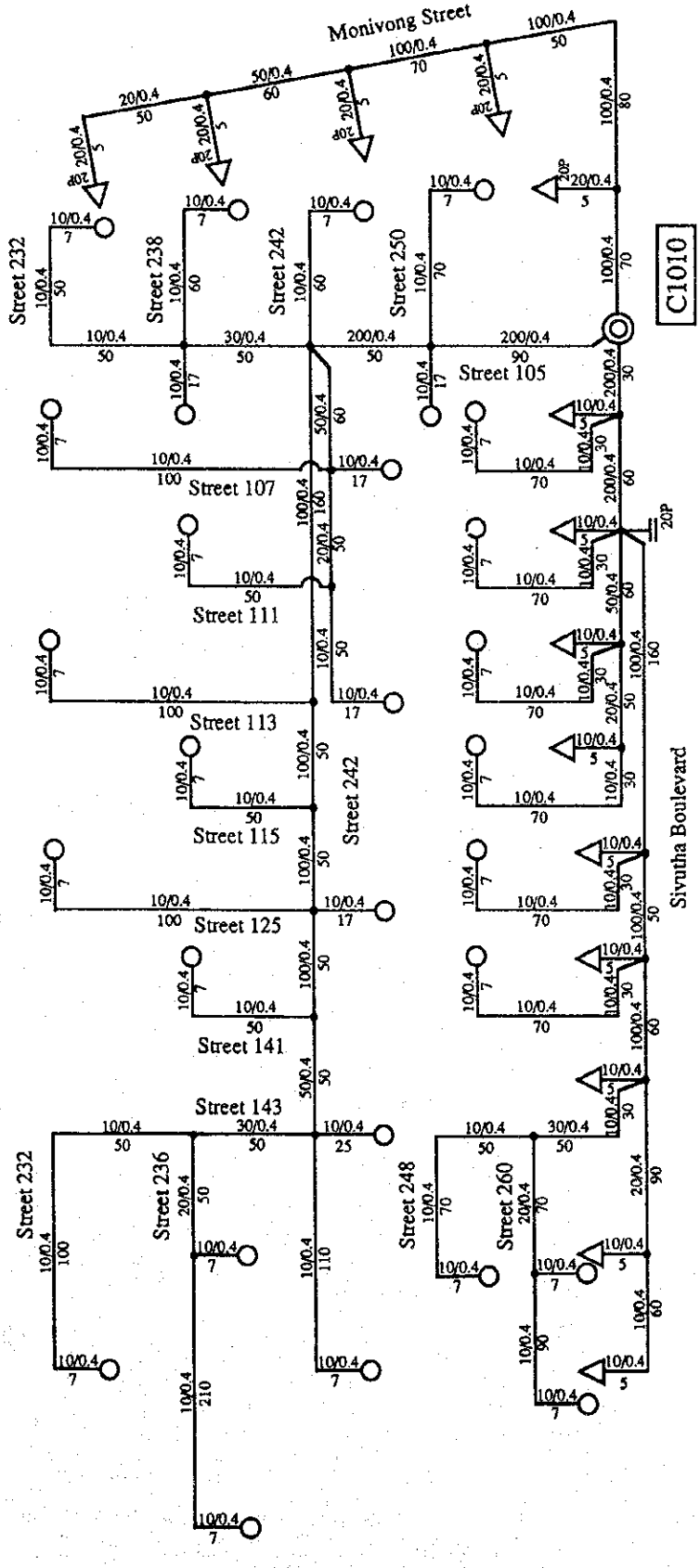
Duct Diagram (AIRPORT Exchange)			
Date	1994.12	No.	8



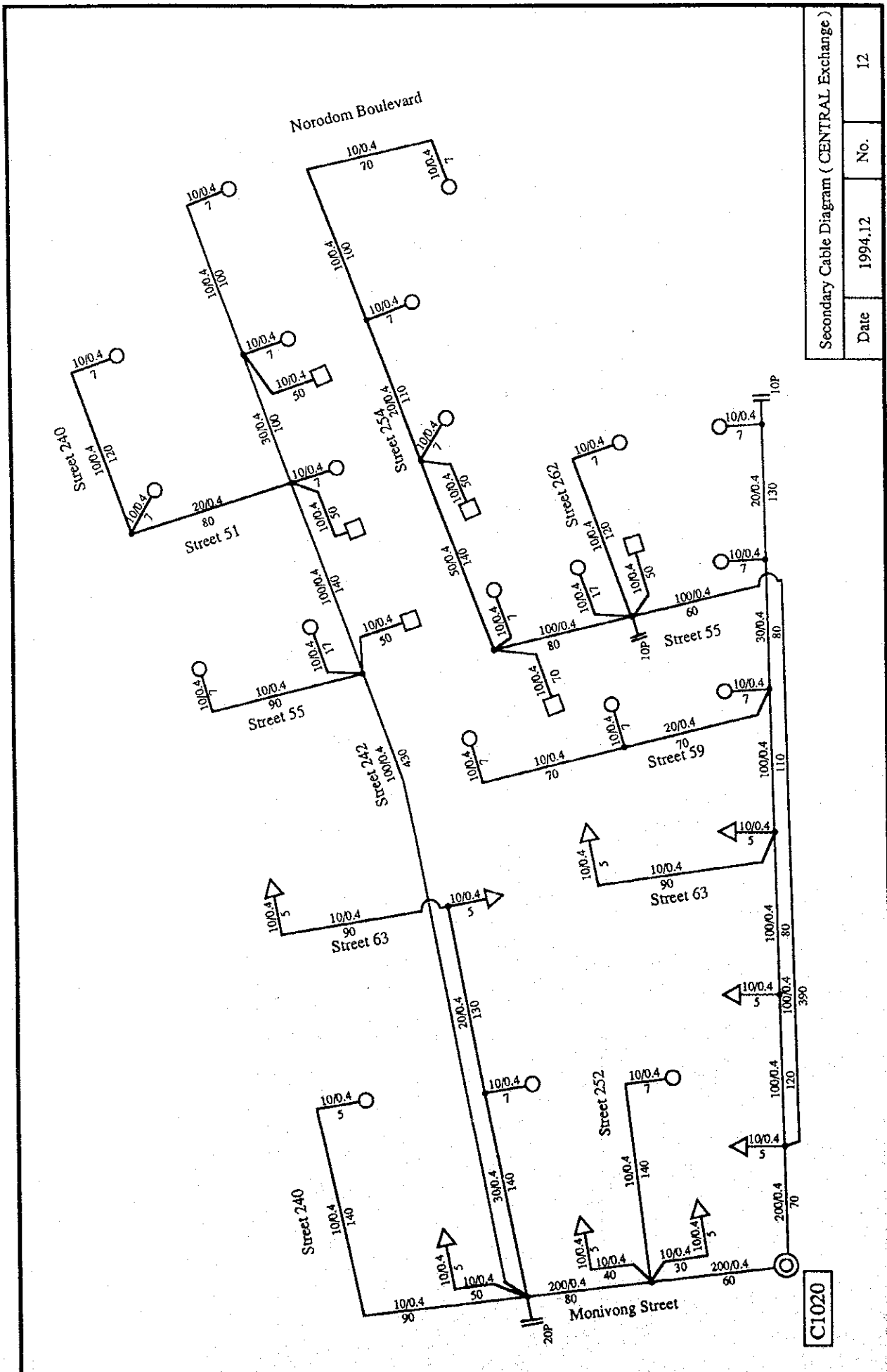
KEY MAP (Junction Cable)			
Date	1994.12	No.	9

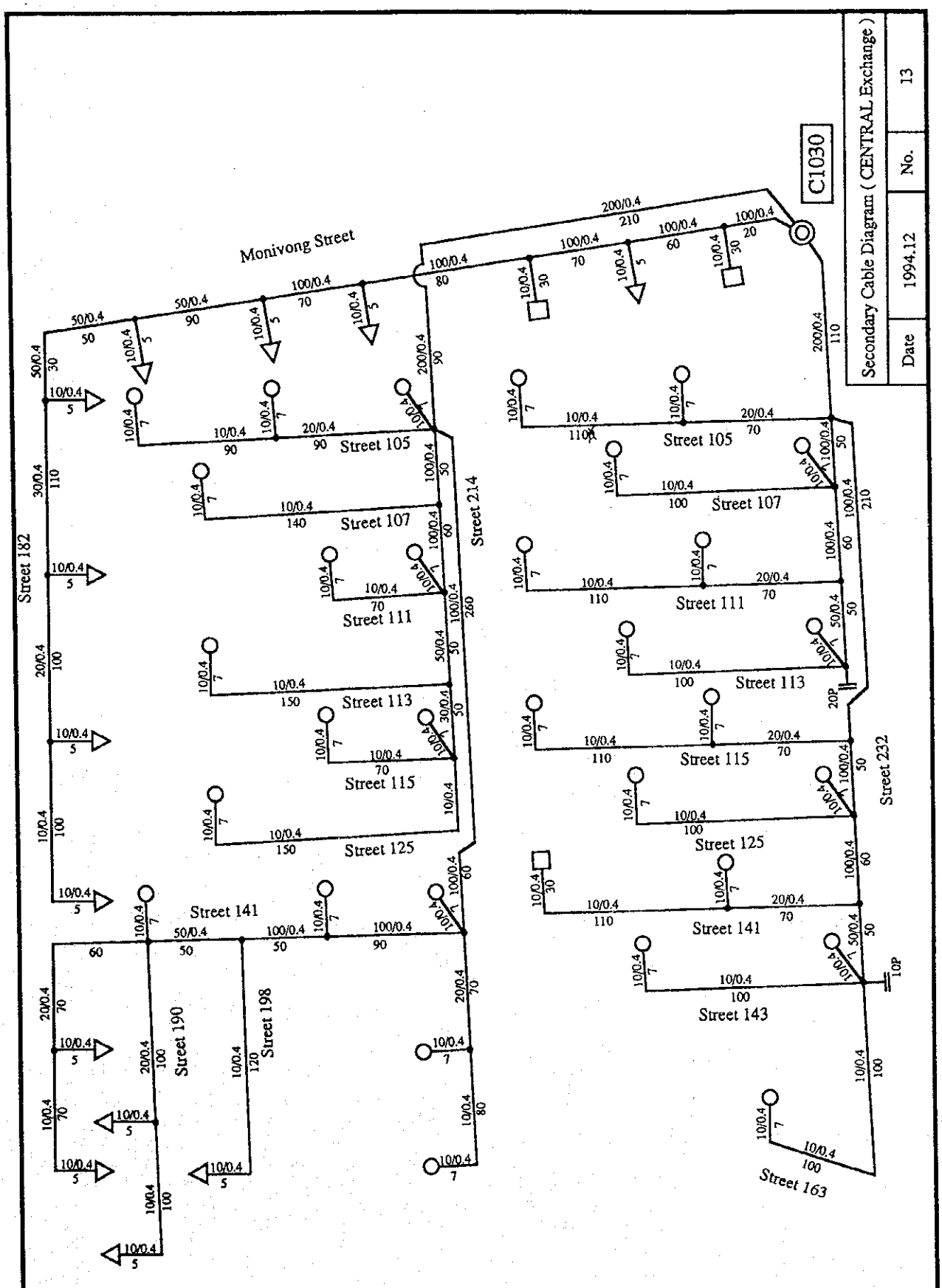


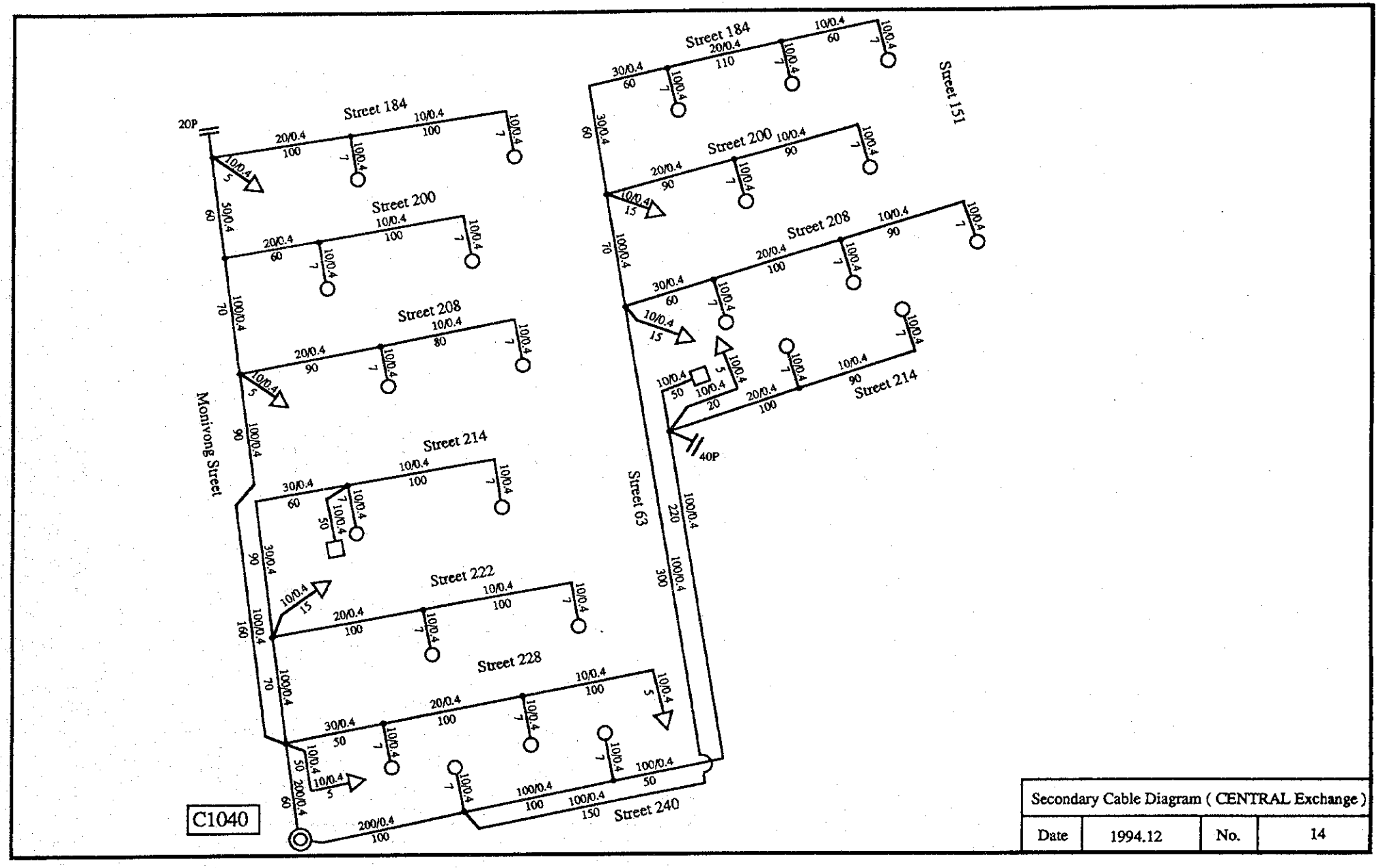
Junction Cable Diagram			
Date	1994.12	No.	10



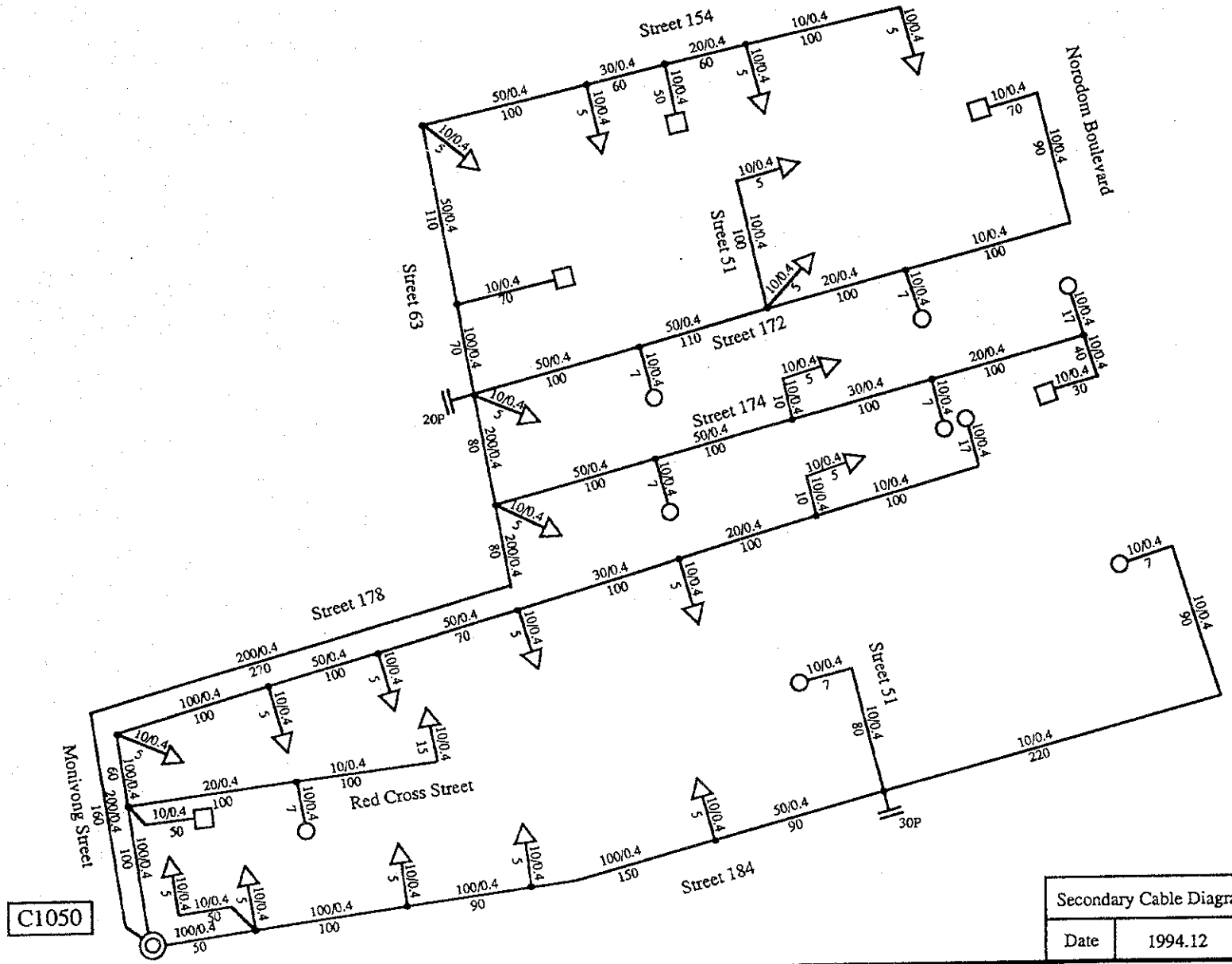
Secondary Cable Diagram (CENTRAL Exchange)		
Date	1994.12	No. 11


Secondary Cable Diagram (CENTRAL Exchange)
Date
1994.12
No.
12
Norodom Boulevard
Street 240
Street 51
Street 254
Street 262
Street 55
Street 59
Street 242
Street 63
Street 252
Monivong Street
C1020

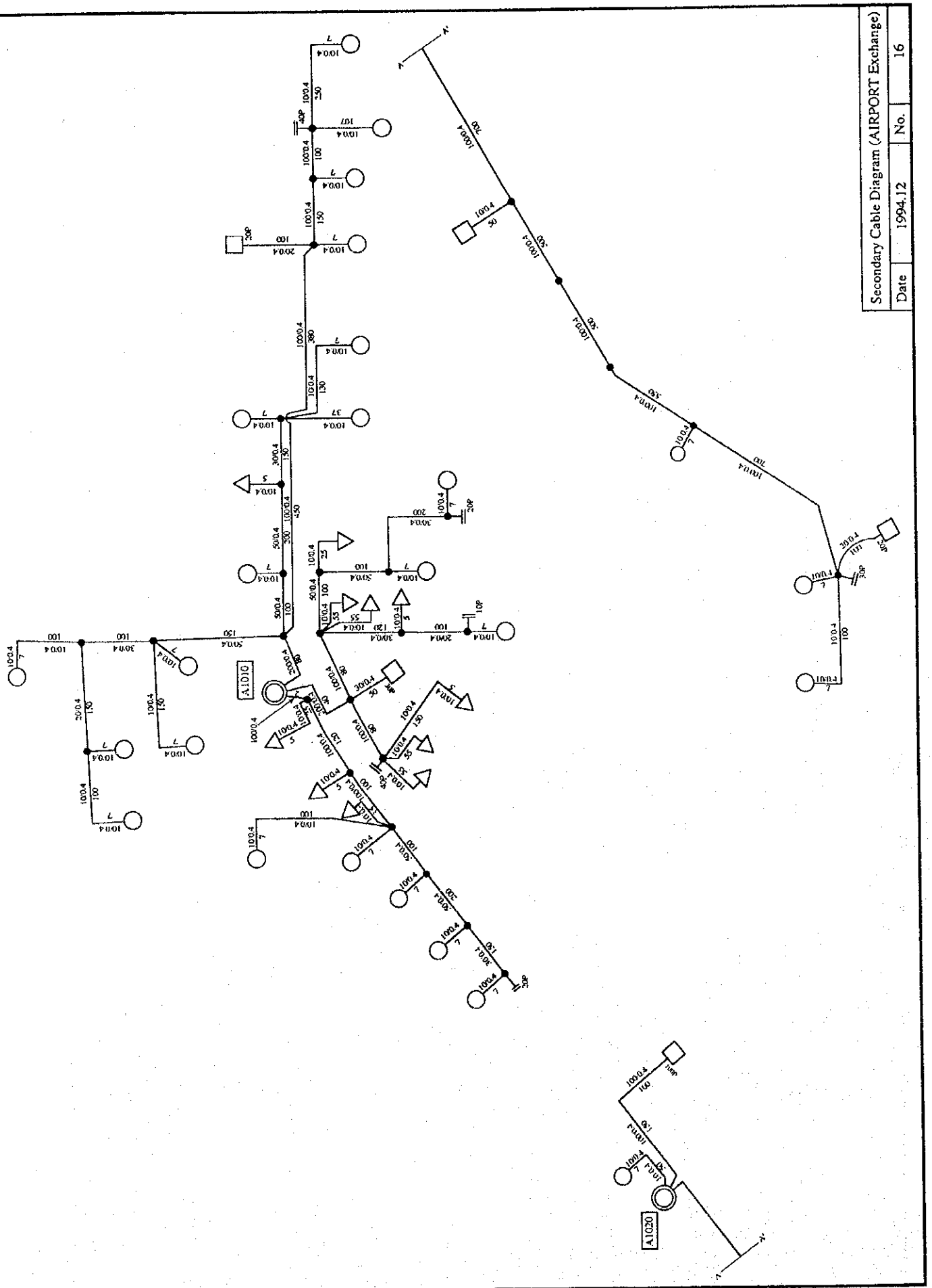

Secondary Cable Diagram (CENTRAL Exchange)
No. 13
Date 1994.12
C1030
Monivong Street
Street 182
Street 214
Street 232
Street 105
Street 107
Street 111
Street 113
Street 115
Street 125
Street 141
Street 143
Street 163
Street 190
Street 198



Secondary Cable Diagram (CENTRAL Exchange)			
Date	1994.12	No.	14



Secondary Cable Diagram (CENTRAL Exchange)			
Date	1994.12	No.	15


Secondary Cable Diagram (AIRPORT Exchange)
Date
1994.12
No.
16
A1010
A1020

Summary of Important Subscribers

Name of District	Category of Important Subscriber	No. of Important Subscriber	Total No. of Important Subscriber	Remarks
Dangkor District	Administrative Office	14	52	
	Police Station	14		
	Hospital / Clinic	13		
	School	7		
	Others	4		
Rossey Keo District	Administrative Office	9	31	
	Police Station	7		
	Hospital / Clinic	6		
	School	4		
	Others	5		
Meanchey District	Administrative Office	9	27	
	Police Station	8		
	Hospital / Clinic	3		
	School	4		
	Others	3		
Por Nhea Loeu District	Administrative Office	2	7	
	Police Station	2		
	Hospital / Clinic	1		
	School	2		
Total	Administrative Office	34	117	
	Police Station	31		
	Hospital / Clinic	23		
	School	17		
	Others	12		

Summary of Subscriber Stations

Present Conditions of Power Supply at Subscriber Stations

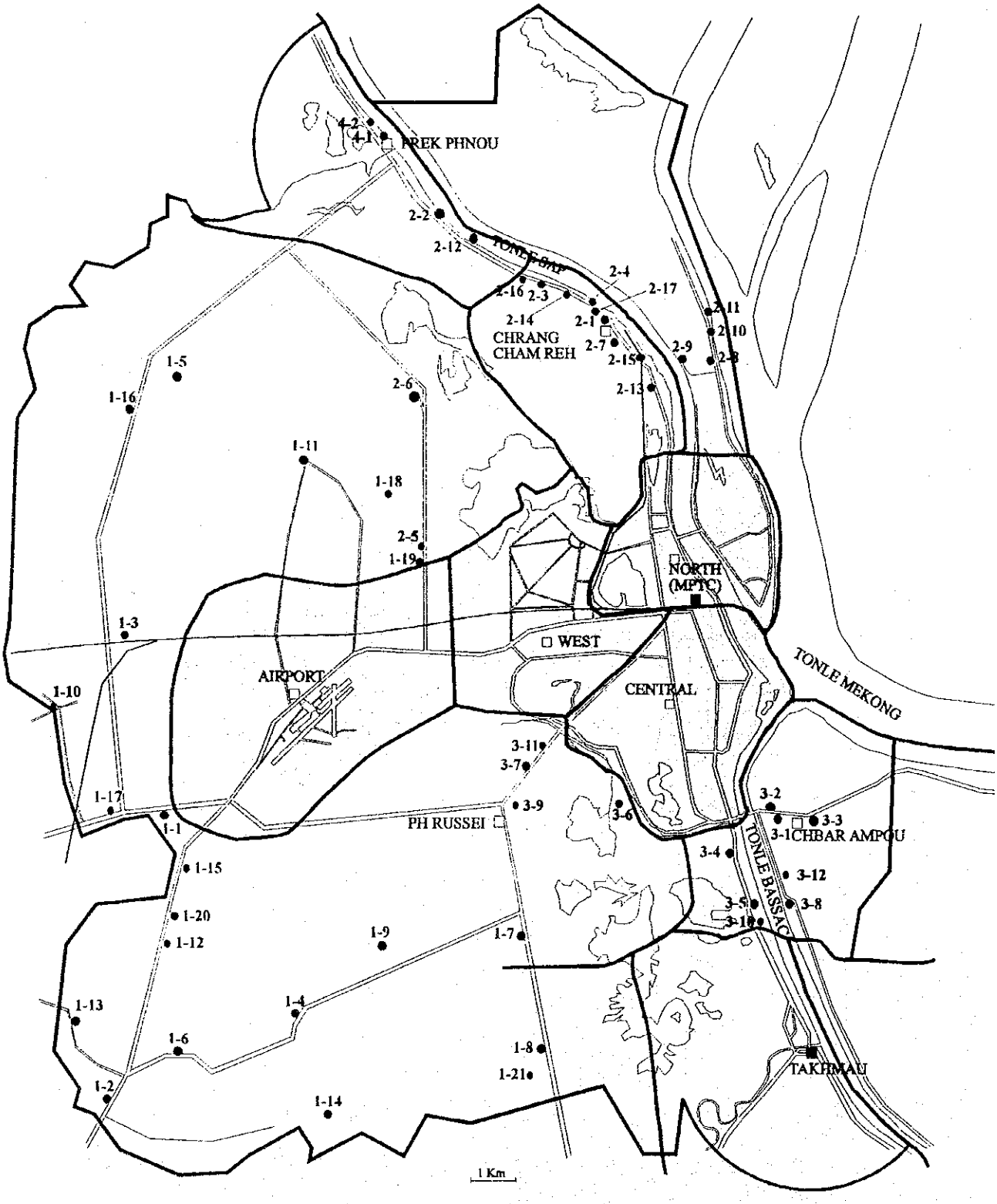
Power Supply Conditions		No. of Subscriber Stations	Remarks
Existence of Power Supply	Supplied by Commercial Power	12	
	Supplied by private E/G	20	
No Power Supply	Easy to newly supply Commercial Power	6	
	Difficult to newly supply Commercial Power	14	
Total		52	

Application of Antenna Pole and Power Supply System at Subscriber Stations

Type of Pole	Rectifier + Batteries	Solar Power System	Total	Remarks
15 m Pole	18	5	23	
18 m Pole	16	5	21	
23 m Pole	3	5	8	
Total	37	15	52	

Note *1 : The number in Figure-1 indicates the subscriber station mentioned in the following tables.

*2 : 15 R: 15 m pole and Rectifier+Batteries, 15 S: 15 m pole and Solar power system
18 R: 18 m pole and Rectifier+Batteries, 18 S: 18 m pole and Solar power system
23 R: 23 m pole and Rectifier+Batteries, 23 S: 23 m pole and Solar power system



□ : Areas covered by Cable System under the Project
■ : Telephone Office (Existing)
□ : Telephone Office (Plan)
● : Subscriber Station for Digital MAS

Locations of Subscriber Stations and Telephone Offices