A STUDY ON A REGIONAL DEVELOPMENT PLAN
FOR TELECOMMUNICATIONS NETWORKS
IN THE BANGKOK METROPOLITAN AREA
IN THE KINGDOM OF THAILAND

FINAL REPORT

FOR
A FEASIBILITY STUDY
ON
AN IMPLEMENTATION PLAN TO UPGRADE
THE TELECOMMUNICATIONS SERVICES QUALITY

MAIN REPORT

October 1992

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to a request from the Government of the Kingdom of Thailand, the Government of Japan decided to conduct a study on a Regional Development Plan for Telecommunications Networks in the Bangkok Metropolitan Area and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Thailand a study team headed by Mr. Satoshi Akaike, NTT International Corporation, twice between July 1991 and August 1992.

The team held discussions with the officials concerned of the Government of Thailand, and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

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 Government of the Kingdom of Thailand for their close cooperation extended to the team.

October 1992

Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency

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List of Abbreviations for Local Exchange Areas in the BMA

NO.	LOCAL EXCHANGE AREA	ABBR	Telecom Area	NO.	LOCAL EXCHANGE AREA	ABBR	Telecom Area
1	Phloen Chit	PNC	1	30	Dao Khanong	DKN	3
2	Samran Rat	SRR	1	31	Bang Phlat	BGT	3
3	Krung Kasem	KKM	1	32	Phasi Charoen	PSN	3
4	Surawong	SRW	1	33	Charan Sanitwong	CSW	3
5	Samsen	SMS	1	34	Rat Burana	RBN	3
6	Asok Din Daeng	ASD	1	35	Lat Ya	LTY	3
7	Pathum Wan	PTW	1	36	Muban Setthakit	MSK	3
8	Sukhumwit	SKW	1	37	Ekkachai	EKC	3
9	Chaiyaphruk	CYP	2	38	Nong Khaem	NGK	3
10	Bang Na	BNA	2	39	Phra Pradaeng	PPG	3
11	Khlong Chan	KGC	2	40	Bang Bue Thong	BBT	3
12	Thung Mahamek	TMM	2	41	Phahonyothin	PYT	4
13	Sathupradit	STD	2	42	Inthamara	ITM	4
14	Thanon Tok	TNT	2	43	Bang Khen	BGN	4
15	Bang Chan	BGC	2	44	Bang Su	BGS	4
16	Phra Khanong	PKG	2	45	Don Muang	DNM	4
17	Hua Mak	HAM	2	46	Lak Si	LKS	4
18	Trok Chan	TKC	2	47	Ram Inthra	RIT	4
19	Lat Krabang	LKG	2	48	Lat Phrao 1	LTP1	4
20	Khlong Toei	KTI	2	49	Lat Phrao 2	LTP2	4
21	On Nut	ONT	2	50	Chaeng Watthana	CWT	4
22	Ramkamhaeng	RKN	2	51	Nonthaburi	NTB	4
23	Samut Prakan	SPK	2	52	Ngam Wong Wan	NWW	4
24	Pu Chao Saming Phrai	PSP	2	53	Pak Kret	PKK	4
25	Bang Phli	BPL	2	54	Pathum Thani	PTT	4
26	Bang Pu	BGU	2	55	Rangsit	RST	4
27	Bang Phli Bang Bo	BBB	2	56	Thanyaburi	TYB	4
28	Thon Buri	TNB	3	57	Nawa Nakhon	NWN	4
29	Bang Khae	BKE	3	58	Bang Phun	BAN	4

List of Abbreviations for the Other Offices and Stations (1/2)

NO.	OFFICES AND STATIONS	ABBR	Remarks	NO.	OFFICES AND STATIONS	ABBR	Remarks
1	Bangkok	BKK		30	Lampang	LPG	
2	Chon Buri	CBI		31	Phayao	PYO	
3	Chachoengsao	CCO		32	Nan	NAN	
4	Rayong	RYG		33	Phitsanulok	PLK	
5	Chanthaburi	CTI		34	Sukhothai	STI	
6	Trat	TRT		35	Uttaradit	UTT	
7	Prachin Buri	PRI		36	Kamphaeng Phet	KPT	
8	Nakhon Nayok	NYK		37	Tak	TAK	
9	Nakhon Ratchasima	NMA		38	Nakhon Sawan	NSN	
10	Chaiyaphun	CPM		39	Phichit	PCT	
11	Buri Ram	BRM		40	Phechabun	PBN	
12	Ubon Rachathani	UBN		41	Uthai Thani	UTI	
13	Si Sa Ket	SSK		42	Chai Nat	CNT	
14	Surin	SRN		43	Saraburi	SRI	
15	Yasothon	YST		44	Lop Buri	LBI	
16	Khon Kaen	KKN		45	Sing Buri	SBR	
17	Maha Sarakham	MKM		46	Ayutthaya	AYA	
18	Roi Et	RET		47	Ang Thong	ATG	
19	Kalasin	KSN		48	Suphan Buri	SPB	
20	Udon Thani	UDN		49	Nakhon Pathom	NPT	
21	Nong Khai	NKI		50	Sumut Sakhon	SKN	
22	Loei	LEI		51	Samut Songkhram	SKM	
23	Sakon Nakhon	SNK		52	Kanchanaburi	KRI	
24	Nakhon Phanom	NPN		53	Phechaburi	PBI	
25	Mukdahan	MDH		54	Ratchaburi	RBR	
26	Chiang Mai	CMI		55	Prachuap Khiri Khan	PKN	
27	Lamphun	LPN		56	Surat Thani	SNI	
28	Mae Hong Son	MSN		57	Chunmphon	CPN	
29	Chiang Rai	CRI		58	Ranong	RNG	

List of Abbreviations for the Other Offices and Stations (2/2)

NO.	OFFICES AND STATIONS	ABBR	Remarks	NO.	OFFICES AND STATIONS	ABBR	Remarks
59	Phuket	PKT		67	Yala	YLA	
60	Phangnga	PNA		68	Pattani	PTN	
61	Nakhon Si Thamarat	NRT		69	Narathiwat	NWT	
62	Trang	TRG		70	Hat Yai	HYI	
63	Krabi	KBI		71	Phra Intharacha	PIR	Repeater
64	Songkhla	SKA		72	Nakhon Chaisi	NKC	Repeater
65	Satun	STN		73	Chon Buri Repeater	CBIR	
66	Phatthalung	PTN		74	Chon Buri Terminal	CBIT	

SUMMARY

SUMMARY

1 Introduction

1.1 Background of the Study

The Study is conducted in two phases:

1) the first phase of the Study aims to formulate a long-term telecommunications development plan in the Bangkok Metropolitan Area and its surrounding area of three prefectures, i.e., Nakhon Pathom, Samut Sakhon, and Ayutthaya.
2) the second phase of the Study aims to conduct a feasibility study on the top priority project which should be selected from the high priority projects in the long-term plan.

A study on "An Implementation Plan to Upgrade the Telecommunications Services Quality" is the second phase of the Study.

1.2 Objectives and Scope of the Study

1) Objectives

The following two items have been selected as the study objectives among many aspects in telecommunications service quality,:

a) improvement of fault ratio, and
b) improvement of call completion ratio.

For steps toward the service upgrade, concrete measures directly related to the two objectives will have been investigated among the following measures:

a) replacement of deteriorated facilities,
b) maintenance management standards, and
c) installation and construction method.

This feasibility study covers five year period between 1993 and 1997 (Phase-1 of the long-term plan).

2) Scope of the Study

a) Target figure

The following target figures were set up to formulate an improvement plan.

i) Fault ratio

Area	Present figure (1991)	Target figure (1997)	Definition
BMA	4.4	2.5	No. of Faults/100 subscribers/month
Provincial Area	4.9	3.0	ditto

ii) Call completion ratio

Area	Present figure (%) (1991)	Target figure (%) (1997)	TOT's target figure (%) (1996)
Study Area	23.5	55	50

b) Study Area

This study covers the BMA and its Surrounding Area as well as the Study on the long-term plan.

c) Facilities Investigated in the Study

The facilities to be covered by the Study are basically the facilities that exist by the end of the sixth ESDP project (existing facilities).

2. Improvement of Facility Fault Ratio

Almost all of the facility faults in both areas occur in outside plant, in particular, in the BMA, 93.3% of the facility faults occur in outside plant, 5.9% in switching facility and 0.8% in others. In the provincial area, 82.9% of the facility faults occur in outside plant, 15.8% in switching facility and 1.3% in others. According to the present state of the faults mentioned above, the improvement measures are proposed in Chapter 2.

3. Improvement of Call Completion Ratio (CCR)

The telephone call completion ratio measured at NEAX-61 switches in the BMA in March 1992 is 23.5% and the categories of incomplete calls are P.S.Abandon (26.8%), B-sub busy (24.4%), P.D.Abandon (7.7%), ringing abandon (5.8%), congestion (5.5%), technical fault.(5.1%) and others (1.2%). According to the present state of the CCR mentioned above, the improvement measures are proposed in Chapter 3.

4 Implementation Plan

4.1 Formulation of Implementation Plan

1) Selection of Implementation Plan

The measures to improve the services quality of the telecommunications in the study area are proposed in Chapter 2 and 3. The Study Team selected the implementation plans from the improvement measures. The implementation plans are formulated by comparing the improvement measures. They basically come under the following conditions.

a) The plan will be expected to directly support the improvement of the fault ratio and the CCR.
b) The plan will be able to carry out smoothly within Phase-1.

Other improvement measures are proposed as the other measures in section 4.5 of Chapter 4.

Twenty six (26) projects were selected as the implementation plans to improve the fault ratio and the CCR. They are estimated to satisfy the target for improving both the fault ratio and the CCR.

2) Priority Order

The selected implementation projects are consisted of two categories. One group includes the effect of improving the fault ratio and the other includes the effect of improving the CCR. The plans are divided into three main classes. The following factors are used to classify the projects. Table 4.1 shows the project ranking.

Table 4.1 Ranking of the Projects

Field	Project Code	Project Name	Work Volume		Total Evaluation	Reference (Section)
Outside Plant		1) Rehabilitation of Subscriber Line				
	OSP-1	Rearrangement of Distribution Point	(Unit: DPs)	8,250	A	2.2.3 3)
	OSP-2	Replacement of Drop Wire with Cable	(Unit: Pair-Km)	94,000	A	2.2.3 3)
	OSP-3	Renewal Drop Wire	(Unit: Drop wire)	200,000	A	2.2.3 3)
	OSP-4	Replacement of Secondary Cable	(Unit: Pair-Km)	231,000	B	2.2.3 2)
	OSP-5	Replacement of Primary Cable	(Unit: Pairs)	343,500	C	2.2.3 2)
		2) Customer Premises				
	OSP-6	Check and Consulting for Customer Premises	(Unit: Subscriber)	187,000	A	2.2.3 5)
		3) Replacement of Public Telephone				
	OSP-7	Replacement of Public Telephone Set	(Unit: Set)	6,158	A	2.2.3 4)
	OSP-8	Replacement of Protector	(Unit:Protector)	17,500	B	2.2.3 4)
Switching & Transmission	S&T-1	Replacement of Line Protector	(Unit: Sub. Line)	855,066	B	2.3.2 2)
	S&T-2	Replacement of XB Switches with SPC Switches	(Unit: Sub. Line)	245,250	C	2.3.2 1)
	S&T-3	Replacement of Circuits	(Unit: Circuit)	3,154	C	2.3.2 1)
	S&T-4	Installation of Automatic Howling Tone Services	(Unit: Equipment)	239	C	3.7.3
	S&T-5	Subscriber Line Accommodation Adjustment			B	3.6.1
	S&T-6	Introduction of Record Announcement	(Unit: Equipment)	61	B	3.9
	S&T-7	Changing P.D. Timing			A	3.7.3
	S&T-8	Improvement of Periodic Maintenance			B	3.7.3
	S&T-9	Replacement of PCM System with FOT	(Unit: DTI)	1,144	C	2.4.2
	S&T-10	Increasing Number of Circuit	(Unit: Circuits)	3,295	A	3.6.2
Others	OT-1	Expansion of Subscriber Lines	(Unit: Subscriber)	500,000	A	3.5.1
	OT-2	Promotion of Multi-hunting-system			A	3.5.2
	OT-3	Promotion of Call-waiting Services			B	3.5.4
	OT-4	Dial Consulting Activities (User Campaign)			A	3.7.1
	OT-5	Promotion of Automatic Answer Telephone			B	3.7.2
	OT-6	Promotion of Call Transfer Service			C	3.5.4
	OT-7	Management on Operator's Answer Delay Time			C	3.7.2
	OT-8	Introduction of Information Service for Changed Number	(Unit: Switch unit)	1	B	3.7.5

1) The weight of effects to improve the fault ratio.
2) The weight of effects to improve the CCR.
3) The investment costs for each project.

4.2 Implementation Schedule

The implementation of the projects is scheduled during the Phase-1.

4.3 Implementation Procedure

1) Effect of Priority Order

In the event that TOT could not carried out the all project, which project should be selected as the top priority is important. Table 4.2 shows the comparison between the effects of each priority group.

Table 4.2 Comparison between Effects from Each Priority Group

Priority Order Group	No. of Projects	Investment Cost (MB)	Improvement Effect (%)	
			Fault Ratio	CCR
1. First Group	10	20,069	72.7	82.2
2. Second Group	9	2,397	19.2	15.5
3. Sub Total (1+2)	19	22,466	91.9	97.7
4. Third Group	7	5,560	8.1	2.3
5. Total (3+4)	26	28,026	100.0	100.0
6. Contingency and Implementation		890		
7. Grand Total (5+6)		28,916		

2) Implementation Method

In preparing the execution of the projects, the following items are taken into consideration.

a) Area Ranking Order

To execute the projects effectively, the area ranking order is given as follows:

i) Narrow Down the Area

ii) Decision of Area Ranking Order

- Central Business Area.

- Rapidly Growing Suburban Area.
- Industrial Area.
- Other

b) Combining the Projects

Implementation of some projects are planned to carry out together with from the viewpoint of efficiency.

c) Office Ranking Order

Office ranking order is planned to carry out the projects such as the replacement of the XB switches with the SPC switches.

4.5 Other Measures to Upgrade the Telecommunications Service Quality

The Study Team proposed many improvement measures to upgrade of the telecommunications services quality in the previous section. Not only the implementation plans, but also another improvement measures are very important to provide high quality telecommunications services to the customers as shown in Table 4.5.

Table 4.5 Recommended Main Improvement Measures

Classification	Improvement Measure Titles	Reference
1 Maintenance Management Standard	Establishment of Maintenance Control System (Improvement of the fault ratio)	2.5.3
	1) Service Control	2.4.2 2)
	Definition of Maintenance Control Value	
	2) Extraordinary Control System	2.4.2 1)
	Definition of Maintenance Control Value	
	3) Plant Control	
	a) Deteriorated Facility Control System	
	b) Peculiar Faults on the plant Control	
	Traffic Management (Improvement of the CCR)	3.8.3 1)
	1) Overall Management	
	2) Segmental Management	
2. Installation & Construction Method (incl. maintenance repair system)	(Outside Plant)	
	1) Improvement of the Repair Method for Drop Wire	2.2.3 3)
	2) Improvement of the Drop Wire Installation Method	2.2.3 3)
3. Others	(Outside Plant)	
	1) Introduction of Water Penetration Monitoring System	2.2.3 2)
	2) Improvement of the Closure	2.2.3 2)
	3) Improvement of the Quality of Drop Wire	2.2.3 3)
	4) Advertisement and Campaign to the Customers	2.2.3 5)
	5) Check Customer Premises before Connection with TOT Network	2.2.3 5)
	(Transmission)	
	6) Introduction of Tool for Channel Assignment	2.4.2 3)
	7) Introduction of Computerized Leased Line Control System	2.4.2 5)
	8) Introduction of Leased Line Remote Testing System (LLTS)	2.4.2 5)
	(O & M)	
	9) Improvement of Centralized Maintenance System	2.5.2
	10) Introduction of Computerized Customer Record System	2.5.2
	11) Establishment of Stock Management System	2.5.2
	12) Technical Skill Advancement	2.5.2

5. Project Evaluation

5.1 Financial Evaluation

The Project is classified into two main activities. One is the activity to reduce the occurrence of the faults and to make the repair periods shorter. The other is to increase the number of complete calls, i.e., improve the CCR (refer Table 5.1.4-2 in 5.1.4 of Chapter 5).

The conclusion is as follows:

1) The proposed rehabilitation Project excluding the new telephone lines installation plan costs 9,789 million Baht in total during the five years Project period,

2) The implementation of the Project will decrease the number of faults, which recovers the lost call revenues for 24.08 million Baht and saves the repairing work load for 175.07 million Baht in total during the five years period,

3) The implementation of the Project will increase the number of complete calls, which brings the call revenues increase for 8,152.615 million Baht in total during the five years period,

4) The IRR of the Project is estimated as 22.61%. The IRR of the Project with 500,000 lines installation plan is estimated as 11.28%,

5) The rehabilitation Project can be financed and carried out within the TOT's own funds and the internal cash generations.

5.2 Social and Economical Evaluation

As the results of implementing the Project, the following effects will be expected to the users, the society, and the telecommunications sector.

1) To the Users

Business and residential users can enjoy not only better basic telecommunications services but also will be benefited from new intelligent services through the telecommunications network with a good quality.

2) To the Society

The society will develop not only a sound platform of the basic infrastructure for national development and integration but also strategic infrastructure around which a new information intensive society can evolve.

3) To the Telecommunications Sector

It can be expected that modernization and expansion of the network (hardware improvement) coupled with operation and maintenance system changes (software improvement) will create an environment for dynamic and innovative business operations for TOT.

5.3 Technical Evaluation

There is no big technical problem in implementing the Project to improve the call completion ratio and facility fault ratio. However, technical know-how and careful planning are necessary for disconnecting and reconnecting installed telephone lines as compared to installing new telephone lines.

5.4 Recommendation

1) Adjustment of the Project

The proposed projects were formulated by examining several sample offices and maintenance areas because of the limited study period. When the projects are executed in the Study Area, therefore, some part may be modified in accordance with the environment of the areas and further study may be required by TOT itself.

2) Coordination with the Seventh ESDP Expansion Project of TOT

Change of the TOT network condition due to the Seventh ESDP Expansion Project must be taken into consideration for implementing some projects.

3) Manpower and Procurement

To implement the proposed project, vast volume of the equipment and materials are required such as the cables and the switches. Since the seventh ESDP expansion project of TOT has been carried by the private firm, it is, therefore, very much distinct to secure the necessary procurement. For these purposes, the early start of the projects are required.

5.5 Conclusion

The proposed plans are very important projects to be immediately executed by TOT. Implementing the project is very effective and the effects are as follows:

1) Financial Viewpoints

a) Considerable project benefit

- Project Cost (5-year period) : 28,916 million Baht
- Project Benefit (5-year period) : 16,075 million Baht
- IRR (10-year period) : 11.28%

b) Manpower saving in the maintenance work (5-year period):

- 432 persons (175.07 million Baht)

2) Social and Economic Viewpoints

a) To the users

- Enjoying every telecommunications services when being necessary.

b) To the society

- Supporting socioeconomic activity.

c) To the telecommunications sector

- Creating an environment for dynamic and innovative business operation.

CHAPTER 1

INTRODUCTION

CHAPTER 1 INTRODUCTION

1.1 Composition of the Study Report

This Final Report consists of the following two parts. Each part also consists of three volumes.

1) Part 1: A Long-term Plan Study
   a) Summary
   b) Main Report
   c) ANNEX

2) Part 2: A Feasibility Study on the Priority Project
   a) Summary
   b) Main Report
   c) ANNEX

This report presents the main report of the Feasibility Study on the Priority Project.

1.2 Background of the Study

Japan International Cooperation Agency (hereinafter referred to as "JICA") has conducted "A Master Plan Study on Telecommunications Development in the Kingdom of Thailand" (hereinafter referred to as "the Master Plan Study") from September 1988 to December 1989 in response to the request of the Government of the Kingdom of Thailand. The Master Plan Study has revealed issues on telecommunications in the Bangkok Metropolitan area and urged the necessity for a further development study in the area.

In response to the request of the Government of the Kingdom of Thailand, the Government of Japan decided to implement A Study on A Regional Development Plan for Telecommunications Networks in the Bangkok Metropolitan Area in the Kingdom of Thailand (hereinafter referred to as "the Study"). JICA and Telephone Organization of Thailand (hereinafter referred to as "TOT") agreed upon the scope of work for the Study in October 1990.

The JICA study team on "A Regional Development Plan for Telecommunications Networks in the Bangkok Metropolitan Area in the Kingdom of Thailand" (hereinafter referred to as "the Study Team") headed by Mr. Satoshi Akaike, a senior manager of Planning Administration Department of Telecommunications Consulting Division in NTT International Corporation, began the Study in July 1991.

The Study is conducted in two phases:

1) the first phase of the Study aims to formulate a long-term telecommunications development plan in the Bangkok Metropolitan Area and its surrounding area of three prefectures, i.e., Nakhon Pathom, Samut Sakhon, and Ayutthaya.
2) the second phase of the Study aims to conduct a feasibility study on the top priority project which should be selected from the high priority projects in the long-term plan.

A study on "An Implementation Plan to Upgrade the Telecommunications Services Quality" is the second phase of the Study.

The Study Team dispatched by JICA has carried out the study Work in Thailand-III from March to May 1992 and Work in Japan-II during the period from May to July 1992 with the TOT counterparts.

This final report presents the study results of the second phase of the Study and proposes the projects to upgrade the telecommunications services quality.

1.3 Objectives and Scope of the Study

1.3.1 The Study Objectives

The objectives of the Study is to make a telecommunications development plan to fulfill telephone subscription demand, to upgrade the telecommunications services quality, to provide new telecommunications services in Bangkok Metropolitan area and its surrounding area.

The area to be covered by the Study is the Bangkok Metropolitan area (Bangkok, Pathum Thani, Samutprakarn, Nonthaburi: hereinafter referred to as "BMA") and its surrounding area (Nakhon Pathum, Samut Sakhon, and Ayutthaya). The planning period of the Study is fifteen (15) years from 1993 to 2007, and after selecting a top priority project, a feasibility study is carried out.

1.3.2 Outline of the Top Priority Project

During the Work in Thailand-II, the JICA study team made a presentation of the Interim Report for the long-term plan. Through meetings and discussions between TOT and the JICA study team, the top priority project to be studied for the second phase of the Study was decided. The title of the feasibility study is "An Implementation Plan to Upgrade the Telecommunications Services Quality".

While there are many aspects in terms of telecommunications services quality, the following two items have been selected as the study objectives:

1) Improvement of Fault Ratio, and
2) Improvement of Call Completion Ratio.

Improvement of fault ratio and improvement of call completion ratio are essential because they directly affect the quality of customer services, performance of telecommunications networks, utilization of facilities, and operating revenues. Therefore, for the second phase of the Study, these two objectives have been selected to upgrade telecommunications services quality and concrete measures to achieve them would be established.

Toward the upgrading the services quality, the concrete measures which directly contribute to the two objectives are studied from the following viwpoints:

1) replacement of deteriorated facilities,
2) maintenance management standards, and
3) installation and construction method.

This study analyzes the present situation of the faults and the call completion ratio; and finds the major causes of the high faults ratio and the low call completion ratio. The Study Team proposes various measures and selects high peiority projects among them as the action plan. The proposed projects are planned to be implemented during the period between 1993 and 1997 (Phase-1).

1.3.3 Scope of the Study

1) Target Figure

To improve the telecommunications services quality during the Phase-1, the following targets are set to be achieved by FY 1997.

a) Fault Ratio

Area	Present figure (1991)	Target figure (1997)	Definition
BMA	4.4	2.5	No. of Faults/100 subscribers/month
Provincial Area	4.9	3.0	ditto

To achieve the target figures of the Phase-1, the number of faults in a month for the existing facilities must be 25 per 100 main telephone lines connected in the BMA and 3.0 in the Surrounding Area. If the target figures are calculated on the basis of both the existing telephone lines and the new ones to be installed by the future telephone expansion plan, i.e., the seventh ESDP of TOT, they will be easily achieved because the new installed facilities are expected to have very low fault ratios at the beginning.

However, even if the target figures are achieved because of the increased new telephone lines with a small number of faults and the existing telephone lines with the same number of faults, the high faults ratio for the existing subscribers will still prevail and the services quality will become worse. This study, therefore, excludes those new facilities from the fault ratio calculation as explained in 'Facilities Investigated in the Study' later.

The Study Team applys the above target figures on the existing facilities only because of the following reasons:

i) It is necessary to keep the fault ratios of the facilities maintained by TOT and by the new contractor close in order to provide customs with fair services,

ii) The Study Team expects that the target figures can be achieved throgh implementing the proposed projects. Among them, improvement of customer premises, the rehabilitation of timeworn subscriber cables, and the replacement of drop wires are quite effective and essential to reduce the number of faults; therefore they should be implemented at first.

b) Call Completion Ratio

Present figure (%)		Target figure (%)	TOT target figure (%)
		(1997)	(1996)
Study Area	23.5	55	50

The target figure for the call completion ratio by the end of the Phase-I (1997) was set at 60% in the Master Plan Study.

However, at present, TOT has set the target figure at 50% by the esnd of FY 1996. The Study Team has decided the target figure as to be 55% by the end of the Phase-1 (1997). The reasons are as follows:

It is expected that the implementation of the first priority projects can improve the call completion ratio as follows because of their high effectiveness.

i) The call completion ratio of 23.5% in 1992 will be improved to become 30% in 1993.
ii) The ratio will increase to become 37.5% in 1994, 45% in 1995, 50% in 1996.
iii) Finally, it will reach 55% by the end of the Phase-1 (1997).

The long-term plan has set up the following target figures for the second objective, i.e., to upgrade telecommunications services quality:

c) Completion of Network Digitization

Switching Systems

Target:	100% Digitization	
the BMA:	Phase-2	(by the end of 2000)
the Surrounding Area:	Phase-1	(by the end of 1997)

d) Decrease in the Outside Plant Faults

Target:	Fault Ratio per 1,000 lines per month		
	Phase-1	Phase-2	Phase-3
the BMA:	25	20	15
the Surrounding Area:	30	20	15

The Study Team set up the same target figures to improve the fault ratio as the long term plan.

2) Study Area

This Study covers the BMA and its Surrounding Area as well as the Study on the long-term plan.

3) Facilities Investigated in the Study

It has been already decided that TOT would not expand the telecommunications network in the BMA and its Surrounding Area by itself during the seventh Economic and Social Development Plan (ESDP) period. Therefore, the facilities to be covered by the Study are basically those existed by the end of the fiscal year of 1991.

1.4 Organization for the Study

1.4.1 Japanese Advisory Committee

The Japanese Advisory Committee provides the JICA Study Team with necessary advises and supervision for the Study. The members of the committee are as follows:

Name	Duty in Charge	Affiliated to
Mr. Osamu KOYAMA*1	Chairman (New Services)	Senior Advisor for International Cooperation Communications Policy Bureau, Ministry of Posts and Telecommunications
Mr. Kaoru SUZUKI*2	Chairman (New Services)	Senior Advisor for International Cooperation International Affairs Department Ministry of Posts and Telecommunications
Mr. Kiyoshi KONO	Member (Network Planning)	Assistant Director Telecommunications Systems Division, Telecommunications Bureau, Ministry of Posts and Telecommunications
Mr. Nozomu GODA	Member (Switching System Planning)	Info-communications Development Specialist Institute for International Cooperation, Japan International Cooperation Agency (JICA)

Note: *1 up to July 1992.
*2 from July 1992.

1.4.2 Study Team

JICA Study Team consists of the following members:

Name	Duty in Charge
Mr. Satoshi AKAIKE	Team Leader
Mr. Katumi MURAKAMI	Assistant Team Leader / Transmission Systems Planning
Mr. Kiyoshi MUSHU	Network Planning
Mr. Tomiatsu TSUJIMURA	Switching Systems Planning
Mr. Tomoyoshi ASO	Outside Plant Systems Planning
Mr. Kiyoshi WASHIZAWA	Operation and Maintenance Planning
Mr. Hiroyuki KANO	Financial and Economic Analyses

1.4.3 Counterpart Team

In order to achieve both technical transfer to TOT and the smooth study, TOT provided its counterparts from Corporate Planning Office (CPO) and other bureaus concerned. The names and duties in charge of TOT counterparts are shown in the following list:

Name	Duty in Charge	Department
Mr. Sanan PHIROMSWAD	Director	Corporate Planning Office
Mr. Deacha MONGKOLRAT	Head of Corporate Planning Process Sector	ditto
Mr. Chakree SUBPRAWONG	Counterpart Team Leader	ditto
Mr. Seree CHINTARATANA	Switching System	ditto
Mr. Suwat NACAPUNCHAI	ditto	ditto
Ms. Jintana PRASERTSOM	Transmission System	ditto
Mr. Arkom KRACHANGMOL	ditto	ditto
Ms. Valaikul SATTHARPHORN	Outside Plant and O&M	ditto
Mr. Kamron TEINTHONGDEE	ditto	ditto
Ms. Chothip SUTHONTHUNYAKORN	ditto	ditto
Mr. Pichet LEEPITAKWATANA	ditto	ditto
Ms. Ratree VIJAKKHANA	ditto	ditto
Ms. Kanungnid RATTANASEREEWONG	ditto	ditto
Mr. Tinnakorn ITSRANGKUL NA AYUTHAYA	Telecommunications Network and Traffic	ditto
Mr. Somchai VICMUKTANONT	ditto	ditto
Ms. Chanida SUKHAVIRAJ	Financial and Economic Analyses	ditto
Ms. Yupa LEEWONGCHAROEN	ditto	ditto
Ms. Chadaporn KUNUDOM	ditto	ditto
Mr. Wichit PUMSUKKHO	Switching System	Bureau of Operation
Mr. Chaowalit JEARANUCHAT	ditto	Bureau of Engineering & Projects
Mr. Paiboon TANGAROONSANTI	ditto	Bureau of Operation
Mr. Charoen WILAIHONG	Transmission System	ditto
Mr. Thawisak KITTIJARURAK	ditto	Bureau of Engineering & Projects
Mr. Amroong HEEBTAMAI	Outside Plant and O&M	Bureau of Operation
Mr. Sopchoke SOMCHAIWONG	ditto	Bureau of Engineering & Projects
Mr. Surasak PUTHANONTHAVIT	ditto	Bureau of Operation
Mr. Ampol SINCHAMPASAK	ditto	ditto
Ms. Sanipong HONGSPANIJ	O & M	Bureau of General Affairs
Mr. Sukij CHANSIAORASMEE	ditto	Bureau of Operation

Name	Duty in Charge	Department
Mr. Subphong THANTARANON	O & M	Bureau of Operation
Mr. Pattharin PATTHARASIKARIN	Network, Traffic	Bureau of Engineering & Projects
Mr. Somchai NAKPLUANG	ditto	Bureau of Operation
Mr. Sinchai KAMOLRUNGSRIPORN	ditto	ditto
Ms. Wannaporn LILAHAJIVA	Financial and Economic Analysis	Bureau of General Affairs

1.4.4 The Work Schedule

The study of the second phase is composed of the following four Works:

Study Work	Main Study Items	Period
Work in Thailand -III	Explanation and discussion of Inception Report, Field surveys, Data collection, Measurement of traffic, Analysis of the data and Explanation of progress of the study.	Mar. 16- May 23, 1992.
Work in Japan - II	Analysis of the data, Improvement plan for fault ratio and call completion ratio, Implementation plan for improvement of fault ratio and call completion ratio, Estimation of investment cost, Management plan, Financial analysis, Preparation of Draft Final Report.	May 24 - Jul. 30, 1992.
Work in Thailand -IV	Explanation and discussion of Draft Final Report.	Aug. 1992
Work in Japan - III	Preparation and submission of Final Report	Sep. 1992

Figure 1.4 shows the work schedule of the Study .

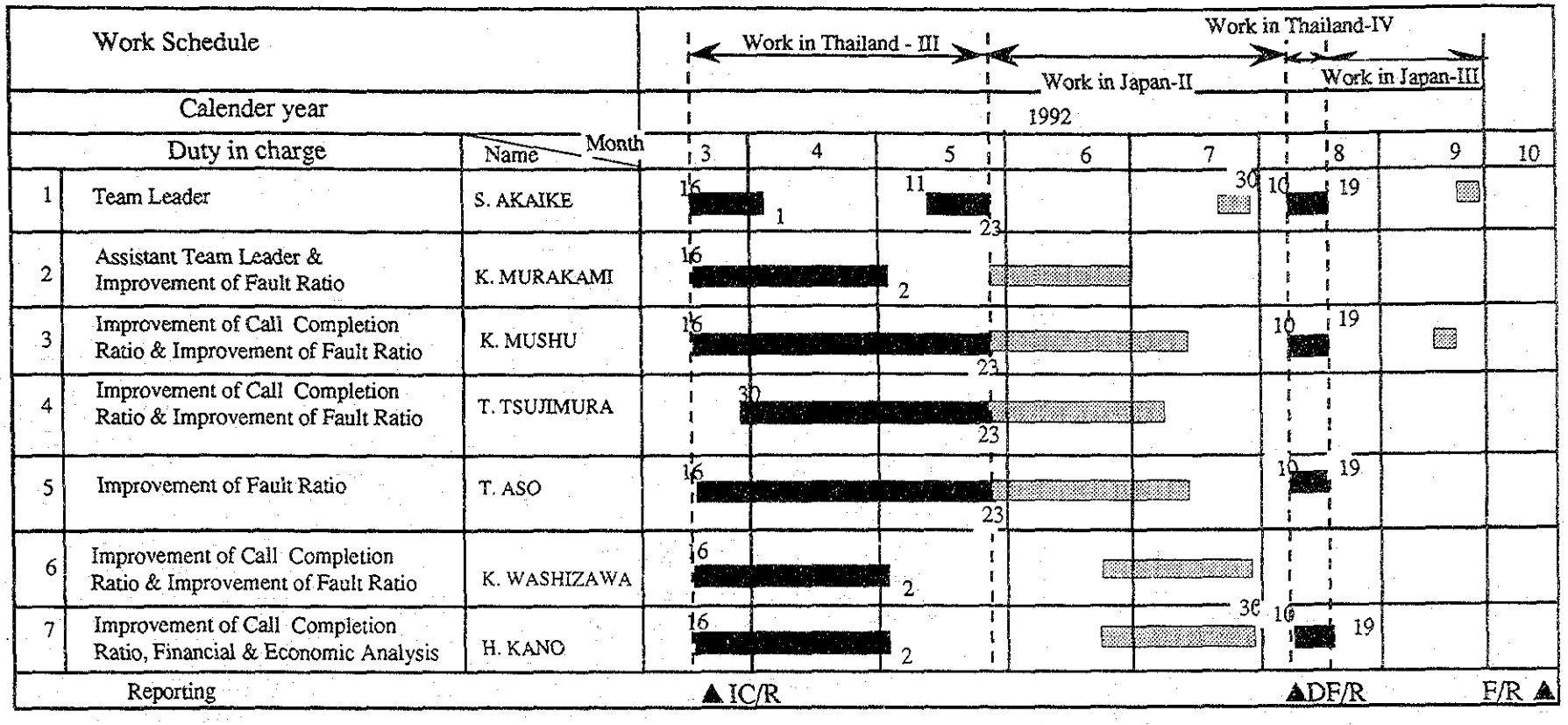


Figure 1.4 Work Schedule of the JICA Study Team Members

CHAPTER 2

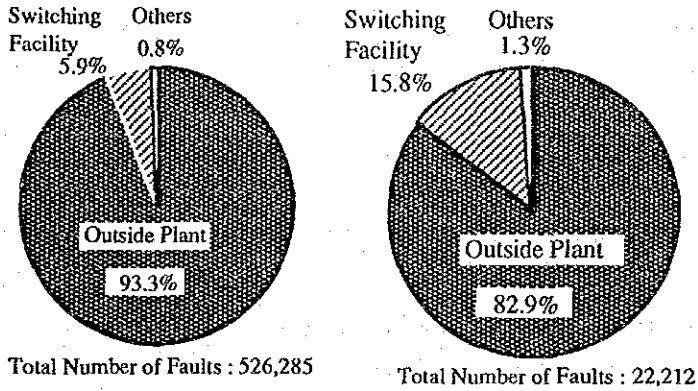
IMPROVEMENT OF FACILITY FAULT RATIO

CHAPTER 2 IMPROVEMENT OF FACILITY FAULT RATIO

2.1 Overview

2.1.1 Feature of Facility Faults

Figure 2.1 shows the percentage distribution of the facility faults in both the BMA and provincial areas in TOT. Almost all of the facility faults in both areas occur in outside plant. In particular, in the BMA, 94% of the facility faults occur in the outside plant, 5.2% in the switching facility and 0.7% in the others. The faults mean those found by the customer claims; however, the faults in public telephones include those discovered by TOT inspections.



(a) BMA (b) Provincial Area

Note; (a) Source: Monthly Maintenance Report (Mar. 1991~ Feb. 1992)
(b) Source: Summary of Monthly Report (Oct. 1990 ~ Jun. 1991)
(Maintenance Center in the Department of Subscriber Services)
(c) 'Test OK' excludes

Figure 2.1 Percentage Distribution of Facility Faults

Outside plant involves cables, drop wires, protectors, inside wires and subscriber sets including public telephones. Switching facilities involve switches, main distribution frame (MDF), fuses, etc. Others means the remainder of outside plant and switching facilities.

The Study Area in the provincial areas is the Surrounding Area which is a part of the provincial areas. But the facility faults represent those in the entire provincial areas because the Study Team could not isolate the faults of the Surrounding Area.

2.1.2 Outline of the Study

1) Outside Plant

To reduce the number of facility faults found by customer claims , the faults in outside plant is critical. The Study Team analyzed the present fault problems by mainly using Monthly Maintenance Report compiled by the Maintenance Center, Summary of Maintenance Report annually issued by the Department of Subscriber Services and Repair Record in the Subscriber Record. The Study Team could not analyze causes and locations of the facility faults because of the lack of data.

The Study Team also made site studies on aerial cables, drop wires and customer premises equipment in several secondary distribution areas of the Krung Kasem Exchange Office to investigate the present conditions. From the site study, the Study Team proposes several improvement measures and recommendations.

Main improvement measures are proposed as follows:

- Rehabilitate deteriorated and timeworn outside plant (excluding protectors, inside wires, subscriber sets),
- Find customers whose premises equipment is not property working and persuade them to replace those equipment with new standardized one installed by TOT contractors.

Main recommendations is as follows:

- Develop and improve materials, parts, equipment and construction methods so as to be suitable for the environment in Thailand.

2) Switching Facility

Taking urgent concrete measures is not necessary to reduce the number of facility faults found by customer claims because its percentage is very low. Nevertheless, the Study Team examined the problems by mainly using Monthly Report by the Center of Metropolitan Switching Office the Sector of Switching Office of Department of Telecommunications Network.

Main improvement measures are proposed as follows:

- Replace XB switches with SPC switches,
- Install the improved line protectors for switches

Main recommendation is as follows:

- Establish a definition of Extraordinary Faults to be informed the TOT headquarter office.

3) Transmission Facility

Transmission facility is not directly related for improving the faults found by customer claims in this study. However, transmission facility is related many issues concerning the operation and maintenance to improve telecommunications service quality such as replacement of the timeworn facilities and increasing reliability of the telecommunications network. The Study Team will, therefore, propose a few improvement measures to upgrade the telecommunications service quality. The study process is as follow:

a) The faults and maintenance issues are analyzed by using the monthly report of the last four months issued by the Transmission Sector in the Department of Telecommunications Network and by discussions with people in the maintenance sections concerned.

b) The major issues found are the present maintenance target figures, the control of extraordinary faults, the present channel assignment method in transmission routes and the leased line service quality. The leased line service quality will become quite important because its customers rapidly increases. They will demand the higher service quality.

c) The Study Team proposes a few improvement measures in each issue. They are the replacement of PCM system, establishment of more reasonable maintenance target figures, the introduction of a new tool for channel assignment, the introduction of 'Leased Line Testing System (LLTS)'. The replacement of PCM system is selected in the implementation plan and the other measures are selected as recommendations.

4) Operation and Maintenance

The Study Team examined the job and work flow concerning the operation and maintenance activities on outside plant, switching and transmission facilities. The Study was conducted by hearings from TOT officers and stafs, the job descriptions of TOT and maintenance records and data.

Main recommendations are as follows:

- Establish a maintenance control system and a traffic management system in order that anyone can do such a maintenance work.
- Establish a standard and rules of storing, leasing, and repairing on spare packages.

2.2 Outside Plant

2.2.1 Introduction

1) Assumptions for the Study

The Study was carried out under the following assumptions:

a) The facilities to be studied are only the existing facilities because new facilities will not be constructed and not maintained by TOT.

b) The investigation was mainly carried out in one exchange area located in the BMA. The results of the investigation were employed for estimating the work volume and the investment cost for the whole Study Area. The reasons are as follows:
   i) Normally, this kind of study requires a detail investigation for the whole study area. Because the outside plants spread widely in the whole study area, it needs much time and workload to carry out a detail investigation.
   ii) TOT has adopted the same type of outside plant materials for the whole area.
   iii) With regard to the Surrounding Area, it was difficult to collect the data and to execute the investigation because of its location and the organization change enforced in 1991.
   iv) The Krungkasem Exchange Area was selected because the fault ratios by all facilities are in the average levels in the BMA.

c) The improvement measures which requires some research and development efforts are excluded from the implementation plan because they usually take long time to establish and introduce. They also include some uncertain factors.

2) Classification of the Faults and Maintenance Responsibility for the Outside Plant

The classification of the faults on the outside plant in TOT is as follows:

Category of the Fault	Facility
Cable	Primary Cable, Secondary Cable and Terminal of the Cable
Drop Wire	Drop Wire and Cabinet Jumper
Protector	Protector
Inside Wire	Inside Wire and Inside Cable
Subscriber Set	Subscriber Set and Public Telephone Set
Test OK	-

Note; Structure of the outside plant is briefly described in APPENDIX.

The maintenance responsibilities of the facilities are assigned as follows:

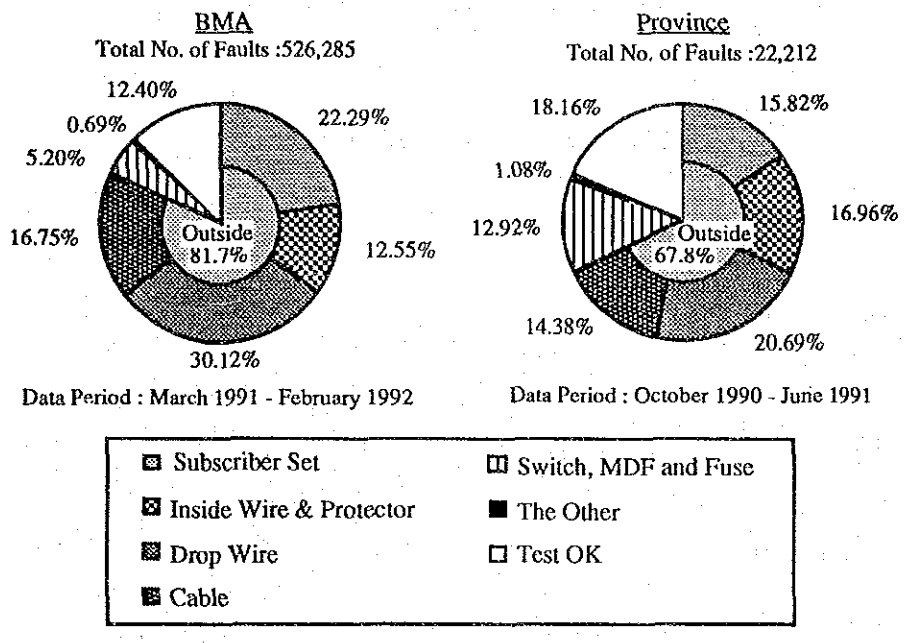
Facility	Type of Subscriber	Maintenance Responsibility
Cable	-	TOT
Drop Wire	-	TOT
Protector, Inside Wire and Subscriber Set	Public Telephone, Government and TOT	TOT
	Ordinary and PABX	Customer

2.2.2 Present State

Figure 2.2.2-1 shows the percentage share of the faults by type of facility in the BMA and in the provincial area. Regarding to the BMA, the figures in the graph are basically compiled from the Monthly Maintenance Report by the Center of Maintenance and Operator Services, but slightly revised with some data concerning the facility faults such as the Statistics of Number of Faults at Customer Premises by the Complaint Center, the Statistics of Public Telephone Faults by the Public Telephone Division. Because the number of faults in these reports are slightly different because of the error data processing at the computer center and some unreported public telephone faults.

Figure 2.2.2-1 shows that over eighty (80) percent of faults have been associated with the outside plant in the BMA, and that about eighty (80) percent of the outside plant faults have occurred at the ending sides of the outside plant such as drop wires, inside wires and subscriber sets.

As for the present state of the facility faults in the Surrounding Area, the necessary data could not be collected because of the reasons mentioned before. Therefore, the percentage share of each cause of the faults in the provincial area is shown in Figure 2.2.2-1 as a reference. This figure also shows that the major faults by type of facility are the outside plant.



Note ; Sources are as follows:
- Monthly Maintenance Report by the Center of Maintenance and Operator Services
- Statistic of the Number of Faults at the Customer Premises by Complaint Center of Area 1
- Statistic of the Public Telephone Faults by the Public Telephone Division
- Summary of Monthly Report by the Department of Subscriber Service

Figure 2.2.2-1 Percentage Distribution of Faults by Types of Facility

1) Cable Fault

The local cable network consists of many kinds of materials as shown in Figure 2.2.2-2. Generally, most of the cable faults originate at the splicing points and terminals of the cables. Because these points are handled repeatedly in the installation and the maintenance works, and the terminals exposed in the air.

Figure 2.2.2-3 shows the number of the repaired cable faults per month. The number has an inclination to increase during the rainy season. It hints that the cable faults have been related with moisture.

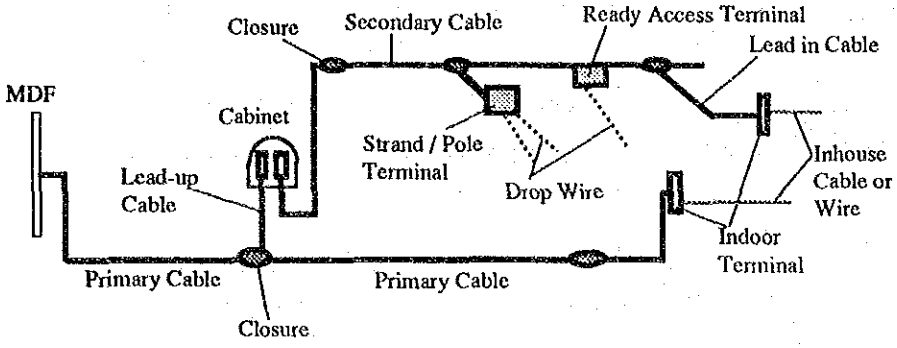
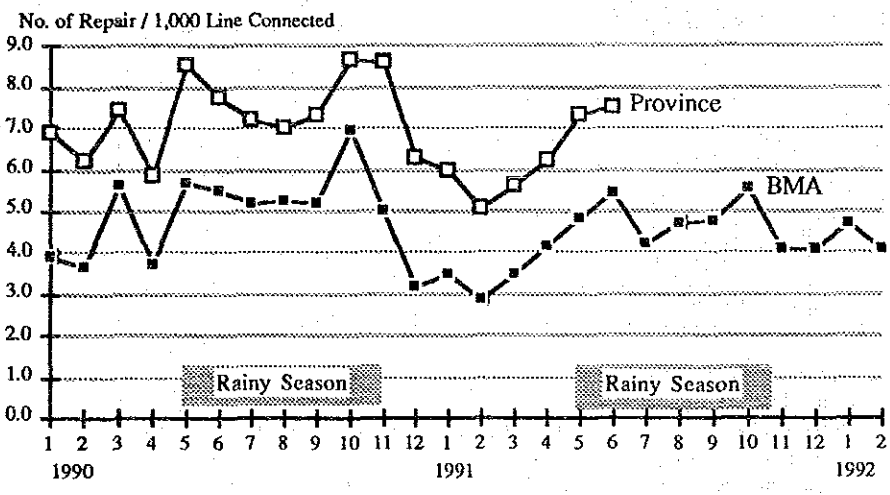


Figure 2.2.2-2 Configuration of the Local Cable Network



Data : Monthly Maintenance Report by Maintenance Center and Summary of Monthly Report by Department of Customer Service

Figure 2.2.2-3 Number of Repaired Cable Faults per 1,000 Lines Connected

Table 2.2.2-1 shows the major reasons of the cable faults, which have been known to TOT. It also shows that many faults are caused by the troubles of the closures.

Table 2.2.2-1 Major Reasons of the Local Cable Faults of TOT

Phenomenon	Reason	Measures of TOT
Water penetration at the heat shrinkable closure	1) Underground cable - Creeping of the cables makes splits between the cable sheaths and closures - Re-bending stress of the cables makes splits 2) Aerial Cable - vibration of the cables makes splits 3) Common - Over heating at the time of construction make cracks on the closures	- Improvement of reliability of the closures - Development of a moisture monitoring system - Change the closures with lead sleeve closures when the closures get some trouble
Water penetration from the ready access type closure	- The cover of closure is blown away by wind - The cover and body change their shape and make splits between them by the deterioration	- Change the closures with lead sleeve closures and stub type terminals - Improvement of the closures
Damage by birds and ants	- Insects go into the closures from splits and make their nests inside the closures	- Ditto
Damage by electric power leakage (Mainly province)	- The ground power lines contact with the bolts for the cables in the pole	- Use insulators between the volt and strand wires of the cables
Damage by lightning	- Low quality of the bonding wires inside the closure - High ground resistance in some places	- (The quality satisfy the specifications) - Improvement of the ground method
Deterioration of the facilities	- Former facility plan only amid at the fulfillment of the subscription demands	- Rehabilitation of the old facilities

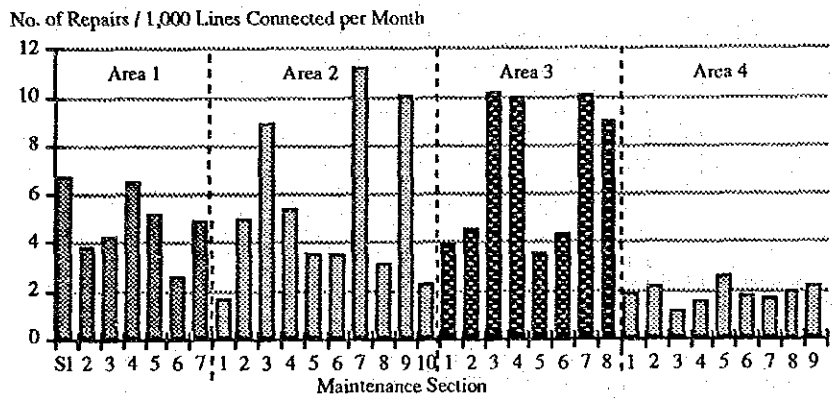
a) Study Method

Generally, there are two steps to reduce the number of faults. One is to replace the faulty facilities and the other is to improve the quality of the facilities. By the reasons of the cable faults described in Table 2.2.2-1, it is better to improve the quality of the materials to reduce the fault ratio fundamentally. However, some research and development on the materials will be needed. It usually takes a long time to develop a new technology and face some uncertainties also. In addition, it is better to consider how to rehabilitate the facilities effectively from the viewpoint of the length of time involved.

To carry out the rehabilitation effectively, knowing the faulty facilities is very important. Hence, the point of this study was narrowed down to how to find the faulty facilities to be rehabilitated and how to set the priority for them.

b) Examination by the Maintenance Report

From the monthly maintenance reports, it can be found fault occurrence conditions are different in each maintenance area as shown in Figure 2.2.2-4. The faults occur unevenly, therefore, giving the highest priority for the rehabilitation to the worst area will make the work most effective.



Data : Monthly Maintenance Report by the Maintenance Center (1991.3 - 1992.2)

Figure 2.2.2-4 Average Number of Repaired Cable Fault per 1,000 Lines Connected in each Maintenance Section in the BMA

c) Examination by the Repair Record for the Primary Cables

Generally, the older facilities cause more frequent faults. If there is a strong correlation between the age of the facility and the fault ratio, it is easy to set a guideline for rehabilitating the facility. To investigate this correlation on the primary cables, the following study was carried out.

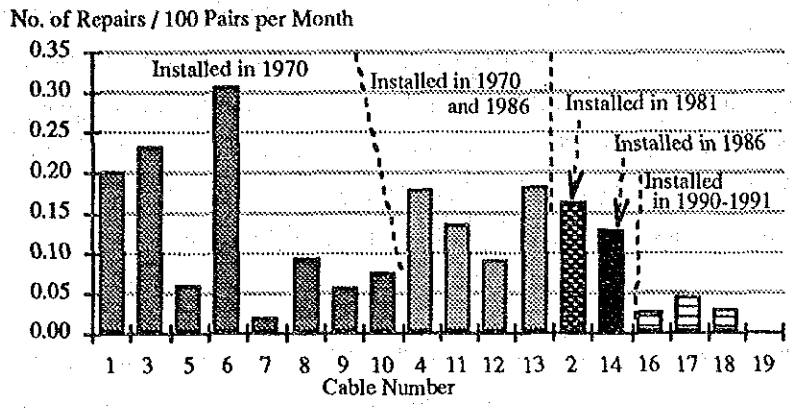
The recent repair records of the faults occurred in the BMA are stored in the Sector of Computer and Operations. Which facility caused the fault can be found by sorting out the records. Information of the facilities such as the age of cables, which cables have been connected to which cabinets, etc. can be found in the outside plant records.

Table 2.2.2-2 and Figure 2.2.2-5 to 2.2.2-7 show the results of the analysis. Figure 2.2.2-5 and 2.2.2-6 were made with the data shown in Table 2.2.2-2. This result shows that the relation ship between the age of the facility and the fault ratio is not so strong. And the faults concentrate to some facilities as the graph on the right hand side in Figure 2.2.2-6 shows that the about fifty (50) percent of the faults have occurred on thirty (30) percent of the cables.

Table 2.2.2-2 Number of Repairs for the Primary Cable Faults in the Krungkasem Exchange Area

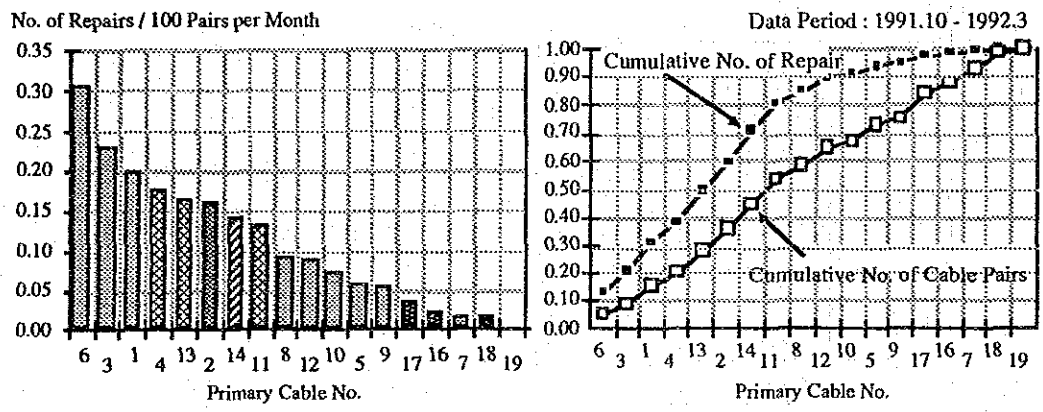
Primary Cable No.	Distributed Pairs	Total No. of Repairs	No. of Repairs / 100 pairs per Month	Installed Year
1	2100	25	0.198	1970
2	2800	27	0.161	1981
3	1450	20	0.230	1970
4	1700	18	0.176	1970, 1986
5	1750	6	0.057	1970
6	1800	33	0.306	1970
7	1750	2	0.019	1970
8	1800	10	0.093	1970
9	900	3	0.056	1970
10	900	4	0.074	1970
11	3150	25	0.132	1970, 1986
12	2200	12	0.091	1970, 1986
13	2850	31	0.181	1970, 1986
14	3000	23	0.128	1986
16	1450	2	0.023	1990
17	3000	8	0.044	1990
18	1900	3	0.026	1990
19	500	0	0.000	1991

Data : Repair Records of the Krungkasem Exchange Area stored in Computer Center (1991.10 - 1992.3)



Data : Repair Records of the Krungkasem Exchange Area in the Computer Center (1991.10 - 1992.3)

Figure 2.2.2-5 Number of Repairs for the Primary Cable Faults per 100 Pairs per Month in the Krungkasem Exchange Area



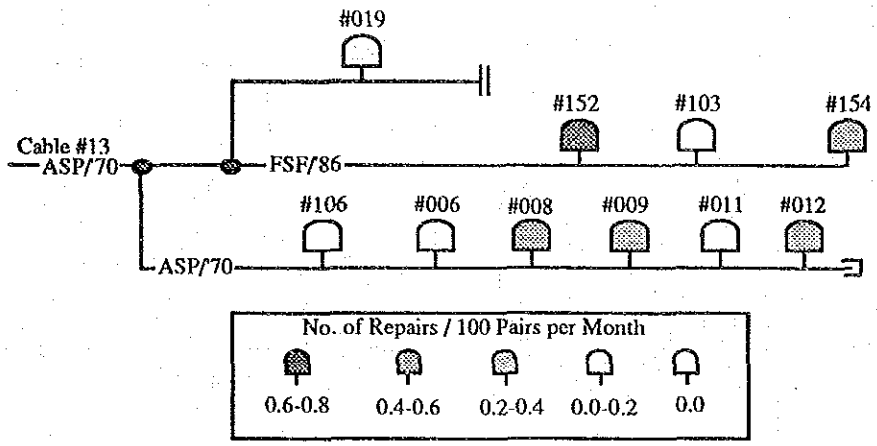
Data : Repair Records of Krungkasem Exchange Area in the Computer Center (1991.10 - 1992.3)

Figure 2.2.2-6 Distribution of the Number of Repairs by Primary Cables in the Krungkasem Exchange Area

The primary cables have some branch cables and the pairs have been connected to some cabinets as shown in Figure 2.2.2-7. It is possible to sort the repair records with the cabinet numbers. Therefore, if some differences in fault occurrence conditions would be found among the cabinet numbers, the facilities to be rehabilitated will be further narrowed down.

Figure 2.2.2-7 shows a result of the above analysis for the primary cable number 13 in the Krungkasem Exchange Area. This figure shows the difference of the number of repairs between the pair groups involved in the same primary cable. For instance, the pair group connected to the cabinet #152 have been repaired more than

the pair groups connected to the cabinet #103 and #154 even though they are connected to the same cable. Accordingly, there is a high probability that the fault points are in the lead up cable between the primary cable and cabinet or in the cabinet.



Note; ASP : Paper or Wood Pulp Insulation STALPETH Sheathed Cable
FSF : Form/Skin Insulation ALPETH Sheathed Filled Cable

Figure 2.2.2-7 Fault Condition by Cabinet on a Primary Cable in the Krungkasem Exchange Area

d) Examination by the Repair Record for the Secondary Cables

When an effective facility rehabilitation is required, it is important to know which facility should be rehabilitated at first.

It can be found that how many secondary cable faults have been repaired in which cabinet area by the same manner for the primary cable faults. And which type of materials have been used for the secondary cables can be checked by the plant record of the secondary cables. Therefore, it is possible to know which cable routes caused the faults.

Figure 2.2.2-8 and Table 2.2.2-3 show the results of the above analysis. These results show the faults concentrate on certain cabinet areas. For example, the graph on the right hand side in Figure 2.2.2-8 shows that about fifty (50) percent of the repairs have been done in about twenty (20) percent of the cabinet areas. To understand causes of the faults, some analyses such as a relation ship between the number of closures and the number of faults, a relation ship between the total length

of cables and the number of faults were made. But, there is only a slight evidence which older facilities have gotten more repairs as shown in Table 2.2.2-3.

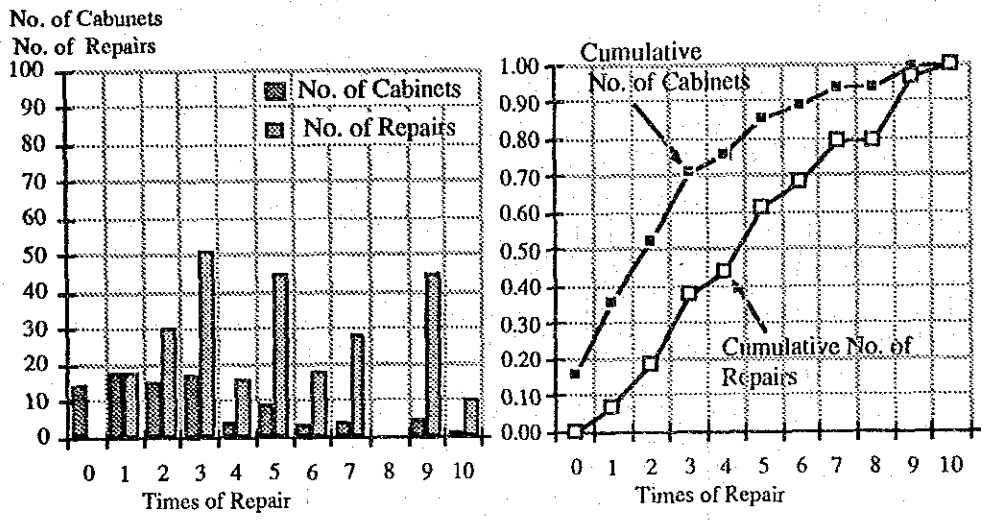


Figure 2.2.2-8 Distribution of the Secondary Cable Faults by Cabinet Area in the Krungkasem Exchange Area

Table 2.2.2-3 Number of Repairs for the Secondary Cables in the Krungkasem Exchange Area

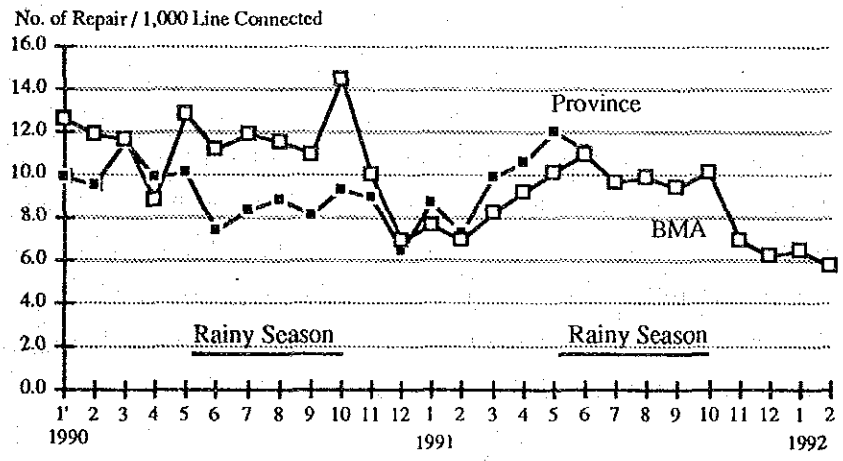
Cabinet No.	Distributed Cable Pairs	No. of Repairs ('91.10 - '92.3)	No. of Repairs / 100 Pairs per Month	Installed Year of the Secondary Cables
152	250	17	1.13	Before 1986
137	250	13	0.87	Before 1986
121	300	15	0.83	1986 - 1990
015	200	9	0.75	1986 - 1990
051	300	13	0.72	Before 1986
002	200	3	0.25	1986 - 1990
141	400	4	0.17	Before 1986
028	250	2	0.13	1990
140	300	2	0.11	1986 - 1990
007	200	1	0.08	1990
023	300	0	0.00	1990
103	200	0	0.00	1990

Note ; The cabinet areas in this table are picked up at random.

2) Drop Wire Fault

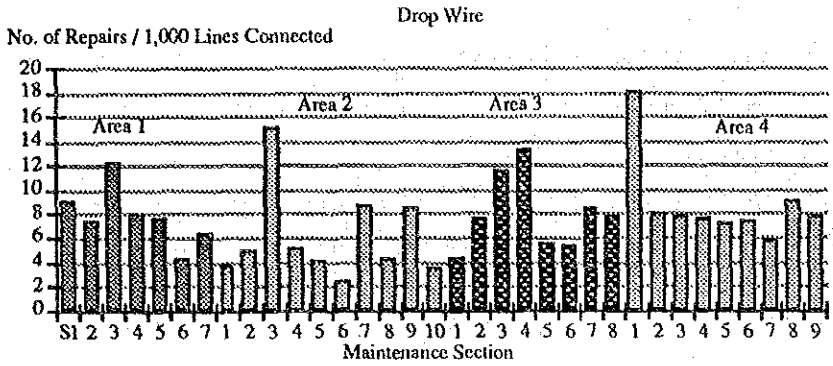
The drop wires are installed from the distribution points on the secondary cables to the protectors installed customer houses, public telephones, etc.

The drop wire faults include the faults at the cabinet jumpers. The drop wire faults occupy about thirty (30) percent of the facility faults in the BMA and about twenty (20) percent in the provincial area. Figure 2.2.2-9 shows the number of repaired drop wire faults. This figure shows that the number of repairs has been steadily decreasing but there is an increasing tendency during the rainy season. And also, the average number of repairs in maintenance areas quite different as shown in Figure 2.2.2-10.



Data : Monthly Maintenance Report by the Maintenance Center
Summary of Monthly Report by the Department of Customer Service

Figure 2.2.2-9 Number of Repaired Drop Wire Fault per 1,000 Lines Connected



Data : Monthly Maintenance Report by the Maintenance Center

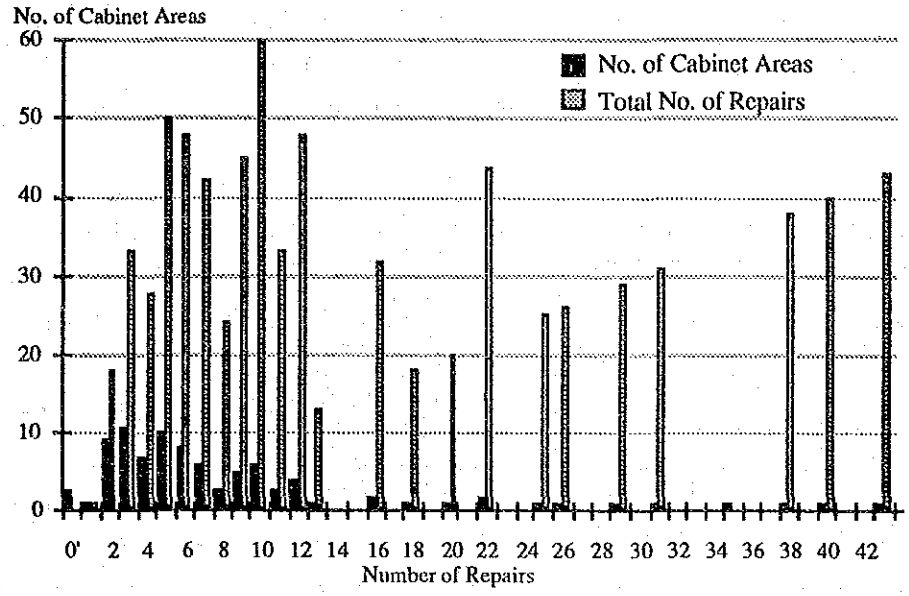
Figure 2.2.2-10 Average Number of Repaired Drop Wire Fault per 1,000 Lines Connected in each Maintenance Section in the BMA (March 1991 - February 1992)

a) Study Method

Generally, the drop wire faults relate to their age and length because the insulators of the drop wires are not so strong against the sever weather conditions and contacts with hard objects. The longer drop wire has more probability to contact with other objects. The drop wires in Thailand look very long and crowded. Therefore, the following investigations are carried out to examine whether or not such tendency can be found to the drop wires of TOT.

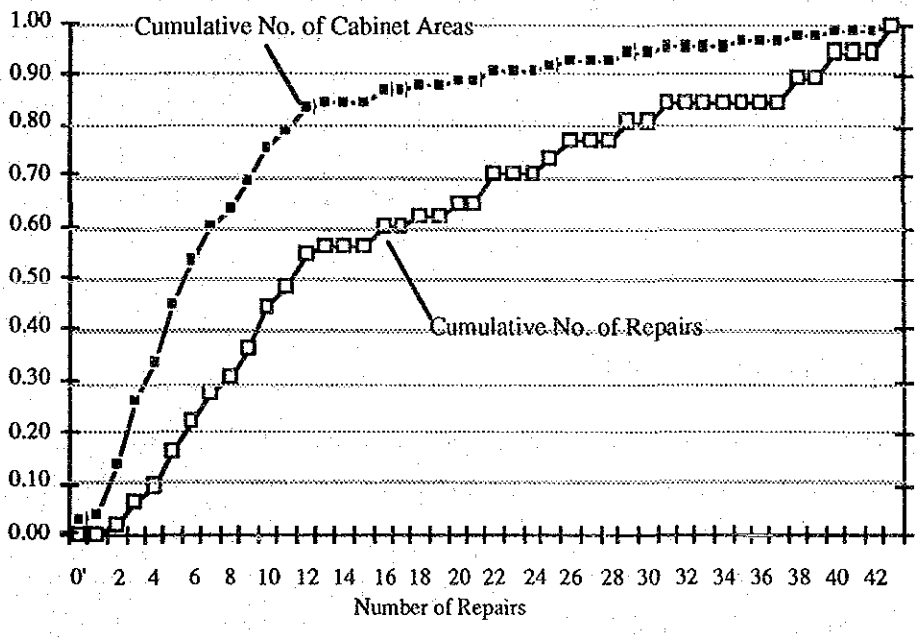
b) Examination by Repair Record

The condition of drop wires is different in different areas. They are installed in a crowded manner in some areas and installed neatly in another areas. Figure 2.2.2-11 shows how many repairs have done in the recent six months in each cabinet area. Figure 2.2.2-12 shows how much percent of the repairs have done in how much percent of the cabinet areas. These figures are made by sorting of the repair records reported in recent six months in the Krungkasem Exchange Area, and also show the repairs concentrate on some cabinet areas.



Data : Repair Record from the Computer Center (91.10-92.3)

Figure 2.2.2-11 Distribution of Repairs for the Drop Wire Faults (1/2)



Data : Repair Record from the Computer Center (91.10-92.3)

Figure 2.2.2-12 Distribution of the Number of Repairs for the Drop Wire Faults (2/2)

Table 2.2.2-4 shows how many times the drop wire faults were repaired for the same subscriber in recent six months in the Krungkasem Exchange Area. This was also obtained by sorting the repair records. This table shows some subscribers

have experienced frequent faults, and also hints that the reason of faults may be unsuitable repair methods. Because the drop wire faults is mainly fixed by twisting the fault points. Most of the twist points are not covered by insulators.

Table 2.2.2-4 Number of Subscribers classified by the Number of Repairs during the Last 6 Months in the Krungkasem Exchange Area

Times of Repair	No. of Subscribers	% (Subscribers)	No. of repairs	% (Repairs)
1	580	85.5	580	69.3
2	80	11.8	160	19.1
3	7	1.0	21	2.5
4	4	0.6	16	1.9
5	2	0.3	10	1.2
6	1	0.1	6	0.7
7	1	0.1	7	0.8
8	1	0.1	8	1.0
9	0	0.0	0	0.0
10	0	0.0	0	0.0
11	0	0.0	0	0.0
12	0	0.0	0	0.0
13	1	0.1	13	1.6
14	0	0.0	0	0.0
15	0	0.0	0	0.0
16	1	0.1	16	1.9
Total	678	100.0	837	100.0

c) Investigation in the Field

More than ninety (90) percent of the drop wire faults have been repaired without changing the wires. Hence, it is possible to find the fault points by field investigations of the drop wires. The five cabinet areas in the Krungkasem Exchange Area were selected to carry out the field investigation. The result of the investigation is shown in Table 2.2.2-5.

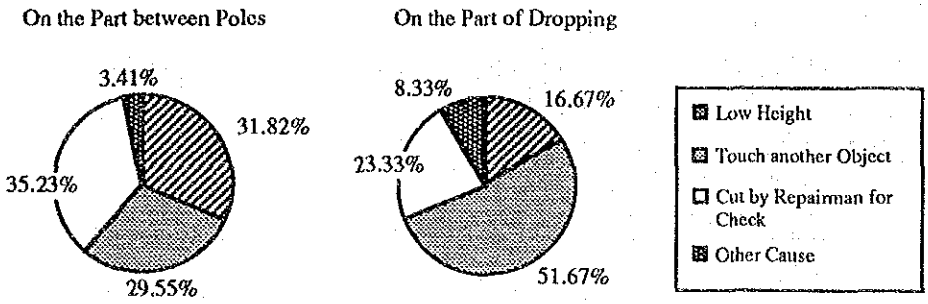
As Table 2.2.2-5 shows, the faults have occurred on both part of between the poles and the dropping. The probability of a drop wire fault is rather high between the poles. This tendency is clear in some areas which are in short of the distribution points such as the cabinet area number 121. These results indicate that the long drop wires are one of the main causes of the faults. Figure 2.2.2-13 shows the percentage of the reasons of repair marks on the drop wires checked by the field

investigation. From the situation in the field, the reason of low height is the drop wires have gotten out from the hungers because they are crowded. The main object of the contact is trees on the streets.

Table 2.2.2-5 Result of the Field Investigation for the Drop Wire faults

Five Cabinet Areas in the Krungkasem Exchange Area in May 1992

Cabinet No.			121	028	137	002	140	Total
Capacity of Distribution Point			85	200	375	206	250	1,116
No. of Faults ('91.10-92.3)			40	25	29	2	2	98
No. of Faults / Capacity of Distribution Point			0.47	0.13	0.08	0.01	0.01	0.09
No. of Checked Poles			58	31	17	27	24	157
No. of Distribution Points on the Checked Poles			9	6	14	14	13	56
No. of Distribution Poles			19	14	12	16	16	77
Between Poles and Customer Houses	Total No. of Drop Wires		57	67	146	109	142	521
	Total No. of Repair Marks		10	14	24	4	8	60
		Low Height	0	4	3	1	2	10
		Touch another Object	5	5	15	2	4	31
		Cut by Repairman for Check	4	2	6	1	1	14
		Other Cause	1	3	0	0	1	5
		% of repair marks	17.5%	20.9%	16.4%	3.7%	5.6%	11.5%
Between Poles	Total No. of Drop Wires		181	91	18	85	120	495
	Total No. of Repair Marks		50	19	5	8	6	88
		Low Height	12	8	3	0	5	28
		Touch another Object	14	8	1	2	1	26
		Cut by Repairman for Check	22	2	1	6	0	31
		Other Cause	2	1	0	0	0	3
		% of repair marks	27.6%	20.9%	27.8%	9.4%	5.0%	17.8%
Total	Total No. of Drop Wires		238	158	164	194	262	1,016
	Total No. of Repair Marks		60	33	29	12	14	148
		Low Height	12	12	6	1	7	38
		Touch another Object	19	13	16	4	5	57
		Cut by Repairman for Check	26	4	7	7	1	45
		Other Cause	3	4	0	0	1	8
		% of repair marks	25.2%	20.9%	17.7%	6.2%	5.3%	14.6%
		% of Low, Touch & Other	14.3%	18.4%	13.4%	2.6%	5.0%	10.1%



Source : Field Investigation in the Krungkasem Exchange Area in May 1992

Figure 2.2.2-13 Percentage of the Reason of Repair Marks on the Drop Wires

Figure 2.2.2-14 shows what percent of the drop wires experienced the faults according to the years after their installation date. Table 2.2.2-6 shows how long it takes to experience the first fault from installation date, and to experience the next fault from the first. These data were collected from the subscriber records selected by a random sampling method at the complaint center in the Krungkasem Exchange Office. The average length of the period between the installation date and the first fault seems too short. It also hints that some unsuitable installation methods and repair methods might have been used.

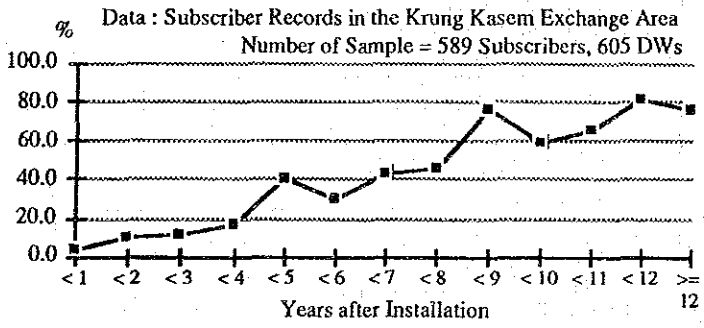


Figure 2.2.2-14 Percentage of the Fault Experience of the Drop Wires

Table 2.2.2-6 Period from Installation to First Fault and the Next Fault after the Repair

Data : Subscriber Records in the Krungkasem Exchange Area

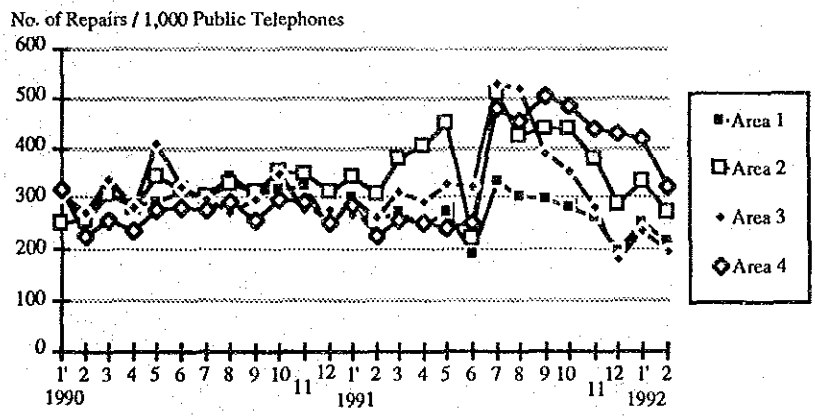
	First Fault	Second Fault	Third Fault
Number of Samples	267	97	44
Average Period (Years)	4.2	2.9	1.4
Maximum Period (Years)	15.5	13.3	4.9

3) Subscriber Set Fault

Most of the subscriber set faults have occurred on the public telephone sets. Hence, the Study focused on the public telephone faults.

a) Examination by the Maintenance Report

Figure 2.2.2-15 shows the repair tendency of the public telephone sets. The number of repairs per 1,000 telephone sets rapidly increased from the middle of 1991. The reason may be the introduction of one kind of telephone sets as shown in Figure 2.2.2-16 to 2.2.2-19.

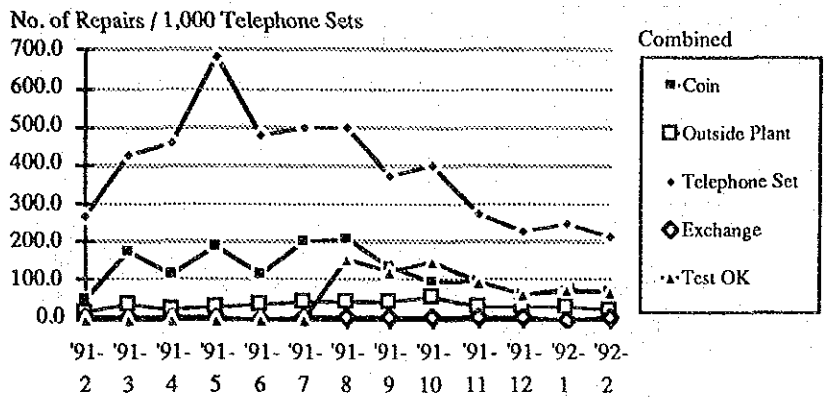


Data : Monthly Maintenance Report by the Maintenance Center

Figure 2.2.2-15 Number of Repairs for the Public Telephone Sets per 1,000 Terminals in each Maintenance Area (March 1991 - February 1992)

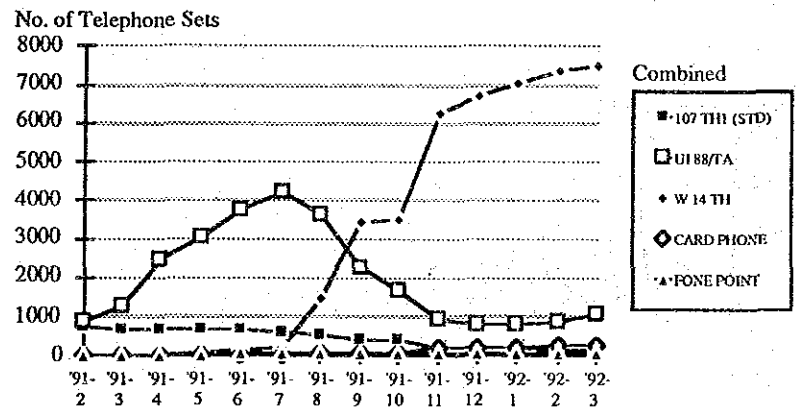
Figure 2.2.2-16 shows the tendency of the causes of the faults on the combined type public telephones in the BMA. Figure 2.2.2-17 shows the number of combined type public telephone sets in the BMA. The number of repairs made on telephone sets increased after the introduction of a new type of public telephone

sets, and decreased according to removal of the telephone sets. Therefore, the reason of many faults can be this telephone set.



Data : Statistical Report by the Public Telephone Division

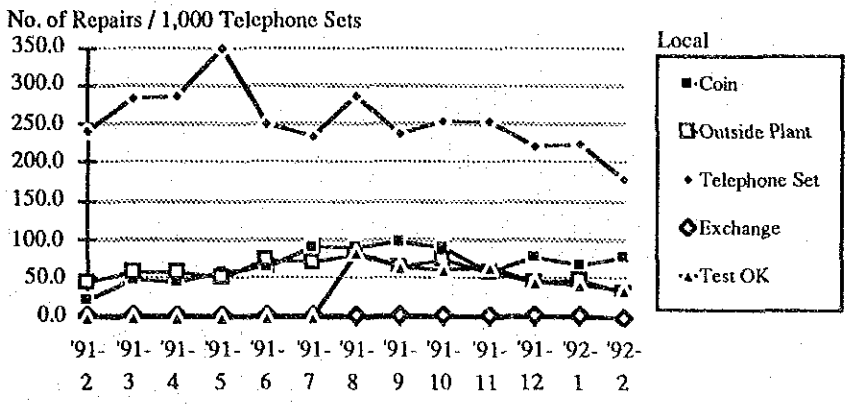
Figure 2.2.2-16 Number of Repairs for the Public Telephones per 1,000 Telephone Sets in the BMA (Combined Type)



Data : Statistical Report by the Public Telephone Division

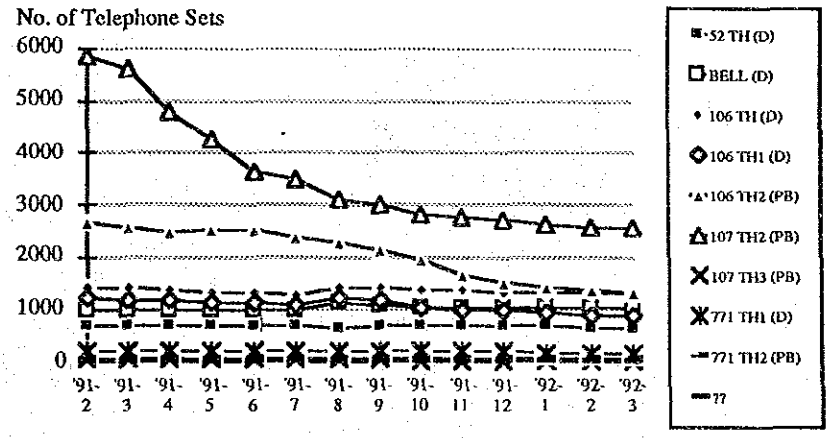
Figure 2.2.2-17 Number of Public Telephones by Type in the BMA (Combined Type)

Figure 2.2.2-18 shows the tendency of the causes of the faults on the local call type public telephones in the BMA. Figure 2.2.2-19 shows the number of local call type public telephone sets in the BMA. The number of fault on the telephone sets has been decreasing according to decrease of the one kind of telephone sets. Therefore, the main reason of the public telephone set faults is this type of telephone set.



Data : Statistical Report by the Public Telephone Division

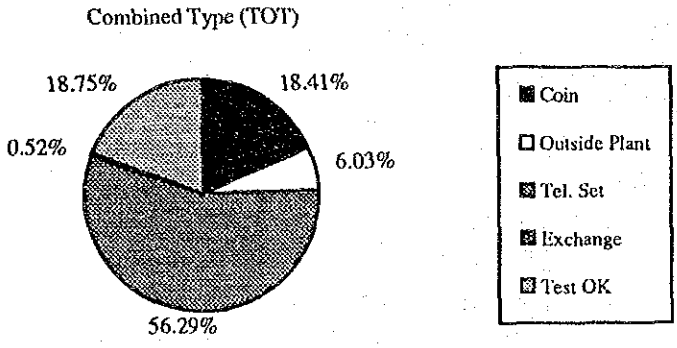
Figure 2.2.2-18 Number of Repairs for the Public Telephone Sets per 1,000 Telephone Sets in the BMA (Local Call Type)



Data : Statistical Report by the Public Telephone Division

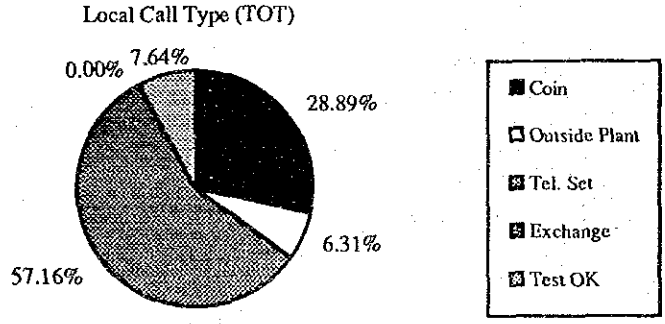
Figure 2.2.2-19 Number of the Public Telephone Sets in the BMA (Local Call Type)

Figures 2.2.2-20, 2.2.2-21 and 2.2.2-22 show the percentages of the causes of the faults by the maintenance responsibility classification. Figure 2.2.2-22 is for the public telephone sets which have been maintained by individual users. The other figures are for the public telephone sets maintained by TOT. There is no big difference of the faults among them.



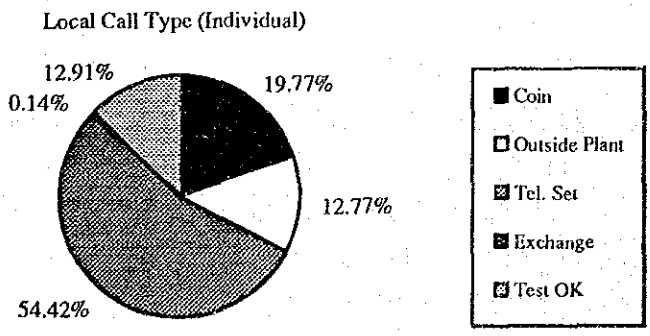
Data : Statistical Report by the Public Telephone Division

Figure 2.2.2-20 Percentage of Types of Faults of the Public Telephone Sets (Combined Type)



Data : Statistical Report by the Public Telephone Division

Figure 2.2.2-21 Percentage of Types of Faults of the Public Telephone Sets maintained by TOT (Local Call Type)



Data : Statistical Report by the Public Telephone Division

Figure 2.2.2-22 Percentage of Types of Faults of the Public Telephone Sets maintained by Individual Users (Local Call Type)

b) Examination with Repair Records

To reduce the number of public telephone set faults, it is necessary to know the differences in fault ratios by types of public telephone sets. Because the number of faults can be reduced to some extent by changing the telephone sets. How many public telephone sets were repaired can be found by sorting the repair records in the computer center. The data is also classified by types of the sets. Hence, the fault ratios by types of the public telephone sets are obtained by calculating the number of public telephone sets by types in the area.

The result of the investigation is shown in Table 2.2.2-7. In this table, the number of repairs per 1,000 telephone sets per month is estimated with the number of the public telephone sets by types in the BMA and the percentage of subscribers in the Krungkasem Exchange Area to the BMA total, because the data of the Krungkasem Exchange Area could not be obtained during the study period.

Table 2.2.2-7 shows that some types of the telephone sets have high fault ratios.

Table 2.2.2-7 Number of Repaired Faults by Types of the Public Telephone Sets in the Krungkasem Exchange Area (October 1991 to March 1992)

Type	Repair	Change Set	Change Parts	Power Parts	Booth	Other Cause	Total Fault	No. of Tel. Set	Fault/1,000 Sets/Month
52TH	55	1	0	5	0	2	63	168	375
BELL	47	0	3	2	0	0	52	254	205
106TH	70	0	5	3	3	6	87	324	269
106TH1	31	0	0	6	2	2	41	231	177
106TH2	210	0	11	41	8	18	288	377	764
107TH1	18	0	2	2	2	2	26	59	443
107TH2	88	0	3	18	2	5	116	654	177
107TH3	5	0	0	1	0	0	6	5	1,144
UI88	238	3	0	3	2	1	247	253	978
W14TH	328	7	2	71	22	46	476	1,566	304
Others	-	-	-	-	-	-	-	141	-
Total	1,090	11	26	152	41	82	1,402	4,031	347

c) The Other

It was noticed that most protectors for the public telephones have not been used. The drop wires were connected directly to the inside wires for the public telephones. According to the staff of TOT, the reason is the low quality of the protectors. However, some sensible parts such as IC, RAM have been stored in the public telephone sets to control the circuits. This situation be in taken into consideration, it is able to consider that some telephone set faults are not related to the protectors.

4) Inside Wire Fault (Customer Premise)

With regard to the inside wire faults, the maintenance responsibility belongs to the customers except telephones used by the government sectors, TOT, and the public telephones. This section discusses how to reduce the faults at the customer premises because most of the inside wire faults have occurred there.

a) Examination by the Repair Records

Table 2.2.2-8 shows the number of subscribers classified by the number of the inside wire repairs during the recent six months. This was obtained by the repair records in the computer center. This data shows that some customers have experienced the frequent inside wire faults.

Table 2.2.2-8 Times of Repairs at One Subscriber Location during the Last 6 Months in the Krungkasem Exchange Area (October 1991 - March 1992)

The Times of Repair	No. of Subscribers (A)	% of Faulted Subscribers (A) ÷ (C)	% Share (A) ÷ Total (A)	Total Number of Repairs (B)	% Share (B) ÷ Total (B)
Once	528	2.11%	90.9%	528	74.4%
Twice	38	0.15%	6.5%	76	10.7%
3 Times	7	0.03%	1.2%	21	3.0%
More than 4 Times	8	0.03%	1.4%	85	12.0%
Total	581	2.33%	100.0%	710	100.0%

Note; (C) = 24,972 (Number of Subscribers in the Krungkasem Exchange Area at the End of February)

b) Examination by Field Survey, etc.

For the inside wire faults, the Study Team did not carry out any specific investigation. But in the Phrakanong Exchange Area, the Study Team got a chance to see the inside wires at three customer residences. The inside wires were not in good condition.

The information gathered during the study period is as follows:

i) There are many splices on the inside wires.
ii) Inside wires for the telecommunication and electric power are wired at the same place.
iii) Inside wires have some branch wires.
iv) The connection method is mainly hand twists, and the splicing points are not protected.
v) Most of subscriber have not installed the protectors.
vi) Some customers do not know any private maintenance service company.
vii) There is no qualification system for the inside wiring in Thailand.
viii) TOT does not check the quality of the inside wires when telephone is installed.

From these, it can be presumed that the major reasons of the inside wire faults are low quality wiring works and lack of the customer knowledge concerning the maintenance of the telephones.

5) Test OK

Test OK means that it is a real fault when an operator checks a subscriber line from the test desk in the complaint center, but that the fault has been already fixed naturally before a repairman checks the facilities at the site. Therefore, it is difficult to find reasons of the Test OKs.

There are some possible reasons of the Test OKs;

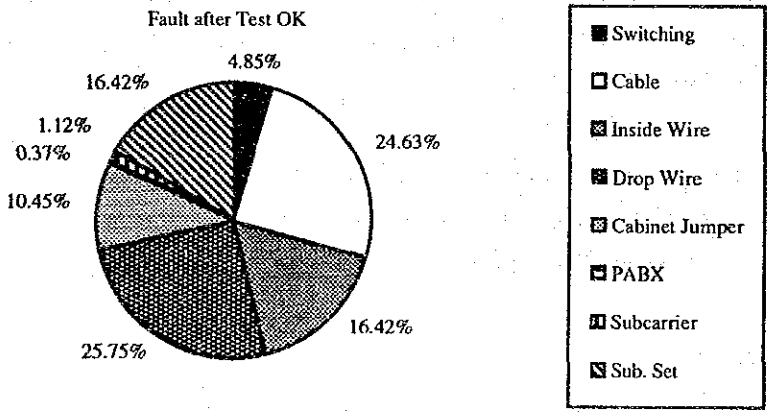
i) Miss operation of the telephone set by a user,
ii) Miss operation in insider works such as installation, routine test,
iii) Intentional happening,
iv) Low insulation resistance to moisture,
v) Loose contact or mutual contact happened for a short time at splicing points, etc.

a) Examination by the Subscriber Record

It can be considered that most of the Test OKs are signs of the real faults. Every fault occurred on every subscriber is recorded in the complaint center. Then, which facility have gotten the fault near after the Test OKs is able to know by checking the subscriber records.

500 subscriber records were selected by a random sampling method. What faults occurred after the Test OKs within 100 days were examined. The sample period was the recent 3 years. The result is shown in Figure 2.2.2-23 and Table 2.2.2-9.

The percentage of the Test OKs has been decreasing along with the decrease of the fault ratio. Therefore, the Test OKs are most likely related to the real fault. Hence, it is expected that the number of the Test OKs per 1,000 lines connected will decrease along with the decrease of another faults.



Data : Subscriber Record of the Krungkasem Exchange Area (Recent 3 years)

Figure 2.2.2-23 Types of Faults occurred after the Test OKs

Table 2.2.2-9 Types of Faults occurred after the Test OKs

Type of Fault after the Test OK	Number of Faults	%
Switching	13	4.9
Cable	66	24.6
Inside Wire	44	16.4
Drop Wire	69	25.7
Cabinet Jumper	28	10.4
PABX	1	0.4
Subcarrier	3	1.1
Subscriber Set	44	16.4
Total	268	100.0

Data : Subscriber Record in the Krungkasem Exchange Area in recent 3 years

6) Repair Method

The outline of repair methods for the outside plant faults of TOT is following.

Type of Facility	Condition of Facility	Repair Method	Issue
Cable	No Vacant Pair	Repair	Temporary Work for the Closures
	Some Vacant Pairs	Change or Repair	
Drop Wire	More than 7 Years past one or deteriorated one	Change with New One	
	Others	Repair or Change Some Parts	Non Protection for the Fixed Point
Public Telephone	Object One of the Replacement	Replace with New Sets	Non Protector
	Impossible to Repair at the Site	Replace with Good Sets	
	Others	Repair	
Customer Premises	-	TOT does not Repair	Non Protector, Uncertain Repair

There are following issues on the fault repair methods.

a) The closures of the secondary cables are sometimes not closed completely. This causes another faults such as low insulation resistance against moisture, damages by birds and insects. Therefore, the complete repair work is expected.

b) About ninety (90) percent of the drop wire faults are repaired without changing the drop wires. The drop wires which are repaired once are easy to get another faults within a short time as shown in Table 2.2.2-6. The drop wires are damaged by repair men during repair work. The connecting points are not often protected by some materials. Therefore, the improvement of drop wire repair methods is expected.

c) TOT does not repair the faults at the customer premises, the fault. Both TOT and customers hope that the repairs are made as soon as possible. Therefore, advice and cooperation from TOT is expected to make smooth repairs.

7) Maintenance Activity for the Outside Plant

The outline of the maintenance activities of TOT is as follows.

Maintenance Activity	Objective	Issue
Continuous Flow Gas Maintenance Periodic Filling Gas Maintenance	Protect the Non-Jelly Filled Cables from Water Penetration	No Monitoring System for the Jelly Filled Cable
Rehabilitation for the Deteriorated and faulty Facilities	Reduction of the Faults	The Plan is Executed 2 Years later
Change the Drop Wire with Cables - More than 10 Years Old Ones - More than 6 Lines on the Same Route	Reduction of the Faults	
Arrangement of the Crowded Drop Wires (Tie up in a bundle)	Reduction of the Faults	
Change the Faulty Public Telephone Set to the Good One	Reduction of the Faults	
Routine Check for the Public Telephone (once every 3 days)	Reduction of the Faults	Shortage of the Manpower
Monitoring for the Public Phone - Number of Coins in the Safe - Condition of Telephone Set	Reduction of the Faults and Quick Repairs	
Investigation for the Ground System	Protect Cable Network from the Induce Current	
Research and Development for the Closures	Improvement of Reliability for the Closures	
Development of the Water Penetration Monitoring System	Protect the Jelly Filled Cables from Water Penetration	

About seventy (70) percent of the primary cables of TOT are jelly filled cables. Some troubles such as water penetration from the heat shrinkable closure have been reported.

Therefore the introduction of the Water Penetration Monitoring System developed by the Test and Development Sector should be considered with a high priority.

2.2.3 Improvement Measures

It is generally more effective if the improvement in the quality of facilities is carried out with some improvement or development of the materials together as shown in Figure 2.2.3. But the plan aims to achieve the target of 2.5 percent per month within five years. And it is slightly difficult to expect that some materials which suitable for the environment of Thailand can be developed during the plan period. Therefore, the Study Team mainly considers the rehabilitation of the facilities for the improvement plan because the rehabilitation with present technique is the most certain way.

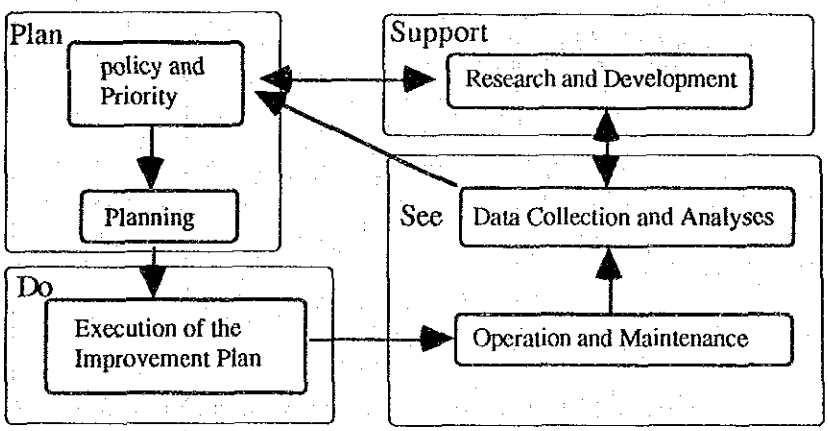


Figure 2.2.3 Cycle for the Improvement of the Quality

To achieve the target of the facility fault ratio, more than 42% of the outside plant faults is required to be reduced. The Study Team proposes the following eight projects (Table 2.2.3-1). The work volume of these projects are estimated with their effects, efficiencies and investment costs are taken into consideration. The details of the projects are described in the following sections and APPENDIX.

Table 2.2.3-1 Proposed Projects (Outside Plant Section)

Facility & Present Fault Ratio (% share of the facility faults)	Existing Volume (A)	Project and Work Volume (B)	% of Existing (B)/(A) %	Expected Fault Ratio after the Project
Cable **0.74 (16.8%)**				**0.46**
Secondary Cable	1,156,126 pair-km (289,0314 pairs)	Rehabilitation 231,000 pair-km	20%	(- 27.6%)*1
Primary Cable	2,293,900 pairs	Rehabilitation 343,500 pairs	15%	(- 11.1%)*1
Drop Wire **1.33 (30.1%)**	1,000,441 drop wires (113,420 km)			**0.55**
		Replacement of Drop Wires with Cables Cable 94,000 pair-km	58% of the total length of drop wires	(- 36.0%)*1
		Rearrangement of Distribution Points 8,250 DPs (99,000 drop wires)	10%	(- 4.0%)*1
		Renewal of Drop Wires 200,000 drop wires	20%	(- 19.1%)*1
Public Telephone **0.60 (13.7%)**	17,495 sets BMA 17,174 Surrounding 317			**0.38**
		Replacement of Public Tel. Sets with Good Type 6,158 sets (BMA 5,841) (Surrounding 317)	35%	(- 31.4%)*1
		Replacement of Protectors with Good Type 17,500 sets	100%	(- 5.5%)*1
Customer Premises	1,250,551 sub.			
- Inside Wire **0.55 (12.6%)**		Facility Check and Consulting Activity 187,000 sub.	15%	**0.41** (- 25.0%)*1
- Sub. Set **0.38 (8.6%)**				**0.27** (- 30.0%)*1
Outside Total **3.59 (81.7%)**				**2.07** (- 42.3%)*1

Note Unit of the fault ratio : Number of faults per 100 subscribers per month
*1 : Expected reduction rete of each facility fault ratio

1) Assumption

This study is not carried out for the whole Study Area as mentioned before. Therefore, the results of the analyses executed for the samples are employed to estimate the effect, work volume and investment cost. And the number of facilities for the estimation is fixed at the end of 1992 or present.

2) Improvement Measures for the Cable Faults

The cable faults have a tendency that more faults occur on the old facilities and concentrate on some areas as described in the section 2.2.2. Therefore, the first priority of the improvement plan for the cable fault is rehabilitation of deteriorated and faulty facilities as follows.

Measure 1) Rehabilitation for the Secondary Cables

According to the result of the study in the section 2.2.2, the effect by this measure is estimated as shown in Table 2.2.3-2.

Table 2.2.3-2 Expected Effect by the Rehabilitation of the Secondary Cables in the Study Area

% of Secondary Cable to be Rehabilitated	Estimated Work Volume (Pair-km)	Estimated Investment Cost (M.Baht) (Contract Work)	Expected Effect (% of Reduction of the Cable Fault)
10	115,613	1,087	17.6
20	231,225	2,174	27.6
30	346,838	3,260	34.9
40	462,450	4,347	40.1
50	578,063	5,434	44.3
60	693,675	6,521	47.7

Note; Estimation procedure is described in APPENDIX

To execute this measure more effective it, the following activities are expected.

i) Repair record analysis and detail field investigation to narrow down the facilities to be rehabilitated.

ii) Setting up the priority for the rehabilitation work. For example the rehabilitation work should be carried out first for the business area.

Measure 2) Rehabilitation for the Primary Cables

This is one of the measure to reduce the fault occurrences on the primary cables. The expected effect of this measure is not so good in relation to the investment cost. But, many paper insulated cables have been used for more than 20 years mainly in the old exchange areas, and the paper insulated cables will become one of the problems when a digital subscriber transmission system will be introduced because of their splicing

method. Therefore, this measure is proposed. The expected effect by this measure is estimated based on the result of the study in the section 2.2.2 as shown in Table 2.2.3-3.

Table 2.2.3-3 Expected Effect by the Rehabilitation of the Primary Cables in the Study Area

% of Primary Cable to be Rehabilitated	Estimated Work Volume (Pair)	Estimated Investment Cost (M.Baht) (Contract Work)	Expected Effect (% of Reduction of the Cable Fault)
10	229,390	1,606	8.2
15	344,085	2,409	11.1
20	458,780	3,211	13.9
30	688,170	4,817	18.6
40	917,560	6,423	22.8
50	1,146,950	8,029	26.4

Note; Estimation procedure is described in APPENDIX

To execute this measure more effective it, the same activities proposed for the secondary cable rehabilitation are expected. And the introduction of digital subscriber transmission system should be taken into consideration.

Measure 3) Introduction of the Water Penetration Monitoring System for the Jelly Filled Type Primary Cables

The jelly filled cable can not protect itself from the water penetration at the closure. If some water penetrates into the closure, the cable pairs are faulted. It will take a long time to clear the trouble. Presently, TOT has the gas maintenance system for the paper insulated underground cables to prevent the cable faults by water penetration. Therefore, it is expected that some preventive system such as the Water Penetration Monitoring System will be introduced as soon as possible. And also many trial tests are required to check reliability of the system.

Measure 4) Research and Development of the Closure

Many troubles on the cables originated to the closures as described before. One of the reason is thinkable that the quality of the closures are not fit to the environment of Thailand, because the closures were developed at foreign country and enough trial tests for them had not been executed. Therefore some research, development and enough trial test for the closures are required to improve the reliability of the cable facility.

3) Improvement Measure for the Drop Wire Fault

The major reason of the drop wire faults is its long length and deterioration as described before. Therefore, the effective measures are to make the length shorter and replace as proposed below.

Measure 1) Change of the Drop Wires with the Cables

As described in the section 2.2.2, many faults have occurred on the drop wires installed between poles. And also, disorderly ones installed into the buildings with many another drop wires have been under the severe environment what easy to cut by something. Hence, faults prevented by this measure are expected as shown in Table 2.2.3-4.

The points of this measure are as follows.

a) It should be enforced with the following priority order.

   i) The area which is in high fault ratio
   ii) Central business area
   iii) Rapidly growing area
   iv) Industrial area

b) It is more effective and economical if it is carried out with the rehabilitation of the secondary cables together.

Table 2.2.3-4 Expected Effect by the Change of the Drop Wires with Cables in the Study Area

% of Drop Wires to be Changed with Cable	Estimated Work Volume (Pair-km) Installation of New Cable	Estimated Investment Cost (Million Baht) (Contract Work)	Expected Effect (% of Reduction of the Drop Wire Fault)
10	9,437	55	3.6
20	18,875	109	7.2
30	28,312	164	10.8
40	37,750	219	14.4
50	47,187	274	18.0
60	56,625	328	21.6
70	66,062	383	25.2
80	75,499	438	28.8
90	84,937	493	32.4
100	94,374	547	36.0

Note; Estimation procedure is described in APPENDIX

Measure 2) Rearrangement of the Distribution Points with New Installation of Terminals

The objective of this measure is the same as the Measure 1). But this can be carried out without the new cable installation. Usually the secondary cables have some spare pairs, therefore, rearrangement of the distribution points for some drop wires is possible by the installation of the new distribution points. The estimated effect by this measure is shown in Table 2.2.3-5.

Table 2.2.3-5 Expected Effect by the Rearrangement of the Drop Point with New Installation of Terminals

% of Drop Wire to be Rearrange the Drop Point	Estimated Work Volume (No. of DP)	Estimated Investment Cost (Million Baht)	Expected Effect (% of Reduction of the Drop Wire Fault)
10	834	1	0.4
20	1,667	3	0.8
30	2,501	4	1.2
40	3,335	5	1.6
50	4,169	6	2.0
60	5,002	8	2.4
70	5,836	9	2.8
80	6,670	10	3.2
90	7,503	11	3.6
100	8,337	13	4.0

Note; Estimation procedure is described in APPENDIX

To carry out this measure, the field investigation such as confirmation of the customer location is important. And, it is necessary that this measure carry out with the Measure 1) together.

Measure 3) Rehabilitation of the Drop Wire with New One

The drop wires are easy to get faulted as they grow old. Therefore, the reduction of the fault occurrences is possible by the rehabilitation for the old ones as shown in Table 2.2.3-6.

The measure should be carried out with the same priority for the Measure 1).

Table 2.2.3-6 Expected Effect by the Rehabilitation of the Drop Wire with New One

% of Drop Wire to be Rehabilitated	Estimated Work Volume (Drop Wire to be Rehabilitated)	Estimated Investment Cost (Million Baht) (Contract Work)	Expected Effect (% of Reduction of the Drop Wire Fault)
10	100,044	65	13.2
20	200,088	130	19.1
30	300,132	195	22.7
40	400,176	260	25.8
50	500,220	325	28.2
60	600,265	390	29.7

Note; Estimation procedure is described in APPENDIX

Measure 4) Unify the Repair Method to Change Only

The repaired drop wires will be faulted again in a few years. The drop wires repaired with the twist method are in danger of self contact or mutual contact. Therefore, to prevent the fault, change of the repair method is recommended.

Measure 5) Improvement of the Drop Wires Installation Method

One of the major reasons on the drop wire faults is that drop wires touch with something as described before. It is effective to prevent the drop wires from touching something by using some protections such as plastic tubes.

Measure 6) Improvement of the Quality of Drop Wire

TOT has used single covered type drop wires. This type is slightly easy to get low insulation resistance by cracks on the insulators. To improve the reliability of the drop wires, improvement in the quality of the wires is recommended. And also, many trial tests are required to check reliability of the wires.

4) Improvement Measure for the Public Telephone

The environment of the public telephone sets is very severe because they have been placed mainly outside and used by many and unspecified persons. There are measures concerning the users and the facilities. But the Study Team recommend measures for the facilities only.

Measure 1) Replacement of the Telephone Set with Good Type

There is a type of the public telephone sets which have high fault ratios as described before. The reduction of the fault occurrences is possible by replacing them. However, to make certain reduction of the faults, many trial tests should be carried out for selecting a type of the public telephone sets.

Table 2.2.3-7 Expected Effect by the Change of the Public Telephone Sets in the BMA

Type of Telephone Set	No. of Telephone Sets to be Changed	Estimated Investment Cost (Million Baht)	Expected Effect (% of Reduction of the Public Telephone Set Faults)
52TH	665	20.0	2.3
BELL	1018	30.5	0.5
106TH	1298	38.9	1.9
106TH2	1342	40.3	12.8
107TH3	21	0.6	0.3
771TH1	170	5.1	0.8
771TH2	80	2.4	0.4
107TH1	167	6.7	0.3
UI88/TA	1080	43.2	12.2
Total	5,841	187.7	31.4

Note; Estimation procedure is described in APPENDIX

Measure 2) Replacement of the Protector with Good Type

Most of protectors for the public telephone sets have been cut from the subscriber loops. The public telephone sets have sensible parts inside. Therefore, some of the faults at the main circuit board would be reduced by using a protector. However, many trial tests are required for selecting a protector type and analyzing the effect.

Table 2.2.3-8 Expected Effect by the Installation of New Protector

Object	Work Volume (Installation of Protector)	Estimated Investment Cost (Million Baht) (Contract Work)	Expected Effect (% of Reduction of the Public Telephone Set Faults)
All of the Public Telephone Set	17,500	8.8	5.5

Note: Assumptions for the estimation are described in APPENDIX

Measure 3) Establishment an Improvement System for the Quality of Telephone Set

Some parts of the public telephone sets such as coin slot, main circuit board have high fault ratio. It is a good way from the economic viewpoint that improving the quality of the parts of existing telephone sets and replacing them with improved ones. To realize this, completion of trouble data collection in the daily maintenance work, analyses of them by using a quality control method and improvement of the quality founded on the result of analyses are indispensable. However, TOT has not such complete system at present. Therefore, establishment of an improvement system which satisfies above functions is recommended.

Additionally, to make clear the mechanisms of the troubles on the telephone sets and to improve the quality of them, getting the cooperation of suppliers will be effective. Hence, it is considerable that TOT introduces a private tender and a continuous purchase to the procurement system for the public telephone sets as one of the way to secure the cooperation of suppliers.

5) Improvement Measures for the Customer Premises (Inside Wire)

It can be considered that the reasons of many faults are low quality of the installation work and lack of knowledge of the customers.

The most certain way to reduce the faults is that TOT maintains these facilities. But TOT deregulated the ownership and maintenance responsibility only five years ago. It might take some year to change the rule again. Therefore, the Study Team recommends the following measures.

Measure 1) Facility Check and Consulting Activity for the Customer Premises by Cooperating with Private Maintenance Service Companies.

This measure can be performed in following steps.

i) TOT offers the maintenance company by public subscription.
ii) TOT gives some training for the maintenance company.
iii) TOT pick up some subscribers who has been gotten frequently fault at the customers premise.
iv) TOT check the customer premises and recommend the private maintenance company which tied up with TOT. When the customer agree with the recommendation, TOT inform it to the private maintenance company.

v) After finish the establishment of the system, TOT introduce it for the routine maintenance such as the repair work by the maintenance staffs.

Table 2.2.3-9 Expected Effect by the Facility Check and Consulting Activity for the Customer Premises

No. of Customer Premises to be checked	Cost (MB)	Effect (% of reduction of the Inside Wire Faults)
More than 10 % of subscribers	24.4	More than 25%

Note: Estimation procedure is described in APPENDIX.

Measure 2) Introduction of Onerous Repair Service by TOT

To introduce this measure, deregulation of the service system is necessary. And enough investigation for decision of the service charge is required. However, this measure is quite effective.

Measure 3) Campaign and Advertisement to the Customers

This measure is that TOT gives some recommendations and advice to the customers by using mass media and the telephone bills.

Measure 4) Check the Customer Premises before Connection with TOT's Network

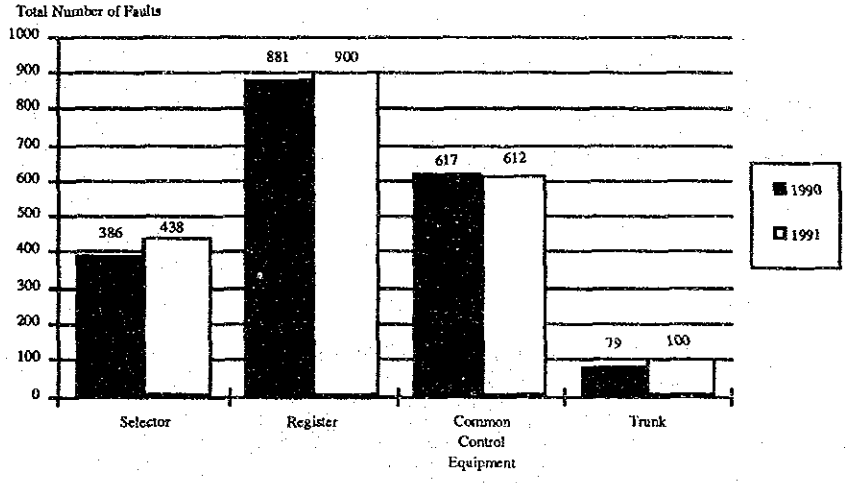
This measure may be effective for the new customers of TOT. But, the new customer will not increase within the following five yeas. However, this measure is useful for the next period.

2.3 Switching Facility

2.3.1 Present State

1) XB Switch Fault

The total numbers of the repaired XB switches (C400) in the BMA are reported to be 1963 in 1990 and 2050 in 1991 according to the Monthly Fault Report. The repaired equipment of the XB switches are classified into the selector, register, common control equipment and trunk categories. Figure 2.3.1-1 shows the total number of repaired faults in each category and Figure 2.3.1-2 shows the number of repaired XB Switch Faults (C400) per 1,000 subscriber lines in each category.



Note: Selector = Switching equipment of XB switch
Source: Monthly Report from the Center of Metropolitan Switching Office

Figure 2.3.1-1 The number of Repaired XB Switch Faults (C400) in the BMA in each Equipment Category

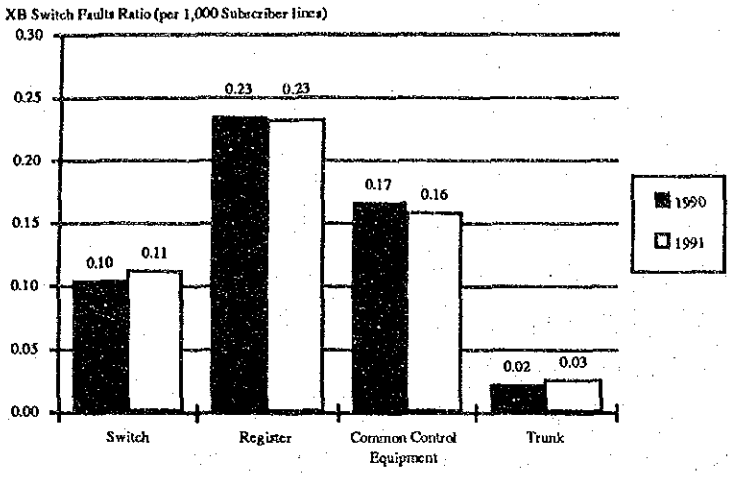


Figure 2.3.1-2 The Number of Repaired XB Switch Faults (C400) per 1,000 Subscriber Lines in the BMA

The percentage Figure s of the repaired equipment category of the XB switches in 1991 are 43.9% for the register, 29.9% for the common control equipment, 21.4% for the selector and 4.9% for the trunk (see also Figure 2.3.1-3).

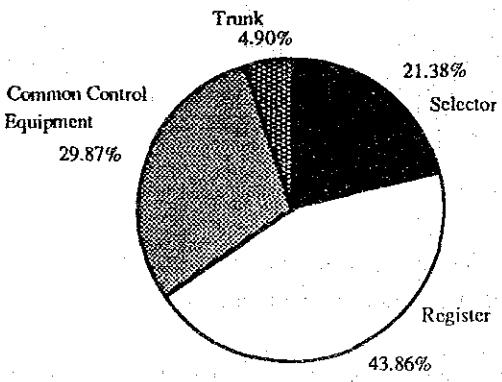


Figure 2.3.1-3 Percentage Figure of Repaired Equipment Categories in 1991

The plant control target value of each equipment category of the XB switches (C400) is shown in Table 2.3.1-1.