JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
MINISTRY OF INFRASTRUCTURE DEVELOPMENT (MOID)
MONGOLIAN COMMUNICATIONS ASSET COMPANY (MCAC)

THE STUDY

ON

TELECOMMUNICATIONS NETWORK

IN

ULAANBAATAR CITY

FINAL REPORT

VOLUME - III

FEASIBILITY STUDY FOR THE PRIORITY PROJECTS

JULY 1996

JAPAN TELECOMMUNICATIONS ENGINEERING
AND CONSULTING SERVICE(JTEC)

NIPPON TELECOMMUNICATIONS CONSULTING CO., LTD(NTC)

TOKYO, JAPAN

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All prices and costs used in this report are those prevailing in April 1996, excepting the case otherwise stated. They are also assumed to be constant during the whole project period.

Exchange Rate : US$1=Mongolian Tugrig (Tg) 490 (April 1996)

PREFACE

In response to a request from the Government of Mongolia, the Government of Japan decided to conduct a study on Telecommunications Network in Ulaanbaatar City and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Mongolia a study team headed by Mr. Yasushi TAKAHASHI, Project Manager, Japan Telecommunications Engineering and Consulting Service, three times between September 1995 and July 1996.

The team held discussions with the officials concerned of the Government of Mongolia, 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 Mongolia for their close cooperation extended to the team.

July 1996

Kimio Fujita

Kimio Fujita
President
Japan International Cooperation Agency

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CHAPTER 1

INTRODUCTION

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INTRODUCTION

1. General

This Volume-III of the Study Report covers a Feasibility Study for two priority projects selected from an urgent development program in the Basic Plan for the development of telecommunications networks in Ulaanbaatar city up to the year 2010.

The Feasibility Study as Phase-II Study has been carried out in accordance with the work plan and schedule of the study which were discussed and agreed upon between MOID/MCAC and JICA. The study work has been done both in Mongolia and in Japan. The major items of the Feasibility Study are referred to in the following:

The Feasibility Study in Ulaanbaatar (27 February - 22 March, 1996)

a) Explanation and discussion of scope of the work for the objective priority projects
b) Decision of objective priority projects for Feasibility Study
c) Collection of data and information regarding the priority projects from a view of both technical and socio-economic points
d) Field survey for the objective priority projects
e) Work for the objective priority projects
f) Technology transfer through feasibility study

The Feasibility Study in Japan (25 March - 31 May, 1996)

a) Socio-economic analysis for the objective area
b) Technical study and project basic design
c) Project cost estimation
d) Project implementation plan
e) Project evaluation
f) Preparation of draft final report of the Feasibility Study

2. Selection of Priority Projects for the Feasibility Study

In the Phase- I Study for preparing the Basic Plan, a project implementation plan up to the year 2010 was prepared. The project implementation plan consists of twenty nine (29) projects which aim to meet rapidly growing telephone demand and to catch up 100 % fulfillment to all demand by the year 2010.

Through the discussion between MOID/MCAC and JICA Study Team, the following two priority projects were selected to conduct feasibility study during Phase- II Study period:

- Installation project of a new exchange unit and its related facilities in ATC-6
- Radio subscriber system introduction project for Ger areas and remote areas

3. Work Schedule for the Feasibility Study

3.1 Overall Time Schedule of the Study

The time schedule of feasibility study by study stage is shown in Table 1-3-1. The feasibility study was carried out in the period of the second study in Ulaanbaatar and the second study in Japan.

Table 1-3-1 Work Schedule of the Study

UB: Ulaanbaatar

Study Stages	1995				1996								
First Study in UB	10W												
First Study in Japan			7W										
Second Study in UB					4W								
Second Study in Japan							6W						
Discussion of DF/R									2W				
Preparation of Final Report											4W		
Submission of Reports	IC/R		P/R				IT/R				DF/R		F/R

IC/R: Inception Report
P/R: Progress Report
IT/R: Interim Report
DF/R: Draft Final Report
F/R: Final Report

W: Weeks

3.2 Progress in the Second Study in Ulaanbaatar

During the second study in Ulaanbaatar from 27 February to 22 March 1996, the study team carried out the following work together with Mongolian counterparts:

a) Explanation and discussion of the Interim Report submitted by the JICA study team
b) Selection of priority projects for feasibility study
c) Collection of data and information for feasibility study
d) Field survey for priority projects selected for feasibility study
e) Preparation of report consisting of basic conditions of feasibility study and outlines of project scope
f) Technology transfer through field survey and basic design of the projects

3.3 Progress in the Second Study in Japan

During the second study in Japan from 15 April to 31 May 1996, the study team prepared the draft final report consisting of basic plan and feasibility study for two (2) priority projects. The study team carried out the following work:

a) Modification of the Basic Plan submitted as Interim Report
b) Basic design and cost estimate for the priority projects selected for feasibility study
c) Evaluation of the objective priority projects for feasibility study
d) Preparation of the draft final report of the feasibility study

4. Priority Projects for the Feasibility Study

4.1 Installation Project of New Exchange Unit and its related Facilities in ATC-6

In this project, new host exchange (capacity ; 16,000 line units) and new cables (11,000 lines) with rehabilitation cables (10,800) will be installed in ATC-6. At the same time, the junction circuit between ATC-6 and ATC-3 will be expanded by optical fiber system.

In the area of existing RSU-36, about 7,000 waiters that are the largest number of waiters in Ulaanbaatar city will still remain at the end of the year 1997, even after the completion of construction work of the existing ADB project.

This project can dissolve the waiters. In addition, the present condition of the cables is extremely bad, which should be completely replaced, and the existing subscribers should be accommodated in the new exchange.

4.2 Radio Subscriber System Introduction Project for Ger Areas and Remote Areas

In this project, a DRCS radio base station with omni-antenna will be installed in ATC-3 building, and many radio subscriber terminal equipment with directional antenna and its supporting pole which can supply several telephone lines will be put in Ger area sites and important subscriber sites located far from telephone exchange.

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CHAPTER 2

FEASIBILITY STUDY ON NEW EXCHANGE UNIT AND ITS RELATED FACILITIES INSTALLATION IN ATC-6

CHAPTER 2

FEASIBILITY STUDY ON "NEW EXCHANGE UNIT AND ITS RELATED FACILITIES INSTALLATION IN ATC-6" PROJECT

1. Background of the Project

MOID/MCAC are required to cope with the rapid growth of telephone demand. Especially, in the area ATC-6, taking into consideration that waiters will reach 7,000 in 1998, and that there exist important subscribers from political, economic and social point of view, it is necessary to install telecommunications facilities using latest technologies, in order to provide high quality telephone lines which can meet the demand.

2. Objectives and Scope of the Project

2.1 Objectives of the Study

This project is aimed to introduce a digital exchange by 1998 and to rehabilitate outside plant at the same time to meet increasing telephone demand in ATC-6 (Bayangol District) area.

JICA study team forecasts 15,560 subscriber lines in the year 2002 as for the supply plan as presented in this Basic Plan.

2.2 Project Location

This project will provide the telecommunication facilities in ATC-6 area. Figure 2-1-2 shows the ATC-6 area.

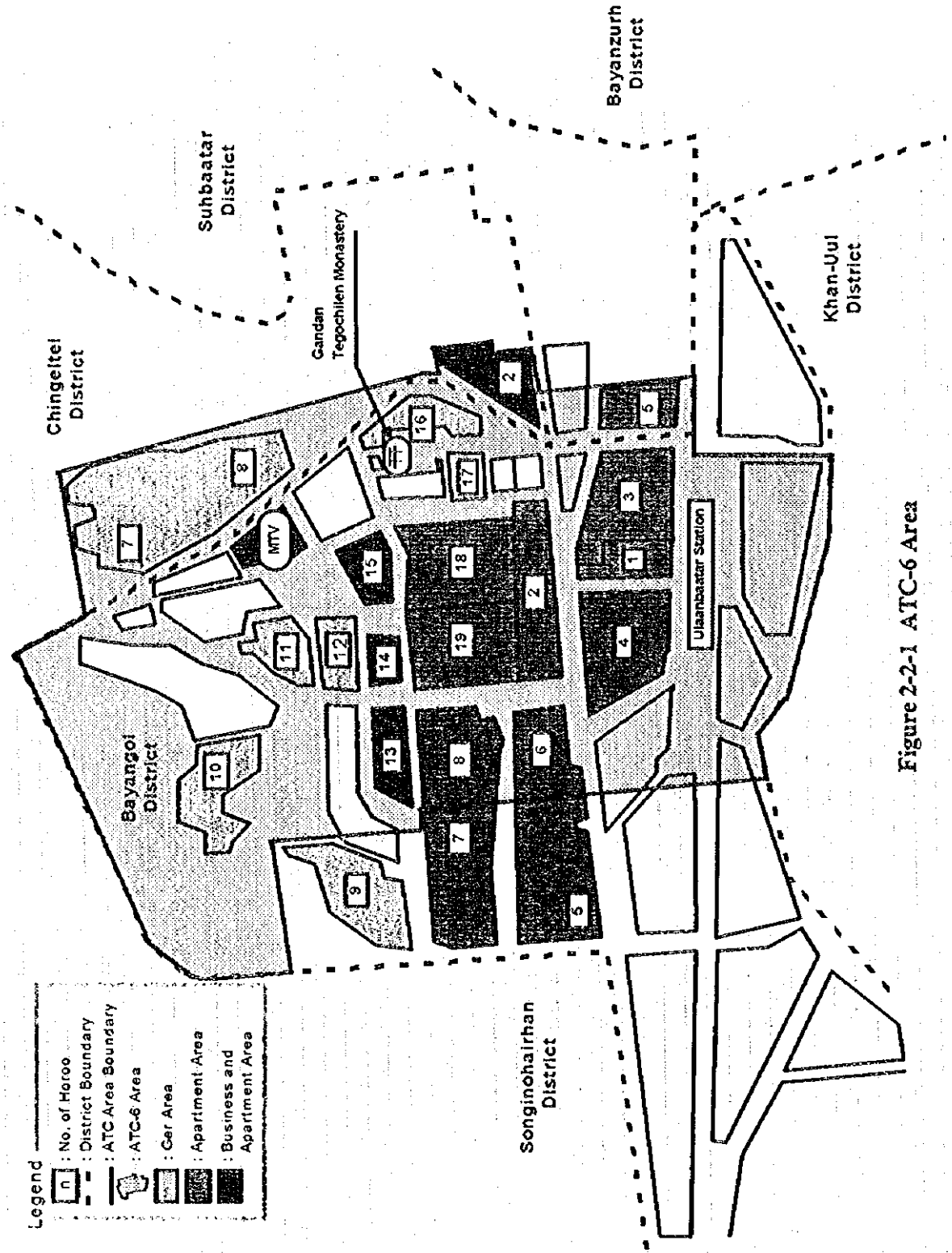


Figure 2-2-1 ATC-6 Area

2.3 Scope of Project

This project includes the planning, purchase, installation, testing, and training of the following telecommunications facilities.

2.3.1 Switching System

A total capacity of around 16,000 subscriber lines (supply volume in 2002) will be installed for the local exchange in ATC-6 area by introducing digital switching system under this project by 1998.

2.3.2 Outside Plant

Primary cables connected to local exchange, secondary cables, civil facilities and supplementary equipment, which are required to satisfy the demand in 2005.

3. Project Basic Design

3.1 Forecast

3.1.1 Demand Forecast

Demand for telephone service is estimated by three methods, i.e., Methods I, II, and III. Method I is for macroscopic forecast for the whole country, based on the former socialist countries data. Method II is for semi-macroscopic forecast for Ulaanbaatar city, and Method III is microscopic forecast for 9 districts in Ulaanbaatar city. Demand forecast for Method II and Method III was done in the Basic Plan Study. Based on the data obtained from the Method II and residential and business demand by study of the basic data of the Ulaanbaatar city telephone network in 1993, Study team forecasts 16,819 subscriber lines in this area in the year 1998. Also Study team forecasts 18,813 subscriber lines, 24,951 subscriber lines and 32,900 subscriber lines in the year 2000, 2005 and 2010, respectively. Table 2-3-1 shows the demand forecasting by exchange up to 2010 in ATC-6 area.

Table 2-3-1 Demand Forecasting by Exchange up to 2010 in ATC-6

No. of Horoo	1,995	1,996	1,997	1,998	1,999	2,000	2,001	2,002	2,003	2,004	2,005	2,006	2,007	2,008	2,009	2,010
SB-5	902	964	1,009	1,076	1,137	1,205	1,281	1,365	1,445	1,535	1,621	1,716	1,816	1,924	2,033	2,117
CH-2	1,316	1,395	1,484	1,563	1,659	1,744	1,859	1,960	2,086	2,224	2,333	2,481	2,638	2,773	2,945	3,122
CH-7	237	253	271	285	303	316	339	356	380	408	423	451	481	502	534	566
CH-8	213	227	244	256	272	284	304	320	342	366	380	405	432	451	480	508
BG-1	330	350	371	396	418	443	471	501	524	556	588	621	658	697	736	775
BG-2	197	209	222	237	250	265	282	300	314	334	351	372	394	416	440	463
BG-3	134	141	149	157	166	176	186	197	209	222	235	249	264	280	297	315
BG-4	503	533	567	602	636	674	716	762	798	847	894	947	1,002	1,062	1,122	1,183
BG-6	809	860	914	977	1,032	1,093	1,162	1,239	1,290	1,371	1,445	1,529	1,617	1,712	1,808	1,900
BG-8	1,488	1,580	1,680	1,795	1,895	2,009	2,134	2,276	2,370	2,518	2,656	2,810	2,973	3,148	3,324	3,494
BG-10	153	163	173	185	196	207	220	235	245	260	274	290	307	325	343	360
BG-11	289	307	325	347	367	389	413	440	460	488	515	544	577	611	645	678
BG-12	192	204	217	232	245	259	275	294	306	325	343	362	383	406	429	451
BG-13	935	992	1,055	1,126	1,189	1,260	1,339	1,428	1,488	1,581	1,668	1,765	1,866	1,976	2,088	2,194
BG-14	1,185	1,258	1,338	1,429	1,509	1,600	1,699	1,811	1,888	2,006	2,115	2,238	2,368	2,507	2,647	2,783
BG-15	1,264	1,342	1,426	1,523	1,607	1,705	1,810	1,930	2,012	2,139	2,255	2,386	2,524	2,673	2,823	2,969
BG-16	143	152	162	172	182	193	205	218	227	242	255	270	286	302	319	337
BG-17	833	884	940	1,004	1,060	1,123	1,193	1,272	1,326	1,409	1,486	1,573	1,663	1,761	1,861	1,956
BG-18	1,547	1,643	1,748	1,867	1,971	2,089	2,219	2,366	2,465	2,620	2,762	2,923	3,092	3,273	3,457	3,634
BG-19	1,318	1,400	1,488	1,590	1,678	1,779	1,890	2,016	2,100	2,232	2,352	2,489	2,633	2,788	2,944	3,095
Total	13,968	14,657	15,783	16,819	17,772	18,813	19,997	21,286	22,275	23,683	24,951	26,421	27,974	29,587	31,275	32,900

Note SB:Suhbaatar District
CH:Chingeltei District
BG:Bayangol District

In line with the telecommunications policy of Mongolian Government, supply plan was made. Table 2-3-2 and Figure 2-3-1 show the demand of business and residential and their sum, and the planned supply.

Table 2-3-2 Demand (Business and Residential) and Supply in ATC-6 up to 2010

	1995	1996	1997	1998	1999	2000	2001	2002
Business	1,734	1,826	1,925	2,031	2,147	2,279	2,414	2,560
Residencial	12,254	13,031	13,858	14,788	15,625	16,534	17,583	18,726
Total	13,988	14,857	15,783	16,819	17,772	18,813	19,997	21,286
Capacity	11,000	11,000	11,000	16,000	16,000	16,000	16,000	16,000
Supply	8,671	8,768	9,211	10,946	12,274	13,839	14,145	15,560

2003	2004	2005	2006	2007	2008	2009	2010
2,713	2,875	3,048	3,231	3,424	3,631	3,848	4,079
19,562	20,808	21,903	23,190	24,550	25,956	27,427	28,821
22,275	23,683	24,951	26,421	27,974	29,587	31,275	32,900
27,000	27,000	27,000	27,000	27,000	40,000	40,000	40,000
16,860	18,575	20,315	22,349	24,624	27,146	29,936	32,900

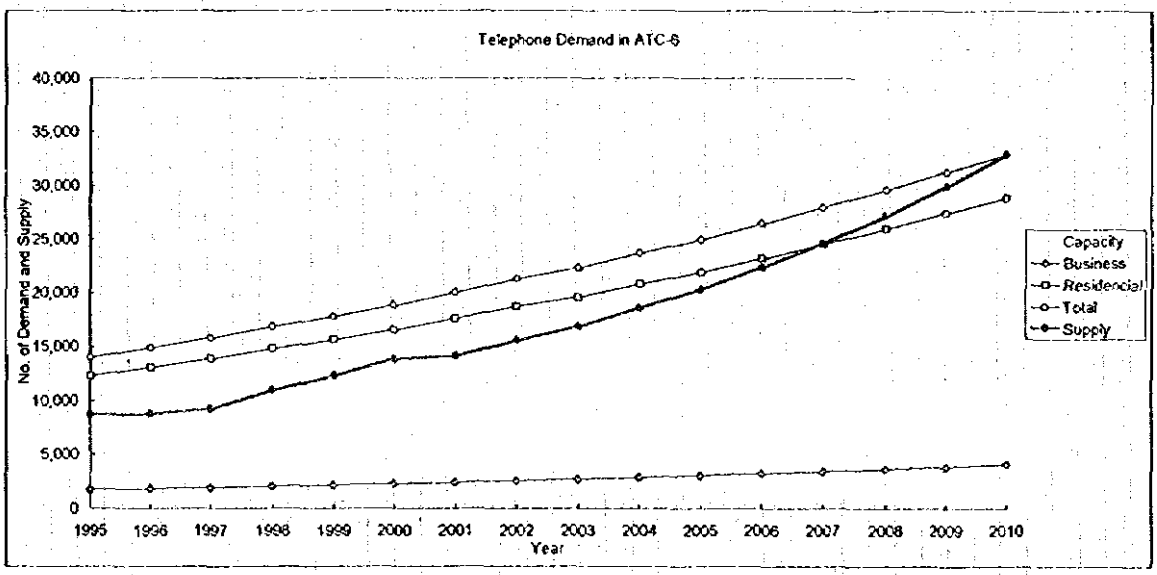


Figure 2-3-1 Demand (Business and Residential) and Supply in ATC-6 up to 2010

In Figure 2-3-1, there are differences between the supply and the exchange capacity every year. If sufficient man power to connect subscriber lines is available, subscriber numbers can be increased within the limit of the differences. In this case, from the viewpoint of financial management, income will increase and the financial internal rate of return (FIRR) will be improved. For reference, supply plan in this case is shown in Chapter 9, Volume IV.

3.1.2 Traffic Forecast

(1) Conditions

Originating calling rate is 0.067 erlang per subscriber line per busiest one hour for administration/business calls, 0.045 erlang per subscriber line per busiest one hour for residential calls in 1995. These values were assumed in view of the planned introduction of the local timed tariff system. And these calling rates were presumed to increase gradually up to 2010 depending on the growth of economic activities in Mongolia. The results of estimation in this study are given in the following table, and also traffic distribution by call categories was given in the Table 2-3-3.

Table 2-3-3 Traffic Distribution Ratio by Call Categories

Year	Calling Rate (erl)		Internal		Long Distance	Inter-national	Special
	Business	Residencial	Local	Intra-office			
1995	0.067	0.045	75.00	18.90	3.60	1.50	1.00
2000	0.078	0.052	74.26	18.60	4.49	1.65	1.00
2005	0.089	0.059	73.57	18.00	5.61	1.82	1.00
2010	0.100	0.067	71.60	18.40	7.00	2.00	1.00

The traffic matrix was made up based on the gravity model, or the methodology presented in General Network Planning, GAS-3, ITU-T.

(2) Local Traffic Calculation Outcome

The traffic of local exchange of ATC-6 in 2000 and 2005 was calculated under the conditions stated in the Chapter-7, Vol. II. Table 2-3-4 and Table 2-3-5 show the traffic between local exchanges.

Table 2-3-4 Local Traffic of ATC-6 in 2000

From \ To		1	2	3	4	5	Total
		H06A	H03A	H03B	H05A	H07A	
1	H06A	151.15	356.15	21.41	228.75	21.35	778.81
2	H03A	362.75					
3	H03B	21.42					
4	H05A	235.33					
5	H07A	21.36					
Total		792.01					

Table 2-3-5 Local Traffic of ATC-6 in 2005

From \ To		1	2	3	4	5	6	7	Total
		H06A	H03A	H03B	H02A	H04A	H05A	H07A	
1	H06A	236.07	337.22	63.87	121.21	46.51	387.52	36.25	1228.65
2	H03A	409.71							
3	H03B	63.93							
4	H02A	121.28							
5	H04A	46.55							
6	H05A	399.5							
7	H07A	36.28							
Total		1313.32							

3.1.3 Inter-local Exchange Circuit Requirements

The number of circuits required to local exchanges in the year 1998 was calculated based on the traffic matrix between local exchanges in the year 2000 which was obtained in the previous section.

In the calculation, the digital circuit modularity applied to was 30 channels, the per-link grade of service was *0.01*, the lower threshold for direct circuit routing was *50.00* earlangs.

Table 2-3-6 and Table 2-3-7 show the circuit matrix in the year 2000 and 2005.

Table 2-3-6 Circuit Matrix by the year 2000 (30 ch modularity)

From \ To		1	2	3	4	5	Total
		H06A	H03A	H03B	H05A	H07A	
1	H06A	6	13	2	9	2	32
2	H03A	13					
3	H03B	2					
4	H05A	9					
5	H07A	2					
Total		32					

Table 2-3-7 Circuit Matrix by the year 2005 (30 ch modularity)

From \ To		1	2	3	4	5	6	7	Total
		H06A	H03A	H03B	H02A	H04A	H05A	H07A	
1	H06A	9	13	3	5	2	14	2	48
2	H03A	15							
3	H03B	3							
4	H02A	5							
5	H04A	2							
6	H05A	15							
7	H07A	2							
Total		51							

3.2 New Equipment Installation Plan

3.2.1 Switching System

(1) Existing Exchange

In ATC-6 area there is a remote switch unit (RSU) the capacity of which is 11,000 lines including 8,671 working lines as of September 1995. The ATC-6 area has a total of 5,317 waiting applicants as of September 1995.

(2) Proposed New Exchange Plan

The new exchange plan was decided in consideration of the fulfillment plan proposed in Chapter 5, Volume II. Study Team estimates 21,286 lines of telephone demand in the year 2002 and suggests to supply 15,560 lines in that year.

According to the fulfillment plan, it is proposed here to introduce a unit of switching system having a capacity of 16,000 subscriber lines. The new switching unit should be of a host exchange type because of the magnitude in capacity. Upon selection of the switching system type, attention was paid to the fact that the RSU had been applied to the cases wherein the required switching capacity was 5,000 lines or less in general.

The new switching unit to be introduced in ATC-6 should be a system which is allowed to have the No.7 signaling system function as well as ISDN function in the future. It should also be able to be equipped with a gate-way switching function to an intelligent network (IN) in the future.

The working subscriber lines of the RSU should be transferred to the new switching unit after its installation is completed. Careful attention should be paid on the occasion of transferring the working lines. The RSU should be relocated later to make use of its remained resources.

3.2.2 Outside Plant

(1) Covering Area in this Study

This study covers ATC-6 area. This ATC-6 area is shown in the Figure 2-3-2 as a geographical location. ATC-6 area is located in the somewhat western side of the centre of the city, and is a mixture of business and residential area, which comprises high-rise apartment houses, schools, shopping complex and hospital and some ger areas in its area. It is projected for this area to further develop in the future. Therefore the telephone demand in this area is projected to rapidly increases for both of business and residential use.

(2) Outline of Subscriber Cable Access Network

The Outline of Subscriber Cable Access Network to be introduced is shown in Figure 2-3-3.

For the network, basically Subscriber Cable, Cross-Connection Cabinet and Conduit System shall be adopted as it has been for many years adopted in Mongolia. And this concept is also followed ADB Project.

As seen in the Figure 2-3-5, Cross-Connection Cabinet is installed between primary cable and secondary cable, which makes the system flexible because the cabinet can adjust the connection freely on the demand of primary cable and secondary cable pairs.

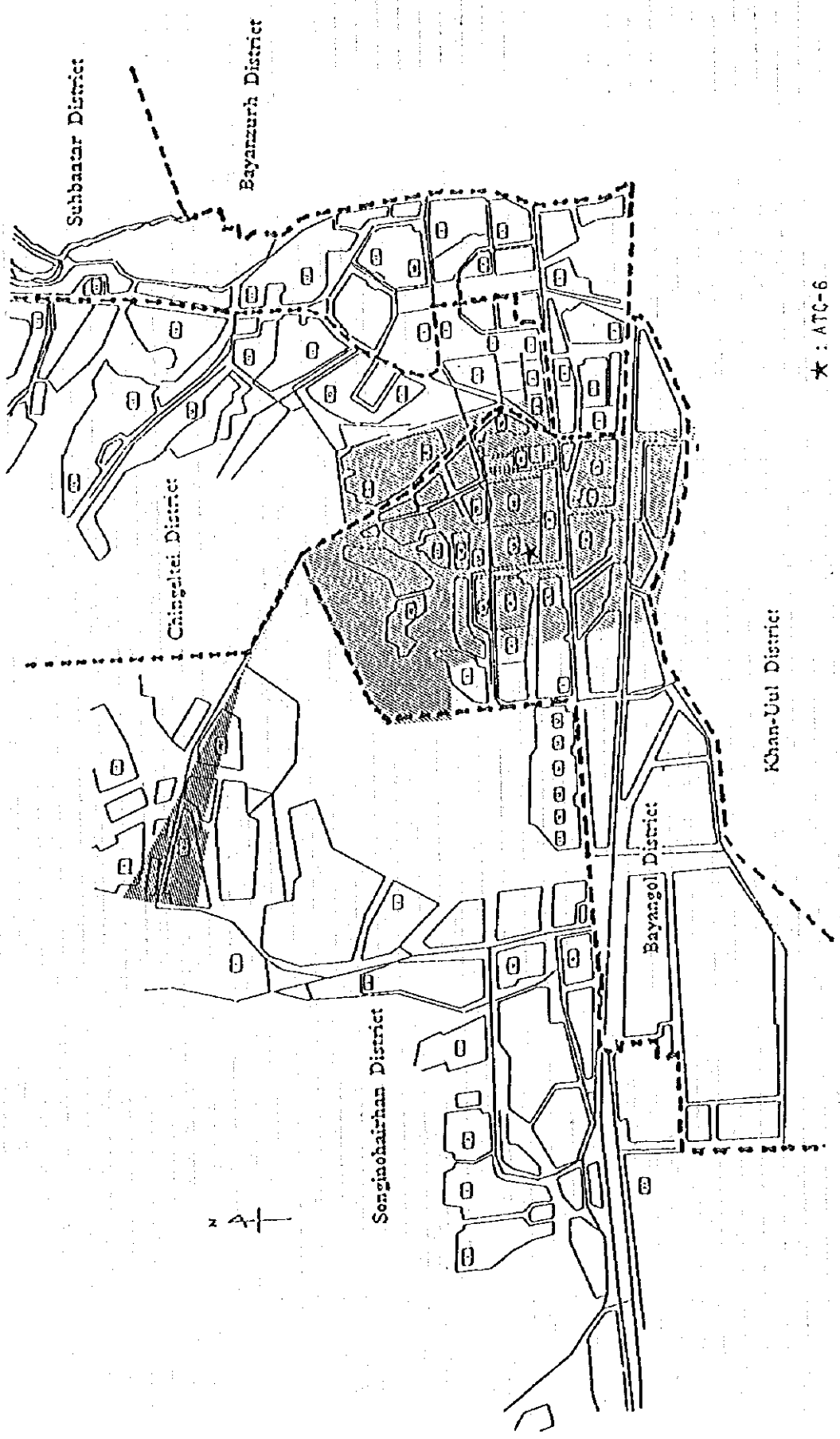


Figure 2-3-2 Covering Area of ATC-6

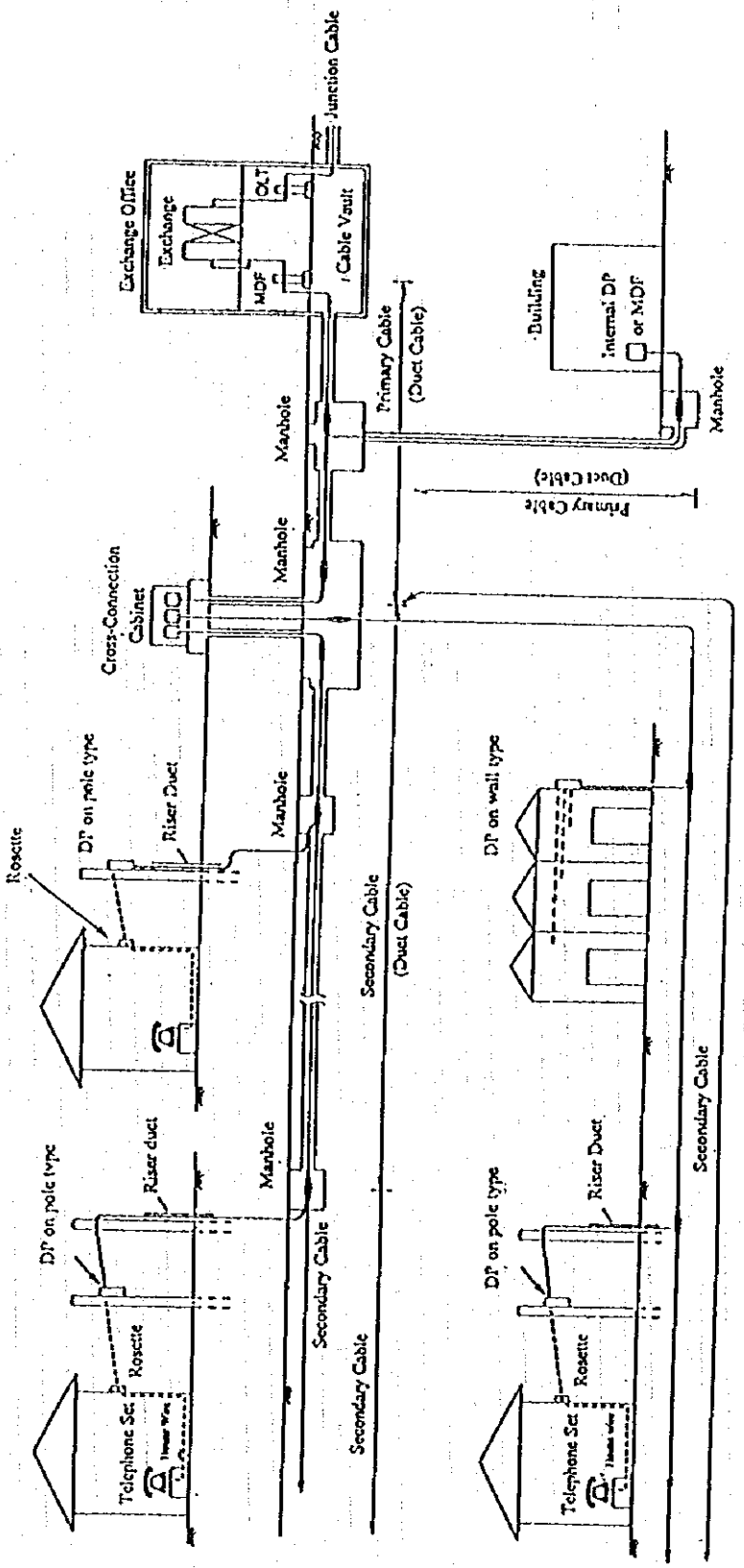


Figure 2-3-3 Outline of Subscriber Cable Access System

(3) Technical Requirements for Outside Plant

Attenuation loss shall be limited to 9.5 dB at 1,500Hz and the loop resistance is 1,200 Ohms between MDF to Telephone set. Refer to Figure 2-3-4.

These technical requirements are defined in ADB project.

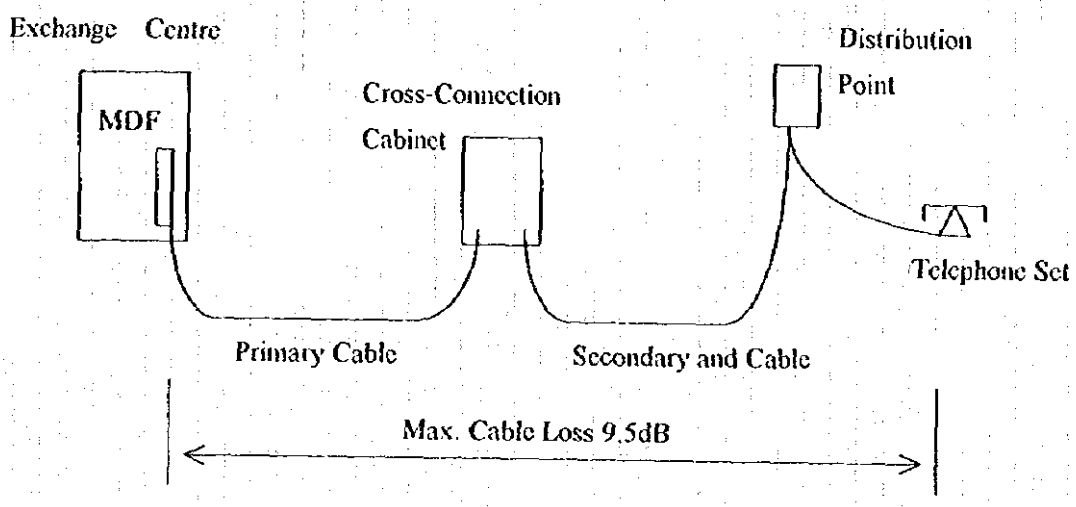


Figure 2-3-4 Cable loss limit between MDF and Telephone set

(4) Flexible Distribution System of Cable Network

Generally, it is difficult to use 100% of the cable pairs, because an exact demand forecasting is not easy, subscribers are scattered in wide area, and likely to move from one location to another location, in addition a cable size (number of Paris) is made at fixed intervals for example 100 pairs, 200 pair. Therefore the access network needs to have a flexible cable distribution method to connect subscribers efficiently.

a) Cross-Connection Cabinet System

Number of secondary terminals should be larger than that of primary one. The ratio of primary pairs and secondary pairs should be determined within the Cabinet Capacity. There are so far three types of Cross-Connection Cabinet in terminal capacity. These are 600 pairs, 1,200 pairs, and 2,000 pairs.

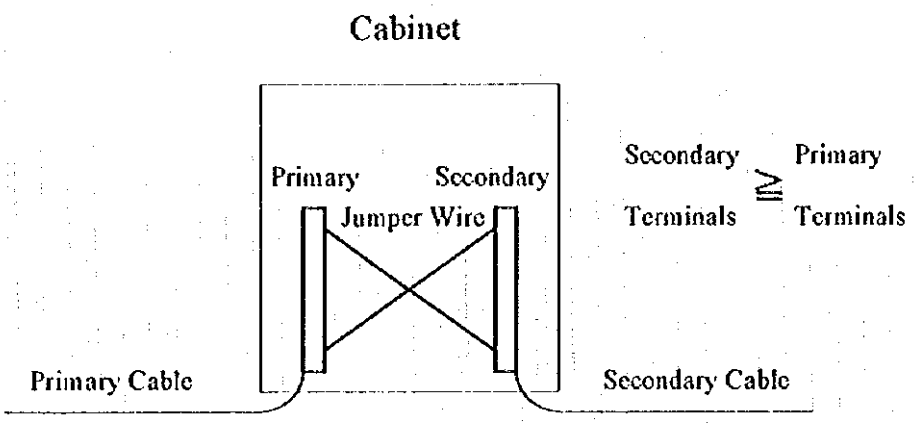


Figure 2-3-5 Outline of Cross-Connection Cabinet

b) Application of Cable Size and Establishment of Spare Paris

In the case of cable pair selection, cable should be selected upper rank than demand. This means that in general, certain level of spare pairs are put along the cable route.

(5) Measure for Maintenance Easy Work

It is needless to say that a network should be simplified as much as possible to make a maintenance work easy and efficient. Therefore, multipair-splicing should not be applied for both primary cable and secondary cable.

A boundary of cabinet area should be determined in consideration of geographical conditions such as along a river, a wide road, or a railway etc. to make cabling and drop-wiring easy. And the maximum number of expected demand for one cabinet area should be determined in principle to 600~800 subscribers.

A conduit system should be applied basically in business and apartment area despite the increased cost because the conduit system is stable and suitable for maintenance work, but in ger areas, overhead system can be applied due to the unconfirmed situation.

(6) Dealing with New Service

With metallic cable, the subscriber cable access system is able to cope with a narrow band ISDN service. It is noted that in case the broad band ISDN service appears, optical fiber cable should be introduced.

(7) Application of Other Subscriber Access System

There are some kind of Subscriber Access System, at present such as optical fiber access, wireless system, etc.

The system to be applied should be selected based on economical comparison, maintenance work and geographical conditions as well as future trend of telecommunications Technologies.

(8) Scope of the Project

a) Work Demarcation of the Project

This project covers the work of from MDF up to Distribution point which is included. MCAC/MTC is responsible from distribution point to telephone set, Figure 2-3-6 shows the work demarcation

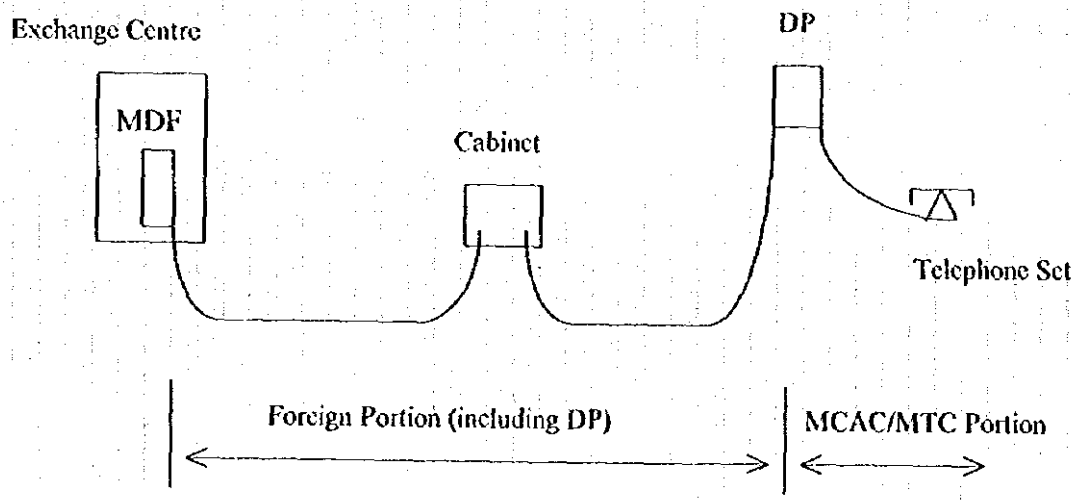


Figure 2-3-6 Definition of Foreign Portion and MCAC / MTC Portion

b) Demand to be used in this Project

With regard to the demand in ATC-6 area in the stage of Feasibility Study, the real demand figure by cross-connection cabinets so far seized by ATC-6 staff was provided and additional site survey in part was made by JICA/MCAC members to confirm the demand.

Table 2-3-8 shows the status of outside plant and demand by cross-connection cabinet. Figure 2-3-7 shows the diagram of each cross-connection cabinet location in ATC-6 area. Among cross-connection cabinets, number 630 and 631 are to be changed over to ATC-2 in the future considering the line loss limitation.

Table 2-3-8 Each Cross-Connection Cabinet and its Demand in 2005

No.	No. of CCC		Length of CCC Cable from ADF (m)	Capacity of CCC	Existing Primary Cable Pairs ①	Existing Secondary Cable Pairs ②	Demand in 2005 year			Necessary Primary Cable pair ④= ③- ①	Necessary Secondary Cable pair ⑤= ③- ②	Total CCC Capacity ①→⑤
							Resident	Business	Total ③			
1		601	1,190	1,200	200	290	174	128	302	102	12	604
2		602	1,040	1,200	400	520	468	0	468	68	0	936
3		603	870	1,200	400	450	402	32	434	34	0	884
4		604	755	1,200	400	340	306	125	431	31	91	862
5		605	854	1,200	400	480	432	0	432	32	0	912
6		606	670	1,200	400	430	348	128	476	76	46	952
7		607	720	1,200	400	510	360	90	450	50	0	960
8		608	890	1,200	400	440	396	3	399	0	0	840
9		609	1,100	1,200	400	550	410	290	700	300	150	1,400
10		610	1,045	1,200	400	440	252	0	252	0	0	840
11	ADB	611	1,525	1,200	400	120	1,607	132	1,739	1,339	1,619	3,478
12		612	750	1,200	400	540	576	54	630	230	90	1,260
13		613	235	1,200	400	420	360	20	380	0	0	820
14		614	200	1,200	400	420	432	38	470	70	50	940
15		615	240	1,200	400	530	424	58	482	82	0	1,012
16		616	260	1,200	400	450	418	15	433	33	0	893
17		617	2,285	600	100	140	0	104	104	4	0	244
18		619	520	2,400	300	450	396	32	428	128	0	878
19		620	1,357	1,200	200	210	144	18	162	0	0	410
20		621	890	1,200	200	200	144	27	171	0	0	400
21		622	485	1,200	200	200	144	7	151	0	0	400
22		623	520	1,200	200	200	144	6	150	0	0	400
23		624	485	1,200	200	200	144	18	162	0	0	400
24		625	740	1,200	400	350	468	15	483	83	133	966
25		626a	1,160	1,200	400	630	268	132	400	0	0	1,030
26		626b	1,200	1,200	300	410	360	0	360	60	0	770
27		627a	1,840	1,200	400	670	468	60	528	128	0	1,198
28		627b	1,770	1,200	300	410	411	5	416	116	6	832
29		628	2,120	1,200	300	340	252	74	326	26	0	666
30	ADB	629	2,672	1,200	200	140	1,020	65	1,085	885	945	2,170
31		630	5,917	600	200	70	252	74	326	126	256	652
32		631	7,350	1,200	300	230	1,430	79	1,509	1,209	1,279	3,018
33		633	2,370	600	200	150	0	96	96	0	0	350
34	ADB	635	1,820	1,200	600	740	684	0	684	84	0	1,424
35	ADB	636	2,445	1,200	500	460	622	0	622	122	162	1,244
36	ADB	637	1,580	2,000	600	740	576	0	576	0	0	1,340
37	ADB	638	1,563	1,200	300	210	320	0	320	20	110	640
38		640	1,095	2,000	600	800	2,250	201	2,457	1,857	1,657	4,914
39		642	1,470	600	400	550	468	82	550	150	0	1,100
40		644	1,430	1,200	400	380	738	117	855	455	475	1,710
41		645	745	1,200	400	340	450	0	450	50	110	900
42		646	1,150	1,200	500	220	360	0	360	0	140	860
43		647	1,580	1,200	100	160	288	0	288	188	128	576
44		648	1,625	1,200	100	100	216	27	243	143	143	486
45	ADB	650	1,715	1,200	400	0	432	0	432	32	432	864
46	ADB	651	1,835	1,200	200	0	638	0	638	438	638	1,276
47	ADB	652	1,180	1,200	200	0	1,200	0	1,200	1,000	1,200	2,400
48	ADB	653	1,345	1,200	500	0	684	0	684	184	684	1,368
49	ADB	654	2,967	1,200	200	0	0	0	0	0	0	200
50	ADB	663	1,140	2,000	400	120	0	90	90	0	0	520
51	ADB	664	1,090	1,200	400	190	757	94	851	451	661	1,702
52	New	655	2,270	1,200	New	0	380	20	400	400	400	800
53	New	650	1,760	1,200	New	0	350	50	400	400	400	800
54	New	657	780	1,200	New	0	380	20	400	400	400	800
55	New	658	2,350	1,200	New	0	100	40	140	140	140	280
		Total	80,963	67,200	17,400	16,940	25,305	2,666	27,915	11,729	12,551	58,623

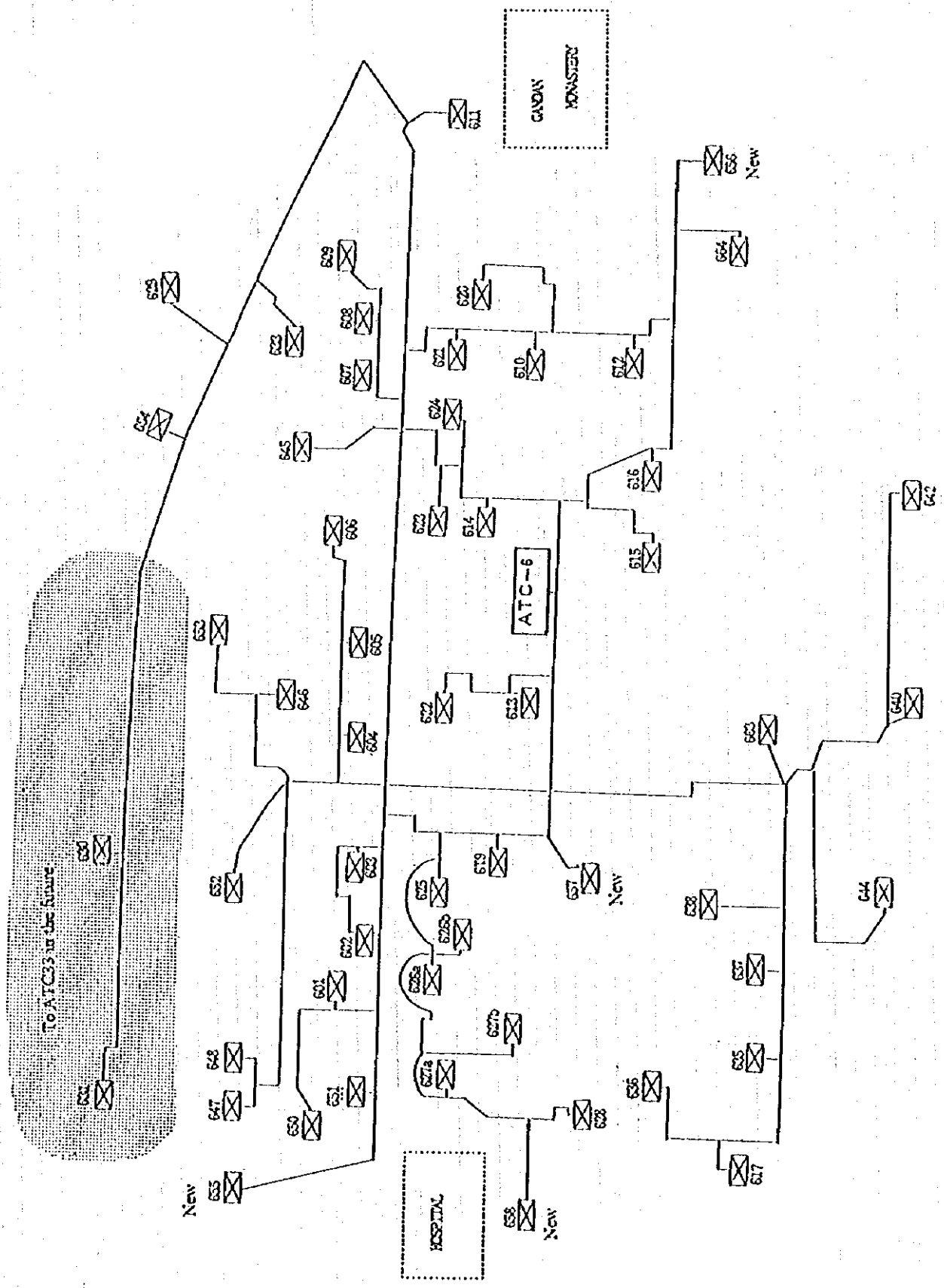


Figure 2-3-7 Diagram of Cross-Connection Cabinet in ATC-6 Area

(9) Basic Design Policy for Outside Plant

a) Expansion Project Period (Provisioning Period)

A capacity of the outside plant should be designed to meet the demand of 5 years from the project completion year, because the expansion project is planned in every 5 years period in the Basic Plan. Therefore a provisioning period of the primary cable and secondary cable should be 5 years. But a provisioning period of the underground duct system for a primary cable should be 15 years.

This expansion project period is decided balancing the ideas that projects have to reduce a repetition of road diggings and public inconveniences as much as possible and on the other hand, it has to make cost reduction as much as possible.

These provisioning period of the main outside plant are described as follows:

(i) Underground Duct System : 15 years ahead
(ii) Primary Cable System : 5 years
(iii) Secondary Cable System : 5 years

b) Determination of Cable Area Boundary

A boundary of cabinet area should be determined to take demand and geographical conditions into consideration for an economical cost performance and maintenance work. Therefore, it is suitable to draw its boundary line along river, wider road or railway, etc.
The number of demand gathered for a cabinet area should be maximum 600~800 basically (in the case of 800, the actual secondary cable pairs come to 800 × 1.4 = 1,200 pairs, for this case, 2,000 pairs capacity of Cross-Connection Cabinet comes with primary cable pairs 800 and secondary side 1,200 pairs).

c) Cabinet Area Modification

In the case that the demand exceeds 600 ~800 for one cabinet, it is necessary to divide the area into two modifying the boundary of the cabinet area or to place another cabinet in the area as a supplement. The modification method is the same as earlier mentioned in item b).

d) Distribution of Demand from Exchange to Cabinets

Demand forecasting data in each district is listed in the Basic Plan, and it is acknowledged that project basically should be planned to that demand figures. But in the stage of feasibility study, it is necessary, as a ordinary procedure, to distribute the demand to each cabinet area based on the so called actual site-survey, because the demand figure to be adopted should be practical as much as possible. It is needless to say that this makes a design easily and the project economically.

e) Location of Cross-Connection Cabinet

Basically, it is hopeful that one Cross-Connection Cabinet is placed in one cabinet area, and if necessary, additional cabinet is admitted as mentioned in item b). The location of cabinet should be selected in the most suitable place taking into consideration being economical and maintenance work. Furthermore, the location should be selected to avoid a damage from vehicle traffic and pedestrian inconvenience.

f) Selection of Duct Route

A duct should be so selected that existing duct route which has vacant pipes is utilized. In the case of new route, the duct route should be selected to make the distance shortest. Furthermore, it is noted that the route should not draw replacement works caused by other authorities such as Road, Water, Electricity, etc. in near future.

g) Location of Distribution Point

A location of distribution point should be selected in consideration of new subscriber places, as well as maintenance work.

h) Countermeasures for High Cable Transmission Loss Subscriber

A standard of cable transmission loss limitation is 9.5 dB and electric loop resistance is limited to 1,200 Ohms. Looking at the cabinet cable length from exchange one by one, cabinet No. 630 and No. 631 are feared to surpass the loss limitation. (See Table 2-3-9)

Table 2-3-9 Cross Connection Cabinet feared to surpass the loss limitation

Cabinet No.	Cable Length from MDF	Attenuation Loss
630	5.917 m	0.5 mm -- 8.9 dB (feared to over 9.5 dB if Secondary cable length considered)
631	7,350 m	0.5 mm -- 11.1 dB

To improve the situation, above two cabinet should be changed over to another ATC-2 which is nearer than ATC-6 in the future.

For another case, No. 665 cabinet, which is now situated in ATC-3 area and its circuits are provided from both ATC-6 and ATC-3, shall be cut off from ATC-6, and transferred outright in consideration of maintenance management.

* Presently, from ATC-6, 100 pairs and from ATC-3, 300 pairs are provided respectively.

(10) Technical Standard for Basic Design

Basic Design should be carried out according to the following technical standards and specifications, which are to be studied out by MTC/Alcatel.

Alcatel has been reportedly awarded the contract of outside plant project of ADB, and is responsible for Rehabilitation and Expansion of local cabinet network in Ulaanbaatar, Darkhan and Erdenet.

a) Cable

Diameter of cable conductor and its transmission loss are shown in Table 2-3-10. The basic design of cable distribution should be carried out making a good combination of these different cable diameters to make project cost economically and local subscriber loss less than 9.5 dB.

Table 2-3-10 Standard of Cable Loss

Diameter of Conductor	Cable Loss at 1 kHz (dB / km)	Loop Resistance (O hm / km)
0.4 mm	1.90	295
0.5 mm	1.51	187
0.6 mm	1.26	130

i) Specifications of Cables in Duct

The cables to be used for the project are of the types specified in the following paragraphs.

(a) Conductor insulation

* Solid PE

* Cellular PE (foam-skin) for 2,400 pairs.

(b) Pair formation,

(c) Stranded in unit of 50 pairs or 100 pairs,

(d) Aluminum type shielding (Laminate / Corrugate),

(e) Single PE Sheath / Jelly Filled.

ii) Specification of Aerial Cables

(a) Conductor insulated with solid PE,

(b) Pair formation,

(c) Stranded in unit of 50 pairs or 100 pairs,

(d) Laminate / Corrugated aluminum tape moisture barrier,

(e) Overhead : Single PE Sheath / air core, and self-supporting

iii) Specifications of Buried Cables

(a) Conductor insulated with solid PE,

(b) Pair formation,

(c) Stranded in unit of 50 pairs or 100 pairs,

(d) Jelly-filled,

(e) Aluminium tape
(f) Inner polyethylene sheath,
(g) Protection bedding,
(h) Corrugated steel tape armour,

iv) Cable Sizes

The cable are shown in Table 2-3-11 and Table 2-3-12.

Table 2-3-11 Duct Cable

Conductor Diameter	Number of Pairs
0.4 mm	10, 20, 30, 50, 100, 150, 200,300,400,500,600,800, 1000, 1200, 1600, 1800
0.5 mm	10, 20, 30, 50, 100, 150, 200, 300, 400, 500, 600, 800, 1000, 1200, 1600, 1800
0.6 mm	10, 20, 30, 50, 100, 150, 200, 300, 400, 500, 600, 800, 1000

Table 2-3-12 Aerial Cabinet

Conductor Diameter	Number of Pairs
0.4 mm	10, 20, 30, 50, 100
0.5 mm	10, 20, 30, 50, 100
0.6 mm	10, 20, 30, 50, 100

b) Cable Splice Connectors and Joint Closures

i) Connectors

The jointing of multipair cables should compulsory be effected by means of IDC (Insulation Displacement Contact) connectors of grease filled, operated by machine or hand tool.

ii) Joint Closure

There are two types of sleeves for closure ; Heat-Shrinkable Sleeves and Mechanical Sleeves. The joint closures should satisfy two main qualities:

* to reproduce in a reliable manner at the joint the physic-chemical parameters of the cable.
* to be made on side by a single operator, while abiding by rules of engineering and telecommunications operation.

c) Cross-Connection Cabinet and Terminal Block

The housing of Cross-Connection Cabinets for connection in public areas must be of metallic, plastic or concrete construction.

Table 2-3-13 shows the Cross-Connection Cabinet sizes.

Table 2-3-13 shows the Cross-Connection Cabinet

Capacity	Primary pairs	Secondary Pairs
600	200 ~ 300	200 ~ 300
1,200	400 ~ 600	800 ~ 600
2,000	800 ~ 1,000	1,200 ~ 1,000

* Alternative combination or Primary pairs and secondary pairs other than above table should not be ruled out.

d) Terminal Block for Cross-Connection Cabinet

The terminal blocks for cross-connection cabinets are made up of an assembly of blocks of 100 pairs or 200 pairs.

c) Distribution Point

Table 2-3-14 shows the types of Distribution Point and its Sizes.

Table 2-3-14 Distribution Point

Types	Capacities
Indoor Wall Mounted Distribution Point	10 Pairs. 20 Pairs. 40 Pairs. 60 Pairs. 100 Pair.
Outdoor Wall Mounted Distribution Point	10 Pairs. 20 Pairs.
Pole Mounted Distribution Point	*10 Pairs. 20 Pairs.*

f) Main Distribution Frame

The Main Distribution Frame (MDF) should be equipped with terminal blocks of reduced dimensions, with a pivoted frame modular protections. The terminal blocks are made up of modules of 100 pairs in the network of 10 pairs unit. The vertical or upright may contain up to 12 superimposed blocks. The terminal blocks should be supplied without cable stub. The multipair cables are fanned out during terminating work on the installed blocks.

g) Manhole

Manholes should be installed at cable jointing points, or key places where rapid curve. The manhole type and size should be determined in consideration of the number of pipes cables and closure, as well as working space. Table 2-3-15 shows the types sizes of standard manholes.

Table 2-3-15 Manholes

Types	Length	Width	Depth
M1	2.64 m	1.27 m	1.85 m
M2	3.52 m	1.40 m	1.85 m
M3	4.27 m	1.76 m	1.85 m
M4	5.02 m	1.76 m	1.85 m

h) Pipes

i) PVC Pipes

The PVC pipes should be used in multi-way conduit systems as well as for individual protection pipes for the underground cables at road crossings and in areas where mechanical damage to the cables is likely to happen. The wall thickness and the length of pipes are defined in Table 2-3-16.

Table 2-3-16 Dimensions of Pipes

Designation of pipes	Nominal thickness	Length of pipes(m)
567 × 3	3	6
99 × 5.5	5.5	6

ii) Steel Pipe

Steel pipes should be applied at a road crossing where high pressure is likely to happen, or bridge crossing section.

i) Poles

i) Wooden poles

The wooden poles to be used should be for resinous species, mainly : pine, fir, spruce, larch. The minimum total height are 7m, 8m and 10m.

ii) Steel poles

Steel poles to be used should be made of galvanised steel and should have an octagonal base. The minimum total height are 7m, 8m and 10m.

(11) Materials and Tools for Maintenance Use

It is necessary to hold materials and tools for maintenance use. Necessary materials and tools are listed in Table 2-3-17.

Table 2-3-17 Materials and Tools for Maintenance Use

Item	Unit	Quantity
Vehicle VAN Type	unit	2
Jelly Filled Cable in Duct		
0.5mm - 30 pairs	m	500
50 pairs	m	500
100 pairs	m	500
300 pairs	m	500
600 pairs	m	500
1,800 pairs	m	250
Self - Supporting Cable		
0.5mm - 30 pairs	m	200
100 pairs	m	200
Cross-Connection Cabinet		
1,200 pairs Capacity	unit	1
2,000 pairs Capacity	unit	2
200 pairs Block	unit	60
100 pairs Block	unit	10
MDF Terminal Block 100 pairs	unit	10
Splice Closure		
Class 1	unit	25
Class 2	unit	5
Class 3	unit	10
Distribution Point		
Internal Type 10pairs	unit	120
Tool Set For Cable Jointers		
For Cables with less than 300pairs	unit	1
For Cables with 300pairs or more	unit	1
Measuring Instrument		
Cable Wire Tester	unit	1
Insulation Tester	unit	1

(12) Work of MCAC/MTC

MCAC/MTC is responsible for New subscriber connection.

(13) Quantity of Main Work in the Project.

Quantity of main work for implementation of this project is shown in Table 2-3-18.

Table 2-3-18 Quantity of Main Work

Item	Unit	Quantity
Expansion		
Primary Cable	km	32
Secondary Cable	km	121
Duct	km	2
Manhole	unit	15
Cross-Connection Cabinet	unit	24
Rehabilitation		
Primary Cable	km	27
Secondary Cable	km	40

4. Project Cost Estimate

4.1 General

The project cost was estimated for the switching system and the external plant that would be executed under a turn-key basis.

4.2 Switching System Cost

Table 2-4-1 shows the estimated switching system cost.

Table 2-4-1 Switching System Project Cost

Item	Cost in US$ 1,000		
	Total	Local Currency Portion	Foreign Currency Portion
Equipment and Training	3,061	0	3,061
Installation Cost	459	2	457
Transportation Cost	367	0	367
Consultancy	194	0	194
All Types of Taxes	559	559	0
Contingency	389	0	389
Total	5,029	561	4,468

4.3 Outside Plant Cost

The project cost is estimated based on Facility Plan described in Vol. III, Chapter 2, subsection 2-3-2. The project cost for Outside Plant is divided into Foreign portion and Local portion. Outside Plant Cost is summarised in Table 2-4-2.

Table 2-4-2 Outside Plant Project Cost

Item	Cost in US$ 1,000		
	Total	Local Currency Portion	Foreign Currency Portion
Equipment and Training	6,160	0	6,160
Installation Cost	1,200	590	610
Transportation Cost	700	0	700
Consultancy	810	0	810
All Types of Taxes	1,100	1,100	0
Contingency	810	60	750
Total	10,780	1,750	9,030

4.4 Total Project Cost

Table 2-4-3 Total Project Cost

(Unit : US$ 1,000)

Item	Total	Switch		Outside Plant	
		Local Currency Portion	Foreign Currency Portion	Local Currency Portion	Foreign Currency Portion
Equipment and Training	9,221	0	3,061	0	6,160
Installation Cost	1,659	2	457	590	610
Transportation Cost	1,067	0	367	0	700
Consultancy	1,004	0	194	0	810
All Types of Taxes	1,659	559	0	1,100	0
Contingency	1,199	0	389	60	750
Total	15,809	561	4,468	1,750	9,030

5. Project Implementation Plan

5.1 General

The proposed project implementation plan was made up on the assumption that the project is implemented under a turn-key basis and taking account of such work states as;

1) Preparing the tender specification;
2) Specification evaluation and tendering;
3) Tender evaluation;
4) Supplier contract negotiation;
5) Contractor's survey and design
6) Approval of design drawing;
7) Manufacturing and shipping; and
8) Installation and testing.

It is very desirable that the project proposed here be commenced as early as possible to make use of this feasibility study. Circumstances may be changed to review this feasibility study, if project commencement is delayed.

5.2 Implementation Schedule of Switching System

Figure 2-5-1 shows the proposed implementation time schedule for exchange portion. The period for this portion was estimated to be 24 months.

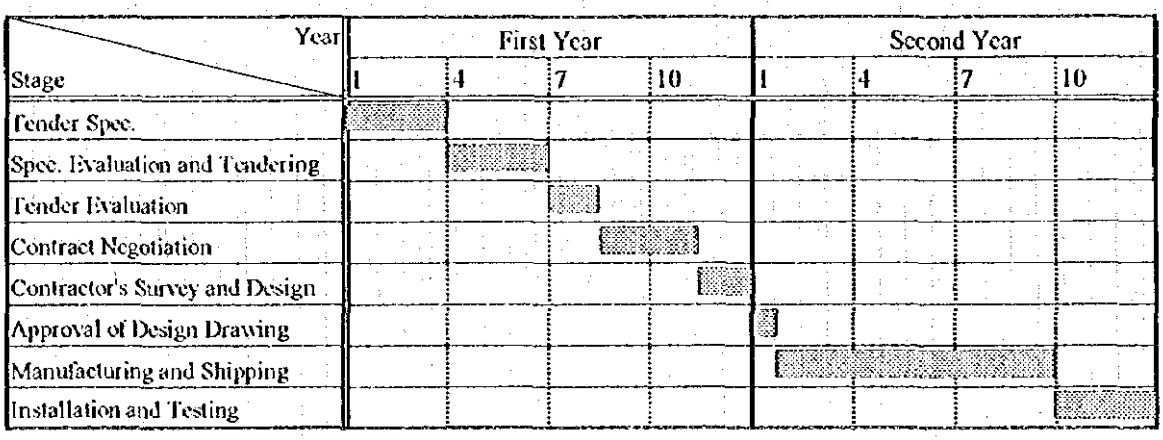
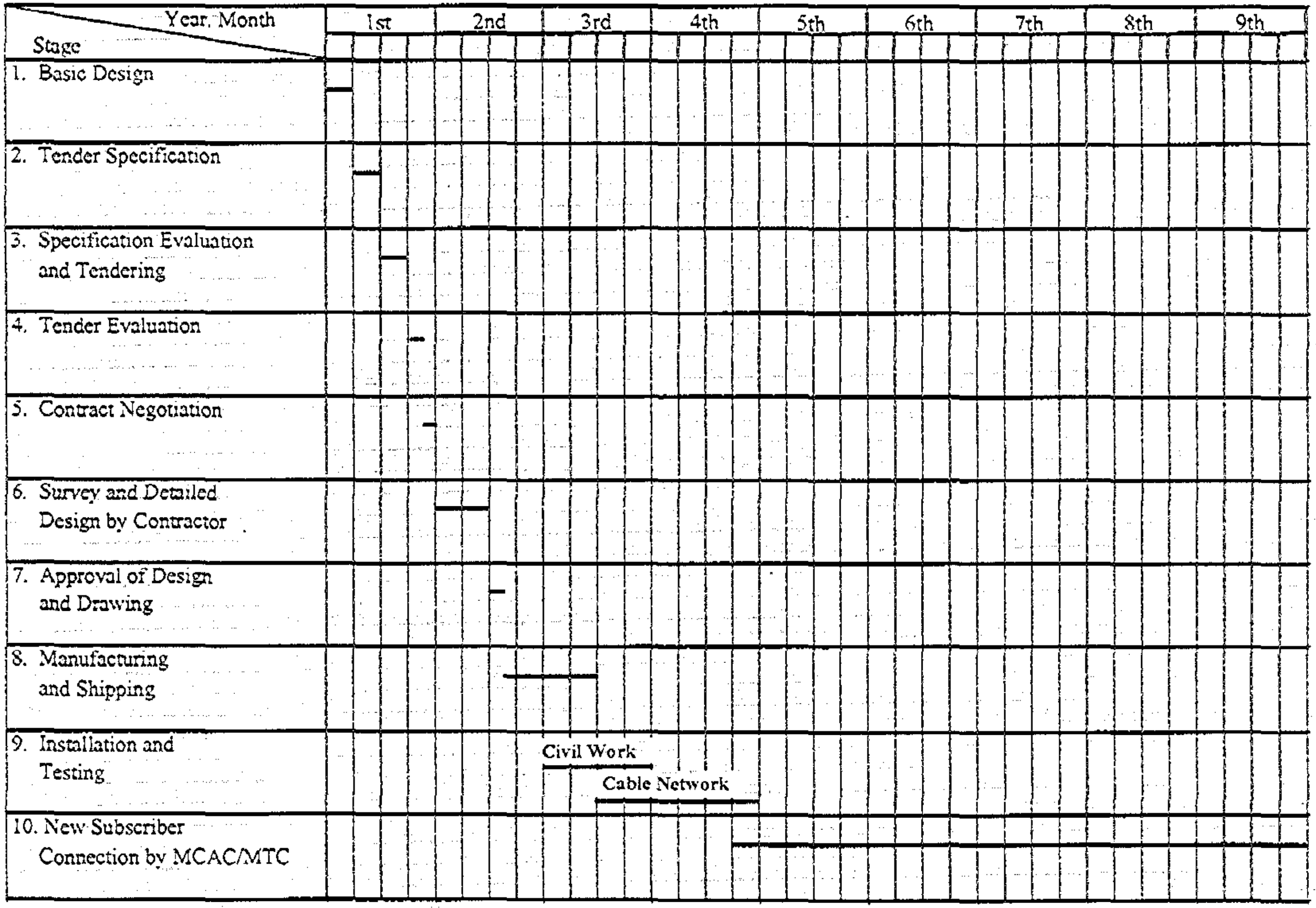


Figure 2-5-1 Exchange Portion Implementation Time Schedule

5.3 Implementation Schedule of Outside Plant

Figure 2-5-2 shows the implementation schedule of Outside Plant.

Figure 2-5-2 Implementation Schedule of Outside Plan



5.4 Installation and Testing

5.4.1 For Smooth Project Advance

Telecommunication project is comparatively large in term of project cost and work volume, so various problems will be encountered during period of the project. Those problems can be reduced by adopting proper supervision system. The main purposes of the supervision work are summarized below.

- Project installation progress control.
- Confirmation of the equipment and system performances.
- Confirmation of the workmanship of installation work.

For smooth progress of the Project, the effective supervision work is indispensable. During the supervision work, the progress of installation should be checked by customer and/or consultant periodically, for instance, every one month. At the end of month, the progress milestone achieved is to be evaluated. When the delay or faults are identified during the inspection, the necessary measures should be taken to recover the delayed schedule.

The installation work is the contractor's main task, but the supervision work is carried out by customer and/or consultant. For the smooth progress of installation, close relationship between customer, consultant, and contractor is also required.

Generally, the supervision of installation work is mainly executed by customer and consultant. At present, MCAC has insufficient experiences through past projects, so MCAC is requested to establish the task force for implementing the telecommunication project under the MCAC project manager. This supervision practice makes completion of project smoothly and creates the valuable opportunities to give the OJT training to Mongolian staff.

5.4.2 Testing

It is very necessary that installing equipment and system are normally operating in conformity with the specified values by testing. The test is divided into three stages in the following:

Stage 1 : Factory Test
Stage 2 : Provisional Acceptance Test

Stage 3: Final Acceptance test

5.5 Training

5.5.1 Switching System

In order to maintain the new switching facilities in a good condition to offer satisfactory service to the users by training is essential. Training should be provided to 2 persons assigned for operation and maintenance of the new switching units, when a new technology is introduced. They should be given a period of 3 months training in the supplier's country as the supplier has his appropriate training facilities in his country. The rest of the personnel assigned to the new switches, 4 to 6 technicians, should be given training by those 2 persons at the training center and or at exchange site in Ulaanbaatar city. In the case that the existing type of switching systems is to be introduced, the number of personnel for each training course should be reviewed. The exact number of trainees should be decided when the switching type is determined.

5.5.2 Outside Plan system

In this Feasibility Study, jelly filled cables are planned to be introduced in full measure in Mongolia. Although this technology is now being introduced in the A.D.B. project, training of related technology such as splicing should be carried out through OJT and classroom for 10 to 15 maintenance/operation technicians.

6. Project Evaluation

6.1 Objective

A project evaluation is conducted with the objective of confirming the feasibility of the Bayangol ATC-6 project (hereafter "ATC-6 project") from financial, economic and social points of view.

6.2 Financial Analysis

6.2.1 Objective

A financial analysis is conducted in order to confirm the financial viability of the ATC-6 project. For this purpose, costs and revenues are estimated. A financial internal rate of return (FIRR) is derived based on the estimated costs and revenues. An income statement and a cash-flow statement are also prepared.

6.2.2 Methodology and Assumptions

(1) Overall

a) A financial analysis is conducted from the point of view of a notional unit of MCAC and MTC combined, respectively responsible for development and operation of the project.

b) The analysis focuses only on the portion of the telecommunications network to be added by the investment by ATC-6 project. The existing portion, therefore, is excluded from the analysis.

c) An evaluation period is 20 years.

d) The analysis is carried out on a real term basis, taking no account of inflation and foreign exchange rate fluctuations. In the event that that these factors influence costs and revenues, tariff and charges should accordingly be adjusted to compensate for the adverse influences.

e) Exchange rate applied is 490 Tg per US$, which is the average figure in April 1996.

(2) Cost

Investment cost is estimated as presented in detail in the previous sub-section. An annual disbursement schedule of the investment costs is prepared as follows.

	(million US$)
1997:	1.509
1998:	3.520
1999:	7.546
2000:	3.234
Total:	15.809

Operation and maintenance costs are estimated as in the same way as for the basic plan. Based on the actual expenditure of MTC in 1995, unit cost for personnel expenditure and non-personnel expenditure are derived as follows.

- non-personnel expenditure : 24,000 Tg/subscriber in 1995 (adjusted in later years assuming a real term growth of 1.8% per year)
- personnel cost : 328,000 Tg/employee in 1995 (adjusted in later years assuming a real term growth of 5.0% per year)

These unit costs are multiplied with the planned incremental number of employees at 15 for the ATC-6 project and the number of new subscribers at 16,000 at maximum. The estimated personnel and non-personnel expenditures for the ATC-6 project at the full operation stage are as follows.

- personnel cost : 0.012 million US$ per year
- non-personnel cost : 0.826 million US$ per year
- Total : 0.838 million US$ per year

Depreciation cost is calculated in order to derive income tax, which is 53% of pre-income tax. A straight line method is applied for a depreciation period of 20 years.

(3) Revenues

The following revenues are estimated.

- call revenues : local, long distance and international
- installation charge revenue
- rental revenue
- other revenues

Each of these revenues is estimated based on the following methodologies and assumptions.

Local call revenue is estimated based on the forecast local traffic and the number of subscribers by category, business including governmental organizations and residential subscribers. The following are the major assumptions and figures used for the estimate.

Call minutes in 1995 :

business : 24 minutes per subscriber per day
residential : 16 minutes per subscriber per day
(These minutes are assumed to grow as a result of an increase in calling rates)

Number of Subscribers at full operation stage (2003 and thereafter) :

business	:	2,575
residential	:	13,425
Total	:	16,000

Revenue from long-distance call is estimated based on the average long-distance call revenue per subscriber in 1995, Tg 11,050/subscriber per year and the number of subscribers to be added. The unit rate of Tg 11,050 per subscriber is adjusted by applying rates of annual change in traffic generation per subscriber estimated as part of traffic forecast.

Revenue from international calls is estimated based on the average international call revenue per subscriber in 1995, Tg 43,100/subscriber per year, and the number of subscribers to be added. The unit rate of 43,100 Tg per subscriber is adjusted by applying rates of annual change in traffic generation per subscriber estimated as part of traffic forecast. Two downward adjustments in the international call tariff level are assumed, first in 1996 and the second in 1998, following the ADB's recommendation. The level of international call tariff in Mongolia will become equivalent to those of other Asian countries as a result of the two adjustments.

Rental revenue is estimated based on the following existing charges and the number of subscriber of each category.

- non-budgetary (business) : Tg 6,600/subscriber/month
- budgetary (government) : Tg 3,900/subscriber/month
- residential : Tg 420/ subscriber/month

Since the demand forecast in the present study did not disaggregate business demand into private business and governmental organizations, an average figure of the two categories at 5,250 Tg/ subscriber/month is applied for rental revenue from business subscribers.

Revenue from other sources are assumed to be 9.0% of the sum of call revenue and rental revenue based on the MTC's 2000 revenue pattern forecast by the ADB's Business Plan. It is assumed that the proportion at 9.0% will remain constant as a result of mixed effects of both decreasing services such as telegram and telex and increasing services such as leased channels and access charges.

Installation charge revenue is estimated applying the existing rates as follows.

- business : Tg 24,000
- residential : Tg 12,000

6.2.3 Result of Financial Analysis

Financial internal rate of returns (FIRRs) are calculated based on the costs and revenues estimated. Table 2-6-1 shows a cash flow of the ATC-6 project. The following FIRRs are derived.

1) normal case : 13.06 %
2) cost 10% up : 10.53 %
3) revenue 10% down : 10.37 %
4) 2) plus 3) : 8.85 %

The normal case FIRR at 13.06% is higher than the average FIRR for the Basic Plan at 8.5%, indicating the higher investment efficiency of the ATC-6 project. It is also higher than the interest rate of the ADB loan relent from the Mongol Bank to MCAC at 6.70% per year, indicating that overall the ATC-6 project will be able to generate sufficient revenue to repay the loan procured under the same condition.

An income statement of the ATC-6 project as shown in Table 2-6-2 indicates that on a current revenue and expenditure basis, the project can be managed soundly. A cash flow statement shows that

the ATC-6 project will be able to be managed soundly under the relending conditions of the Mongolian government for the present ADB project except that a grace period of 1 year needs to be provided.

6.3 Economic Analysis

6.3.1 Objective

An economic analysis is conducted for the ATC-6 project in order to confirm the economic viability of the project. The difference of the economic analysis from the financial analysis presented in the previous subsection is that an economic analysis focuses on costs and benefits of the project from the perspective of an overall economy in stead of from that of implementing agency as is the case for a financial analysis.

6.3.2 Methodology and Assumptions

6.3.3 Overall Methodology and Assumption

- An evaluation is made on a real term basis taking no account of inflation and foreign exchange rate fluctuations.
- An evaluation period of 20 years is applied.
- Investment and operation and maintenance costs applied to the financial analysis are modified so that they represent resource utilization.
- Consumer surplus is calculated based on the results of the Socio-Economic Survey. The portion of consumer surplus is added to the tariff level to derive total economic benefit.
- An EIRR, economic internal rate of return, is derived as a criterion for evaluation.

6.3.4 Costs

The investment cost and operation and maintenance cost estimated and used for the financial analysis are modified to be used for an economic analysis. The objective of the modification is to adjust the local currency portion of the costs to eliminate distortion of prices and covert them such that prices reflect utilization of resources. The modification made in the economic analysis is elimination of transfer payment, custom duty and commercial tax, to be imposed on imported equipment. Other

investment costs in local currency is not adjusted due to the lack of reliable data on conversion factors. Investment costs thus adjusted for economic evaluation is as follows.

	(million US$)
1997 :	1.351
1998 :	3.151
1999 :	6.754
2000 :	2.895
Total :	14.150

Operation and maintenance costs estimated for the financial analysis is adjustment by multiplying the ratio of adjusted investment costs to financial investment costs (0.895).

Income tax is not derived since it is a transfer payment.

6.3.5 Benefit

Economic benefit of the ATC-6 project is estimated based on the financial revenue derived in the financial analysis and consumer surplus estimated based on the Socio-Economic Survey conducted in Ulaanbaatar in March 1996. Data on consumer surplus were collected by inquiring interviewees the maximum call tariff level and installation charge of a phone, up to which they accept to pay. The sum of the portion above the planned tariff level can be regarded as consumer surplus.

Consumer surplus portion was added to the financial revenue for the following categories.

- local call
- long-distance call
- international call
- installation charge

No consumer surplus was estimated for rental charge, regarding only revenue portion as economic benefit.

The following proportions are derived as the portion of consumer surplus to the financial revenue.

Local call/long distance call/international call
- residential subscriber : 12%
- business subscriber : 77%

installation charge :
- residential subscriber : 75%
- business subscriber : 48%

The consumer surplus portion estimated for local calls based on the survey results is applied to long-distance calls and international calls. For calculating economic benefit of installation, weighted average of residential and business subscribers at 72% is used for the sake of calculation simplicity.

A detail of deriving these proportions are given in Chapter 6 Financial, Economic and Social Analysis of Volume IV "Supporting Document".

6.4 Result of Economic Analysis

Based on the costs and benefit estimated as above, EIRRs (economic internal rate of return) are calculated. Table 2-6-3 presents a flow of costs and benefits. The following EIRRs are derived.

1) normal case :	26.49%
2) cost 10% up :	23.23%
3) benefit 10% down :	23.53%
4) 2) plus 3)	20.55%

These EIRRs show high economic return of the ATC-6 project. Even under the 4) case, in which costs are increased by 10% and benefit reduced by 10%, an EIRR is derived at 20.55%, which is higher than an estimated opportunity cost of capital in Mongolia at around 12%.

6.5 Social Analysis

The Socio-Economic Survey conducted during the second survey in Mongolia provides an insightful view into the expected improvement of people's life by the implementation of the ATC-6 project. A detail of the Socio-Economic Survey is presented in Chapter 7 of Volume IV.

In response to a question concerning the improvement people feel after installing a phone, the following answers are given.

- Easier to communicate with people
- Saves a lot of time and travel expenses
- Easy to call an ambulance and a doctor
- Speedier and more successful work
- Life became interesting and comfortable.
- Easier communication, especially for old people

It is found that the life becomes easier and more comfortable by having a phone through reduced time, money and energy for travel, more efficient work made possible, and an increased sense of security in emergency cases. The improvements in these aspects have even greater impact on socially vulnerable people such as old people and children. These benefits would be strongly felt especially in a place like Mongolia and Ulaanbaatar where public transportation system is underdeveloped and climate is severe.

The Socio-Economic Survey revealed that in the absence of telephone people spend plentiful time and energy for traveling in order to communicate with people. Some people spend almost 2 hours for traveling 20 kilometers to see somebody. It is common for people having no phone to travel several kilometers spending 20 to 30 minutes just to see someone. Avoidance of these travels by having a phone at home or a public phone close to home would substantially reduce the burden for communication, resulting in longer time being able to be spent for other activities, thus securing a more comfortable and enriched life.

An important point made clear by the Socio-Economic Survey is the need for improving access to telephone for emergency cases. Many respondents mentioned that they had a trouble in calling an ambulance in the case of sickness, baby delivery and injury. Some people could not call the police when they were burglarized or broken in into their ger plot. Although the frequency for making calls for emergency cases is lower than general calls, it is very in these crucial moments when telecommunication plays the best role.

With the implementation of the ATC-6 project, the telephone penetration ratio is planned to reach 25 telephones per 100 population in 2010 as opposed to present 8.1. This means that such social benefits as mentioned so far will be felt by most of the population in the ATC-6 area estimated to be about 134 thousand in 2010, realizing more comfortable and secure life of the population.

Table 2-6-1 Financial Internal Rate of Return of ATC-6 Project

FIRR = 1) Normal case : 13.06% 2) Cost 10% up : 10.53% 4) 2) plus 3) : 8.85%
3) Revenue 10 % down : 10.37%

(Unit : million US$)

Year	Costs			Revenue							Income before tax	Income tax	Income after tax + depreciation
	Investment	OM	Depreciation	Call revenue			Rental revenue	Installation revenue	Other revenue	Total			
				local	long distance	International							
1997	1.509	0.000	0.075	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-1.584	0.000	-1.509
1998	3.520	0.000	0.251	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-3.771	0.000	-3.520
1999	7.546	0.643	0.251	0.594	0.369	1.054	0.288	0.202	0.207	2.714	-5.726	0.000	-5.475
2000	3.234	0.725	0.629	0.614	0.442	1.232	0.306	0.042	0.233	2.869	-1.718	-0.911	-0.179
2001	0.000	0.741	0.790	0.640	0.480	1.307	0.320	0.010	0.247	3.004	1.473	0.781	1.483
2002	0.000	0.815	0.790	0.726	0.568	1.509	0.340	0.038	0.283	3.464	1.858	0.985	1.664
2003	0.000	0.838	0.790	0.760	0.623	1.614	0.343	0.011	0.301	3.652	2.023	1.072	1.741
2004	0.000	0.838	0.790	0.782	0.669	1.691	0.343	0.000	0.314	3.799	2.170	1.150	1.810
2005	0.000	0.838	0.790	0.794	0.709	1.750	0.343	0.000	0.324	3.920	2.291	1.214	1.867
2006	0.000	0.838	0.790	0.815	0.761	1.831	0.343	0.000	0.338	4.088	2.459	1.303	1.946
2007	0.000	0.838	0.790	0.830	0.809	1.899	0.343	0.000	0.349	4.230	2.602	1.379	2.013
2008	0.000	0.838	0.790	0.851	0.865	1.983	0.343	0.000	0.364	4.406	2.777	1.472	2.096
2009	0.000	0.838	0.790	0.872	0.926	2.071	0.343	0.000	0.379	4.591	2.963	1.570	2.183
2010	0.000	0.838	0.790	0.885	0.980	2.137	0.343	0.000	0.391	4.736	3.108	1.647	2.251
2011	0.000	0.838	0.790	0.885	0.981	2.140	0.343	0.000	0.391	4.740	3.112	1.649	2.253
2012	0.000	0.838	0.790	0.885	0.981	2.140	0.343	0.000	0.391	4.740	3.112	1.649	2.253
2013	0.000	0.838	0.790	0.885	0.981	2.140	0.343	0.000	0.391	4.740	3.112	1.649	2.253
2014	0.000	0.838	0.790	0.885	0.981	2.140	0.343	0.000	0.391	4.740	3.112	1.649	2.253
2015	0.000	0.838	0.790	0.885	0.981	2.140	0.343	0.000	0.391	4.740	3.112	1.649	2.253
2016	0.000	0.838	0.790	0.885	0.981	2.140	0.343	0.000	0.391	4.740	3.112	1.649	2.253
2017	0.000	0.838	0.790	0.885	0.981	2.140	0.343	0.000	0.391	4.740	3.112	1.649	2.253
2018	0.000	0.838	0.790	0.885	0.981	2.140	0.343	0.000	0.391	4.740	3.112	1.649	2.253
Total	15.809	16.332	15.435	16.243	16.049	37.198	6.742	0.303	6.861	83.396	35.820	24.858	26.397

Note : Income tax : 53% of pre-tax income

* Depreciation is calculated in order to derive income tax. Depreciation is added to income after tax to derive FIRR to investment

Other revenue : 9% of the sum of call revenues and rental charge revenue

Table 2-6-2 Income Statement and Cash Flow Statement of the ATC-6 Project : Base Case

(Unit : million US$)

Item	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
(Income Statement)														
Revenue	0.000	0.000	2.714	2.869	3.004	3.464	3.652	3.799	3.920	4.088	4.230	4.406	4.591	4.736
Personnel & other cost	0.000	0.000	0.643	0.725	0.741	0.815	0.838	0.838	0.838	0.838	0.838	0.838	0.838	0.838
Depreciation	0.000	0.075	0.251	0.629	0.790	0.790	0.790	0.790	0.790	0.790	0.790	0.790	0.790	0.790
Income before tax	0.000	-0.075	1.820	1.515	1.473	1.859	2.024	2.171	2.292	2.460	2.602	2.778	2.963	3.108
Income tax	0.000	0.000	0.964	0.803	0.780	0.985	1.072	1.150	1.215	1.304	1.379	1.472	1.570	1.647
Income after tax	0.000	-0.075	0.855	0.712	0.692	0.874	0.951	1.020	1.077	1.156	1.223	1.305	1.392	1.461
(Cash Flow Statement)														
Sources :														
Income after tax	0.000	0.000	0.855	0.712	0.692	0.874	0.951	1.020	1.077	1.156	1.223	1.305	1.392	1.461
Depreciation	0.000	0.075	0.251	0.629	0.790	0.790	0.790	0.790	0.790	0.790	0.790	0.790	0.790	0.790
Loans	1.509	3.520	7.546	3.234	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total	1.509	3.595	8.653	4.575	1.483	1.664	1.742	1.811	1.867	1.946	2.013	2.096	2.183	2.251
Applications :														
Investment	1.509	3.520	7.546	3.234	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Loan repayment	0.000	0.139	0.464	1.159	1.458	1.458	1.458	1.458	1.458	1.458	1.458	1.458	1.458	1.458
Total	1.509	3.659	8.010	4.393	1.458	1.458	1.458	1.458	1.458	1.458	1.458	1.458	1.458	1.458
Cash surplus (defecit) for Year	0.000	-0.064	0.643	0.181	0.025	0.206	0.284	0.353	0.410	0.489	0.556	0.638	0.725	0.793
Accumulated profit (defecit)	0.000	-0.064	0.579	0.761	0.786	0.992	1.276	1.629	2.039	2.527	3.083	3.721	4.446	5.240

Item	2011	2012	2013	2014	2015	2016	2017	2018
(Income Statement)								
Revenue	4.740	4.740	4.740	4.740	4.740	4.740	4.740	4.740
Personnel & other cost	0.838	0.838	0.838	0.838	0.838	0.838	0.838	0.838
Depreciation	0.790	0.790	0.790	0.790	0.790	0.790	0.790	0.715
Income before tax	3.112	3.112	3.112	3.112	3.112	3.112	3.112	3.187
Income tax	1.649	1.649	1.649	1.649	1.649	1.649	1.649	1.689
Income after tax	1.462	1.462	1.462	1.462	1.462	1.462	1.462	1.498
(Cash Flow Statement)								
Sources :								
Income after tax	1.462	1.462	1.462	1.462	1.462	1.462	1.462	1.498
Depreciation	0.790	0.790	0.790	0.790	0.790	0.790	0.790	0.715
Loans	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total	2.253	2.253	2.253	2.253	2.253	2.253	2.253	2.213
Applications :								
Investment	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Loan repayment	1.458	1.458	1.458	1.458	1.458	1.458	1.458	1.319
Total	1.458	1.458	1.458	1.458	1.458	1.458	1.458	1.319
Cash surplus (defecit) for Year	0.795	0.795	0.795	0.795	0.795	0.795	0.795	0.894
Accumulated profit (defecit)	6.035	6.830	7.625	8.421	9.216	10.011	10.806	11.701

Assumptions :

Income tax :	53% of pretax income
interest :	6.70% / year
repayment period :	20 years
grace period :	0 years
Tariff increase :	0% /year

Table 2-6-3 Economic Internal Rate of Return of ATC-6 Project

EIRR =

1) Normal case : 26.49%
2) Cost 10% up : 23.63%
3) Benefit 10% down : 23.23%
4) 2) plus 3) : 20.55%

(Unit : million US$)

Year	Cost		Benefit						Net benefit
	Investment	OM	Calls			Rental charge	Installation fee	Total	
			local	long distance	International				
1997	1.351	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-1.351
1998	3.151	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-3.151
1999	6.754	0.575	0.760	0.472	1.348	0.288	0.347	3.215	-4.114
2000	2.895	0.649	0.780	0.562	1.566	0.306	0.072	3.286	-0.257
2001	0.000	0.663	0.816	0.612	1.666	0.320	0.017	3.432	2.768
2002	0.000	0.729	0.921	0.720	1.913	0.340	0.065	3.960	3.230
2003	0.000	0.750	0.963	0.789	2.045	0.343	0.019	4.159	3.409
2004	0.000	0.750	0.990	0.847	2.141	0.343	0.000	4.321	3.571
2005	0.000	0.750	1.006	0.898	2.216	0.343	0.000	4.463	3.713
2006	0.000	0.750	1.031	0.963	2.317	0.343	0.000	4.654	3.904
2007	0.000	0.750	1.052	1.025	2.406	0.343	0.000	4.825	4.075
2008	0.000	0.750	1.077	1.095	2.510	0.343	0.000	5.026	4.276
2009	0.000	0.750	1.103	1.171	2.620	0.343	0.000	5.237	4.487
2010	0.000	0.750	1.120	1.240	2.704	0.343	0.000	5.407	4.657
2011	0.000	0.750	1.120	1.241	2.708	0.343	0.000	5.412	4.662
2012	0.000	0.750	1.120	1.241	2.708	0.343	0.000	5.412	4.662
2013	0.000	0.750	1.120	1.241	2.708	0.343	0.000	5.412	4.662
2014	0.000	0.750	1.120	1.241	2.708	0.343	0.000	5.412	4.662
2015	0.000	0.750	1.120	1.241	2.708	0.343	0.000	5.412	4.662
2016	0.000	0.750	1.120	1.241	2.708	0.343	0.000	5.412	4.662
2017	0.000	0.750	1.120	1.241	2.708	0.343	0.000	5.412	4.662
2018	0.000	0.750	1.120	1.241	2.708	0.343	0.000	5.412	4.662
Total	14.150	14.617	20.577	20.325	47.116	6.742	0.521	95.282	66.514

7. Conclusion

7.1 Technical Aspect

In order to meet the telephone demand increasing rapidly in keeping with the aspiration of people and economic growth, MOID/MCAC is required to provide more capacity of telephone switching system, transmission system and outside plant. Also because of the present time, there is only one digital exchange at ATC-3 in Ulaanbaatar city, network reliability and security is bad.

In order to improve above mentioned, new exchange (capacity : 16,000 line units) will be installed and the junction circuit between ATC-6 and ATC-3 will be expanded by optical fiber system in the year 1998. At the same time, new cables (11,000 lines) and rehabilitation cables (10,800 lines) will be installed up to 2000.

7.2 *Cost Estimate*

Table 2-7-1 shows the project investment cost.

Table 2-7-1 Project Investment Cost

(Unit : US$ 1,000)

Item	Total	Switch		Outside Plant	
		Local Currency Portion	Foreign Currency Portion	Local Currency Portion	Foreign Currency Portion
Equipment and Training	9,221	0	3,061	0	6,160
Installation Cost	1,659	2	457	590	610
Transportation Cost	1,067	0	367	0	700
Consultancy	1,004	0	194	0	810
All Types of Taxes	1,659	559	0	1,100	0
Contingency	1,199	0	389	60	750
Total	15,809	561	4,468	1,750	9,030

7.3 Project Evaluation

An FIRR is estimated to be 10.9 %, considered fairly high for a public investment project. This project will generate sufficient revenue to repay a loan with the present ADB loan conditions assumed.

An EIRR is estimated to be 20.3 %, indicating the sound economic viability of the basic plan.

The ATC-6 project will improve the life of the population in terms of realizing comfortable life with more time and energy spent on other activities than communication and an increased sense of security through easier access to telecommunications services in emergency cases.

Overall, the ATC-6 project is recommended to be implemented from its sound technical, financial, economic and social viability.

CHAPTER 3

FEASIBILITY STUDY ON RADIO SUBSCRIBER SYSTEM PROJECT FOR GER AREAS AND REMOTE AREAS

CHAPTER 3

FEASIBILITY STUDY ON RADIO SUBSCRIBER SYSTEM INSTALLATION FOR GER AREA AND REMOTE AREAS

1. Background of the Project

As a result of the introduction of a market oriented economy, telephone demand in Mongolia has tended to increase rapidly, and the Government of Mongolia is endeavoring to install an adequate, efficient and reliable telecommunications network as a national development policy in order to meet the increasing demand. In addition to that, most of the existing telecommunications facilities are obsolete, especially subscriber cables are not in adequate condition to provide normal telephone services.

Considering the above situation, the Government of Mongolia requested the Government of Japan to formulate a long term telecommunications plan covering demand forecast and supply plan up to the year 2010.

Since a huge project cost and manpower will be required to complete the telecommunications network according to the long term plan, the first priority should be given to upgrading telephone services in the government offices and business areas. There are few chances for people in residential areas to have their telephone services improved in the near future.

Residential areas of Ulaanbaatar city are divided into modern apartment building areas and traditional ger areas. Basic infrastructures such as water and electric power supply in ger areas are in very poor condition compared with those in apartment areas, and there is very little possibility of acquiring new telephone services in ger areas.

The Government of Mongolia has been planning to improve basic infrastructures in ger areas as part of its national policy assisted by the World Bank. Under these circumstances, MCAC/MOID plan to provide telephone services in ger areas in line with the above plan.

2. Objectives and Scope of the Project

2.1 Objectives of the Study

This project aims at providing telephone services to inhabitants in ger areas by using radio system. At present, there are no telephone cable facilities installed nearby, therefore telephone cables should be installed from the telephone office a long way for telephone services in ger areas.

The Digital Radio Concentration System (hereinafter called DRCS) has the advantage of easy installation and system flexibility compared with the conventional cable system, and subscriber terminals can be installed anywhere in the line of sight to/from the base station. The DRCS system will provide better telephone services to existing subscribers who are experiencing problems due to cable degradation.

This system will also cover 4 enclaves in the Ulaanbaatar administration area where the traffic is small. The services areas to be covered by this DRCS system are listed below.

- New telephone network in ger areas.
- Upgrading of telephone services in 4 enclaves of Jaargalant, Nairamdal, Gachuurt and Honhor.
- Upgrading of existing unsatisfactory telephone services for hospitals, schools, public organizations and VIP subscribers in Ulaanbaatar city

The above areas are shown in Figures 3-2-1, and 3-2-2.
As detailed location of telephone sets is not fixed yet at this stage, the system design was carried out on the assumption that all subscribers in ger areas are uniformly located and VIP subscribers are located at random in Ulaanbaatar city.

2.2 Scope of Project

This project includes procurement, installation, testing, and training using the following telecommunications facilities.

2.2.1 DRCS System

This system consists of a base station, subscriber terminal stations and repeater stations. The system and functional configuration are illustrated in Figures 3-2-3 and Figure 3-2-4. ATC-3 station is selected for the base station, and the base station equipment will be installed in the equipment room in that station. All telephone sets in subscriber terminal stations will be connected to/from the base station by digital radio system, and a repeater station will be placed to connect above two stations when the line of sight for radio propagation is not obtained.

a) Base Station

The total number of subscribers is expected to be about 400 and all subscribers will be connected to E-10B switching equipment at ATC-3 through a radio system which has a capacity of 2/4Mb/s. The base station consists of an antenna system, a radio transmitter-receiver, a system controller, a concentrator and O&M controller equipment with a Visual display unit (VDU) unit.

The antenna for the DRCS system will be mounted on the roof-top of that building and the equipment will be installed in the existing equipment room on the 6th floor. Power supply to the DRCS facilities will be provided by the existing power system in ATC-3.

b) Subscriber Terminal Station

The subscriber terminal consists of an antenna, an antenna pole, DRCS terminal equipment, telephone sets and power supply equipment. One subscriber radio terminal can accommodate 5-15 telephone sets connected by copper cables.

A solar system will be used for power supply in the subscriber terminal where commercial power supply is not available or unreliable.

c) Repeater Stations

(A) repeater station(s) will be installed where the radio path is obstructed by tall constructions or mountains. These repeater stations are normally located on the top of mountains in order to obtain line of sight.

The repeater station in the DRCS system is unattended. In the case that commercial power is not available, a solar power system will be adopted.

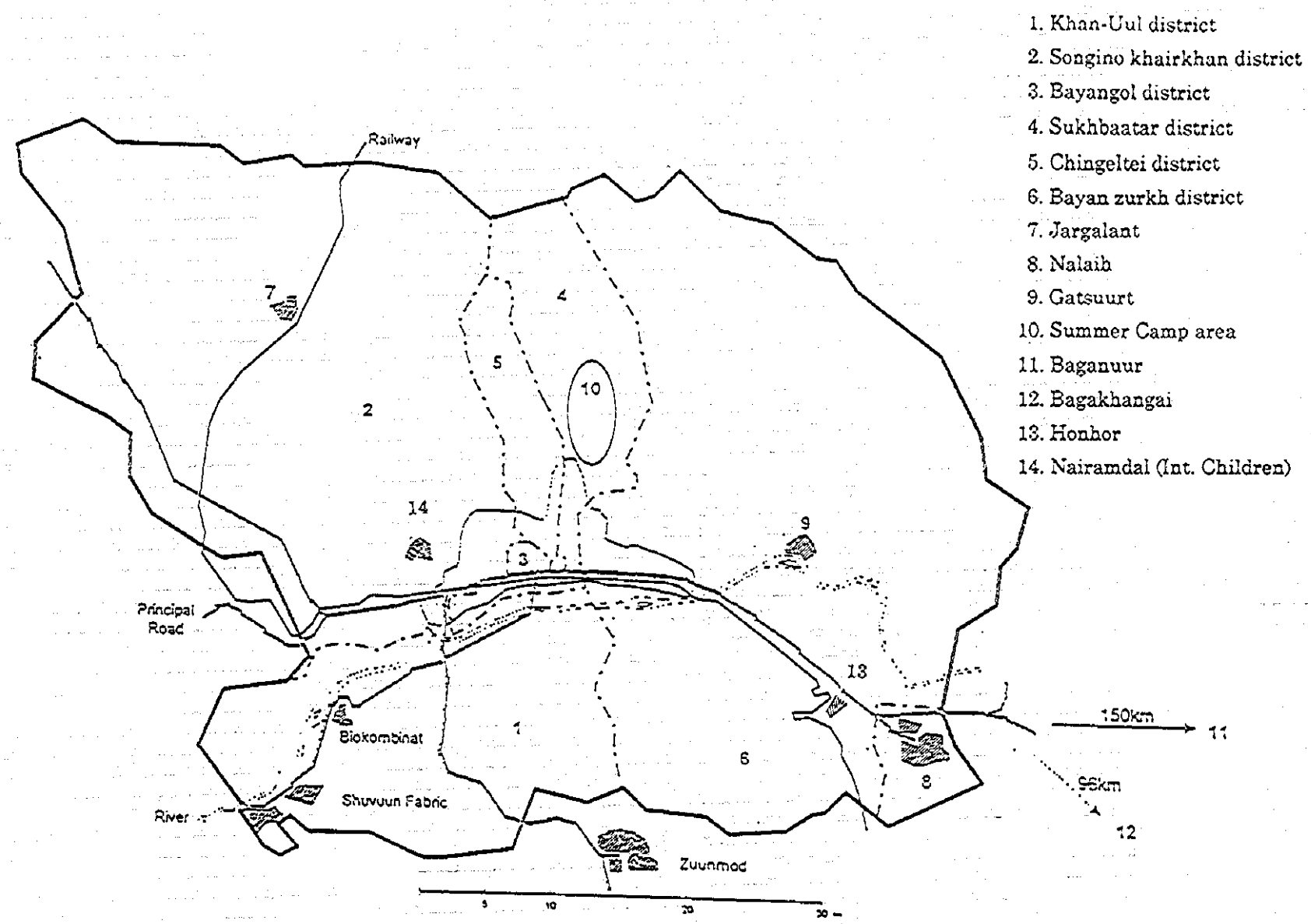


Figure 3-2-1 Service Covering Locations of DRCS System

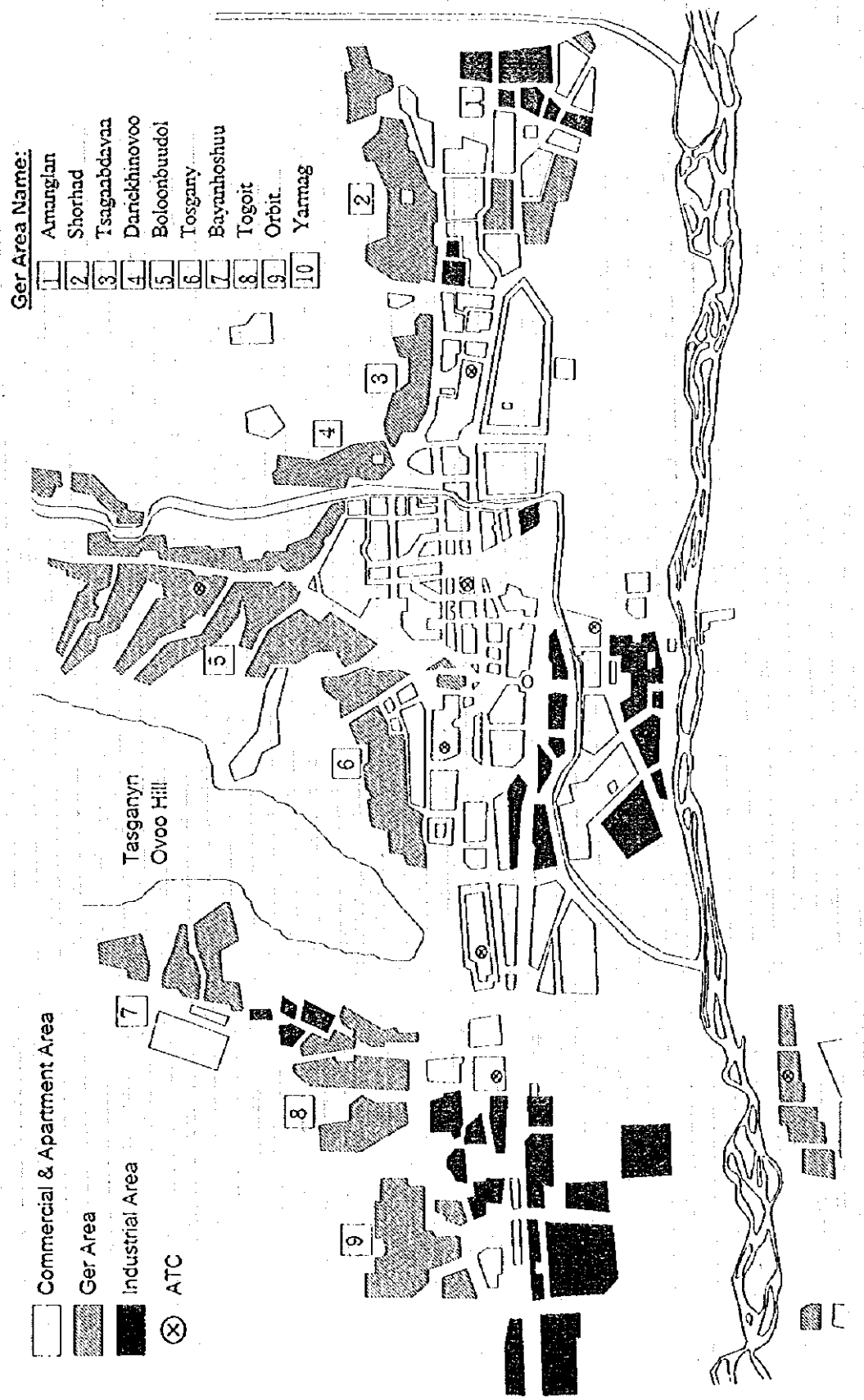


Figure 3-2-2 Locations of Ger Areas for DRCS System

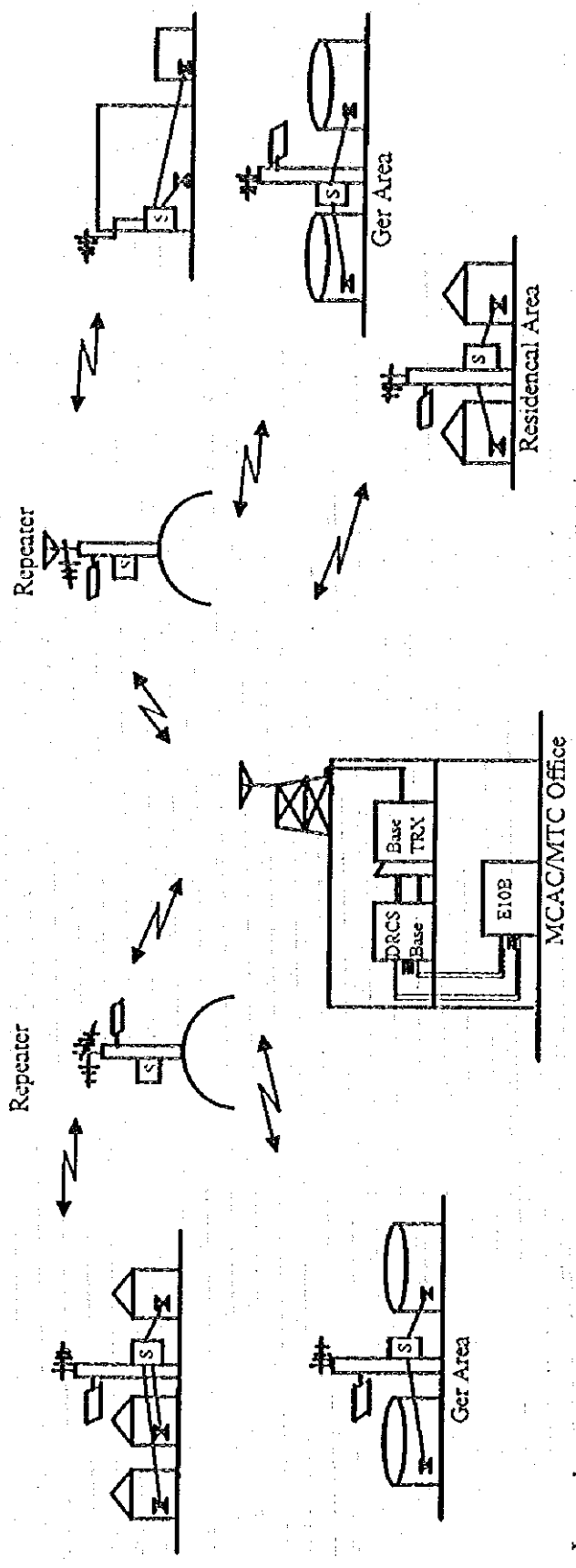


Figure 3-2-3 DRCS System Configuration

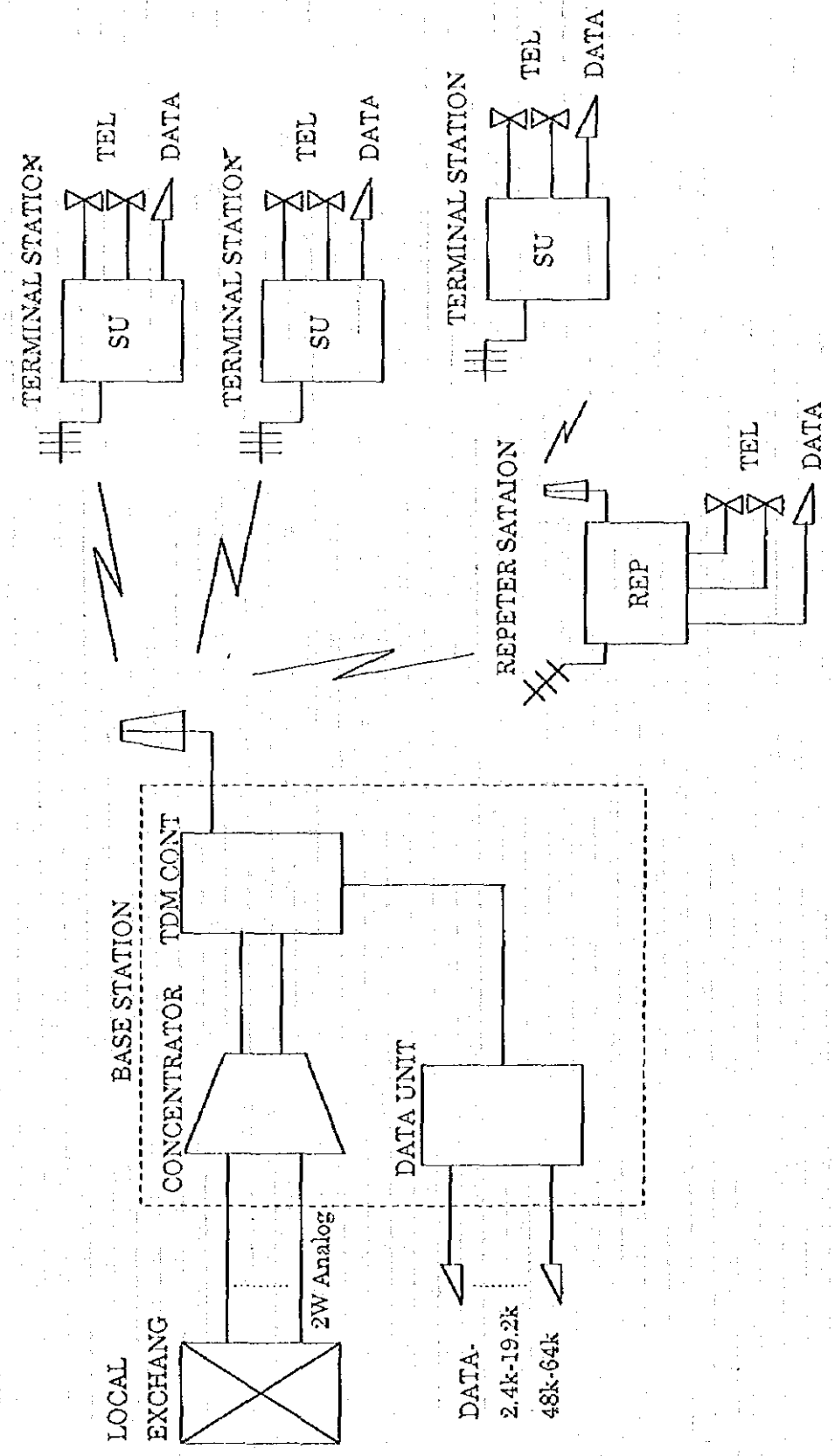


Figure 3-2-4 DRCS System Functional Configuration

2.2.2 Switching System

The E-10B switching system capacity of ATC-3 should be expanded to be 14,300 in 1998 in accordance with the basic plan. This capacity is enough to accommodate DRCS subscribers.

DRCS subscribers are to be connected to E-10B switching system through MDF like ordinary subscribers. MDF is the point of demarcation of responsibility for operation/maintenance activities between transmission and switching .

3. Present Condition of Telecommunications Services and Demand in the Target Areas

3.1 Present condition of telecommunication services

Detailed information on existing telecommunication conditions is given in the main report of the Basic Plan (refer to Vol. II, Chap.4). The present condition of the telephone network for the area to be covered by the DRCS system is considerably poor.

Telephone service is extremely poor in ger areas, and most of the ger residents have no experience of making telephone calls. Ger residents have to go out of the area to the nearest telephone facilities when they want to make a telephone call.

As for the 4 enclaves of Ulaanbaatar city, telephone service is very poor. An obsolete open-wire carrier system is being used between those 4 enclaves and Ulaanbaatar city, and the average distance is 40 to 50 km. Frequent serious interruptions of the service occur due to failure of the system in winter.

3.2 Demand of Telephone Sets

Number of telephones to be installed in this project was determined based on the limitation of the radio transmission capacity.

According to the survey data obtained by the Team in April 1996, a 300m walk for making telephone calls was accepted by the ger inhabitants. Therefore, one telephone set is located in each 300x300 square meters in ger areas. Number of telephone sets to be installed in each area is shown in the following Table 3-3-1, including 4 enclaves, government offices and VIP subscribers.

Table 3-3-1 Number of Telephone Sets in the DRCS System

No.	Ger name	Ger dimensions (km^2) ※1	Telephone sets	Terminal station ※2
1.	Amaglan	2.00	22	2
2.	Shorhad	6.00	67	5
3.	Tsagaabdavaa	1.20	13	1
4.	Darickhinovoo	0.64	7	1
5.	Boloonbuudol	10.00	111	8
6.	Tosgany Ovoo	0.90	10	1
7.	Bayanhoshuu	2.25	25	3
8.	Tolgoit	1.00	11	1
9.	Orbit	5.60	62	5
10.	Yarmag	1.50	16	1
11.	Jargalant	-	10	1
12.	Gachuurt	-	10	1
13.	Honhor	-	10	1
14.	Nairandal	-	10	1
15.	Gov. & VIP	Inside city	24	3
	Total		408	35

Remarks :

※1 Land dimension is estimated for telephone location only.

※2 5-15 telephone sets are accommodated in one terminal station.

4. Project Basic Design

This paragraph describes DRCS system design with the object of confirming the final system configuration and facilities plan.

At the start of the system design, site selection for the radio system stations is carried out using topographical maps for antenna height calculation.

Generally, a map of the scale 1/50,000 is needed for site selection. Here, the maps of 1/100,000 were used because those of 1/50,000 were not available. Further studies should be executed in order to finalize the network in the project implementation stage by using more precise maps.

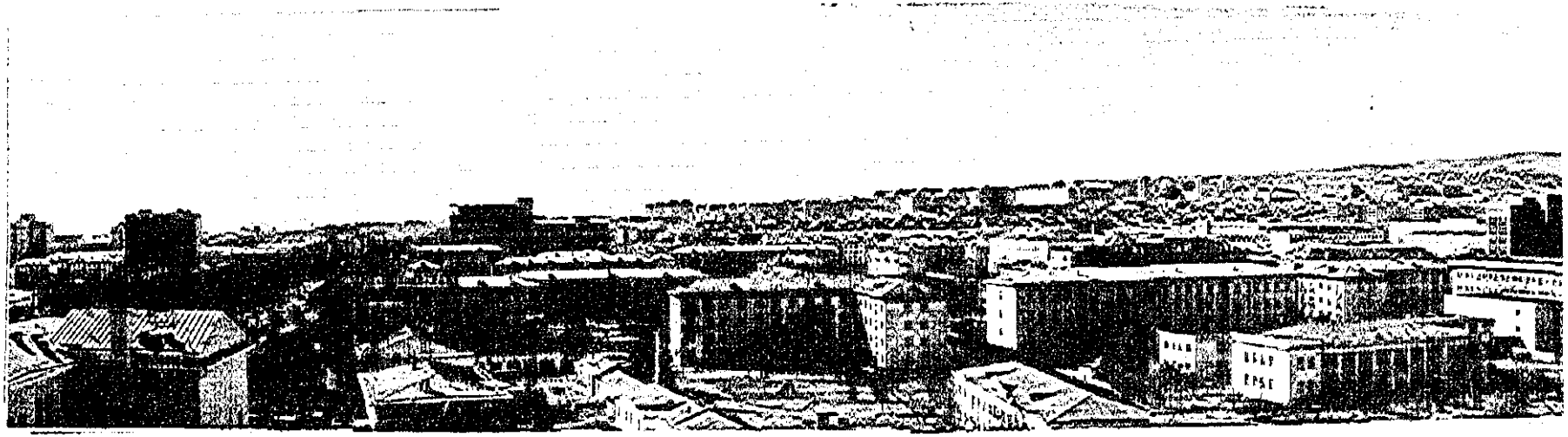
As the result of the field survey, it was found that Tasganyn hill obstructs radio propagation between ATC-3 and ger areas 7 , 8 and part of 9 shown in Figure 3-2-2. Therefore, a repeater station will be necessary in order to obtain good line of sight conditions for the above 3 ger areas. Same high apartments also present partial obstruction, but most of the ger directions have good line of sight conditions. Figures 3-4-1 and 3-4-2 show photographic views in all directions from the ATC-3 roof-top.

As it is not possible to decide the actual locations of subscribers at this stage, the antenna heights cannot be calculated. For the feasibility study, the antenna height was estimated as the follows:

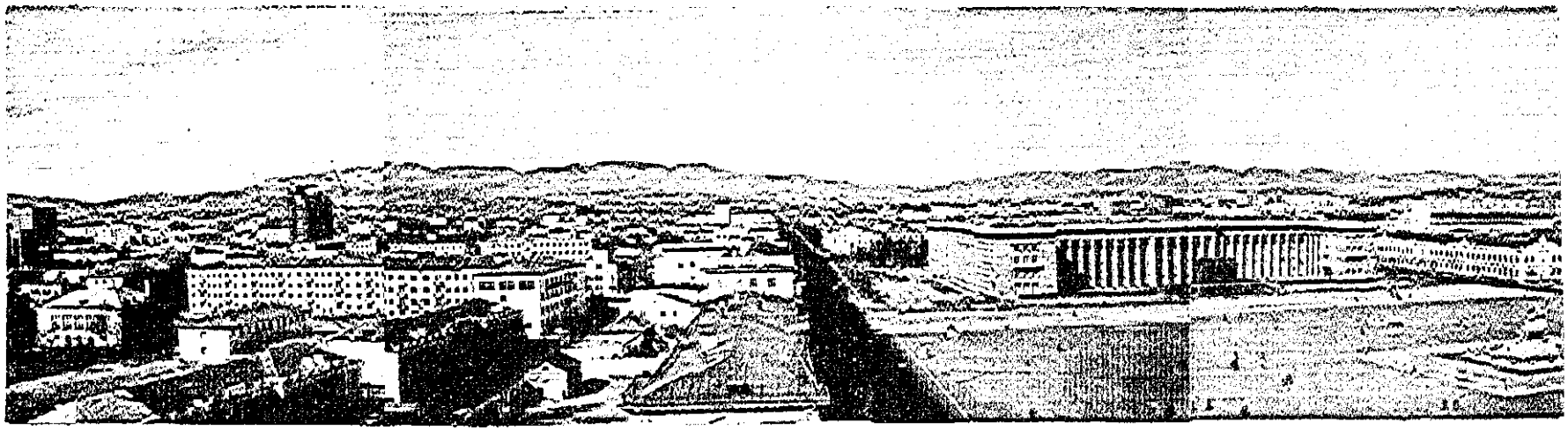
- 10 m antenna height within 10 km distance from the base station.
- 15 m antenna height over 10 km from the base station.
- 10 m antenna height except in ger area.

As E-10B exchange of ATC-3 accommodates DRCS subscribers, DRCS customers are treated as the same subscribers connected by metallic cables.

The introduction of new DRCS subscribers does not require major modifications to the existing network except charging.

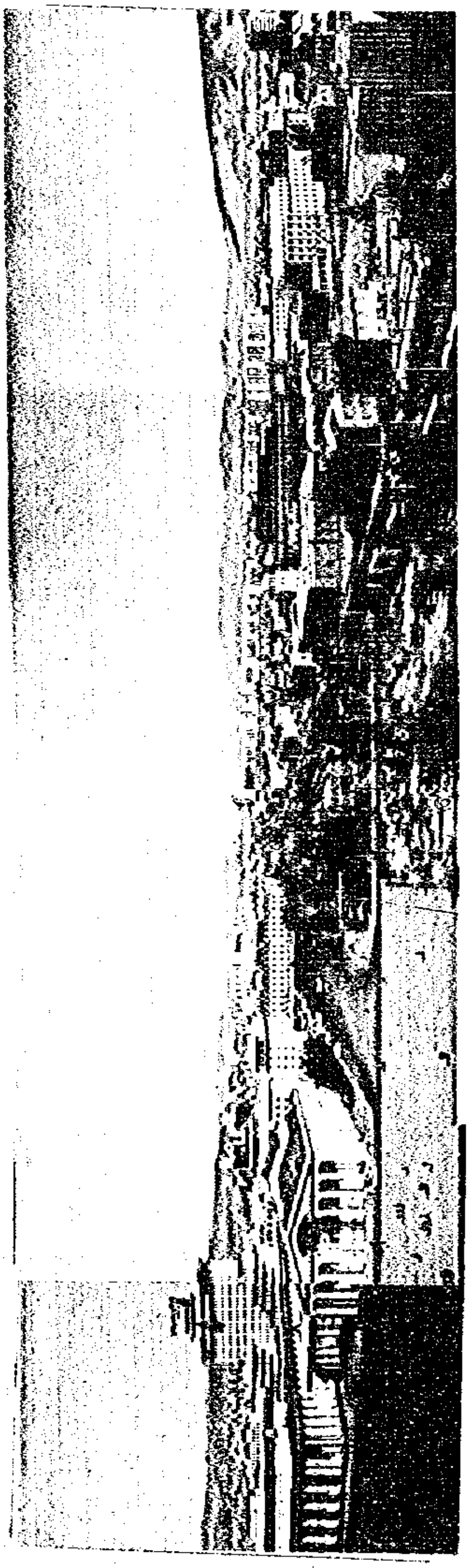


(West)

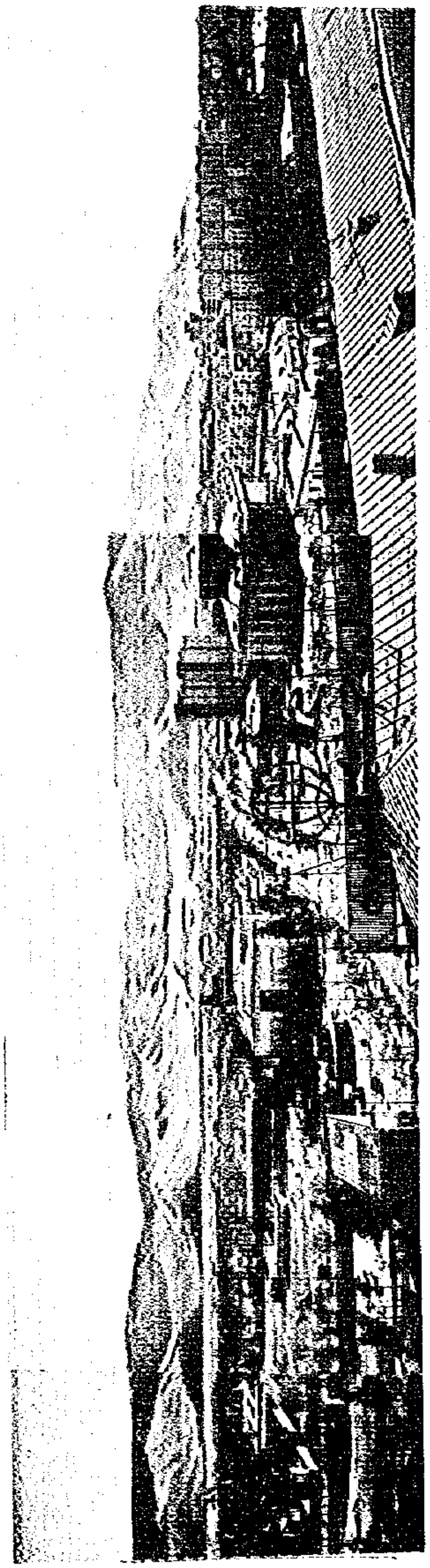


(North)

Figure 3-4-1 Photographic Views from the Base Station (West&North)



(East)



(South)

Figure 3-4-2 Photographic Views from the Base Station (East&South)

4.1 Transmission Capacities

The transmission capacity is normally determined based on a combination of the Grade of Service (hereinafter called GoS) and the traffic demand forecast. Radio System Capacities of 2 or 4 Mb/s are normally used in subscriber radio access systems.

The relationship between the number of calls to be carried and the GoS is in reverse correlation when transmission capacity is fixed. If degradation of the service is permitted, the number of subscribers can be increased without limitation.

4.2 Subscriber Network Plan

Among various subscriber access networks, metallic cable networks and digital radio system are compared here. The two systems have merits and demerits. As the circumstances are changing rapidly in the telecommunications field, there is no appropriate method of comparing the three access systems using conventional means.

The merits and demerits of the metallic cable access method are listed below.

Merits

1. Comparatively low cost (about US $300/ 1 sub.).
2. Installation materials can be procured locally.
3. The value is large in terms of property.

Demerits

1. Little flexibility in networking.
2. Much O/M work is required.
3. Long installation period.
4. Considerably difficult civil work is necessary.

The applicable subscribers using those access methods in Ulaanbaatar are listed in Table 3-4-1.

Table 3-4-1

Access Method	Applicable Subscriber	Remarks
Metallic Cable	Standard subscribers near exchanges	Apartment area
DRCS System	No cable or difficult installation areas Far from exchanges and sparsely scattered	Ger and enclave area

4.2.1 Introduction of DRCS System

Since the DRCS system has the advantage of easy installation, it was adopted as the system for the feasibility study. The advantages of the subscriber radio system are as follows:

1. Flexibility in networking.
2. Less installation work and short installation period.
3. Stations can be installed without access road.
4. O/M work is easy and of low cost.

Item 1 and 2 are considered to be the main reasons for selecting the DRCS system for ger area subscribers, and because of network flexibility, the terminal equipment can be replaced easily when the metallic cables are installed in ger areas in the future.

4.2.2 Transmission System

Various factors affect transmission performance, and the standard for them is recommended by ITU-T and -R. Loudness and Bit Error Rate (BER) are generally regarded as the main performance criteria to be measured. Most countries have their own technical standards based on the above ITU-T and R recommendations.

In Mongolia, the technical telecommunications standards are still in the process of being formulated. An explanation of the basic transmission performance is described in the main report of the basic plan.

According to the equipment standard, 8 dB is allocated to the subscriber cable section, so the total loss between the base station and the telephone sets should be designed within 8 dB including the DRCS and subscriber cable sections.

The radio system consists of 2-4 hops, and all radio sections should be designed to accommodate the allowable BER objectives prescribed in ITU-T and R.

4.2.3 Interconnection with Ulaanbaatar Network

All DRCS subscribers are accommodated with ATC-3 E-10B switching equipment. The junction network is shown in Figure 3-4-3.

Subscribers in the 4 enclaves are also connected with ATC-3, and the subscribers in Jargalant are located more than 40 km away from ATC-3. The telephone tariff for enclave subscribers should be calculated on such basis, since subscribers in the 4 enclaves should be treated as normal cable subscribers.

4.2.4 Radio System Design

Ulaanbaatar city is surrounded by many mountains, especially to the south and north, and this geographic condition makes site selection for the radio network more difficult. According to weather information, wind velocity in the mountain area is extremely high. So the antenna height has been set at 10m with a maximum height of 15m from both technical and financial standpoints.

Figure 3-4-4 shows the DRCS radio system route configuration. The total number of repeater stations is 5 stations of which 3 are required to connect the radio network to Jargaland station because of the obstruction of mountains.

The antenna height in ger areas is mentioned paragraph 5 in this report, and most of Ulaanbaatar city can be covered by the DRCS system with 10m and 15m towers. However, it is inevitable in any radio system that weak radio signal areas are created at the receiving terminals due to obstructions. Therefore, special attention should be given to the existence of weak-signal areas at the time of installation.

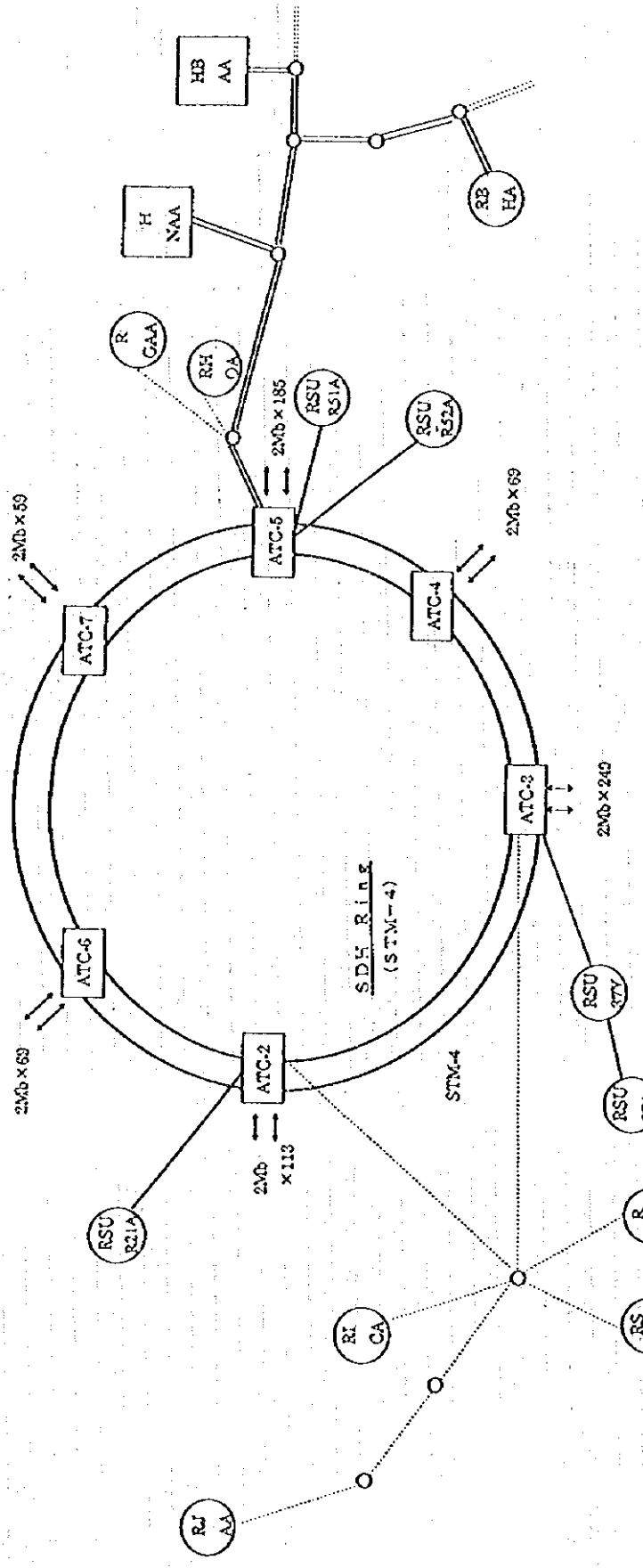


Figure 3-4-3 The Junction Network in Ulaanbaatar city

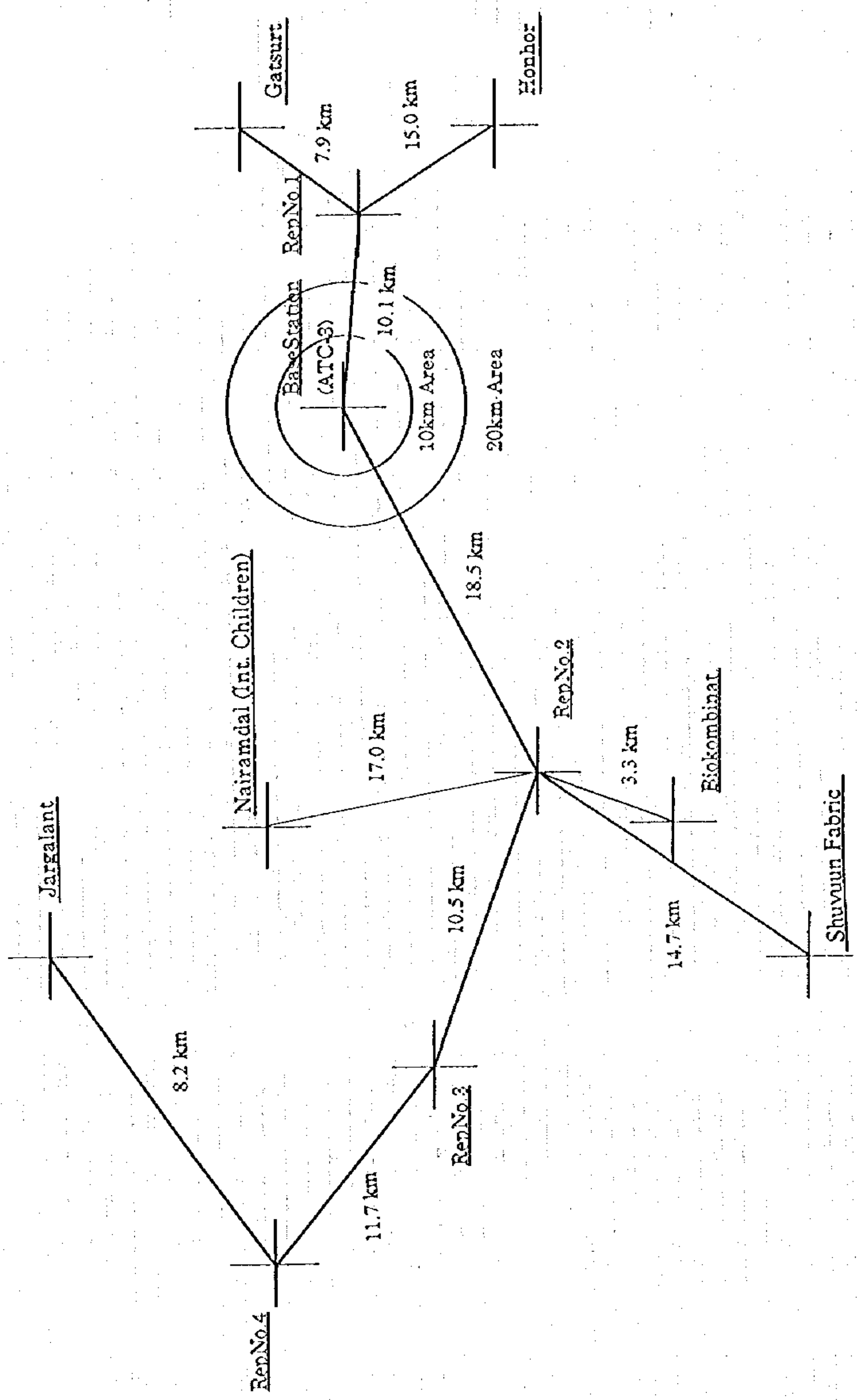


Figure 3-4-4 DRCS Radio Route Configuration

4.3 Facilities Plan

Based on the basic design in this report, a facilities plan will be studied to finalize the required number of equipment and units. The following system parameter are typical value for the DRCS facilities plan.

a)	Service Area	:	30 km (hop distance), 500 km (coverage radius)
b)	Transmission capacity	:	2 or 4 Mb/s (30 or 60 time slots)
c)	Busy hour call	:	0.09 Erlang/subscriber
d)	Grade of service	:	1% (blocking probability)
e)	Frequency band	:	2.6 GHz / 3.5 GHz
e)	Ambient Temperature	:	Base station ------ -10° C～ +50° C
			Rep. and term ------ -30° C～ +50° C
f)	Multiple Access method	:	Demand Assigned Multiple Access (DAMA)

4.3.1 DRCS Transmission Facilities

The base station consists of various kinds of equipment such as transmitters-receivers, DRCS controllers, concentrators with subscriber loop circuits and VDU display unit. The equipment is to be installed in the existing transmission room on the 6th floor of the ATC-3 station, and the equipment layout is shown in Vol. V, Chap.3 of Data Book of this report. Antenna height at the base station is shown in Figure 3-4-5. The equipment components are expected to be almost the same in the terminal and repeater stations except for the telephone sets. Typical system configurations for both stations are illustrated in Figure 3-4-6.

4.3.2 Aerial System

The type of antenna will be selected based on antenna gain and radiation directivity. An omnidirectional antenna will be installed at the base station, since the subscribers are scattered all over whole Ulaanbaatar city. Directional antennas are preferable at the repeater and terminal stations, and larger gain antennas will be required where the distance from the base station is longer.

The Table 3-4-2 lists the type of antenna with its typical performance.

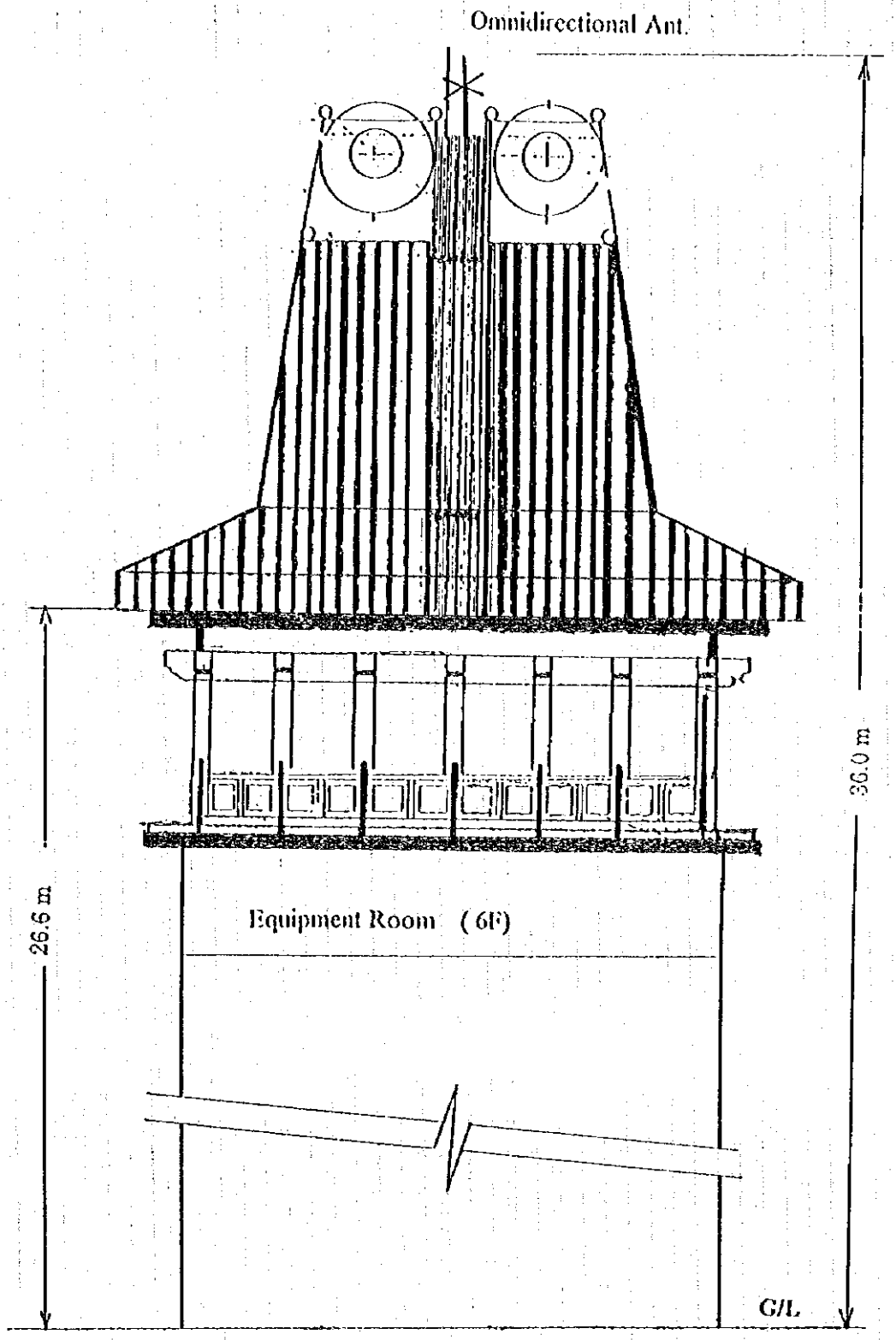


Figure 3-4-5 Antenna Height Layout in Base Station

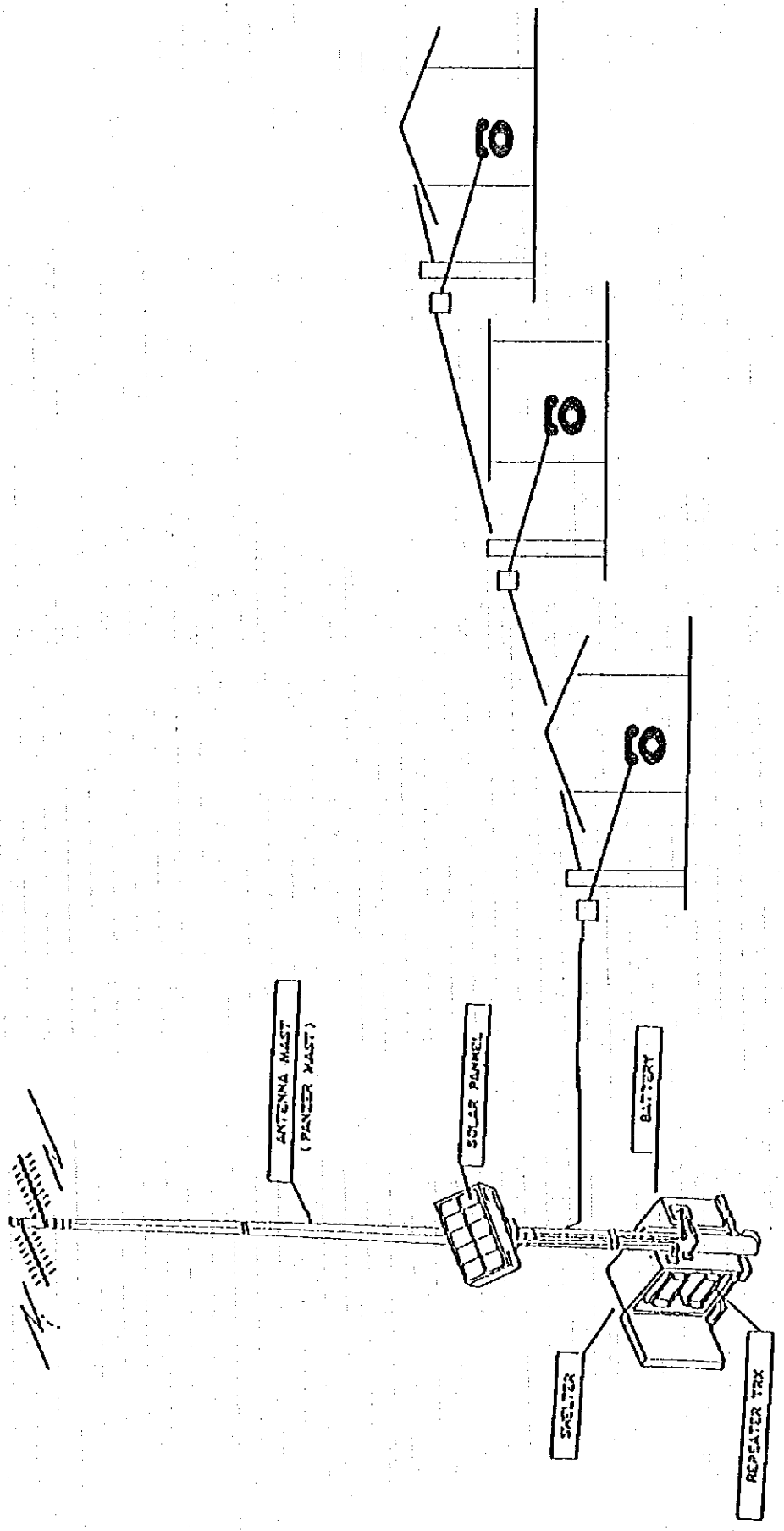


Figure 3-4-6 Typical Equipment Layout for Terminal and Repeater Stations

Table 3-4-2

Antenna type	Used station	Antenna gain	Antenna weight	Others
Omnidirectional	Base, Rep.	3.0 dB	15.0 kg	with materials
Grid Parabolic	Terminal, Rep.	12.0 dB	22.0 kg	〃
Horn Antenna	Terminal, Rep.	8.0 dB	18.0 kg	〃
Yagi Antenna	Terminal	8.0 dB	12.0 kg	〃

Antenna height is estimated based on geographical maps attached in Vol. V, Chap.7 of the Data Book.

4.3.3 Power Supply Facilities

The power consumption of the DRCS system is considerably small, and Table 3-4-3 shows the typical power facilities requirement.

Table 3-4-3 Typical Requirement of DRCS Power Supply

Station type	Supply voltage	Power consumption	Remarks
Base Station	-48.0V	60 W	No. of sub. 450
Repeater Station	+12.0V	35 W	Outdoor type
Terminal Station	+12.0V	15 W	Outdoor type

Considering the harsh weather condition in Mongolia, equipment installed outside should be provided the protection against temperatures down to -30° C. Batteries in particular, will not operate well under such chilly conditions.

a) Base Station Power Facilities

The existing power system consisting of 2 sets of DE (200 kVAx1, 100 kVAx1), 3 sets of batteries and rectifier sets, has enough capacity for the new DRCS equipment. The power wiring diagram at the ATC-3 station is shown in Vol. V, Chap. 3.

b) Subscriber Terminal and Repeater Stations

Solar and commercial power systems are preferable power supply method for both of these stations. The commercial power supply is advantageous from technical and economic viewpoints, but in some areas it is not available. A Solar power system can be adopted in any type of stations, and commercial power supply where available.

5. Project Cost Estimate

As the result of the previous studies on basic design and facilities plan in this report, the project costs were estimated. Unit prices and installation costs are based on the prices for similar projects in the past. The total project cost is estimated as the following Table 3-5-1.

Table 3-5-1 Project Cost for DRCS System

(Unit: 1,000 US$)

No.	Item	Total	Foreign	Local
1.	Base Station Equip.	188	188	0
2.	Repeater Equip.	389	389	0
3.	Terminal Sta. Equip.	1,134	1,134	0
4.	Measuring Equip.	150	150	0
5.	Spare parts and Manual	69	69	0
	Sub-total	1,930	1,930	0
6.	Installation	579	519	60
7.	Transportation	232	232	0
8.	Tax	352	0	352
9.	Consultancy	219	219	0
10.	Contingency	274	274	0
	Grand Total	3,586	3,174	412

6. Project Implementation Plan

6.1 General

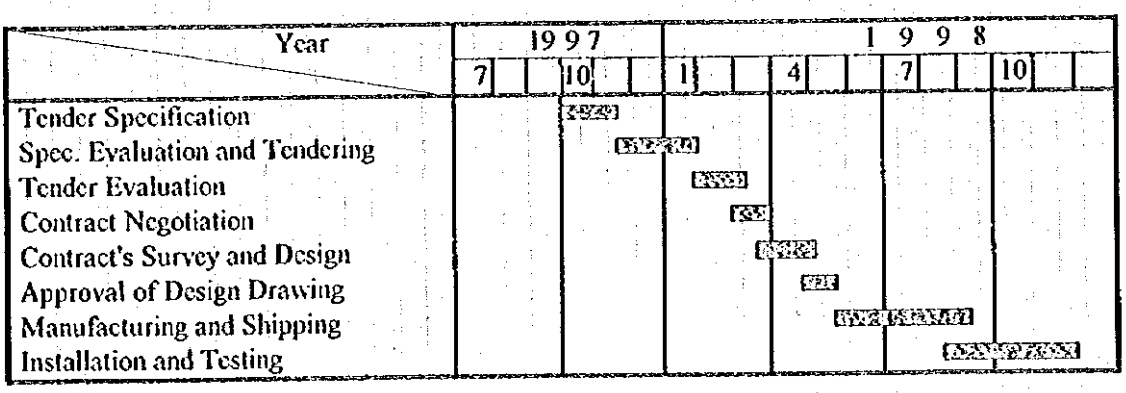
The proposed project implementation plan was compiled on the assumption that the project will be implemented on a turn-key basis and taking account of such work as:

1) Preparation of the tender specifications.
2) Tendering.
3) Tender evaluation.
4) Supplier contract negotiation.
5) Contractor's survey and design.
6) Approval of design drawings.
7) Manufacturing and shipping.
8) Installation and testing.

6.2 Implementation Schedule

The implementation schedule is shown in Table 3-6-1. The total period is estimated to be 14 months. Considering the harsh weather conditions in Mongolia, the outside installation work such as antenna and feeder construction should not be scheduled during the months of November, December and January.

Table 3-6-1 DRCS Project Implementation Plan



6.3 Management on Project Implementation

6.3.1 For Smooth Project Implementation

A telecommunications project is comparatively large in term of project cost and work volume, so various problems will be encountered during period of the project. Those problems can be reduced by adopting proper supervision system. The main purposes of the supervision work are summarized below.

- Project implementation progress control.
- Verification of the equipment and system performances.
- Inspection of the workmanship of installation work.

For smooth progress of the project, effective supervision is indispensable. During the supervision work, the progress of installation should be checked by customer and/or consultant periodically, for instance, every month. At the end of month, the progress milestone achieved is to be evaluated. When the delay or faults are identified during the inspection, the necessary measures should be taken to recover the delayed schedule.

The installation work is the contractor's main task, but the supervision work is carried out by customer and/or consultant. For the smooth progress of the installation, close relationship between customer, consultant and contractor is also required.

Generally, the supervision of installation work is mainly executed by customer and consultant. At present, MCAC has insufficient experiences through past projects, so MCAC is requested to establish the task force for implementing the telecommunication project under the MCAC project manager. This supervision practice makes completion of project smoothly and creates the valuable opportunities to give the OJT training to Mongolian staff.

6.4 Testing

It is very necessary that installed equipment and system should be operated in conformity with the specified values by testing. The test is divided into three stages as shown in the following:

Stage 1 : Factory Test

Stage 2 : Provisional Acceptance Test
- Station test
- Hop Test
- Reliability Test
- Speech Test

Stage 3: Final Acceptance test

6.5 Training

To maintain new radio system in a good condition to offer satisfactory service to the users, training is very important. Training should be provided to 2 persons assigned for operation and maintenance of the DRCS system at the early stage of the implementation period. They should be given a period of one month training in the supplier's country for both of theoretical and practical knowledge. Those trained persons must give training to 3 to 5 persons at the training center and at the project sites in Ulaanbaatar. Five to seven persons will be sufficient for the operation/maintenance of the system..

7. Project Evaluation

7.1 Objective

A project evaluation is conducted with the objective of confirming the feasibility of the Digital Radio Concentration System (DRCS) project from financial, economic and social points of view.

The DRCS project aims to provide digital radio communication system for a total number of 408 telephones to the following types of subscribers.

- ger area population (344 telephones)
- enclave areas (40 telephones)
- important organizations in Ulaanbaatar for urgent need (24 telephones)

It is assumed that all the telephones to be installed in ger areas be used as public telephones shared by population in the vicinity. For enclave areas, 8 telephones are assumed to be used at telephone offices and remaining 32 telephones at public organizations such as schools and offices. All 24 telephones for important organizations in Ulaanbaatar are assumed to be used at public organizations.

7.2 Financial Analysis

7.2.1 Objective

A financial analysis is conducted in order to confirm the financial viability of the DRCS project. For this purpose, costs and revenues are estimated. A financial internal rate of return (FIRR) is derived based on the estimated costs and revenues.

7.2.2 Methodology and Assumptions

(1) Overall

a) A financial analysis is conducted from the point of view of a notional unit of MCAC and MTC combined, respectively responsible for development and operation of the project.

b) The analysis focuses only on the portion of the telecommunications network to be added by the investment by the DRCS project. The existing portion, therefore, is excluded from the analysis.

c) An evaluation period is 10 years.

d) The analysis is carried out on a real term basis, taking no account of inflation and foreign exchange rate fluctuations. In the event that these factors influence costs and revenues, tariff and charges should accordingly be adjusted to compensate for the adverse influences.

e) Exchange rate applied is 490 Tg per US$, which is the average figure in April 1996.

(2) Cost

Investment costs and operation and maintenance costs are estimated as presented in detail in the previous subsection. An annual disbursement schedule of the investment costs is prepared as follows.

	(million US$)
1997 :	1.076
1998 :	2.510
Total :	3.586

Operation and maintenance cost is assumed to be 3% annually of the investment cost. Operation and maintenance cost is estimated to be 0.108 million US$ per year.

Depreciation cost is calculated in order to derive income tax, which is 53% of pre-income tax. A straight line method is applied for a depreciation period of 10 years.

(3) Revenues

(a) Ger area

Revenue in ger areas is estimated according to the following steps.

- estimate of average population and household density in ger areas
- estimate of the number of people to benefit from the Digital Radio Subscriber project
- estimate of the level at which a telephone is used
- assuming of tariff level and estimate of revenue

Household/Population Density

An average population density in ger area is estimated based on the data collected on area and population by horoo in Khan-Uul and Songinohairghan districts. No data were made available for other districts. Average population density of all the 18 ger horoos is estimated to be 9.75 persons in a hector. This is equivalent to 1,026 square meters per household assuming an average number of persons per household at 4.7.

Beneficiary Population

The number of persons to benefit from the DRCS project is estimated to be around 142,000 persons in 1996 as calculated below.

- area to be covered by the project : 31,090,000 square meters
- average area per household : 1,026 square meters per household
- average number of household member : 4.7 persons

Revenue in Ger Area

Revenue in ger area is estimated based on the following assumptions.

- Beneficiary population to grow at 1.5% per year
- Frequency of making call : once a week per person
- Average length of calls : 3 minutes
- Charge for calls : 3 Tugrig per minute

The assumptions in frequency and length of calls are set based on the data collected in the Socio-Economic Survey as shown in Chapter 7 "Financial, Economic and Social Analyses" of Volume IV "Supporting Document". Call charge at Tg 3 per minute is set based on the planned timed local call charge level. At the actual introduction of the system, an appropriate tariff level should be found taking into consideration the affordability of ger population and aimed profitability level.

Based on these assumptions, average minutes per a telephone is estimated to be about 150 minutes per day. In the ongoing ADB project, the average minutes assumed for a public phone is 120 minutes per day. The lower telephone penetration ratio in ger area would result in higher use of public phones than in other areas. Considering this aspect, the difference of about 30 minutes per day per phone is judged to be within a reasonable range. Revenue thus estimated is shown in Table 3-7-1.

(b) Enclave

The following types of revenues are estimated for enclaves.

- revenue from telephones installed at public organizations :
  - Installation charge revenue
  - Rental revenue
  - Call revenue (local, long distance and international)
- revenue from public call offices (8 telephone)

Public Organizations

Installation charge revenue is estimated based on the charge at Tg 24,000 and the number of telephones to be installed at 32.

Rental revenue is estimated based on the rental charge at Tg 3,900 per month and the number of telephone to be installed at 32.

Call revenue are estimated as in the same manner as for the financial forecast for the Basic Plan. The following are the values applied.

Local call :

call minutes :	24 minutes per subscriber per day in 1995
tariff :	Tg 3 per minute above 150 minutes per month

Long distance call :

revenue per subscriber : Tg 11,050 per subscriber in 1995

International call :

revenue per subscriber : Tg 43,100 per subscriber in 1995

Public Call Office

Revenue of public call office telephones is estimated applying the call minutes used in the ADB projects per day at 120 minutes and the tariff at Tg 3 per minute.

Revenue in Enclaves

Revenue for the enclaves is estimated to be US$ 12,199 in 1999 and US$ 13,678 in 2008, the final year of the project life.

(c) Important Organizations in Ulaanbaatar

Altogether 24 telephones are planned to be installed at important organizations. Revenue from these telephones are estimated as a proportion to the revenue in enclaves excluding that of public call office. The proportion applied is 75% (24/32).

7.2.3 Result of Financial Analysis

Table 3-7-1 shows a cash flow of the DRCS project. Under the assumed tariff level at 3 Tg per minute, a negative FIRR is derived, indicating costs exceed revenues without discounting. Under this assumption, therefore, an arrangement is needed to subsidize the implementation of the project.

A sensitivity analysis was conducted with regard to the project's profitability in relation to different tariff levels for public telephone. As shown in Table 3-7-2, FIRR turns positive at Tg 13.1 per minute. The Socio-Economic Survey conducted as part of the present study clarified that people coming to use privately-managed pay phones pay 10 tugrig per minute on average. At the actual introduction of the system, an appropriate tariff level should be found taking into consideration the affordability of ger population and the aimed profitability level.

As an approach to subsidize the DRCS project, the possibility of combining the ATC-6 project and the DRCS project is analyzed from the financial perspective. Tariff assumed for the DRCS project in ger area is 3 tugrig per minute. An FIRR for this case is derived at 12.70%. FIRR calculation is shown in Table 3-7-3.

7.3 Economic Analysis

7.3.1 Objective

An economic analysis is conducted for the DRCS project in order to confirm the economic viability of the project. The difference of an economic analysis from the financial analysis presented in the previous subsection is that an economic analysis focuses on costs and benefits of the project from the perspective of an overall economy in stead of from that of implementing agency.

7.3.2 Methodology and Assumptions

(1) Overall Methodology and Assumptions

- An evaluation is made on a real term basis taking no account of inflation and foreign exchange rate fluctuations.
- An evaluation period of 10 years is applied.
- Investment and operation and maintenance costs applied to the financial analysis are used with modification so that they represent resource utilization.
- Consumer surplus is calculated based on the results of the Socio-Economic Survey. The portion of consumer surplus is added to the tariff level in order to derive total economic benefit.
- An EIRR (economic internal rate of return) is derived as a criterion for evaluation.

(2) Costs

The investment cost and operation and maintenance cost estimated and used for the financial analysis are modified to be used for the economic analysis. The objective of the modification is to adjust the local currency portion of the costs to eliminate distortion of prices and covert them such that prices reflect utilization of resources. The modification made in the economic analysis is elimination of transfer payment, custom duty and commercial tax, to be imposed on imported equipment. Adjustment

of other local currency portion of the investment costs is not made due to the lack of reliable data on conversion factors. Investment costs thus adjusted for economic evaluation is as follows.

	(million US$)
1997:	0.970
1998 :	2.264
Total :	3.234

Operation and maintenance costs are assumed to be 3% annually of the investment costs. Income tax is not derived since it is a transfer payment.

(3) Benefit

Economic benefit of the DRCS project is estimated based on the data on the willingness-to pay collected by the Socio-Economic Survey conducted in Ulaanbaatar in March 1996. For public organizations in enclaves and for urgent need in Ulaanbaatar, as is the case for the economic analysis for the ATC-6 project, data on consumer surplus for telephone calls and installation using private phones were collected by inquiring interviewees with regard to maximum call tariff level and installation charge of a phone up to which they accept to pay .

The method of estimating the willingness-to-pay for public phones and consumer surplus for phones for public organizations is explained hereunder.

Willingness-to-pay for Public Phones in Ger Area and Enclaves

The Socio-Economic Survey included inquiries targeting people coming to make a phone call at privately-run public phones at such places as stores, schools and post offices. Data were collected with regard to the charge they paid or usually pay and the length of their calls. A detail is shown in Chapter 7. "Results of Socio-Economic Survey" of Volume IV. According to the 13 interviewees, the charge is either 20 Tugrig or 30 Tugrig. They make calls for a range of 1 to 6 minutes. On average they pay 25 Tugrigs for 2.5 minutes, which is equivalent to 10 tugrig per minute. This average figure is regarded as representing willingness-to-pay of public phone users. In the economic analysis of the DRCS project, therefore, Tg 10 per minute is applied as benefit.