KINGDOM OF THAILAND

DETAILED DESIGN REPORT
of the
BANGKOK TELEPHONE JUNCTION LINES PROJECT

prepared for
OVERSEAS TECHNICAL COOPERATION AGENCY
GOVERNMENT OF JAPAN

by
THE NIPPON TELECOMMUNICATIONS CONSULTING CO., LTD.

Tokyo
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Mr. Keiichi Tazuke
Director General
Overseas Technical Cooperation Agency

November 1972

Detailed Design Report of the
Bangkok Telephone Junction Lines Project

Dear Sir :

We deem it a great honor to submit the Detailed Design Report in connection with the construction project for the Bangkok Telephone Junction Lines Network which has been entrusted to this company.

In regard to the fundamental telephone plan for Bangkok, favorable acknowledgement has already been made by the Telephone Organization of Thailand (TOT) and in the implementation of this Project, and the necessity for the speedy execution especially of the detailed design of the junction lines network was proposed.

In March of 1972, the Government of Thailand asked the Government of Japan for assistance in the detailed design work for the Bangkok junction lines network and the "Plan of Operation for the Detailed Design of the Bangkok Telephone Junction Line Project" and the "Agreement on Technical Discussion concerning Detailed Design of Bangkok Telephone Junction Line Project" was agreed upon and concluded between the two Governments in May. These documents specify the scope of the work to be executed and the items, etc. to be supplied by the Japanese design team.

Based on the Plan of Operation and the matters decided in discussions with TOT, the Japanese design team executed the design for the project which will be carried out by international tender. The project is of a large scale comprising the construction of approx. 290 Km. of underground conduit cables, approx. 28 Km. of aerial cables and 138 systems of the PCM-24 system.

We hereby wish to express our sincerest appreciation for the kind assistance and cooperation extended to the members of our survey and design team by the officials of the Government of Thailand, Telephone Organization of Thailand and Japanese government offices in Thailand as well as the Ministry of Foreign Affairs, Ministry of Posts & Telecommunications, Nippon Telegraph & Telephone Public Corporation and members of the Work Supervisory Committee.

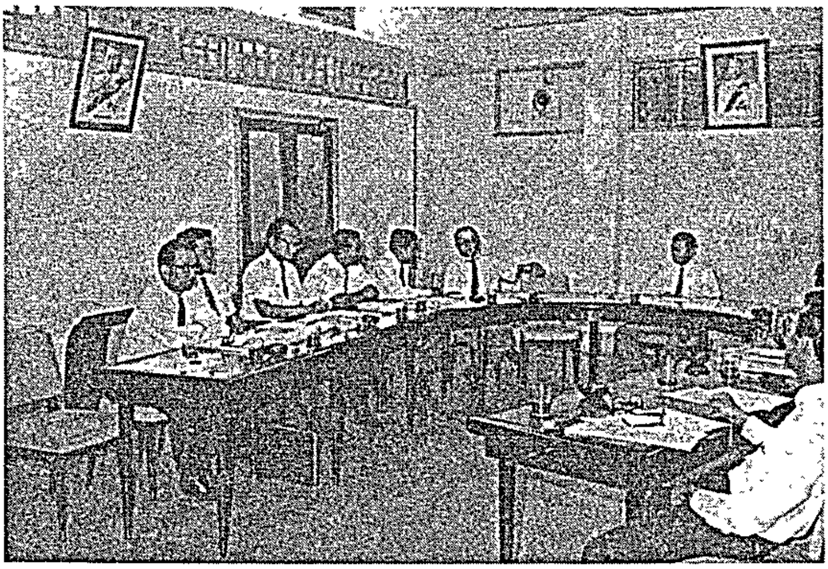
Very sincerely,

The Nippon Telecommunications
Consulting Co., Ltd.

S. Hase
President

H. Sano
Chief, NTC Survey Team

Mr. Boonchu, Director of Planning and Project, TOT, visits the NTC Bangkok Office.



Mr. Sano, NTC Survey Team Chief, explaining the design policy and amount of construction work to Mr. Chamroon, Director General, and senior members of the engineering staff of TOT at the TOT conference room.

Survey of aerial cable route between LS and PTN Exchanges.

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SECTION 1. PREFACE

1.1 Course Taken in Detailed Design Work

The Telephone Organization of Thailand (TOT) has been progressing with a telephone expansion programme, based on a long-term plan, and the Greater Bangkok Metropolitan Area Expansion Plant Project which is a part of this Project has been named the "Bangkok Telephone Plant Project 1972 - 1976".

The scope of this Project is as under:

1) Acquisition of 19 plots of land for new telephone exchanges.
2) Construction of 13 new telephone exchange buildings.
3) Modification and extension of 9 existing telephone exchange buildings.
4) Discontinuation of the service of 19,000 Step-by-Step exchange lines.
5) Installation of 139,100 exchange lines of new cross-bar automatic switching equipments.
6) Construction of about 188,850 pairs of the primary subscriber network and associated secondary network
7) Construction of about 250,000 pair-kilometers of junction network to expand the existing junction network for the increasing traffic.
8) Construction of 120 kilometers of cable conduits.

Upon completion of this Project in 1976, it is envisaged that TOT will be able to provide the public in the metropolitan area with 310,000 terminals and 457,060 subscriber lines.

As to the detailed deisgn for completion of the above Project, due to the shortage of TOT engineers for engineering of the junction network specified in Para. 1 1 7) above, TOT made a request, through the Government of Thailand, to the Government of Japan for technical cooperation. In response to the request from TOT, the Japanese Government commissioned the Overseas Technical Cooperation Agency (OTCA) to execute the said technical cooperation. In compliance with such request, OTCA then entrusted The Nippon Telecommunications Consulting Co , Ltd. (NTC), a firm with wide experience and project accomplishments in design and supervision of construction work for the Bangkok telephone facilities, to execute the detailed design of the junction network.

1.2 Scope of Detailed Design

Engineering works requested by TOT were carefully studied by NTC's engineer groups, and were divided into two categories, one coming under the Inside Plant Engineering Dept. and the other under the Outside Plant Engineering Dept.

The actual works were arranged in three steps, i e., Preliminary Study, Field Surveys and Drawing up of Designs.

The engineering principles, work schedule and amount of works were seriously studied and, finally, the following work items were established.

1.2.1 Scope of Work by Inside Plant Engineering Department

A. Preliminary Study

1) Drawing Up of Diagram for Inter-Exchange Junction Lines Plan

After receipt of the traffic data and trunking diagram prepared by TOT for the initial year, 5 years, 10 years and 15 years hence after service-in, the inter-exchange junction line diagram will be drawn up.

2) Office Study of Required Number of VD Coils and Other Equipment

In regard to the VD coils, both way repeaters, impedance compensator, PCM equipment, etc., an estimation of their required numbers will be made after discussions with the Outside Plant Engineering Dept. and a layout plan will be prepared for the installation of these equipments in the MDF room.

3) Preparation of MDF Terminal Block

A diagram of the terminal block mounting for termination of the junction cables and subscribers' cables to the MDF and a layout plan for installing these equipment in the MDF room will be prepared.

B. Field Survey

1) Investigation of MDF Room of Each Exchange

For confirmation of the layout plan prepared in Japan for the MDF, VD coils and other equipment, an investigation of the existing conditions of the MDF rooms and, if necessary, other rooms in the exchanges will be made.

2) Investigation into Number of Existing Equipment

In order to confirm the required number of MDF, VD coils and other equipment, in the layout plan prepared in Japan, an investigation into the number of these existing equipment will be made.

3) Survey of Direct Lines and Miscellaneous Lines

In order to make a final decision on the number of inter-exchange junction lines, a detailed survey to clarify the actual distribution of the existing direct lines and miscellaneous lines will be made because the information concerned are not indicated in the Traffic Data. This survey is to be assisted by the staff of the Outside plant Engineering Department The results of this demand survey will be indicated in the inter-exchange junction lines plan diagram.

4) Discussions with TOT's Departments in Charge

Based on the inter-exchange junction line plan diagram, discussions will be held with TOT in regard to the following:

Classification of junction lines

Number of junction lines

Traffic routing

Classification of VD coil and other equipment

Number of VD coils and other equipment

Classification of miscellaneous lines

Number of miscellaneous lines

C. Works After Survey

Compiling of the survey data and the drawing up of the following diagrams:

Line Assignment for Junction Network

Layout Plan for Junction Equipment

D. Calculation of Amount of Work

1.2.2 Scope of Work by Outside Plant Engineering Department

A. Preliminary Study of Fundamental Idea in Relation to Design

In the design of the junction line network, an overall study of the following items will be executed and decisions will be made on the junction sections, kinds of cables, number of cable pairs and the cable gauges.

1) Planning of Office Establishment Programme (To be prepared by TOT)

2) Line assignment for junction network (To be prepared by NTC Inside Plant Engineering Dept.)

3) Transmission loss allocation

4) Present state of roads, bridges, etc. and future plans.

5) Induction of new techniques and economization of facilities.

6) Relation with existing equipment.

From the foregoing studies, decisions will be made on the cable gauge and the number of cable pairs according to the following procedures:

1) Determining the Cable Gauge

    a) A cable usually is to accommodate a number of circuit groups which connect an exchange to other exchanges. This fact means that the cable gauge has to be decided, taking into consideration the longest possible connection through that cable, so that the cable loss can be within such a limit as is permissible for the part of overall transmission loss of the said longest circuit connection.

b) For deciding the conductor gauge of the cable, the following conditions, in addition to the above description, should be fully considered:

- Required number of junction circuits
- Contents of circuits
- Conductor of existing cable
- Number of circuits
- Possibility on transfer of existing cable.

As reference:

TOT Criteria on Transmission Loss and D. C. Loop Resistance Limits

Classification of Junction Circuit	Transmission Loss	D. C. Loop Resistance
Direct Trunk	11 dB	2,000 ohm
Parent and Satellite	3 dB	"
Toll Trunk	4 dB	"
Tandem Incoming Trunk	4 dB	"
Tandem Outgoing Trunk	6 dB	"

c) In accordance with the number of lines, signaling, trunk distance, kind of lines, etc., studies will be made as to whether a negative impedance repeater should be installed or to rely on the PCM system; after which, an economical cable gauge will be selected.

2) Determining the Number of Cable Pairs

a) The design installation period will be determined upon discussions with TOT but, for the time being, aerial cables will be for 10 years ahead and underground cables will be for 15 years ahead after service-in.

b) Since there is a shortage of underground conduits in Bangkok, the maximum number of cable pairs for the required conductor gauge will be installed as a matter of principle.

c) The conduit cables will be designed for 15 years ahead but in the case of existing conduit lines, the design installation period will be changed upon economic comparisons according to the time of conduit extension and conduit usage plan, etc.

3) Determining Kind of Lines

Decisions will be made as to the sections where the aerial cables and the underground cables will be applied and for the underground cables, the application of the conduit type or the direct buried type will be determined.

4) Selection of Routes

In the planning of the routes, 2 to 3 routes will first be selected from a study on the map and in consideration of the existing facilities and future plans, the order of the advantageous routes will be determined after a comparative study of the economic aspects regarding problem points from the standpoint of construction, operation and maintenance.

5) Layout of Loading Spacing

Regarding loaded cables, the H-88 type loading is utilized in Bangkok according to the following Standards:

Standard (So)	1830 m
Deviation between Standard (So) and Average (S)	$\pm 2\% > \frac{So - S}{So} \times 100$
Individual deviation from Average (S)	$\pm 2\% > \frac{S - S_1}{S} \times 100$
End Section	$\frac{So}{4} \leqq S \text{ half} < \frac{3}{4} So$

In case the above standards cannot be satisfied, compensation by B O.N. or other methods will be made

6) Design of PCM System

The repeating spacing will be determined according to the number of required systems and selection will be made of the repeating points.

B. Field Survey

Based on the design plan made from the preliminary study, the following field surveys will be carried out.

1) Route Selection - 11 routes (approx. 110 Km)

Regarding the proposed routes, the various conditions will be considered and after comparative studies, the routes will be determined.

2) Surveying - 50 routes (approx. 300 Km)

In regard to the routes for underground cables, the actual measuring of both the existing and new installation cables will be made, and the loading manholes, PCM manholes, etc. will be determined.

In regard to aerial cables, studies will be made on the method of cable placement and where there is the fear of inductive interference, study will be made as to its counter-measure. Surveys will also be made on the location of poles and guys, etc. and on the pole mounting method, etc. for loading poles, PCM poles, etc.

3) Manhole Investigation - 300 units

Investigations of duct position in which the cable will be placed, cable placement method and cable bending method will be carried out and the method of cable placement, location of cable splicing, etc.

will be determined.

Regarding loading manholes, etc., the modification or construction of new manholes, etc. will be determined according to the availability of space.

4) Investigation of MDF and Cable Vault in Exchange - 34 exchanges

The riser position of entrance cables and way of cable placement in cable vault will be investigated and studies will be made for preparation of the Junction Cable Terminating Plan at MDF.

5) Discussions with TOT

Upon completion of the design plan, discussions will be held with the senior members of TOT and approval for the said Plan will be obtained.

The foregoing surveys will required a total of approximately 4 months

C. Preparation of Drawings

The following drawings will be prepared:

1) Key Map of Duct Scheme Plan
2) Duct Scheme Plan
3) General Junction Cable Plan
4) Layout Plan for Junction Equipment

5) Junction Cable Terminating Plan at MDF

6) Layout Plan for Loading Spacing

7) Jointing Diagram

8) Junction Cable Construction Detailed Plan

9) Manhole Racking Diagram

10) Gas Pressurization System

11) Line Assignment for Junction Network

12) Computed Transmission Performance and Line Resistance

D. Amount of Cable Work Calculation

The amount of the entire works will be computed from the above drawings.

The foregoing is the work items studied prior to commencement of the design work.

1.3 Organization of Survey Team

As soon as this Project was entrusted to NTC by OTCA, a survey team was immediately organized in line with the preparation of the detailed design work, and the members who executed the field surveys are as under:

	Name & Assignment	(1972) Survey Period
Team Chief	Hideo SANO (Overall supervision)	Apr. 23 - Sept. 24
	Manager, NTC Bangkok Office Chief Engineer (Registered Consulting Engineer)	

Raisuke TSUKADA (Overall supervision) Senior Engineer Chief of Commercial Section, NTC Commercial Dept.	Aug. 2 - Aug. 13
Yasuhisa IMAI (In charge of Outside Plant) Senior Engineer, NTC Outside Plant Engineering Dept. (Registered Consulting Engineer)	May 9 - Sept. 2
Tadamasa KOMURA (In charge of Outside Plant) Senior Engineer NTC Outside Plant Eng Dept.	June 1 - Aug. 19
Yoshiaki KOBAYASHI (In charge of Outside Plant) Assistant Engineer, NTC Tokyo Branch Office	May 15 - Sept. 2
Minoru Takagi (In charge of Inside Plant) Engineer, NTC Inside Plant Engineering Dept. (Registered Consulting Engineer)	May 15 - June 26
Hideyasu IMAIZUMI (In charge of Inside Plant) Engineer, NTC Inside Plant Eng. Dept. (Registered Consulting Engineer)	May 9 - June 7

Tadayoshi OHTA (In charge of Inside Plant)	May 15 - June 24

Assistant Engineer,
NTC Inside Plant Engineering Dept.

1.4 Establishment of Work Supervisory Committee

For the smooth execution of the detailed design work and the supervision thereof, a work supervisory committee was established.

1.5 Course taken in Discussions on Design with TOT

During the design work, Mr. Onward, Mr. Predar and Mr. Sakuda of TOT were appointed liaison officers for close contact between TOT and NTC. Furthermore, in line with the progress of the work, the following persons visited the NTC Bangkok Office for discussions on the design ideas and inspected the work progress.

July 5	-	Mr. Surin, Chief of Outside Planning Center
July 11	-	Mr. Roj, Chief of Inside Planning Center
July 19	-	Mr. Boonchu, Director of Planning and Project

Finally, on August 4th, Mr. Sano, NTC Survey Team Chief, made an explanation on the entire scope of design at the TOT Conference Room to the Director General of TOT, Mr. Chamroon, and all the senior members of the engineering staff and received their acknowledgement.

SECTION 2. DISCUSSIONS ON SCOPE OF WORK AND DESIGN STANDARDS

2.1 Course of Negotiations with Government of Thailand (DTC) and TOT

Before commencement of the detailed design work, the Work Supervisory Committeemen, Messrs. Yasuda and Ushijima, and NTC Survey Team Chief, Mr. Sano, went to Thailand on April 23, 1972 to hold discussions with officials of the Government of Thailand (DTC) and TOT in regard to the fundamental items and engineering standards in line with the execution of the said design work. These discussions resulted in the agreement and the signing on May 17th, the "Plan of Operation for the Detailed Design of the Bangkok Telephone Junction Lines Project" and the "Agreement on Technical Discussion concerning Detailed Design of Bangkok Telephone Junction Lines Project" which are attached hereto.

As to the Engineering Standards, the matter of the tandem circuits (two-tandem alternative routing) was left as unfinished business but, ultimately, this was cut out and an agreement to this effect was reached between Mr. Surin of TOT and NTC Team Chief Mr. Sano. A copy of the said agreement is also attached hereto.

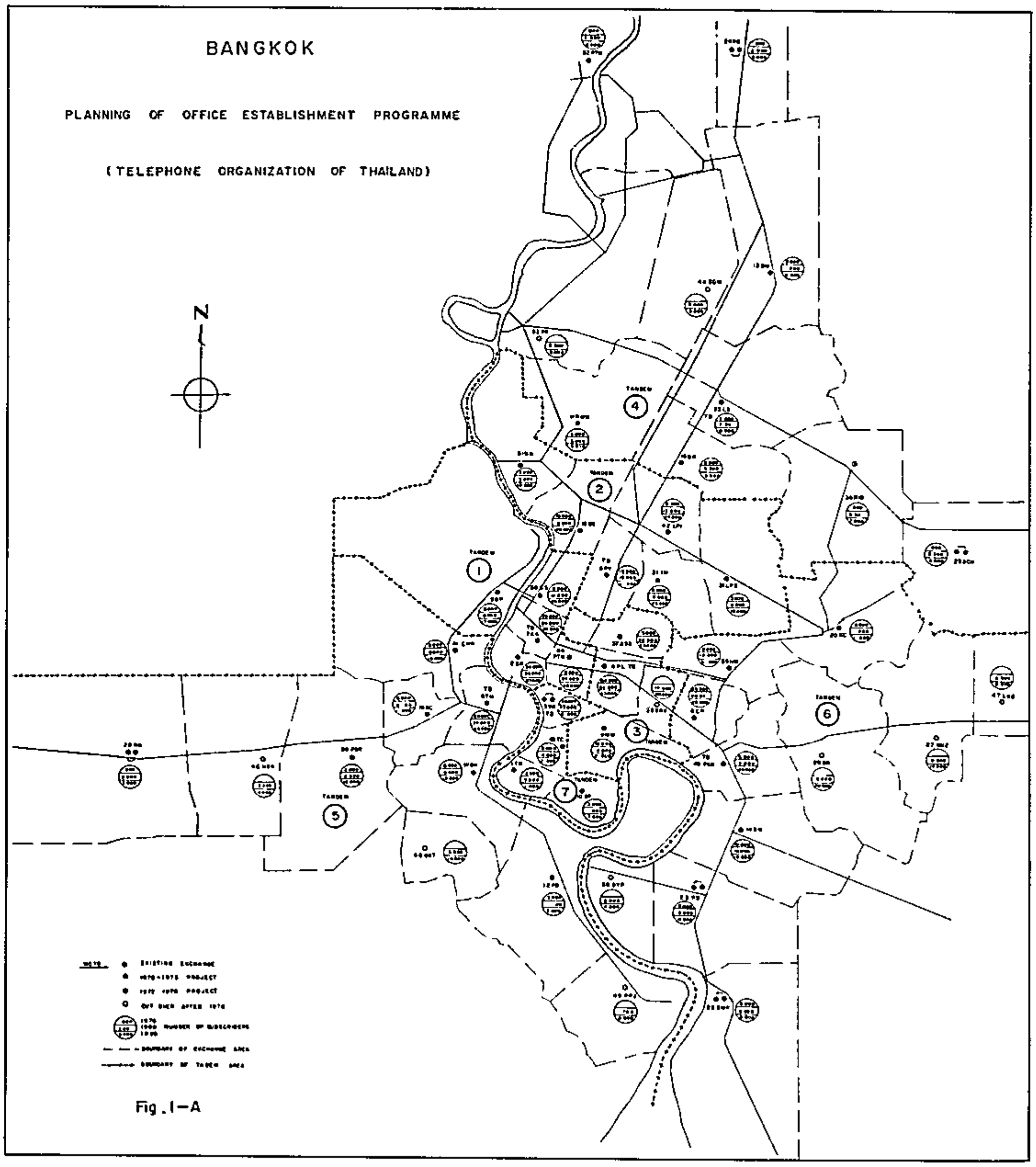

BANGKOK
PLANNING OF OFFICE ESTABLISHMENT PROGRAMME
(TELEPHONE ORGANIZATION OF THAILAND)
N

Fig. 1—A

DEMAND FORECAST OF SUBSCRIBERS

TD	EX \ YEAR	1976	1980	1990
T1 KK	KK	20,000	20 000	20 000
	SR	30,000	36 000	57 000
	BP	8.000	8 000	17 000
	PTW	5 000	24 000	43 000
	SS	5 000	10.000	25.000
	TOTAL	68 000	98 000	162.000
T2 PY	PY	15.000	15 000	18.000
	BS	10.000	12 000	28 000
	IM	6 000	15 000	26 000
	LP1	5 000	12 000	24 000
	LP2	3 000	9 000	15 000
	NN	3 000	5 000	10.000
	TOTAL	42 000	68 000	121 000
T3 PL	PL	20 000	22 000	43 000
	MM	10 000	10 000	21 000
	ASD	5 000	20 000	33 000
	SKV		17 500	28.000
	TOTAL	35 000	69.500	125.000
T4 LS	LS	2 000	3 500	8 000
	NWW	5 000	5 000	8 000
	DM	3 000	4 000	6 500
	BK	5 000	3 200	5 500
	RS	800	2 000	5 000
	BCH	800	3 500	6 500
	PK		3 500	6 000
	RID	800	3 300	7 000
	SDM		3 600	5 000
	PTN	800	2 000	5 000
	TOTAL	18 200	33 600	62 500
T5 TH	TH	20 000	22 000	35 000
	PD	3 000	4 000	7 000
	BC	6 000	6 000	13 000
	DK	8 000	9 000	15 000
	NK	800	2 000	3 000
	PSR	2 000	6 000	10 000
	BKT		6 500	14 000
	CHW	5.000	8 800	19 000
	MSK		3 200	4 400
	PPJ		1 700	3 800
	TOTAL	44 800	69 200	124 200
T6 PKN	PKN	5 000	12 000	20 000
	CP	20 000	20 000	25 000
	BN	10 000	10 000	16 000
	KC	8 000	11 000	17 000
	PS	5 000	10 000	16 000
	SMP	5 000	6 000	9 800
	ON1		8 000	20 000
	ON2		5 500	14 000
	HM	8 000	16 000	32 000
	BYP		2 800	4 000
	LKB		2 500	2 500
	TOTAL	61 000	103 800	176 300
T7 SW	SW	30 000	33 000	51 000
	TK	3 000	7 000	11 000
	SP	3 000	4 000	7 500
	TC	5 000	14 000	21 000
	TOTAL	41 000	58 000	90 500
G.	TOTAL	310 000	500 100	861 500

Fig. 1 – B

SECTION 3. BASIC DESIGN DATA

3.1 Planning of Office Establishment Programme Supplied by TOT

Various studies were made of the Traffic Data (annexed sheet A) supplied by the TOT Inside Plant Planning Center and, upon mutual discussions, the points not clear were clarified. They essentially were the matter of the tandem circuit but this circuit was cut out because the transmission loss exceeded 11 db and the circuit efficiency for the local junction network was not so improved. Regarding the Traffic Data lastly received, the 4 points in question remaining were confirmed by Letter (annexed sheet B) and, with this final Traffic Data as the basic data for junction lines design, the design work was commenced.

A brief explanation of the Planning of Office Establishment Programme (Annexed Fig. 1-A and Fig. 1-B) and the above data is as follows:

The number of subscribers lines in 1976 will be 310,000; in 1980, 500,100; and in 1990, 861,000 which, in comparison with the present number of subscribers is 2.0 times, 3.1 times and 5.4 times in ratio of growth, respectively. Furthermore, the number of telephone exchanges at the end of 1973 will be 28; at the end of 1976, 40; and at the end of 1980, 50 exchange offices. Tandem exchanges will increase from the 3-Tandem (KK, PY, PL) to 7-Tandem (KK, PY, PL, LS, TH, PKN, SW) at the end of 1976.

The Greater Bangkok local area was expanded to 1230 Km^2 and with the inclusion of suburban exchanges, it became an area extending approx. 60 Km. east to west and 70 Km. north to south, which is approximately 2 times that of Tokyo. As to the telephone density, it will be 1 telephone per 100 inhabitants at the time of completion of the Project at the end of 1976 when the population of Bangkok will be approximately 3,000,000.

3.2 Forecast on Direct Lines

In the drawing up of the junction lines network, the number of direct lines required must be added to the number of circuits in the traffic data prepared by TOT. The forecast was executed according to the following methods.

a) A request in writing was sent to the various government organs -- Postal Ministry, Police Headquarters, Interior Ministry, Civil Aviation Authority, etc. -- for the providing of forecast data on the growth in number of direct lines for 5 years' and 10 years' hence, and the figures in these official replies were utilized.

b) Regarding the number of direct lines for general civil use, the growth ratio for general direct lines in the 1955 to 1973 period in Tokyo was adapted and, finally, the demand for such lines was forecasted as in the tabulation below.

Forecast on No. of Direct Lines for Bangkok

Year	1972	1976	1980	1990
Growth Ratio	1	2.5	4.6	7.2
No. of Direct Lines	1308	3269	6014	9399

The reason why Tokyo's growth ratio was adapted was that: Firstly, the respective ratios of the government offices and enterprises using the direct lines were similar to those of Tokyo as under:

Organ / City	Banks & Firms	Police	Gov't Offices, etc.
Bangkok	58.4%	20.9%	20.7%
Tokyo	64.9%	25.1%	10.0%

Secondly, telephone demand growth in Bangkok for the 1972 - 1982 period is similar to the subscriber growth in Tokyo from the 1955 to 1965 period as indicated in the tabulations below.

Bangkok Telephone Demand Forecast (1972 - 1982)

Year / Item	1972	1977	1982
Subscribers' lines	160,000	360,000	570,000
Growth Ratio	1.0	2.3	3.6

No. of Telephone in Tokyo (1955 - 1965)

Year / Item	1955	1960	1965
Subscribers' lines	422,000	742,000	1,521,000
Growth Ratio	1.0	1.8	3.6

The similar points in the above two tabulations were adapted to the extension of the direct lines in Bangkok. As to the distribution of the growth in direct lines to each exchange, the number of the existing direct lines, conditions at each exchange, etc. were considered and the distribution to the respective exchanges was executed. As reference, the trend in the growth in direct lines in Tokyo is as indicated below:

Trend in Tokyo's Direct Lines

Year / Item	1955	1959	1963	1973
No. of Direct Lines	6,129	11,400	20,800	58,000
Increase Ratio	1.0	1.90	3.4	9.5

3.3 Diagram of Inter-Exchange Junction Lines Plan

Adding the forecasted number in direct lines to the Traffic Data received from TOT, a diagram of the inter-exchange junction lines plan (Annexed sheet C) was drawn up in which the most convenient method of grouping circuits was instituted. This was arranged according to each exchange and each existing trunk route, and the markings denoting the different circuits are as follows:

X for Direct Line (11 dB)

△ for Tandem Outgoing (6 dB)

• for Tandem Incoming (4 dB) and

▽ for Satellite (3 dB)

Moreover, the numerical values for the direct Lines have been circled.

Other marks indicated are as under:

※ for metallic lines and

______ (underlined) for miscellaneous lines

Based on this Inter-Exchange Junction Lines Plan diagram, the grouping of circuits was carried out and the number of cable pairs was determined.

SECTION 4. DESIGN POLICY

4.1 Basic Idea

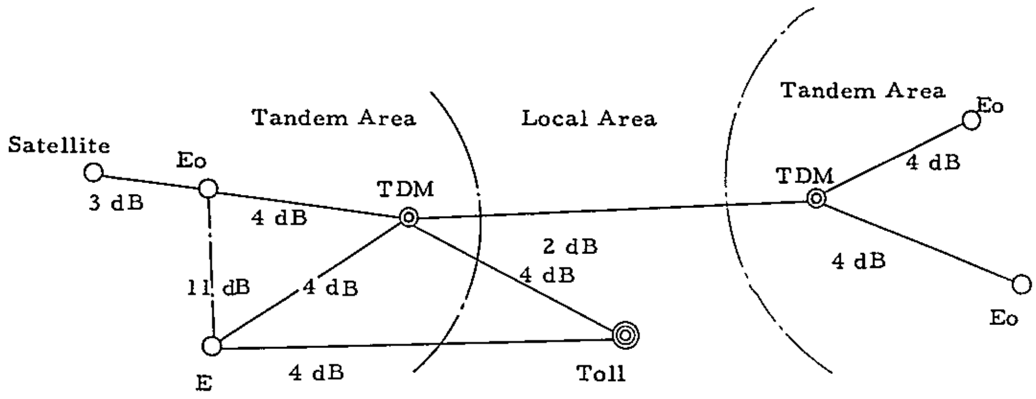
The engineering standards necessary for setting up the basic idea were decided upon in the discussions with TOT prior to commencement of the work, as set forth in Section 2. According to the Planning of Office Establishment Programme supplied by TOT, the design work is for the installation of a junction lines network to cope with 500,100 subscribers which is approx. 3 times that of the present. Furthermore, in line with the increase in the tandem exchanges, there was a large change in the existing trunk routes and the necessity for a fundamental change arose. Also in line with the expansion of the local area, a re-study of the transmission system is required from the standpoint of transmission loss allocation. In consideration of the large changes in the foregoing conditions, the setting up of the basic idea was carried out.

In order to simplify the complicated junction lines network, the trunk route will be:

End office → Tandem Office (sending office) → Tandem Office (jumpering through) (receiving office) → End Office

and, in principle, such trunk route will be centralized in each Tandem Office.

The actual trunk route is as indicated in Fig. 2 but, in general, it is as shown below.



———————— ordinary cable routes

—— —— short cut (high usage) cable routes

In other words, with the Tandem Incoming as 4 dB and the Tandem Outgoing as 6 dB since the route will be via Tandem Office jumpering to End Office and because the transmission loss allocation between Tandem to Tandem is 2 dB and between Tandem to End Office is 4 dB it was set as follows:

4 dB (Tandem Incoming) + 1 dB (loss in exchange) + 2 dB (Tandem to Tandem) + 4 dB (Tandem to End Office) = 11 dB

However, for the following cases, short-cut routes were prepared.

a) For trunk lines between different Tandem areas, in case it would be more advantageous economically to utilize short-cut cables.

b) In case the plan will require use of existing facilities.

The foregoing is the basic idea in the junction lines network. The short-cut cables are as indicated in Fig. 3.

4.2 Determining Number of Cable Pairs

In accordance with the basic idea, the Cable Grouping Data was prepared. This was arranged by separating the cables within the same Tandem area and cables in different Tandem areas, and by making the transmission loss allocation between these exchanges the most economical, the loss allocation of inter-exchange cables was determined. From this, the number of circuits between exchanges according to the kind of transmission system was computed and the number of cable pairs (attached data D) was determined. The decision on the number of cable pairs was made in accordance with the Technical Agreement to meet the number of cable pairs necessary in 1990. However, because the special conditions in Bangkok will make the construction of underground conduits difficult, for efficient use of the conduits, it was planned that the cables in the central part of the city, between Tandem offices, etc. be placed with the maximum number of cable pairs.

4.3 Adoption of PCM-24 CH System

As stated in the foregoing, in line with the expansion of the local area, the length of the junction lines became longer. As examples, looking at the distance between Tandem Offices and End

Offices, the distance between LS Office (Tandem 4) and PKN Office (Tandem 6) is 26.9 Km; between LS Office (Tandem 4) and PTN Office (End Office), 27.8 Km; and between the furtherest office, PTN Office, and SMP Office it is actually 69.2 Km. These distances are not normally that of local junction lines but that of toll lines. Under these conditions, it is inevitable that the PCM-24 CH system and the PEF-P cables be adopted. In case the transmission loss allocation is 2 dB, the limit for 0.9 mm loaded cables is 5.9 Km. and in case of 4 dB, it is 13.3 Km

On the other hand, from the suitable advantage limit of the PCM system, the system is advantageous when the distance is approx. over 15 Km. Furthermore, due to the high water level situation in Bangkok which makes construction of cable tunnels difficult, it would be necessary to reduce the number of cables by use of the carrier system in consideration of the future expansion of local network. As one example, with the adoption of the PCM system, 10 cables of 0.9 mm x 600 P expected to be placed in 1980 from the LS Office to the center of Bangkok were reduced to 2 cables.

In view of the foregoing, the PCM system was adopted in accordance with the following principles:

a) In case the distance between Tandem Offices is over 15 Km.

b) Aside from the above principle, should the distance between Tandem Office and End Office be less than 15 Km. and there is a shortage of cable pairs inspite of utilizing aerial cables with the maximum number of cable pairs and in case it is economically advantageous when compared with underground cable conduits.

The PCM System Planning is as indicated in Fig. 4.

4.4 Adoption of Toll PEF-P Cable

There are two kinds of cables to be used on the PCM system, i.e., the ASP cable and the toll PEF-P cable. The toll PEF-P cable, naturally, is of higher cost but it has the advantage of reducing the number of repeating points by lengthening the distance between the repeaters. This has relevance to the number of systems and the distance between exchanges. For the installation of approx. over 60 systems and for distances of over 15 Km , it would be advantageous to use the toll PEF-P cable. The toll PEF-P cable was adopted as a transmission media for the PCM system of this Project because it satisfies either of the above conditions.

4.5 Selection of Routes

New routes were selected with the reorganization of Tandem areas and in line with the construction of new exchanges. These routes are as indicated in Fig. 5. The reasons for selection of the main routes are as under:

1) New Sathon Bridge Route

The junction cables between the Thonburi side and the Bangkok side are presently submarine cables placed across the Chaophya River alongside the Memorial Bridge. 9 cables are already installed and it is difficult to install additional new cables. On the other hand, since the present routes from Tandem 6 (TH) to Tandem 7 (SW), Tandem 3 (PL) and Tandem 6 (PKN) are big roundabout routes, the selection of a new route alongside a bridge at the lower reaches of the river will shorten the distance. With the selection of this new route, the plan for the construction of the junction cable along the Yawaraj Road where the traffic is heavy was cancelled, and the use of the existing cable has great advantages both from the standpoint of construction and maintenance.

2) Asodindang Road Route

The route from the Tandem 2 (PY) and Tandem 4 (LS) to Tandem 6 (PKN) presently goes via the Phyathain Road - Rama 1 Road - Sukumvit Road but since this route goes through the central part of the city and is also a roundabout route, the route through Soi Dindang - Asodindang - New Phetburi - Phrakamong was selected as a new short-cut route. This new route not only is shorter but avoids the heavy road traffic area in the central part of the city.

3) Kongton Road Route

This proposed route was selected due to the change of the KC Office from Tandem 2 (PY) to Tandem 6 (PKN).

4) Ngamwongwan Road Route

This is a new route due to change of the NWW Office from Tandem 2 (PY) to Tandem 4 (LS).

5) Arerunan Road Route

The route between PL Office and SW Office presently passes through the Rama I Road and Phyathai Road but as a shorter route and in line with the city's road reconstruction project, the route through the Rama I Road and Arerunan Road was newly selected.

4.6 Rearrangement of Existing Cables

The existing cable accommodates different groups of junction circuits. However, since this will be a big junction lines network for 500, 100 subscriber lines, in consideration of ease in maintenance, the many branch cables were cut out and reformed to a simple junction cable. Consequently, after completion of the work, the cables between offices will be consolidated.

LAY-OUT OF JUNCTION CABLE & CIRCUIT ROUTE

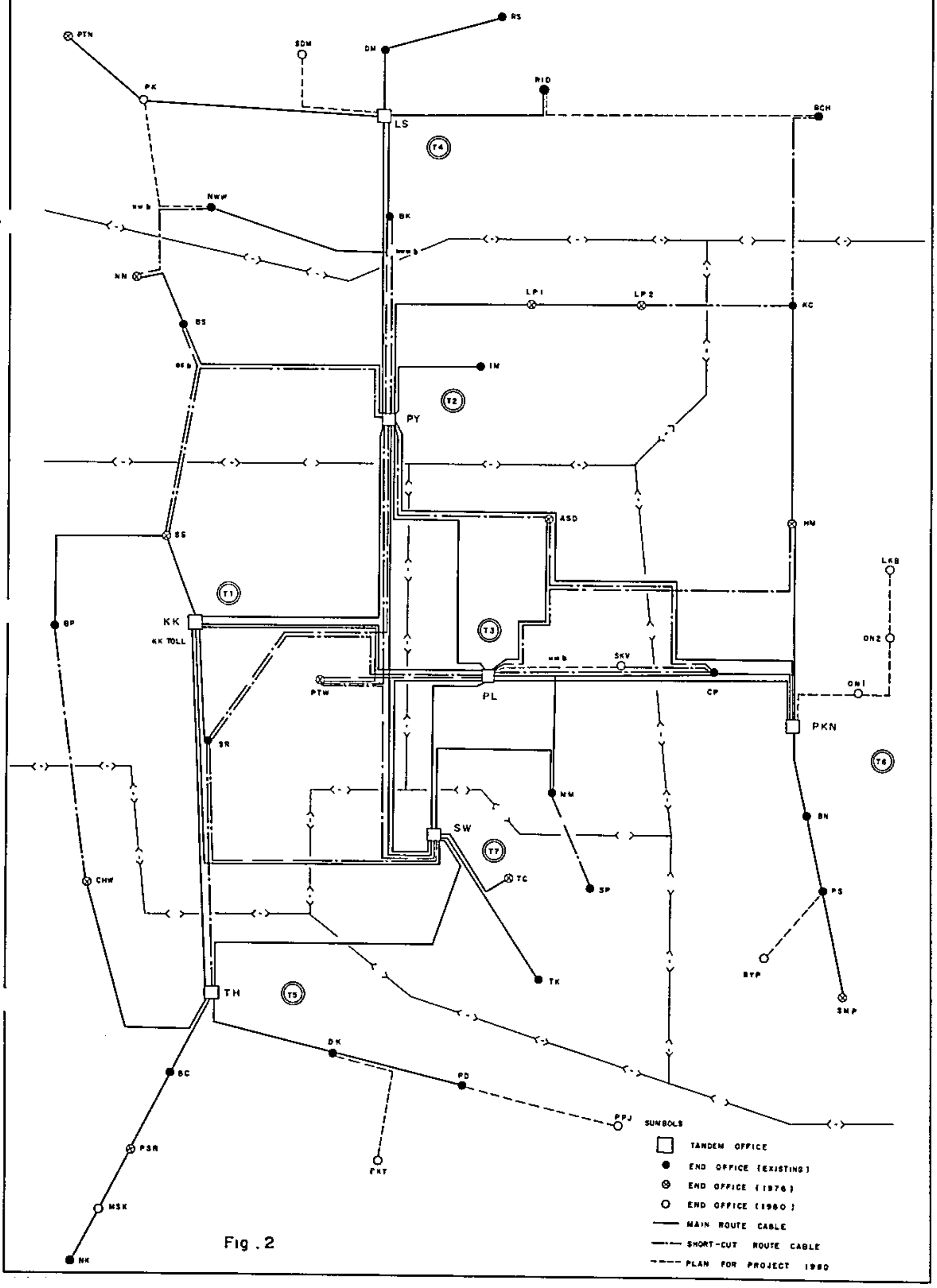


Fig. 2

TRAVERSAL CIRCUIT

PTN —— / P K	NWW / BS, NN
NWW ——	BS, NN / SS, BP
NWW —— Through PY	T_2(Excluding NN, BS) / T_1(" SS, BP) / T_3, T_5, T_6, T_7
BK —— Through PY	$T_1, T_2, T_3, T_5, T_6, T_7$
BCH ——	T_2 / T_6(Excluding PKN)
NN / BS ——	T_1
PTW ——	T_2 (Excluding NN, BS) / T_3, T_6, T_7, T_5
BP ——	T_5
SS ——	CHW
SR ——	T_2(Excluding NN, BS) / T_3, T_6, T_7, T_5
ASD ——	T_6 (Excluding KC HM) / T_2, T_4
Through PY / KC —— / Through PL	BCH / T_4 (Excluding BCH) / T_2 / T_3

KC Through PL / " "	T_1 (Excluding KKTOLL 4db, KK 6db) / T_5, T_7 / HM, CP
HM	CP
HM Through PL / "	LP_1, LP_2 / T_2(Excluding LP, LB) / T_1, T_4, T_5, T_7
CP ——	$T_1, T_2, T_3, T_4, T_5, T_7$
SKV ——	T_6(Excluding HM, KC, CP)
SKV ——	CP
MM ——	T_5, T_7
SP Through PL	T_1, T_2, T_3, T_4, T_6

Fig. 3

PCM SYSTEMS PLANNING

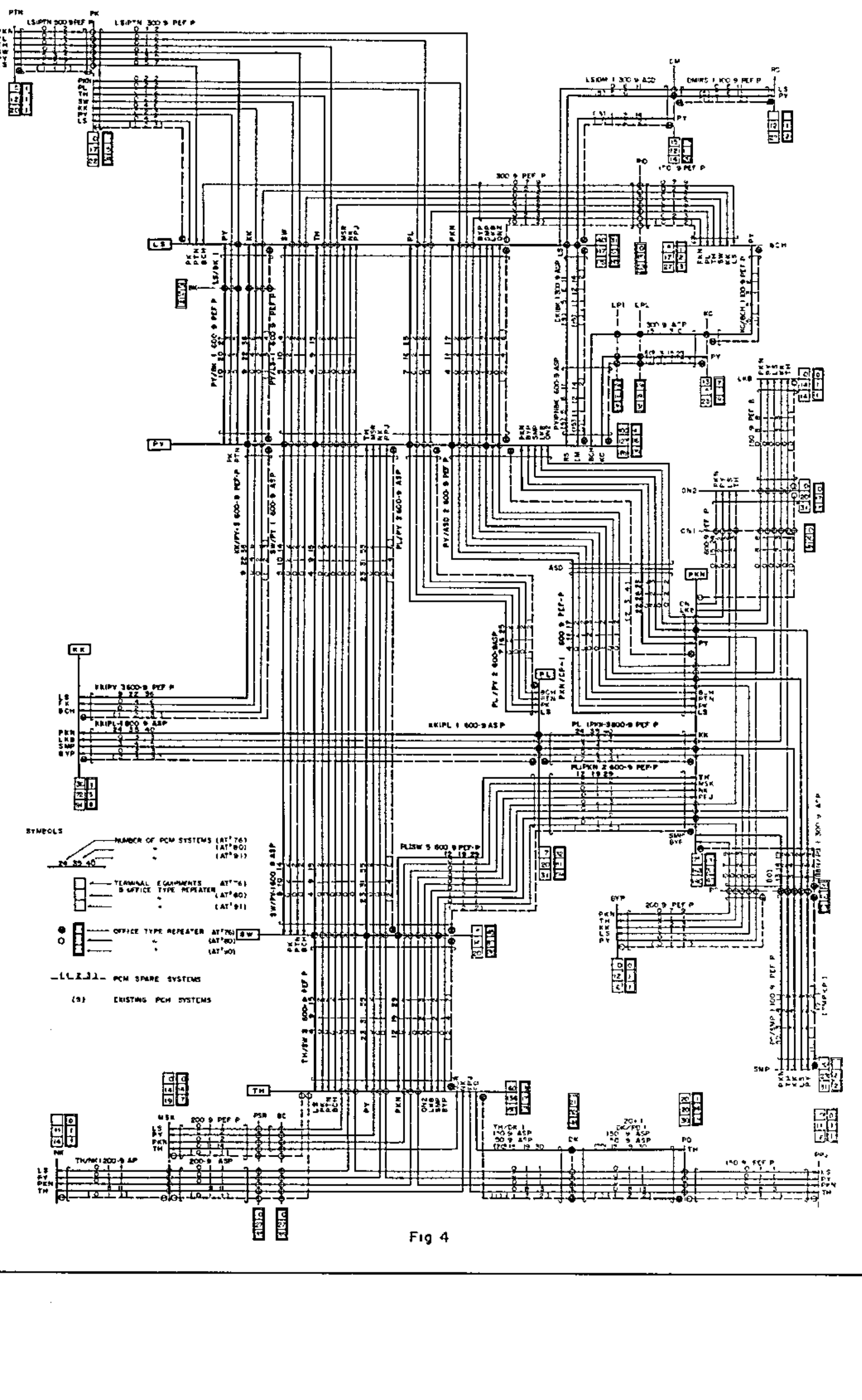


Fig 4

BANGKOK NEW CONDUIT ROUTES JUNCTION NETWORK

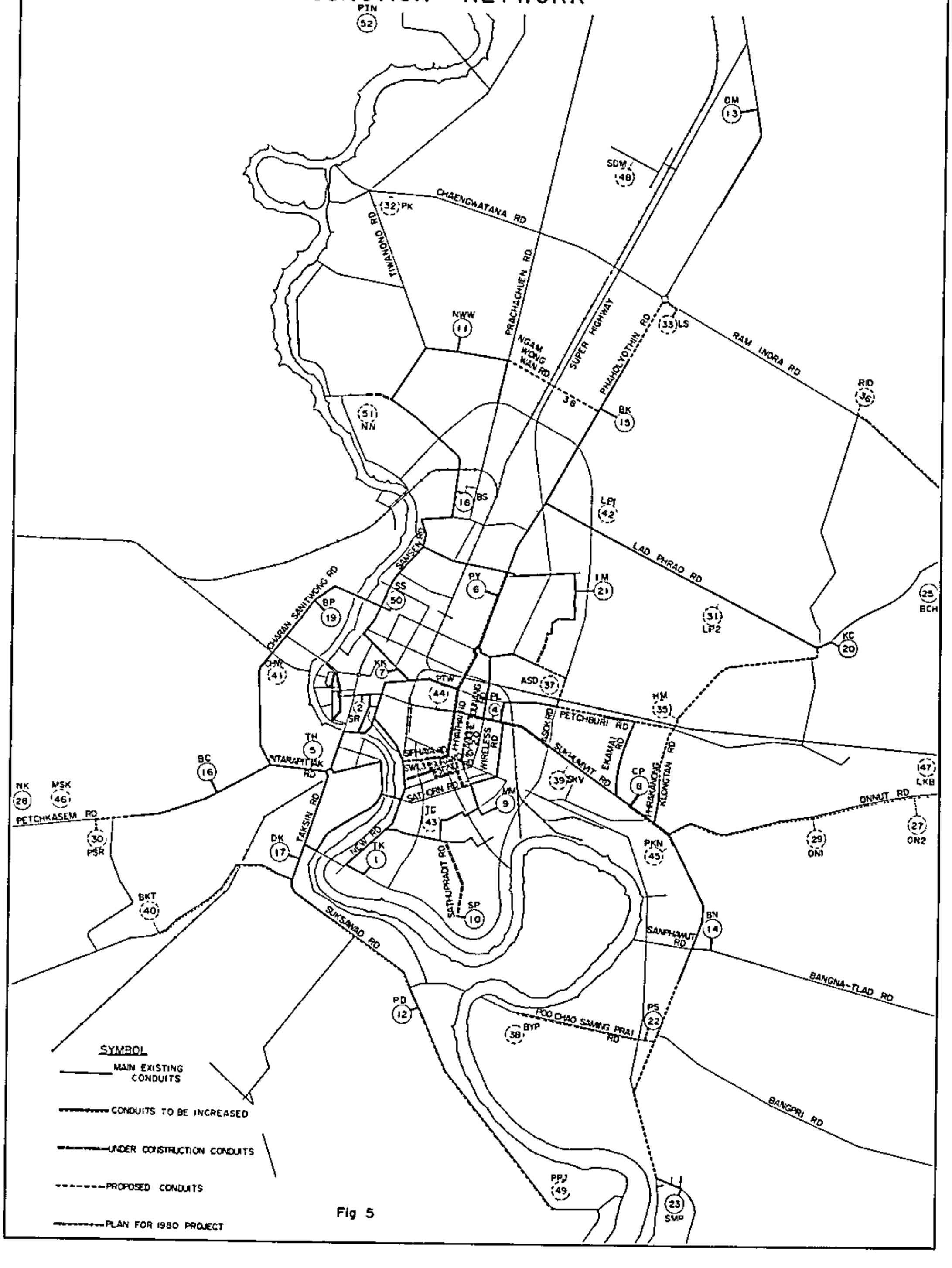


Fig 5

SECTION 5. DETAILED DESIGN

5.1 Loading Layout

In accordance with the Engineering Standards, the loading layout is for the H-88 type. Since the plots of land for the new exchanges are still undecided at present, the starting points of loading spacing are the existing exchanges in principle. When the land plots are determined in the future, arrangements will be made at the new exchange sides. The compensations for loading spacing were based on TOT standard procedures. Furthermore, the study data for loading for each section spacing is as in Attached Data (E).

1) Compensation for Loading Spacing

Should the standard loading spacing not satisfy the allowable minimum values, then it must be compensated by the capacitance equivalent to the required length of cable.

2) Compensation for Half Section

In the event of non-active circuits, should the end section be smaller than $\frac{So}{4}$, the Building-out Condenser (B. O. C.) must be inserted and should it be larger than 3/4 So, the compensating network must be inserted.

The active circuits were inserted with either the B. O. C. or compensating network in order to maintain a complete half section.

3) Outgoing Toll Junction Lines

In the outgoing toll junction circuits, the impedance compensator is first inserted at the toll exchange (KK exchange) side and in case of utilizing the 0.5 mm conductor cable, the low frequency corrector must be connected to the impedance compensator to improve the low frequency characteristic of the cable impedance.

5.2 Loading Layouts for Toll PEF-P Cables

Since the mutual capacitance of ASP cables is 52 mμF/Km while that of toll PEF-P cables is 38.5 mμF/Km, the loading spacing naturally will differ from that of ASP cables. The standards are as under:

Load 88 mH where So = 2470 m.

$$So/2 = 1235 \text{ m.}$$

$$\frac{So - S}{So} \times 100 \text{ within } \pm 2\ \%$$

$$\frac{S - Si}{S} \times 100 \text{ within } \pm 2\ \%$$

where So : standard loading spacing
S : average loading spacing
Si : individual loading spacing

An explanation for the reason in deciding such standards is :

H-88	52 mμF/Km	1,830 m.
H-88	38.5 mμF/Km	2,470 m.

Therefore, $\frac{52}{38.5} \times 1830 = 1.35 \times 1830 = 2,470$ m.

The study of the electrical characteristic in loading spacing is as follows:

1) Basic Numerical Values for Calculation

Rs = 56 Ω/Km ...... D.C. resistance value of 0.9 mm conductor at 30°C

$Rc = \frac{8.4 \times 1.06}{2.47}$ = 3.6 Ω/Km ..... D.C. resistance value of loading coil at 30°C

Ls = 0.76 mH/Km ...... inductance of cable

Lc = 88 mH .... inductance of loading coil

$Lc' = \frac{88}{2.47}$ = 35.6 mH/Km ......

G = 0.2 μʊ/Km .... conductance of cable

Cs = 38.5 mμF/Km ...... mutual capacitance of cable

S = 2.47 Km .... loading spacing

2) Electrical Characteristics

a) Characteristic Impedance Zo (Ω) 1 KHz

$$Zo = \sqrt{\frac{Lo}{Cs\ S}}$$

= 962Ω -- 83 mμF/Mile
(985)

b) Cut-off Frequency fc (Hz)

$$fc = \frac{1}{x\ \sqrt{Lo\ Cs\ S}}$$

= 3484 Hz/C

(3550) ----------83 mμF/Mile

c) Attenuation Constant β (dB/Km) 1 KHz 30°C

$$B = \frac{Rs + Rc}{2}\sqrt{\frac{Cs}{Lc'}} + \frac{G}{2}\sqrt{\frac{Lc'}{Cs}}$$

= 0.0311 NP/Km

$$= 20 \log_{10} e \cdot B = 0.27 \text{ dB/Km}$$
(0.27)

Figures in parenthesis ( ) denote values according to annexed sheet 5.

5.3 Cable Design for PCM - 24 System

5.3.1 Repeater Spacing Layouts

In the detailed design work for the Bangkok Telephone Junction Lines Project, the 2 kinds of cables to be adapted for the PCM-24 system are the 0.9 mm toll PEF-P cables and the 0.9 mm ASP cables (Stalpeth type), and the former are the new installation cables while the latter are the existing cables.

The design idea for the repeater spacing of the foregoing cables is as stated in the following.

Furthermore, in principle, the cables between the exchanges were determined as 1 repeating section and the repeating spacing was executed.

1) 0.9 mm Toll PEF-P Cable

Based on the required number of systems 15 years ahead, the repeater spacing was executed in accordance with the procedures specified in the Telecommunications Engineering Standard Execution Method of the Nippon Telegraph and Telephone Public Corporation.

2) 0.9 mm ASP Cable

Based on the required number of systems 15 years ahead, the repeater spacing was executed in accordance with the procedures specified in the Telecommunications Engineering Standard Execution Method of the Nippon Telegraph and Telephone Public Corporation. Furthermore, since there is no criterion for do_9 max in the above Execution Method, it will be converted according to the following equation.

$$\frac{Lo_{65} \cdot do_{65} \text{ max. (dB)}}{Lo_9 \text{ (dB/Km)}} = do_9 \text{ max. (Km)}$$

This is :

Lo_{65} do_{65} max. ... . Line loss value to cope with the required number of systems 15 years ahead of the 0.65 mm 600 P unit pair cable at 772 KHz.

Lo_9.................. Attenuation constant average value of 0.9 mm unit pair cable at 772 KHz.

do_9 max. .... Maximum repeater spacing of 0.9 mm ASP cable.

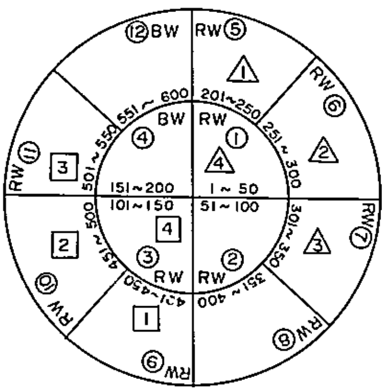
5.3.2 PCM Conductor Line Assignment

1) 0.9 mm Toll PEF-P Cable

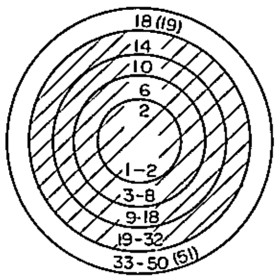
Line assignments were made for the west to east group from the No. 1 quad of the center layer. For the east to west group, considerations were made on the number of systems, required number of loading pairs, etc. 15 years ahead for the west to east group and line assignments were made for the east to west group with a shielding layer of over 1 layer. Furthermore, in case many loading pairs are required at the initial stage, cable pairs reserved for future PCM systems are used as loading pairs at this time, and such loading pairs are to be deloaded when the PCM systems are to be increased at some future date.

2) 0.9 mm ASP Cable

East to West Group   West to East Group



0.9 mm 600 P
Cross-section



50 P Unit
Cross-section

The makeup of cable pairs and units for ASP cables are as indicated in the above diagrams.

Line assignment was made in order from the first pair of the center layer. The PCM pair will not be assigned to the outermost layer.

The line assignments of the west to east group and the east to west group are as indicated in the above cross-section. The west to east and east to west groups will be placed between the inter-facing △ – □ , and the deloading will be executed for the required number of pairs at each time of actual installation of PCM.

5.3.3 Selection of Repeater Equipment

Since only non-metallic conduits were adopted for the underground conduits in Bangkok, the repeater equipment to be installed in the manholes shall all be the R manhole repeater equipment (with arresters).

5.3.4 Computation of No. of Systems

1) In the installation of the PCM-24 system, the number of systems 15 years ahead shall be computed according to the equation below.
   However, spare pairs will be reserved for 15 years ahead.

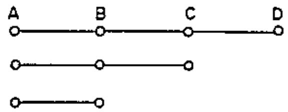
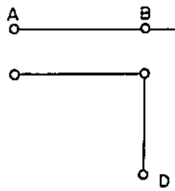
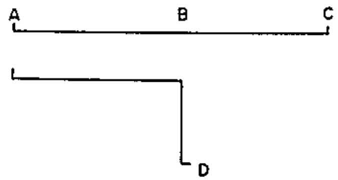
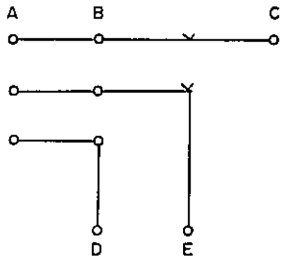
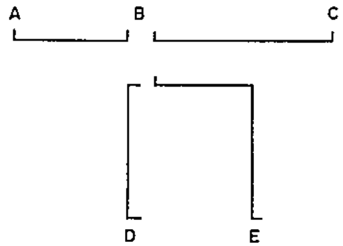
$$X = \frac{C}{24}$$ (Fractions to be raised to next round number)

where X : No. of PCM-24 systems

C : No. of trunk lines

2) One spare system shall be prepared for each 20 systems according to the following spare system diagram.

SPARE PCM SYSTEM DIAGRAM

	Kind of Route		Transmission Line Route	Spare System	Remarks
PCM-24 System N L.	In case of route without branch-ing				Spare system will be up to the office type repeater
	In case of route with branching, 1 spare system will be installed.	In case of over 11 systems in branch routes			
		In case of less than 10 systems in branch routes, and in the event the branches are at MH, etc.			

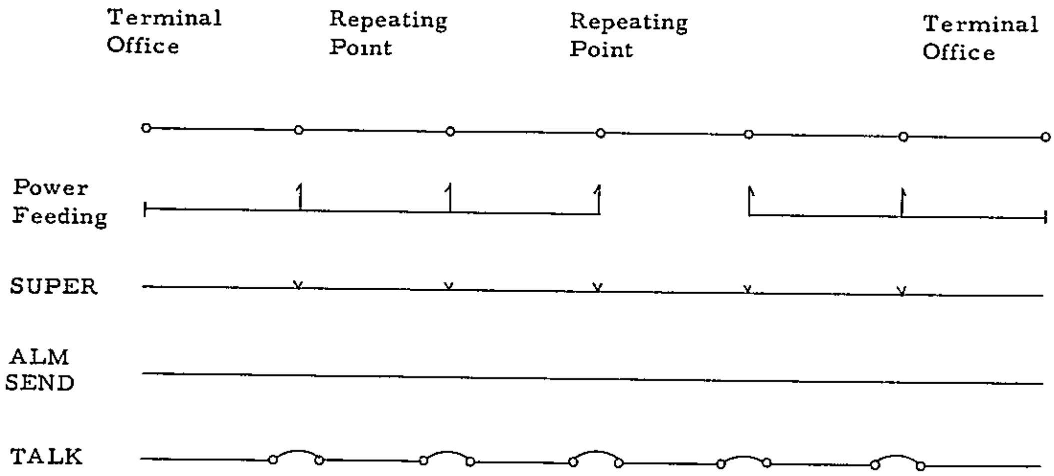
Terminal equipment

Office type repeater

Manhole type repeater

3) Talking, Supervision and Alarm Sending Pairs

The talking, super and alarm sending pairs were established in each section, based on the diagram shown below, and these pairs will be used in the loading pairs as a matter of principle



Use	Required No. of Pairs	Conductor
PCM Pair Route	2 Pairs x No. of systems (Power feeding will be by phantom circuit)	Non-loaded
Supervision	1 P (Regarding 12 freq.)	Loaded
TALK	1 P (Regarding 1 route)	"
ALM SEND	1 P (Regarding 8 freq.)	"

4) Others

In case the PCM-24 system and the V. D. cable co-exist in the same cable, separation to another cable was made to avoid complete interruption of service when trouble occurs.

5.3.5 Measures for PCM Cables Planned by TOT

The junction circuit extension work to be served by the PCM system on the existing cables are to be carried out by TOT in the 1971 - 1973 Project. The new exchanges will be established after 1973 along the 3 junction sections which are included in the above Project. Therefore, in the 1972 - 1976 Project, the said PCM cables are planned to be cut and placed-in to the proposed exchanges as shown in the No. 1 to 6 plans.

The attached sheets No. 1 to No. 6 indicate the measures for the respective cases as follows:

A Plan .... In case change will be made in a part of the repeating points.

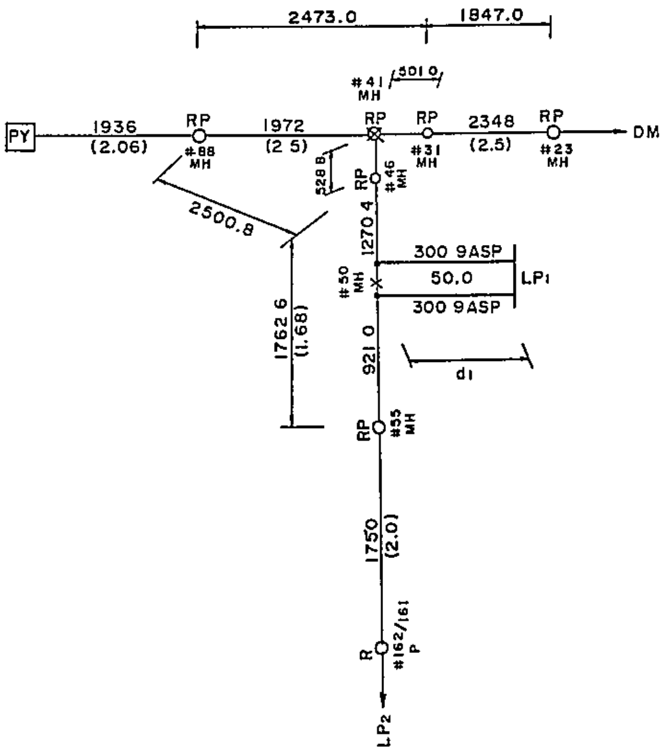
B Plan .... In case no change as in above is made.
(Exchange offices where the cables are to be placed-in will have office type repeater equipment)

The plots of land for the new telephone exchange offices have not yet been decided upon at present but should such land plots be determined by the time of commencement of the above PCM extension work, it is believed that the A Plan would be advantageous.

In consideration of the case whereby the A Plan could not be adopted due to various conditions, the detailed design drawings for the 1972 - 1976 Project were drawn up according to the B Plan.

No. 1 A PLAN

Entrance to LP_1 Office of the 0.9 mm 300 P ASP Cables between PY - KC Exchanges



Studies

1. In case the cable is cut and placed-in to the LP_1 Office, the section length of 2291.4 m from Manhole #41 - LP_1 - MH #55 must satisfy the following equation.

   $2291.4 \leqq C - (1.5\ B - d_1) = do\ max$

   $do\ max = 2.82 - (1.5 \times 0.76 - 0) = 1.68$ Km.

2. Therefore, it is necessary to shorten the section length of Manhole #41 - LP_1 - MH #55 as under:

   2291.4 - 1680.0 = 611.4 m.

3. Methods for shortening are:

   1) Move the repeater in #55 manhole towards the LP_1 Office side.

   2) Move the repeater in #41 manhole towards the LP_1 Office side.

However, 1) above would be difficult from the point of allowable distance, therefore, it will be according to 2). But, in consideration of the far end crosstalk at the cable branching point, it would be necessary to also move the repeaters between PY and DM as in the diagram on the left.

Note : do max .... maximum repeater spacing

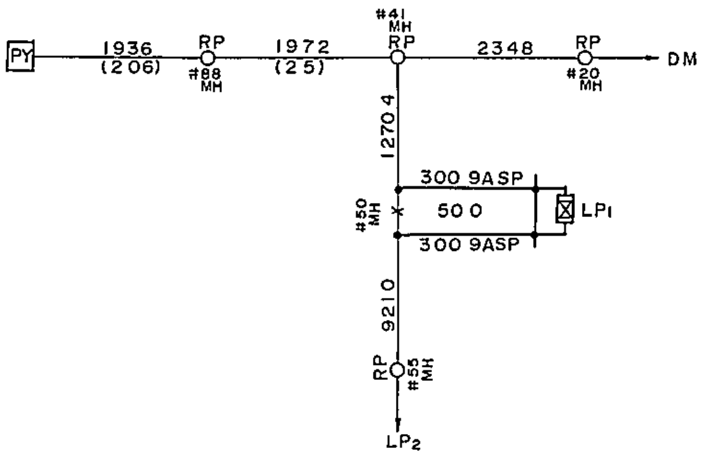
B .... minimum repeater spacing between exchanges and new repeating point

C .... standard repeater spacing between exchanges and new repeating point

d_1 .... distance between exchange and near branch point

No. 2 B PLAN

Entrance to LP_1 Office of the 0.9 mm 300 P ASP Cables between PY - KC Exchanges



Studies

1. In case the cable is cut and placed-in to the LP_1 Office, the section Length from RP - LP_1 - RP must be less than 1.68 Km, but the section length from #41 manhole - LP_1 - #55 manhole will be 2291.4 m.

2. As a counter-measure, repeating equipment will be installed in the LP_1 Office.

   In this case, the 1320.4 m. between #41 manhole - LP_1 Office and the 971.0 m. between LP_1 - #55 manhole will become the distance between exchange and near repeating point, respectively.

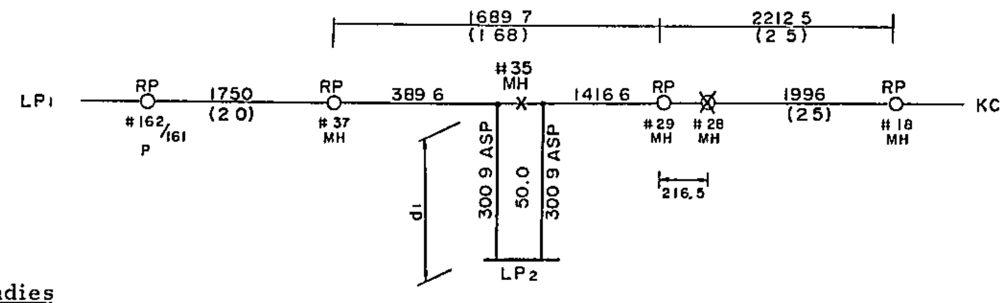
3. If the distance between exchanges and near repeating point is within the limit of 2.06 (max) - 0.76 (min.) Km., then, it would be adequate and will satisfy either conditions.

No. 3 A PLAN

Entrance to LP_2 Office of the 0.9 mm

300 P ASP Cable between PY - KC

Exchanges



Studies

1. In case the cable is cut and placed-in to LP_2 Office, the section length of 1906.2 m. from #37 manhole - LP_2 - #28 manhole must satisfy the following equation.

   $1906.2 \leq C - (1.5\ B - d_1) = do\ max$

   do max = 2.82 - (1.5 x 0.76 - 0) = 1.69 Km.

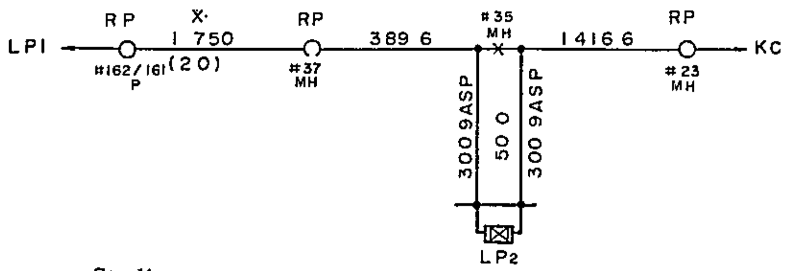
2. Consequently, it would be necessary to shorten the section length from #37 manhole - LP_2 - #28 manhole as follows:

   1906.2 - 1680.0 = 226.2 m.

3. Therefore, the repeater in the #28 manhole will be moved to the #29 manhole.

No. 4 **B PLAN**

Entrance to LP_2 Office of the 0.9 mm 300 P ASP Cables between PY - KC Exchanges



Studies

1. In case the cable is cut and placed-in to the LP_2 Office, the section length from RP - LP_2 - RP must be below 1.68 m. But the section length from #37 manhole - LP_2 - #28 manhole will be 1906.2 m.

2. As a counter-measure, repeating equipment will be installed in LP_2 Office. In this case, the 439.6 m. between #37 manhole and LP_2 Office and the 1466.6 m. between LP_2 Office and #28 manhole will become the distance between exchange and near repeating points, respectively.

3. If the distance between exchanges and near repeating points is within the limit of 2.06 (max) and 0.76 (min.) Km, it would be adequate and there will be no problem between LP_2 Office and #28 manhole but between the #37 manhole and the LP_2 Office, further study will be required.

4. However, if the section length of the general section (marked with *) next to distance between exchanges and near repeating points is less than the distance obtained in the equation below, 439.6 m. would be allowable. In other words,

$$do\ max = C - \left[B - (\text{shortened distance})\right]$$

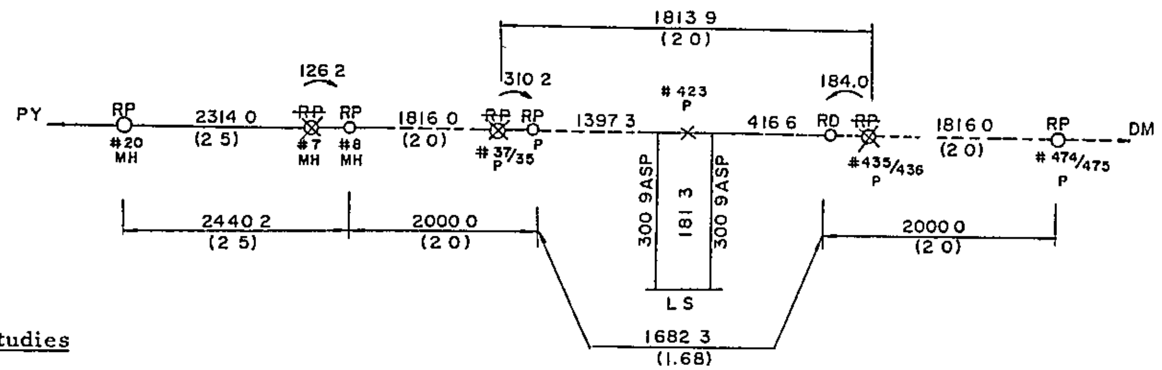
$$= 2.82 - (0.76 - 0.44)$$

$$= 2.5 \text{ Km.}$$

5. Therefore, in case the distance between exchange and near repeating points is shortened to 0.44 Km, if the section length of the next general section is less than 2.5 Km, it would be adequate, and the distance between exchange and near repeating point of 439.6 m. would be allowable.

No. 5 A PLAN

Entrance to LS Office of the 0.9 mm 300 P ASP Cables between PY - DM Exchanges



Studies

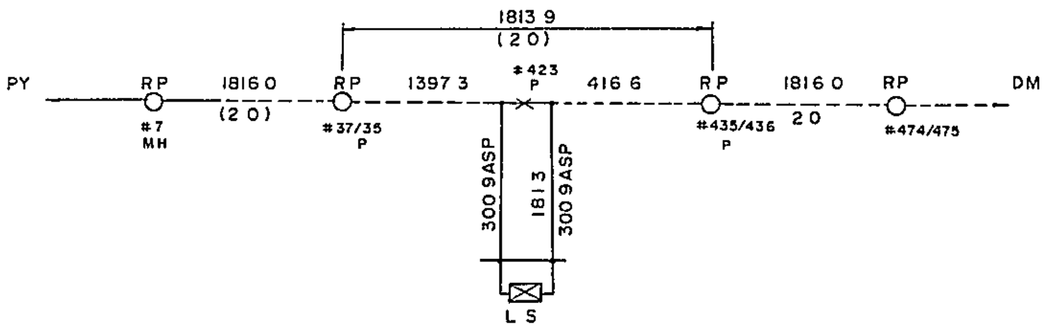
1. In case the cable is cut and placed-in to LS Office, the section length from RP - LS - RP must be less than 1. 68 Km. But, the section length of this section will be 2176. 5 m.

2. Consequently, the section length from RP - LS - RP would require shortening by : 2176. 5 - 1680. 0 = 496. 5 m.

3. Therefore, as indicated in the above diagram,a change in the RP points will be executed.

No. 6 B PLAN

Entrance to LS Office of the 0.9 mm 300 P ASP Cables between PY - DM Exchanges



Studies

1. In case the cable is cut and placed-in to LS Office, the section length from RP - LS - RP must be less than 1.68 Km. However, it will be 2176.5 m.

2. As a counter-measure, repeating equipment will be installed in the LS Office.

3. In this case, the 1578.6 m. between the repeaters in #37/#35 manholes and the LS Office and the 597.9 m. between the LS Office and the repeaters in the #435/#436 manholes will be the distances between exchanges and near repeating points, respectively.

4. These distances between exchanges and near repeating points, as indicated in the PY - KC B PLAN, will be allowable without any problem.

5.4 Problems in Conduit Routes

In this design work, changes may occur in the following 3 routes due to city planning, and alternative plans were prepared for 1) and 3) below.

1) PS - SMP Route

The work on this route has been planned with the aim of constructing underground conduits but in the event the new construction of underground conduits should be delayed in line with road construction work, the PCM systems will be additionally installed in the existing cables. (This alternative plan is shown in Volumes I - 12)

2) LS - DM Route

For this section, the placement of 0.9 mm 600 P ASP cables should have been executed in this Project but since it seems that the road construction work will be delayed, the existing 300 P cables will be utilized. After the new construction of underground conduits in the future, the cables will be newly placed.

3) SW - TH Route

This new cable will be attached to the proposed new Sathon Bridge but in the event the completion of the bridge is delayed, a submarine cable will be placed between the City Hall on the Thonburi side and the mission school on the Bangkok side. (This alternative plan is shown in Volumes I - 12)

5.5 Design Principle for Gas Pressurization of Cables

The manholes of Bangkok are almost always filled with water, therefore, the underground cables must all be gas pressurized. Furthermore, due to the high humidity and sudden changes in temperature, the aerial cables will all be gas pressurized. The work of installing test valves, gas dams and contactors to the junction cables will be carried out.

However, since the equipment in the exchange offices such as air dryer equipment, etc. will be jointly used for the subscribers cables, they will be excluded from this Junction Lines Project.

5.6 Line Assignment for Junction Network

In the assignment of cable pairs, the purpose was basically for ease in maintenance and in consideration of the classifications according to kinds of lines, switching functions, line connections, etc., it was carried out as follows:

1) Classification According to Kinds of Lines

In accordance with the characteristics of the lines to be used, a wide classification was made as under:

i) General public lines

ii) Miscellaneous lines

iii) Direct lines

2) Classification of Higher and Lower Ranking Offices According to Switching Functions

As indicated in Fig. 6 Office Ranking, the office with the

OFFICE RANKING

EX. NO	NAME	ABBREV	TANDEM AREA	RANKING NO
7	KRUNG KASEN	KK 1 T KK 2 T_1	1	1, 2, 15
6	PHAHONYOTHIN	PY 1 PY 2 T_2	2	3, 14
4	PHLOEN CHIT	PL 1 PL 2 T_3	3	4, 12
33	LUK SI	LS T_4	4	5, 40
5	THONBURI	TH2 T_5	5	6, 13
45	PRAKHANONG	PKN T_6	6	7, 51
3	SURAWONG	SW 1 SW 2 T_7 SW 3	7 7	8, 11
1	THANONTOK	TK	1	9
2	SAMRAN RAT	SR 1 SR 2 SR 3	6	10
8	CHAIYA PHRUT	CP 1 CP 2	3	16
9	THUNGMAHAMEK	MM	7	17
10	SATHUPRADIT	SP	4	18
11	NGAM WONG WAN	NWW	5	19
12	PHRA PRADAENG	PD	4	20
13	DONMUANG	DM	6	21
14	BANGNA	BN	4	22
15	BANGKHEN	BK	5	23
16	BANGKAN	BC	5	24
17	DAOKANONG	DK	2	25
18	BANGSU	BS	1	26
19	BANGPLAD	BP	6	27
20	KLONG CHAN	KC	2	28
21	INTHAMARA	IM	6	29
22	POO CHAO SAMING PRAI	PS	6	30
23	SAMUT PRAKAN	SMP	4	31
24	RANG SIT	RS	4	32
25	BANGCHAN	BCH	6	33
27	ON NUT 2	ON2	5	34
28	NONG KHAEN	NK	6	35
29	ON NUT 1	ON 1	5	36
30	PHASEE CHAROEN	PSR	2	37
31	LAT PHRAO 2	LP 2	4	38
32	PAKKRET	PK	6	39
35	HUA MAK	HM	4	41
36	RAM INDRA	RID	3	42
37	ASOK DIN DAENG	ASD	6	43
38	BANG YA PHRAEK	BYP	3	44
39	SUKHUMVIT	SKV	5	45
40	BANG KHUN TIAN	BKT	5	46
41	CHARAN SANIT WONG	CHW	2	47
42	LET PHRAO 1	LP 1	7	48
43	TROK CHAN	TC	1	49
44	PATHUMWAN	PTW	6	50
46	MUBAN SETHAKIT	MSK	5	52
47	LAT KRABANG	LKB	6	53
48	SNAMBINDONMUANG	SDM	4	54
49	POM PHRAJUL	PPJ	5	55
50	SAMSEN	SS	1	56
51	NONTHABURI	NN	2	57
52	PATHUM THANI	PTN	4	58

Fig. 6

lower number is the higher-ranking office.

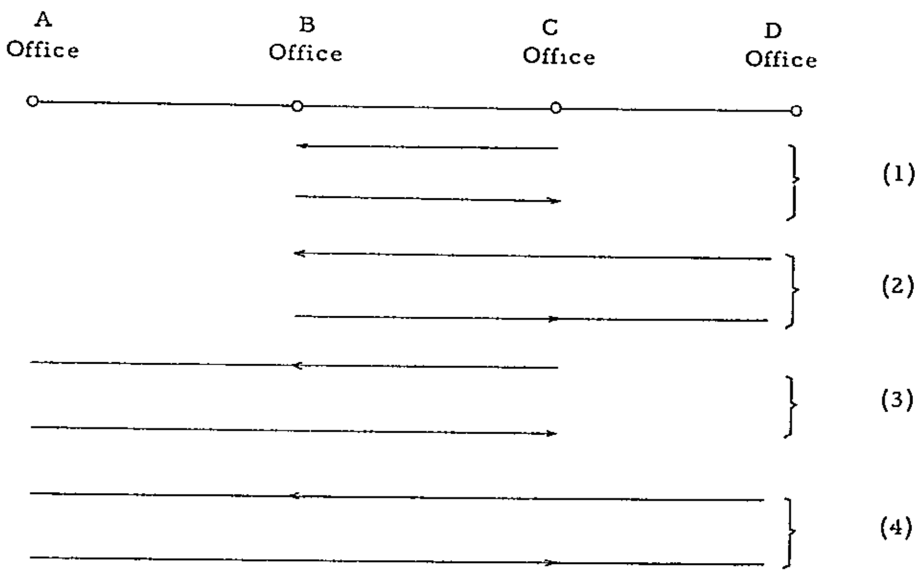
However, in case of a combined switch, the line assignment will be made according to the ranking of end offices.

3) Classification According to Line Connections

In conforming with the existing lines, the line assignment will be according to the diagram below in principle. As an example:

Cable Line Assignment for B Office

(B Office is a higher ranking office than C Office)



However, no classification will be made according to direction for the direct lines.

4) Line Assignment for Existing Cables and New Cables

In consideration of the increased installation of lines to meet the future increase in number of subscribers' switch terminals, in principle, the line assignment will give preference to the existing cables and arrangements will be made for cable pairs which will make maintenance easier.

However, in case of complicated work due to the situations at the offices, the line assignment will be made for new cables upon consideration of the foregoing points.

Furthermore, when the lines of the same section are in the same cable, the numbers in sequence were assigned wherever possible in the sense of making maintenance easier.

5.7 DC Resistance Value and Attenuation Constant at 30°C

Since the average temperature is approx. 29°C throughout the year in Bangkok, it would be necessary to use the values at 30°C for DC resistance value and the attenuation constant of the cables.

The respective values were computed as under:

a) DC Resistance Value

$$R\,30 = R\,20\left[1 + 0.004265 \times (30 - 20)\right]$$

where,

R 30 .... Loop resistance value at 30°C Ω/Km

R 20 .... Loop resistance value at 20°C "

Conductor Dia. (mm)	R 20	R 30	R30/R20
0.9	53	56	1.06
0.65	108	112	1.04
0.5	170	176	1.04

b) Attenuation Constant

i) Loaded line (H-88 system)

$$B = \frac{Rs + Rc}{2} \sqrt{\frac{C}{L}} + \frac{G}{2} \sqrt{\frac{L}{C}}$$

where,

RS ..... DC resistance value of cable at 30°C Ω/Km

Rc .... " " of loading coil 30°C Ω/Km

C = 52 mμF/Km .. .... Mutual capacitance of cable

L = 48.1 mH/Km....... Inductance of loading coil per Km

G = 1.6 μ℧/Km ...... Conductance of cable.

β 30°C	dB/Km
0.9 mm	0.27
0.65 mm	0.52
0.5 mm	0.81

ii) Non-loaded line

$$B = \frac{Rs}{2} \sqrt{\frac{C}{L}} \quad f_4$$

L = 0.7 mH/Km .... Inductance of cable

f_4 (0.9) = 0.39

$f_4\ (0.65) = 0.28$

$f_4\ (0.5) = 0.23$

Ø 30°C	dB/Km
0.9 mm	0.82
0.65 mm	1.18
0.5 mm	1.50

Section 6. AMOUNT OF CONSTRUCTION WORK

Section : A

Unit Designation	No. of Unit	(See footnote)
A8 A10 A12	21 205 15	
Section "A" Total	241	

Section : B

Unit Designation	No. of Unit	(See footnote)
B1BS B1DS	98 21	
Section "B" Total	119	

Section : C

Unit Designation	No. of Unit	(See footnote)
C2 - 1A C2 - 2A	98 21	
Section "C" Total	119	

Section : E

Unit Designation	No. of Unit	(See footnote)
E 300.9 PEF-P	286	
Section "E" Total	286	

Section : G

Unit Designation	No. of Unit	(See footnote)
G 600.5B1	15	
G 900.5B1	62	
G 1200.5B1	100	
G 1500.5B1	52	
G 1800.5B1	512	
G 150.65B1	1	
G 300.65B1	43	
G 600.65B1	2	
G 1100.65B1	41	
G 1200.65B1	932	
G 300.9B1	13	
G 400.9B1	4	
G 450.9B1	29	
G 600.9B1	449	
G 100.9 PEF-P	1	
G 200.9 PEF-P	1	
G 300.9 PEF-P	2	
G 600.9 PEF-P	724	
Section "G" Total	2,983	

Section : J

Unit Designation	No. of Unit	(See footnote)
J 100 P. 5	13	
J 200 P. 5	31	
J 300 P. 5	195	
J 400 P. 5	40	
J 100 P. 9 (PEF)	3	
J 150 P. 9 (PEF)	4	
J 200 P. 9 (PEF)	5	
J 300 P. 9 (PEF)	9	
J 400 P. 9 (PEF)	2	
J 600 P. 9 (PEF)	7	
Section "J" Total	309	

Section : M

Unit Designation	No. of Unit	(See footnote)
M1BP	12	
M1CP	137	
M3BP	9	
M3CP	1,407	
Section "M" Total	1,565	

Section : N

Unit Designation	No. of Unit	(See footnote)
N	13,506	
Section "N" Total	13,506	

Section : O

Unit Designation	No. of Unit	(See footnote)
01	62	
02	120	
04	1	
07	63	
08	2	
09	1	
Section "O" Total	249	

Section : S

Unit Designation	No. of Unit	(See footnote)
S 100	14	INCLUDING 3 REUSED TAKEN OFF.
S 150	11	INCLUDING 1 REUSED TAKEN OFF.
S 200	35	INCLUDING 4 REUSED TAKEN OFF.
S 250	1	
S 300	14	
S 400	16	
S 450	1	
S 500	40	
S 600	31	
S 800	17	
S 900	3	
S 1000	13	
S 1100	9	
S 1200	5	
S 1600	3	
S 100 (44mH)	2	
S 150 (44mH)	1	
S 200 (44mH)	1	
S 300 (44mH)	5	
S 400 (44mH)	1	
S 450 (44mH)	1	
S 500 (44mH)	2	
S 600 (44mH)	2	
S 900 (44mH)	1	
S 1000 (44mH)	1	
S 1100 (44mH)	1	
S 100 - 019	1	

Section : S No. 2/5

Unit Designation	No. of Unit	(See footnote)
S 100 - 035	1	
S 100 - 040	1	
S 150 - 011	1	
S 150 - 033	1	
S 150 - 034	3	
S 150 - 059	2	
S 200 - 002	1	
S 200 - 004	1	
S 200 - 009	1	
S 200 - 012	1	
S 200 - 018	2	
S 200 - 019	1	
S 200 - 021	1	
S 200 - 024	1	
S 200 - 028	1	
S 200 - 029	1	REUSED ONE TAKN OFF.
S 200 - 031	2	INCLUDING 1 REUSED TAKEN OFF.
S 200 - 036	1	
S 200 - 060	1	
S 200 - 063	1	
S 200 - 067	1	
S 200 - 082	1	
S 300 - 006	1	
S 300 - 012	1	
S 300 - 016	1	
S 300 - 018	1	

Section : S

No. 3/5

Unit Designation	No. of Unit	(See footnote)
S 300 - 027	2	
S 300 - 030	1	
S 300 - 036	1	
S 300 - 063	1	
S 400 - 004	1	
S 400 - 006	1	
S 400 - 007	1	
S 400 - 008	2	
S 400 - 010	1	
S 400 - 011	1	
S 400 - 012	1	
S 400 - 015	1	
S 400 - 032	1	
S 400 - 037	1	
S 400 - 047	1	
S 450 - 027	1	
S 500 - 003	2	
S 500 - 006	2	
S 500 - 008	2	
S 500 - 009	1	
S 500 - 016	1	
S 500 - 018	1	
S 500 - 022	1	
S 500 - 023	1	
S 500 - 024	1	
S 500 - 027	1	
S 500 - 033	1	

Section : S

No. 4/5

Unit Designation	No. of Unit	(See footnote)
S 500 - 034	3	
S 500 - 052	1	
S 500 - 060	1	
S 500 - 067	1	
S 500 - 072	2	
S 600 - 012	1	
S 600 - 018	1	
S 600 - 021	1	
S 600 - 026	1	
S 600 - 055	3	
S 600 - 065	1	
S 600 - 070	1	
S 600 - 075	1	
S 800 - 004	1	
S 800 - 011	1	
S 800 - 018	1	
S 800 - 021	1	
S 800 - 022	1	
S 800 - 028	1	
S 800 - 033	1	
S 800 - 044	1	
S 800 - 058	1	
S 800 - 064	1	
S 900 - 021	1	
S 1000 - 016	1	
S 1000 - 018	1	
S 1000 - 021	1	
S 1000 - 031	1	

Section : S

Unit Designation	No. of Unit	(See footnote)
S 1000 - 084	1	
S 1100 - 003	1	
S 1100 - 065	1	
S 1200 - 034	1	
S 1200 - 037	1	
S 1200 - 070	1	
S 1600 - 006	1	
S 1600 - 060	1	
Section "S" Total	336	

Section : T

Unit Designation	No. of Unit	(See footnote)
T	203	
Section "T" Total	203	

Section : U

Unit Designation	No. of Unit	(See footnote)
U (2)	526	
Section "U" Total	526	

Section : V

Unit Designation	No. of Unit	(See footnote)
V	16, 320	
Section "V" Total	16, 320	

Section : X

Unit Designation	No. of Unit	(See footnote)
X (1)	276	
X (2)	644	INCLUDING 11 REUSED TAKEN OFF.
X (3)	77	
X (4)	212	
X (4)	36	(Terminal Repeater for Spare System.)
X (1)	10	(Terminal Equipments should be removed from CP. EX to PKN EX.)
Section "X" Total	1,255	

PLAN OF OPERATION

FOR

THE DETAILED DESIGN OF

THE BANGKOK TELEPHONE JUNCTION LINES PROJECT

GUIDE TO CONTENTS

Introduction

1. The Government of Thailand desires to provide additional telephones to cope with growing demand of the public in the Bangkok Metropolitan area and to coordinate with the Third National Economic Development Plan 1972-1976.

2. The master plan of the Bangkok Metropolitan Telephone Plant Projects 1972-1976 was made by Telephone Organization of Thailand (TOT).

3. The Government of Thailand has requested the Government of Japan for its cooperation to draw up the detailed design for constructing about 250,000 pair-kilometers of junction network to expand the existing junction network for the increasing traffic.

4. The Government of Japan, in response to the subsequent request made by the Government of Thailand for technical cooperation with regard to the above junction network project, decided to take necessary steps to carry out detailed study and detailed design of the project, and entrusted the works to the Overseas Technical Cooperation Agency (OTCA), which is an agency of the Government of Japan for executing technical cooperation.

5. This document sets forth a plan of operation in regard to the detailed study and detailed design for the project.

I. Works to be carried out by the Japanese experts

6. The following field survey will be undertaken for a period of about four (4) months by a team of not more than eight (8) experts.

(1) Route survey

Cable routes will be decided according to the result of investigation of the existing facilities, study of future plans, and comparison of several proposed routes.

(a) Preliminary survey

Proposed routes will be plotted on a map taking the city plans and existing plant records into consideration.

(b) General survey

General survey will be conducted at the sections where cables are to cross rivers or railways.

(c) Detailed survey

Detailed survey will be made for all the newly proposed cable routes. Study of the existing cables will be made on the basis of the plant records, and if necessary, on-the-spot survey of the existing cables will be carried out.

(2) Manhole investigation

Ducts to be used will be selected after checking cable placement and location of cable splices in the existing manholes.

(3) Survey of MDF and cable vault

Location of riser cables to MDF and way of cables placement in cable vaults will be investigated.

7. The detailed design work of the following items will be undertaken by the Japanese experts in Japan.

(1) Key map to duct scheme plan

(2) Duct scheme plan

(3) General junction cable plan

(4) Layout plan for junction equipment

(5) Junction cable terminating plan at MDF

(6) Layout plan for loading spacing

(7) Jointing diagram

(8) Junction cable construction detail

(9) Manhole racking diagram

(10) Gas pressurization system

(11) Line assignment for junction network

(12) Computed transmission performance and line resistance

Note : Examples of these drawings are attached herewith as annex I.

8. The following documents will be prepared in English and presented to the Government of Thailand by the end of November, 1972.

A. Design report 20 copies

B. Drawings 20 copies

12 sorts of the drawings described in the Item 7

C. Amount of cable work 20 copies

An example is attached herewith as annex II.

II. Arrangements to be made by the Government of Thailand

9. The following will be arranged for the survey team by the Government of Thailand.

(1) Procurement of data and documents necessary for the design of the project.

(2) Procurement of permits, when necessary for execution of outdoor works, to be issued by the authorities concerned.

(3) Appointment of two liaison officers who accompany the team during the field survey.

III. Privileges and exemptions to be granted to the survey team

10. The members of the team engaged in the survey will be entitled to such privileges and exemptions as the Government of Thailand normally extends to Colombo Plan experts in respect of tax exemptions and

immigration facilities.

IV. Signature

11. The undersigned agreed on the foregoing on behalf of the parties concerned on this date of May 17, 1972.

(Signed) Xujati Pramoolpol	(Signed)Kanji Yasuda	(Signed)Surind Vanichseni
Mr. Xujati Pramoolpol	Mr. Kanji Yasuda	Mr. Surind Vanichseni
Deputy Director-General	Head of Japanese	Chief of Outside Plant
DTEC	Survey Team	Planning Centre
Ministry of National Development	O.T.C.A. Japan	For Director of TOT
		Ministry of Communications

21st September, 1972

Supplement to Annex Sheet of Engineering Standard, Sheet 1, Clause 1, Transmission Engineering Standard, wherein it is marked with ? concerning the tandem circuit which means subject to be agreed upon by both parties, the undersigned now come to a conclusion that in view of the transmission loss which might occur at those circuits, therefore, have agreed to cut out the suggested circuits between tandem offices.

(Signed) H. Sano	(Signed) Surind Vanichseni
Chief of N. T. C. Survey Team	Chief of Outside Plant Planning Centre, T. O. T.

Agreement on Technical Discussion

concerning detailed design of

Bangkok Telephone Junction Lines Project

I. Material to be Supplied by T.O.T.

1. Planning of Office Establishment Programme

   Shall comprise of information concerning the locations of telephone offices to be newly established in Great Bangkok Area and the service area of each such office.

2. Office Ranks (toll and local tandem offices)

   Shall comprise of information indicating local tandem offices, local sub-tandem offices, local offices, satellite offices, etc.

3. Switching System and Trunking Scheme

4. Number of Trunk Lines (at the time of service-in, five years and 15 years after service-in)

   Shall comprise of information indicating the number of direct trunks, tandem incoming trunks, tandem outgoing trunks, parent-satellite office trunks, toll trunks, etc. Referential traffic data are also required.

5. Long-term Plan of Conduit Lines

   Plan, if any, inclusive of long-term subscriber line prospects is required.

6. Great Bangkok City Planning

   Shall comprise of map information showing roads, bridges, etc., to be newly constructed or improved.

Plant Records

Maps of Bangkok

Provided that the correct data of the above required informations to be furnished by T.O.T. not later than end of May, 1972, otherwise, the design work will not be completed by November, 1972.

II. Engineering standards concerning the design of junction cable

Transmission Engineering Standard

As per separate sheet 1, annexed

Limit of DC Resistance

As per separate sheet 1, annexed

Transmission Loss, Gain and DC Resistance of Junction Equipment

As per separate sheet 2, annexed

The Electrical characteristics of Cable

As per separate sheet 3, 4 and 5 annexed

Condition of Loading Layout

As per separate sheet 6, annexed

The Electrical characteristics of loading coil, Building-out Condenser, Impedance Compensator and Low Frequency Impedance

Corrector, Terminating Repeating Coil, etc.

As per separate sheet 7, annexed

7. Design of Cable Placing Method

As per separate sheet 8, annexed

8. Rules for Determining Cable Gauge and Number of Pairs in Cable

As per separate sheet 9 and 10, annexed

9. Relations to Subscriber Cable Plans under 1972-1976 Project

10. Design to Prevent Inductive Interference

11. Rules and Numerical Values applicable to Economic Comparison

Note : For item 9, 10, 11 and other Minor problems which will be decided after further discussions between T.O.T. and Japanese experts.

The undersigned have fully examined the contents of this agreement to their mutual satisfaction and have therefore affixed their signatures on the 17th day of May 1972.

(Signed) Kanji Yasuda
Chief of Mission
O.T.C.A.

(Signed) S. Vanichseni
Chief of Outside Plant
Planning Centre T.O.T.

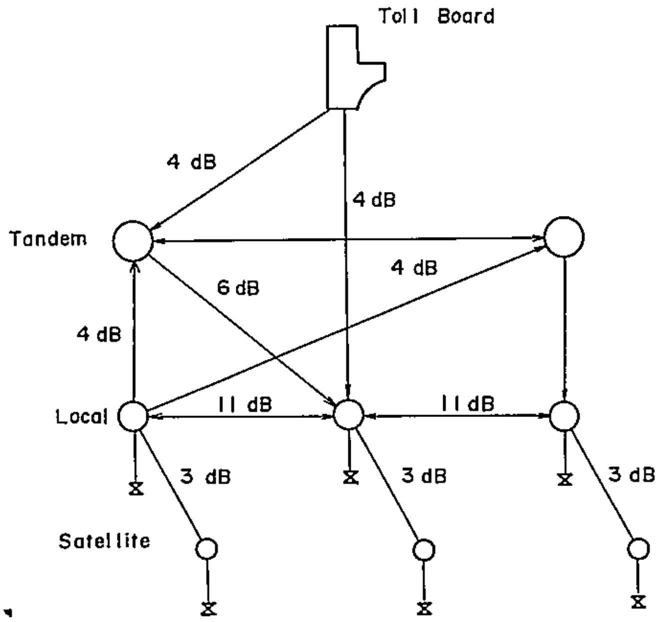
Annexed Sheet

Engineering Standards

Sheet 1

Transmission Engineering Standard and Limit of DC Resistance

1. Transmission Engineering Standard



Trunk	Value (dB)	Note
Direct trunk	11	
Trunk between parent office and satellite office	3	
Toll trunk	4	
Tandem incoming trunk	4	
Tandem outgoing trunk	6	at 1 KHz

2. Limit of DC Resistance

2,000 ohm at 30°C

Note : ? means subject to be agreed upon by both parties

Sheet 2

Transmission Loss, Gain and DC Resistance of Junction Equipment

1. H-88 Loading Coil

   DC Resistance .... 8.8 ohm or less at 30°c

2. V-88A Compensating Network

   DC Resistance .... 17.9 ohm or less at 30°c

3. V-44A Impedance Compensator

   DC Resistance .... 9.45 ohm or less at 30°c

4. VD-1000 Junction Coil

Frequency (KHz)	0.3	0.8	1.5	3.4
Transmission Loss (dB)	0.6 or less	0.3 or less	0.25 or less	0.25 or less

   DC Resistance .... 15.8 ohm or less at 30°c

5. S-2-222A Bothway Repeater

   Gain .... 6 dB, maximum, for each of central equipment and terminal equipment

The above electrical characteristics are minimum values, equipments of better quality can be accepted.

Sheet 3

Cable

An outline of cable to be used is as follows:

Conductor Diameter (mm)	0.9	0.65	0.5
Conductor Insulation	Paper-insulated or pulp-insulated		
Gathering	By pair layer twist		
Armoring	Stalpeth type		
Number of Pairs and Kinds	50-600 (9 kinds)	1,000-1,200 (10 kinds)	150-2,100 (10 kinds)
Outer Diameter of Cable (max., mm)	Approx. 79	Approx. 77	Approx. 82
DC Loop Resistance (ohm/km at 20°c)			
Nominal Value	53	106	170
Maximum Value	57	116	180
Mutual Electrostatic Capacity (uF/km)			
Mean Value	0.052	0.051	0.052
Maximum Value	0.056	0.056	0.056
Attenuation Constant (dB/km at 1 KHz, 20°c)	0.78	1.12	1.43

Note · Temperature shall be changed to 30°C

Sheet 4

Transmission Characteristics of Non-Loaded Cable

Conductor Diameter (mm)	Mutual Electro-Static Capacity (uF/km)	Attenuation Constant (dB/km at 1 KHz, 20°c)	DC Loop Resistance (ohm/km at 20°c)	Characteristic Impedance (ohm at 1 KHz)	Remark
0.9	0.039	0.70	53	460 ∠43°	
	0.045	0.75		430 ∠43°	
	0.050	0.79		410 ∠43°	
	0.056	0.84		390 ∠43°	
0.65	0.045	1.06	106	620 ∠44°	
	0.050	1.12		590 ∠44°	
	0.056	1.19		550 ∠44°	
	0.059	1.22		530 ∠44°	
0.5	0.050	1.42	170	740 ∠44°	
	0.053	1.46		700 ∠44°	
	0.056	1.50		690 ∠44°	

Note : Temperature shall be changed to 30°C.

Sheet 5

Transmission Characteristics of Loaded Cable (H-88 Loading System)

Conductor Diameter (mm)	Mutual Electro-Static Capacity (uF/km)	Cut-Off Frequency (Hz)	Characteristic Impedance (ohm at 1 KMz)	Attenuation Constant (dB/km at 1 KHz,20°c)	Remarks
0.9	0.039	4050	1120	0.22	
	0.045	3750	1035	0.24	
	0.050	3550	985	0.23	
	0.056	3350	925	0.26	
0.65	0.045	3750	1035	0.46	
	0.050	3550	985	0.49	
	0.056	3350	925	0.51	
	0.059	3275	905	0.52	
0.5	0.050	3550	985	0.70	
	0.053	3450	955	0.76	
	0.056	3350	925	0.81	

Note : Temperature shall be changed to 30°C

Sheet 6

Loading System

An outline of loading system to be adopted is as follows:

Name of System	H-88 Loading System
Induction of Loading Coil	88 mH
Standard Coil Spacing (S_o)	1,830 m (6,000 feet)
Standard Half-Coil Spacing (S_H)	915 m (3,000 feet)

Allowable Deviation of coil spacing

(1) Deviation between Standard Coil Spacing and Mean Coil Spacing (S)

$$\frac{S_o - S}{S_o} \times 100 \quad \text{within} \quad \pm 2\%$$

(2) Maximum Deviation between Mean Coil Spacing and Each Coil Spacing (S_i)

$$\frac{S - S_i}{S} \times 100 \quad \text{within} \quad \pm 2\%$$

(3) Deviation of Half-Coil Spacing

$$\frac{S_o}{4} < S_H < \frac{3}{4} S_o$$

Compensation of Coil Spacing

If the coil spacing cannot be established within the allowable deviation specified above, the necessary compensation is made by "B.O.C.", "COMP. NET." or "IMP. COMP."

Sheet 7

Loading Coil

Building-out Condenser (B. O. C.)

As per T. O. T. Specifications

Impedance Compensator

1. Compensating Network

2. Impedance Compensator

VD-1000 Repeating Coil

All the above are as per T. O. T. Specifications.

Sheet 8

Type of Cable Line

1. Aerial Cable or Underground Cable

   In areas where underground facilities for local telephone network are envisaged in the cable plan 15 years from now, underground cable is to be adopted as a matter of principle. In other areas, except in the undermentioned cases, aerial cable is to be adopted.

   (1) In case the conductor pairs of cable exceed the limits given below.

0.5 mm cable	600 pairs
0.65 mm cable	600 pairs
0.9 mm cable	300 pairs

   (2) In case the aerial cable lines to be installed exceed 3 lines.

   (3) In case the situation exists where the adoption of aerial cable is not advisable.

2. Conduit cable or Buried Cable

   (1) In areas where underground facilities for local telephone network are envisaged in the cable plan 15 years from now, conduit cable is to be adopted as a matter of principle.

   (2) In other areas than (1) above, buried cable is to be adopted as a matter of principle.

Sheet 9

Conductor Gauge and Conductor Pairs

1. Conductor Gauge

Conductor gauge of cable is to be determined from the viewpoint of economy, based on the transmission engineering standard and the limit of DC resistance in the section where the cable is installed and by considering the following items (1) and (2).

(1) In case the trunk lines with different transmission loss values coexist in the same one section, conductor gauge is determined in the way to suit the trunk line with the minimum transmission loss value.

(2) An integral study should be made as to the number of cable lines required and the type thereof, as well as the conductor gauge of the existing cable and the number of cable lines in use, plus the advisability of transfer from the existing to new cable lines, in order to determine the optimum conductor gauge.

(3) If necessary for adoption of negative impedance repeater and PCM system, an integral study should be made as to the number of cable lines required, signalling system, section length, and cable line configuration, in order to select the economically suitable conductor gauge.

2. Conductor Pairs

(1) Design Installation Period

As a rule, the design installation period is as follows. In case the said basic rule is impracticable, the workable design period is to be determined by considering the situation in individual cases.

Sheet 10

Aerial cable	To make design so as to meet the prospective demand 10 years ahead.
Conduit cable	To make design so as to meet the prospective demand 15 years ahead.
Direct buried cable	To make design so as to meet the prospective demand 15 years ahead.

(2) Conductor Pairs

The number of conductor pairs required to meet the design installation period mentioned in (1) above is to be determined by the higher rank method, that is, by adopting the standard pair number that rank immediately above the design pair number.