5. Circuit Calculation

Junction circuit calculaiton is carried out for the estimated traffic between exchanges, as is shown in PART II of this report.
Alternative routing is applied in this calculation, based on the formula in VI of the CCITT Manual "Local Network Planning 1979", thus attaining the best balance between the cost of switching and of transmission systems.

5-1 Traffic Routing

When discussing traffic routing, it is customary to distinguish among three separate routing methods: namely, direct, tandem and alternative routings.

1) With direct routing, the entire traffic is carried directly from one local exchange to another.

2) In the case of tandem routing, the entire traffic between two exchanges is conducted via one or more tandem exchanges.

3) Finally, alternative routing implies that the traffic is offered in the first place to direct lines and secondly, if all circuits in the direct route are engaged, to tandem circuits via one or more tandem exchanges.

All three routing methods mentioned above are alternatives to choose from, because the inherent economy varies from case to case. This means that the network structure must be planned in such a way that it will be possible to employ the method of traffic routing which will prove to be the most economical in each case.
Traffic routings by types of traffic are categorized in the Jakarta Telephone Network as follows:

5-1-1 Local Traffic

The following routing rules are assumed for local traffic:

1) Alternative routing with single tandem exchange is applied to the originating traffic from PRX type and proposed exchanges.

2) Area originating tandem network is assumed for the connection within the same local tandem area.

3) Area terminating tandem network is assumed for the connection to other local tandem areas.

4) Alternative routing is not applied to the originating traffic from an EMD exchange; therefore, direct route to a local or a tandem exchange is established from an EMD type exchange.

Homing arrangement in the Jakarta Telephone Network is shown in Figure IV-8. Routing rules are shown in Figure IV-9.

5-1-2 SLDD Traffic

SLDD traffic from/to a local exchange is directly carried from/to an SLDD exchange which is located at the Gambir 1 Exchange. (refer to Figure IV-10.) The type of switching system used for SLDD exchange is Metaconta 10C.

5-1-3 Suburban Traffic

Suburban traffic from a local exchange is directly carried to a suburban tandem exchange which is located in the Gambir 1 Exchange. On the other hand, suburban traffic to local exchanges is carried via corresponding area tandem exchange from a suburban tandem exchange. (refer to Figure IV-11.) The switching system is of the Janus type which is the 4-wire cross-bar common control system.

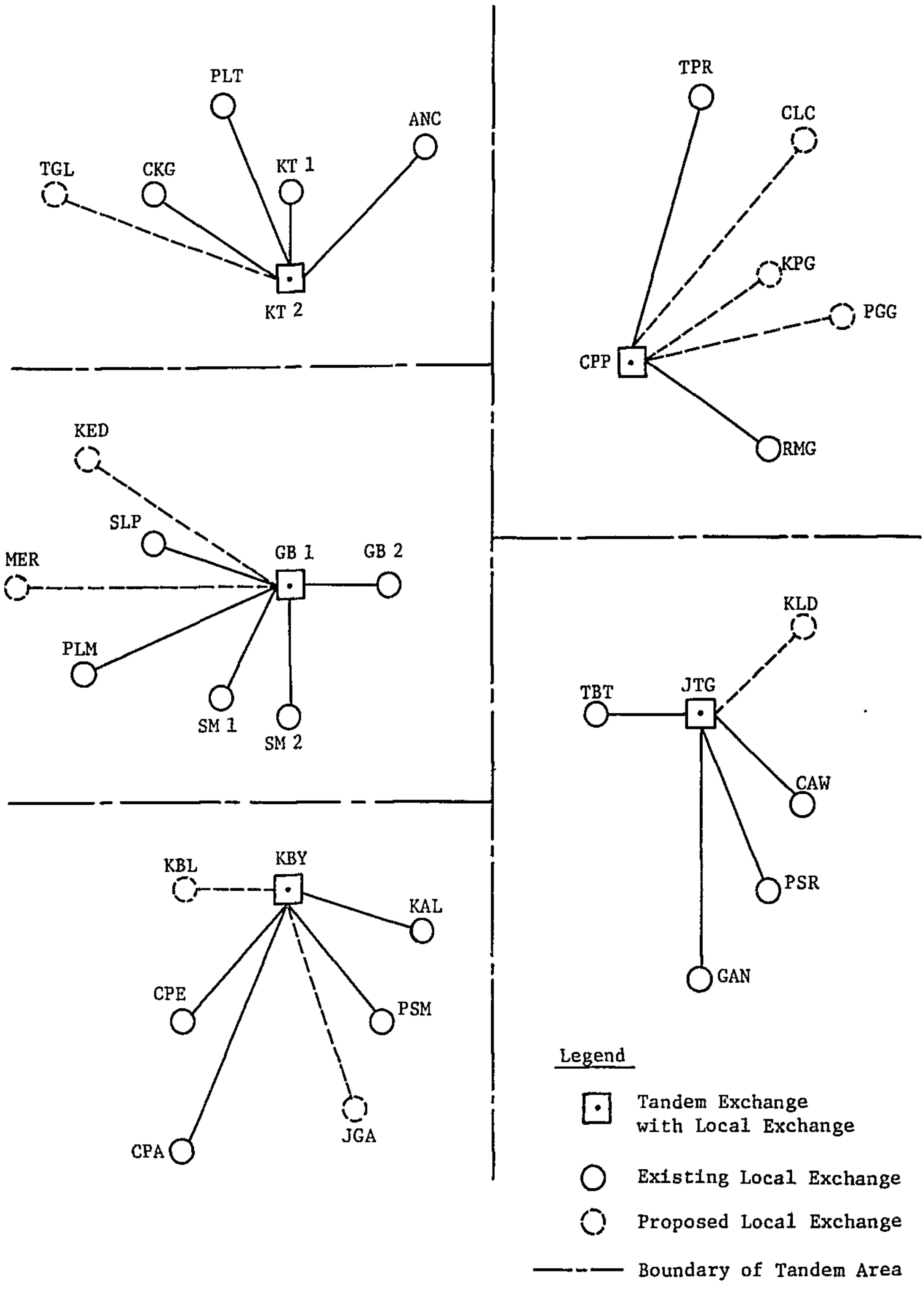


Figure IV-8 Homing Arrangement of Jakarta Telephone Network

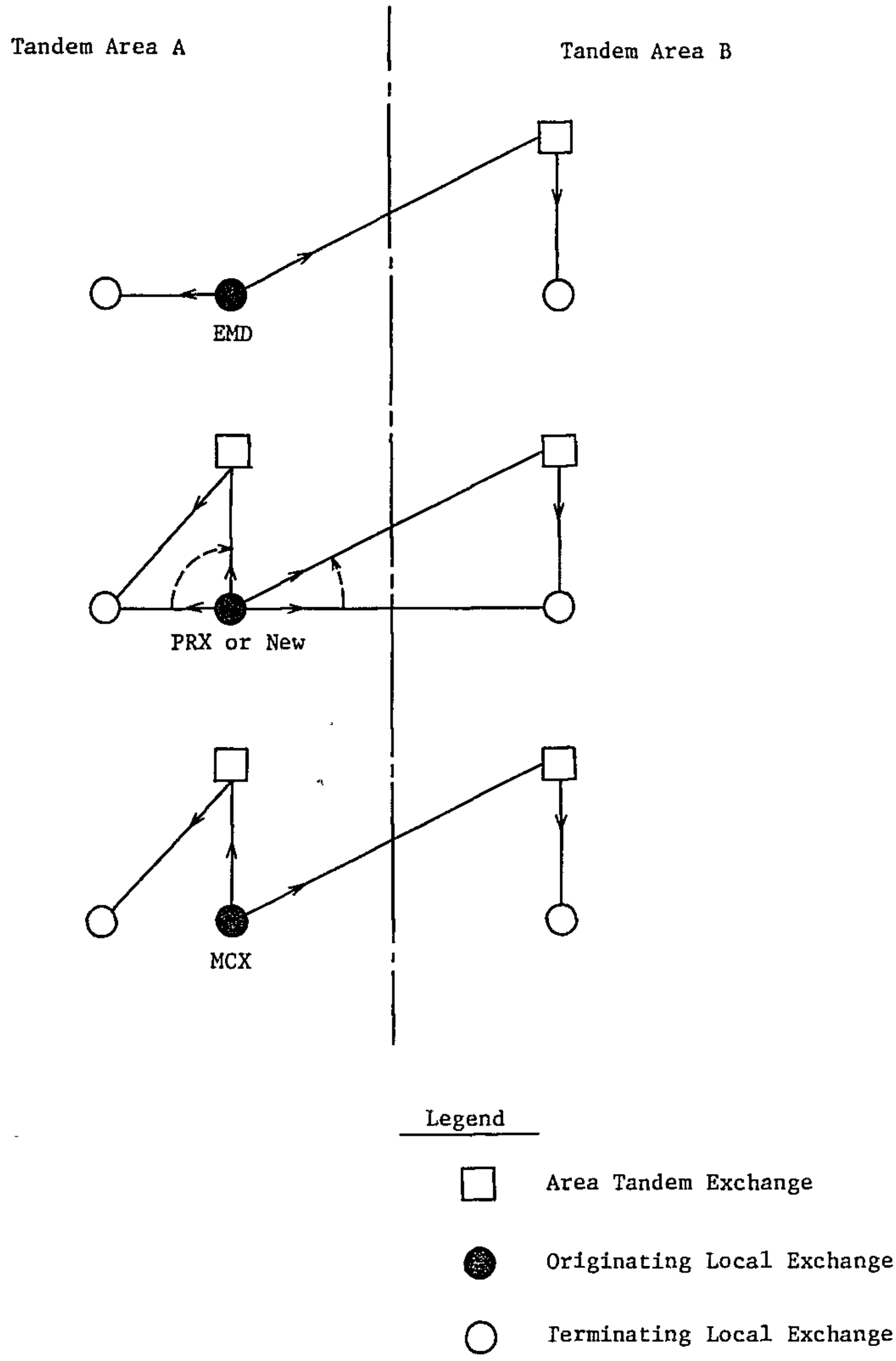


Figure IV-9 Routing for Local Traffic

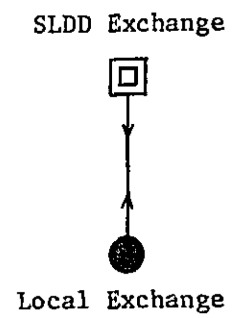


Figure IV-10 Routing for SLDD Traffic

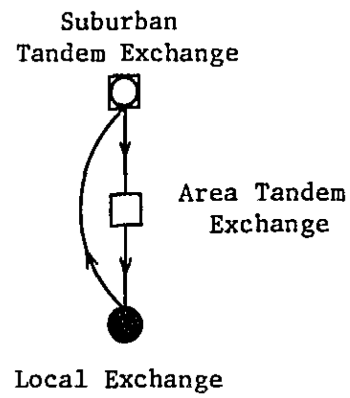


Figure IV-11 Routing for Suburban Traffic

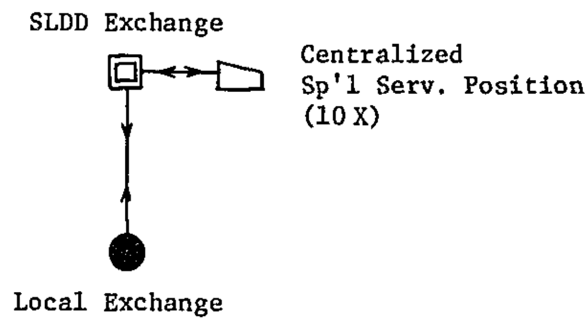


Figure IV-12 Routing for Special Service Traffic (10 X)

5-1-4 Special Service Traffic

There are two types of special service traffic: 10x and 11x traffic. Each uses its own routing.

(1) 10x traffic

The 10x traffic is an operator assisted traffic which is directly carried to a special service exchange in the Gambir 1 Exchange from each local exchange. (Figure IV-12.) This special service exchange is the combined type with an SLDD exchange.

(2) 11x traffic

The 11x traffic is directly carried to the 8 distributed special service centers. Routing from each local exchange is shown in Figure IV-13.

5-2 Calculation Formula

5-2-1 O'Dell's Experimental Formula

For the traffic originated from EMD switching system, the O'Dell's experimental formula is used to calculate the number of circuits required. The formula is as follows:

$$Aij - Ao = (0.47\, Ao/\underline{no} + 0.53\, E^{1/\underline{no}})(nij - no)$$

Where:

Aij = the offered traffic in Erlang from exchange i to exchange j

Ao = the volume of traffic in Erlang which can be offered to the circuits with the availability of no for the given grade of service E

no = the availability of group selector of EMD

E = the grade of service

Then, the number of circuits (nij) can be obtained by the following formula:

$$nij = \frac{Aij - Ao}{0.47Ao/\underline{no} + 0.53E^{1/\underline{no}}} + no$$

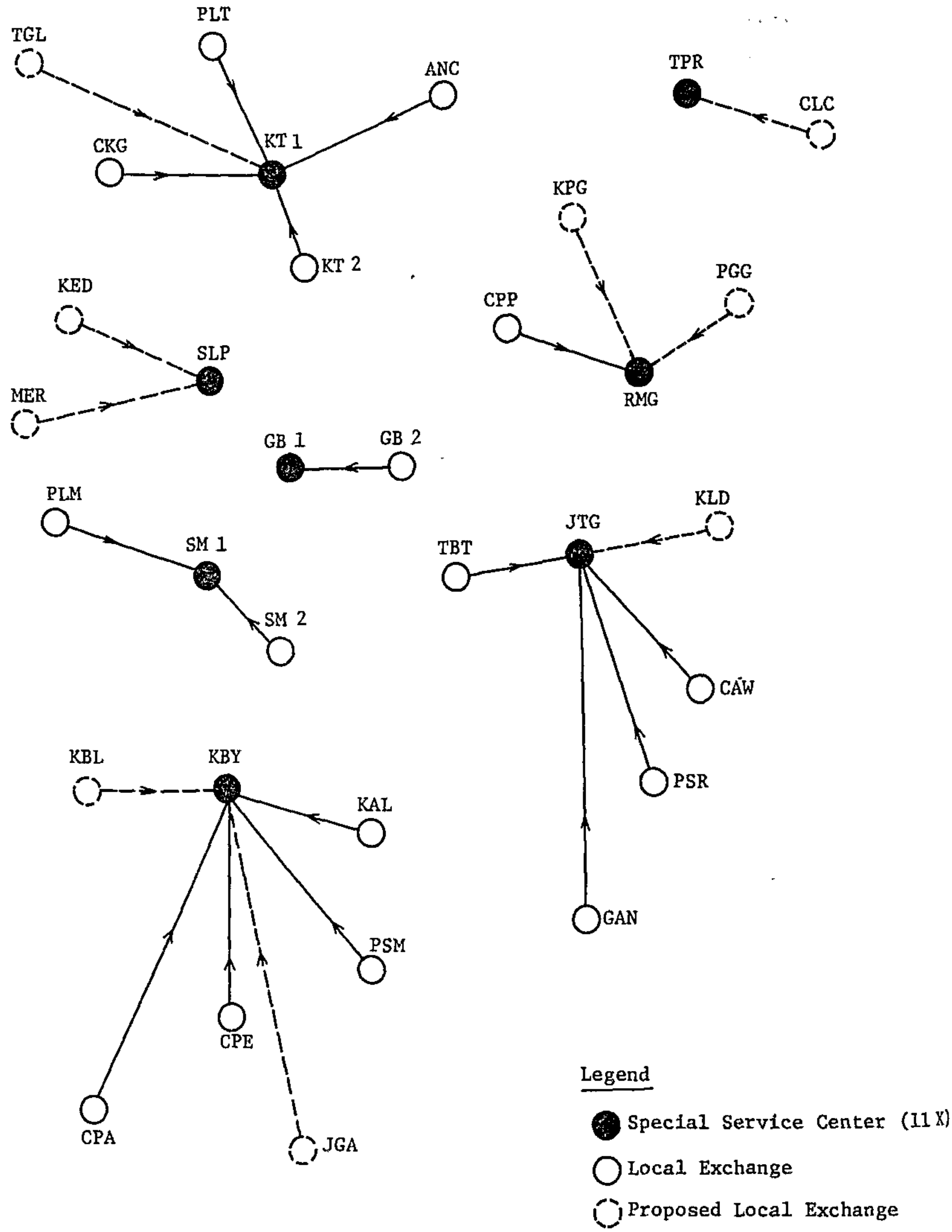
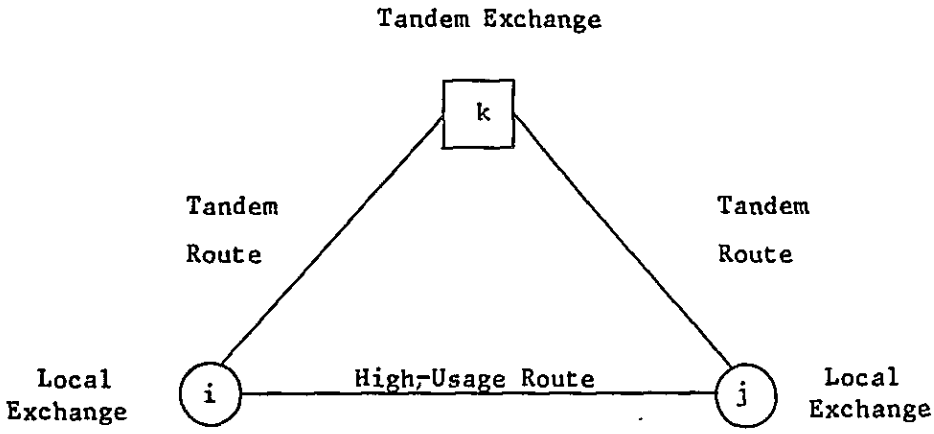


Figure IV-13 Routing for Special Service Traffic (11X)

5-2-2 Alternative Routing

It is a well-known fact that substantial economy in operation can be achieved in local networks by use of optimum alternative routing. A simple example of alternative routing is shown below.



Calls from exchange i to exchange j are connected over the direct route i - j, and when all the circuits in that route are occupied, overflow traffic is offered to an alternative route i - k - j via tandem exchange at k. The direct route is called the high-usage route as it carries most of the traffic, and the alternative route is called the tandem route. The economy of alternative routing is that routing the traffic between two exchanges partly over the high-usage route and partly over the tandem route can be less expensive than routing all the traffic over the high-usage route.

For the traffic originated from PRX, MCX and proposed switching systems, the alternative routing is used to calculate the number of circuits. The calculation formulas are described below.

(1) High-Usage Circuit

The number of high-usage circuits nij for all routes i - j between exchanges can be known by the following formula:

$$Aij[E(nij,Aij) - E(nij+1,Aij)] = \varepsilon ij[1- 0.3(1-\varepsilon ij^2)]$$

where:

E = grade of service

Aij = offered traffic in Erlang from exchange i to exchange j

εij = cost ratio

Cost ratio is expressed as follows:

$$\varepsilon ij = \frac{Bij}{Bik + Bkj}$$

where:

Bij, Bik, Bkj = Incremental cost for junctions between exchanges (i,j) and between exchanges and tandem stage (k)

(2) Tandem Circuit

Mean value Pij and variance Vij of traffic rejected from each high-usage route are expressed as follows:

$$Pij = Aij \times E(nij, Aij)$$
$$Vij = Pij[1-Pij + \frac{Aij}{nij+1+Pij-Aij}]$$

Then, mean value M and variance V of traffic offerred to the tandem route are expressed as follows:

$$Mit = \sum_j Pij, \quad Vit = \sum_j Vij$$

$$Mtj = \sum_i Pij, \quad Vtj = \sum_i Vij$$

Then, equivalent traffic A* and equivalent number of junctions n* on the tandem routes are expressed as follows:

$$A^* = V + 3 \frac{V}{M} (\frac{V}{M} - 1)$$

$$n^* = \frac{A^*}{q} - M - 1$$

where: $q = 1 - \frac{1}{M + \frac{V}{M}}$

Therefore, the number of tandem circuits m is expressed as follows:

$$A^* \times E(n^* + m, A^*) = Eo \times M$$

where: Eo = grade of service on tandem route

5-2-3 Grade of Service

The grade of service is an important factor for the calculation of the number of circuits. This is determined by the probability of failing to establish a connection. The grade of service used in Indonesia for each category of call is as follows:

	Type of Call	Grade of Service
a)	Local call	0.005
b)	SLDD call	0.01
c)	Suburban call	0.01
d)	Special service call (10X)	0.01
e)	Special service call (11X)	0.005

5-3 Calculation Result

The number of junction circuits is calculated for the years 1983, 1987 and 1993, based on the routing rules described in the previous Paragraph 5-1. The calculation procedure is shown in Figure IV-14. Calculation is carried out by use of computer. A computer aided design enables a more complex model to be considered without introducing those doubtful simplifications that may be unavoidable in a manual procedure. Calculaiton results are shown in Tables IV-9 to IV-11.

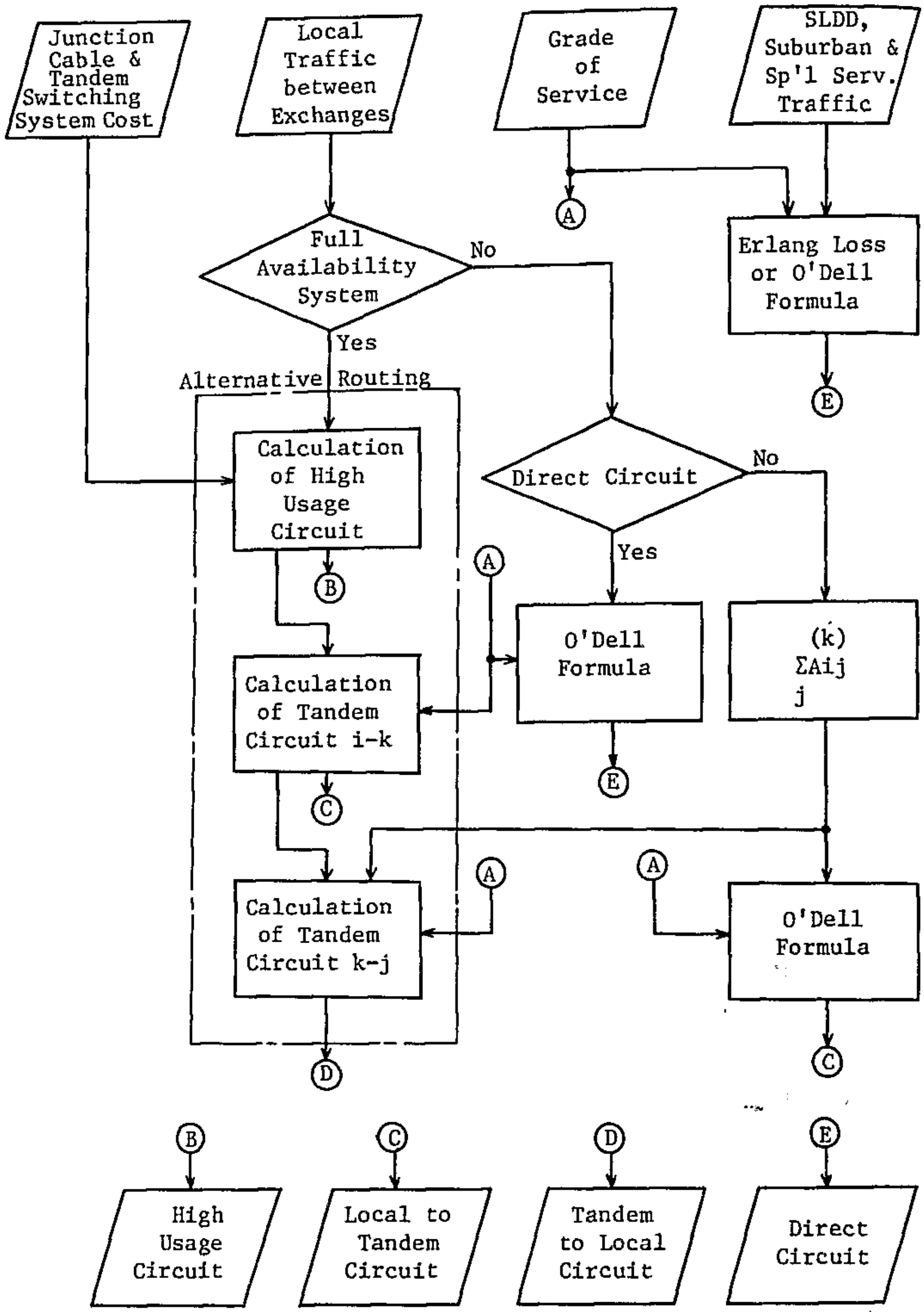


Figure IV-14 Procedure of Circuit Calculation

Table IV-9 Number of Circuits as of 1983

FROM \ TO	KT1	KT2 A	KT2 B	KT2 C	KT2 D	CKG	PLT A	PLT B	ANC A	ANC B	TGL	GB1 A	GB1 B	GB1 C	GB1 D	GB2 A	GB2 B	GB2 C	GB2 D	SM1 A	SM1 B	SM2 A	SM2 B	SLP A	SLP B	PLM A	PLM B	KED	MER	CPP A	CPP B	RMG A	RMG B	TPR A	TPR B
KT1	163	55	55	55	55	15	31	38	29	16	7																								
KT2 A	33	21	21	21	21		6	7	6			22	21	11	11	8	8	24	13	7		5		8	9					8	9	5		6	
KT2 B	33	21	21	21	21		6	7	6			22	21	11	11	8	8	24	13	7		5		8	9					8	9	5		6	
KT2 C	33	21	21	21	21		6	7	6			22	21	11	11	8	8	24	13	7		5		8	9					8	9	5		6	
KT2 D	33	21	21	21	21		6	7	6			22	21	11	11	8	8	24	12	7		5		8	9					8	9	5		6	
CKG	12					15						8	8					9	5	5				6	7										
PLT A	24	8	8	8	8		13	15				11	11	5	5			12	6					5	5										
PLT B	20	10	10	10	10		15	16	5			14	13	7	7			15	8					6	7						5			5	
ANC A	19	7	7	7	7				12	8		11	10	5	5			13	7												5			9	6
ANC B	10								8	6		5	5					6																5	
TGL						5					5																								
GB1 A												90	87	44	44	34	34	105	57																
GB1 B												95	92	46	46	36	36	111	65																
GB1 C	20	10	10	10	10			5				32	32	19	19	11	11	32	18	10	5	8	5	7	8					8	9	5			
GB1 D	20	10	10	10	10			5				32	32	19	19	11	11	32	18	10	5	8	5	7	8					8	9	5			
GB2 A	14	7	7	7	7							22	21	11	11	19	19	46	28	9	5	8	5		5					7	8	6			
GB2 B	14	7	7	7	7							22	21	11	11	19	19	46	28	9	5	8	5		5					7	8	6			
GB2 C	43	21	21	21	21		8	10	10	5		62	60	32	22	46	46	125	72	26	15	24	16	14	17	9				22	25	20	8	11	6
GB2 D	26	12	12	12	12			5	5			35	34	18	18	28	29	72	43	15	8	13	9	8	9	5				12	14	10		5	
SM1 A																				28	16	23	16	12	14	10	7	6	4						
SM1 B	8											12	11	6	6	5	5	16	9	14	10	10	7		5										
SM2 A	12	5	5	5	5							17	17	9	9	9	9	27	15	18	11	21	15	6	7	6				5	6				
SM2 B	8											12	11	6	6	6	6	18	10	13	8	15	12		5										
SLP A																				13	8	11	8	14	16	8	6	6	4						
SLP B	19	9	9	9	9			5				18	17	9	9	6	6	20	11	9	5	7	5	15	17						5				
PLM A	7											9	9					11	6	8	5	7	5			9	6								
PLM B																		6								6	5								
KED	5											5						5							5			6							
MER																													3						
CPP A	15	8	8	8	8							17	17	9	9	8	8	24	13	6		5								16	18	6		5	
CPP B	17	9	9	9	9							20	19	10	10	9	9	28	16	7		6			5					19	20	10		6	
RMG A	12	6	6	6	6							15	16	7	7	8	8	26	14	6		6								10	11	23	13	5	
RMG B	5											6	6					11	6												5	13	8		
TPR A	23	8	8	8	8			5	11	7		14	14	7	7	6	6	20	10											9	10	7		29	20
TPR B	14	5	5	5	5				8			8	8					12	6											5	6			20	14
RPG	6											6	5					8													5				
CLC	9								5			6	6					9																12	8
POG	8											3	8					15	8											6	7	8			
KBY A																																			
KBY B	12	5	5	5	5							16	16	8	8	8	8	24	13	16	10	15	10	6	7	7					5				
KBY C	12	5	5	5	5							16	16	8	8	8	8	24	13	16	10	15	10	6	7	7					5				
CPA																																			
CPE	8											11	10	5	5	5	5	18	9	11	6	11	7												
PSM																																			
KAL	9											13	12	6	6	7	7	24	12	12	7	12	8								5	5			
JGA																																			
JTG A	11	5	5	5	5							16	16	8	8	9	9	29	16	8		7								8	9	9			
JTG B	12	6	6	6	6							17	17	9	9	10	10	32	17	8		7	5							8	9	10			
CAW A	6											10	10			5	5	19	10	6		5										5			
CAW B												7	7					14	7																
PSR																		7																	
TBT	10	5	5	5	5							15	15	7	7	9	9	29	16	8		7	5							6	7	6			
GAN																		5																	
KLD																		6																	
SLDD	88	40	40	40	40	25	27	33	27	16	12	75	73	40	40	40	40	110	63	42	25	40	28	30	35	23	14	15	8	35	39	40	20	40	27
SUB TDM																																			
OPERATOR	27	14	14	14	14	10	10	12	10	7	6	23	22	14	14	14	14	32	20	15	10	14	31	11	12	9	6	7	4	12	14	16	8	14	10
KTT A,B	252	170	170	170	170	112	140	148	148	104	50																								
GBT A,B												220	222	162	162	170	170	298	218	194	144	162	154	170	180	146	86	84	44						
CPT																														170	167	178	124	156	175
KBT																																			
JTT																																			
TOTAL	1140	531	531	531	531	182	268	327	302	189	80	1140	1108	591	591	578	576	1647	945	572	322	514	351	255	422	245	140	134	67	404	472	408	191	346	218

FROM \ TO	RPG	CLC	POG	KBY A	KBY B	KBY C	CPA	CPE	PSM	KAL	JGA	JTG A	JTG B	CAW A	CAW B	PSR	TBT	GAN	KLD	GBDD	SLDD	SUB TDM	10X	11X	KTT A,B	GBT A,B	CPT	KBT	JTT	TOTAL
KT1																					107	19	20	11	—	459	125	78	76	1412
KT2 A				6	5	5						5	5				5				40	10	11	7	18	37	26	19	20	530
KT2 B				6	5	5						5	5				5				40	10	11	7	16	37	26	19	20	530
KT2 C				6	5	5						5	5				5				40	10	11	7	18	37	26	19	20	530
KT2 D				6	5	5						5	5				5				40	10	11	7	18	37	26	19	20	530
CKG																					25	7	7	5	48	53	23	28	18	290
PLT A																					27	8	8	5	22	47	29	23	20	333
PLT B																					33	9	9	6	21	53	28	27	28	404
ANC A																					27	6	8	5	24	51	27	21	23	332
ANC B																					16	5	4	4	28	39	21	13	16	191
TGL																					12	4	4	3	25	34	12	12	10	126
GB1 A																				10	112	16	20	10	238	155	130	104	103	1395
GB1 B																				11	93	17	28	10	190	124	104	84	83	1263
GB1 C				9	7	7						7	7				6			7	40	10	11	7	25	23	27	19	21	537
GB1 D				9	7	7						7	7				6			7	40	10	11	7	25	23	27	18	21	537
GB2 A				8	6	6				5		6	8				8				40	10	11	7	27	30	30	20	26	522
GB2 B				8	6	6				5		6	8				8				40	10	11	7	27	30	30	20	26	522
GB2 C	5		9	26	19	19		9		16		24	26	12	9		26			7	110	22	24	13	36	41	38	31	39	1611
GB2 D			5	14	10	10		5		8		13	14	6			14				63	14	15	9	30	33	36	24	32	821
SM1 A																					47	10	11	7	71	161	44	68	53	606
SM1 B				10	7	7															25	7	7	5	30	28	24	17	28	319
SM2 A				16	12	12		5		8		6	7				8				40	10	11	7	29	31	30	19	29	519
SM2 B				11	8	8				5							5				28	8	6	5	32	30	27	17	29	352
SLP A																					32	8	9	6	75	103	31	32	26	416
SLP B				8	6	6															35	9	9	6	29	34	31	20	29	441
PLM A				7	6	6															23	7	7	5	32	43	21	18	22	279
PLM B																					14	5	5	4	22	44	13	20	16	158
KED																					15	5	5	4	27	42	14	16	13	169
MER																					8	3	3	3	12	23	7	11	8	81
CPP A				5								7	7				6				35	9	9	8	27	43	26	25	21	436
CPP B			5	8								8	9				7				39	10	10	7	30	44	24	28	23	496
RMG A			7	5						8		10	11				7				40	10	11	7	31	56	26	28	33	495
RMG B																					20	6	6	5	26	45	22	19	28	237
TPR A		10										5	5								40	10	11	7	30	61	28	28	28	500
TPR B		7																			27	7	8	5	27	55	24	19	24	324
RPG	7																				19	6	6	4	29	44	29	15	20	209
CLC		13																			24	7	7	5	35	54	33	17	24	274
POG			14									6	6								27	8	8	5	35	58	30	24	26	318
KBY A				48	37	37	5	19	7	21	4										58	12	13	8	83	279	48	—	64	734
KBY B				28	22	22		8		9		6	7				7				40	10	11	7	29	34	31	13	27	520
KBY C				28	22	22		8		9		6	7				7				40	10	11	7	29	34	31	13	27	520
CPA				9	8	8	7	9	4	7	4										13	5	5	4	16	43	11	—	16	169
CPE				16	12	12		24		9		5	5				5				36	9	10	6	38	50	30	22	34	434
PSM				8	7	7	3	6	5	8	3										13	5	5	4	15	44	12	—	15	166
KAL				14	10	10		7	5	25		10	11	9	7		10				40	10	11	7	35	50	33	17	26	496
JGA											3										8	3	4	3	9	22	8	14	13	87
JTG A				8	6	6				10		22	23	8	6		13				40	10	11	7	29	53	34	20	17	506
JTG B				9	7	7				11		23	24	9	6		14				43	10	11	7	28	51	36	20	17	537
CAW A				7	5	5				12		10	10	19	15	6	9				34	9	9	6	35	61	34	25	17	409
CAW B				5						9		7	8	15	13	5	6				27	7	8	5	31	64	30	27	16	318
PSR										6				7	6	9					19	6	6	4	21	53	19	26	23	212
TBT				9	6	6				10		12	13	6	5		21				40	10	11	7	29	59	31	23	18	492
GAN														5		5		8			16	5	6	4	18	46	17	26	21	164
KLD												5	5						5		14	5	5	4	18	39	21	15	15	157
SLDD	19	24	27	51	40	40	13	36	13	40	8	40	43	34	27	19	40	16	14	12	—	—	—	—	—	—	—	—	—	1886
SUB TDM																					—	—	—	—	55	98	39	36	34	262
OPERATOR	8	9	10	17	14	14	6	13	6	14	4	14	15	12	10	8	14	7	6	6	—	—	—	—	—	—	—	—	—	669
KTT A,B																					—	—	—	—	—	—	—	—	—	1634
GBT A,B																				60	—	—	—	—	—	—	—	—	—	3110
CPT	109	93	139																		—	—	—	—	—	—	—	—	—	1261
KBT				182	155	155	36	143	59	158	28										—	—	—	—	—	—	—	—	—	916
JTT												162	173	161	133	78	190	60	78		—	—	—	—	—	—	—	—	—	1035
TOTAL	148	156	216	605	465	465	70	294	99	410	54	451	478	303	237	130	457	91	103	140	1964	482	517	330	1969	3422	1740	1341	1498	35575

Table IV-10 Number of Circuits as of 1987

FROM \ TO	KT 1	KT 2 A	KT 2 B	KT 2 C	KT 2 D	KT 2 E	CKG A	CKG B	PLT A	PLT B	ANC A	ANC B	TGL	GB 1 A	GB 1 B	GB 1 C	GB 1 D	GB 2 A	GB 2 B	GB 2 C	GB 2 D	SM 1 A	SM 1 B
KT 1	101	32	32	32	32	41	5	5	16	33	16	20		41	40	21	21	15	15	47	41	15	16
KT 2 A	29	17	17	17	17	21			5	9	5	6		17	16	9	9	6	6	18	16	6	7
KT 2 B	29	17	17	17	17	21			5	9	5	6		17	16	9	9	6	6	18	16	6	7
KT 2 C	26	17	17	17	17	21			5	5	5	6		17	16	9	9	6	6	16	16	6	7
KT 2 D	29	17	17	17	17	21			5	9	5	6		17	16	9	9	6	6	18	16	6	7
KT 2 E	38	21	21	21	21	26			6	12	6	8		22	21	11	11	8	8	26	21	7	9
CKG A	9						11	11					7	5	5					6	5		
CKG B	9						11	11					7	5	5					6	5		
PLT A	21	6	6	6	6	8			11	17				8	8					9	8		
PLT B	39	12	12	12	12	15			17	28	6	7		16	15	6	8	5	5	16	15	6	7
ANC A	17	5	5	5	5	7				5	10	12		8	8					10	8		
ANC B	20	7	7	7	7	9				6	12	13		10	9	5	5			12	10		
TGL	10						7	7					12							5			
GB 1 A														69	66	34	34	27	27	81	70		
GB 1 B														74	71	35	36	28	28	87	76		
GB 1 C	18	8	8	8	8	10				6				26	26	16	16	9	9	25	22	8	10
GB 1 D	18	8	8	8	8	10				6				26	26	16	16	9	9	25	22	8	10
GB 2 A	13	5	5	5	5	7								17	16	9	9	16	16	37	33	8	9
GB 2 B	13	5	5	5	5	7								17	16	9	9	16	16	37	33	8	9
GB 2 C	29	16	16	16	16	22			6	12	8	10		46	46	25	25	37	37	96	86	23	28
GB 2 D	34	14	14	14	14	19			5	11	7	8		42	41	22	22	33	33	85	76	20	24
SM 1 A																						25	29
SM 1 B	16	6	6	6	6	9				5				20	20	11	11	10	10	30	26	23	27
SM 2 A	11					5								13	13	7	7	6	6	20	18	15	18
SM 2 B	16	6	6	6	6	8				5				19	19	10	10	10	10	30	27	23	25
SLP A																						10	11
SLP B	35	14	14	14	14	18	5	5	6	13	5	6		25	28	14	14	10	10	32	28	15	18
PLM A	6													7	6					8	7	7	8
PLM B	6													7	6					8	7	7	8
KEO	9													7	7					8	7		5
MER																							
CPP A	14	6	6	6	6	9								14	14	7	7	7	7	20	18	5	6
CPP B	25	11	11	11	11	15				7	5	7		25	24	13	13	12	12	36	32	9	11
RMG A	10					6								11	11	5	5	6	6	15	17		5
RMG B	9					5								9	9			5	5	16	14		
TPR A	19	6	6	6	6	8				6	9	11		10	10	5	5			14	12		
TPR B	25	8	8	8	8	11				8	11	12		13	13	6	6	5	5	18	15		5
KPG	14	5	5	5	5	7								11	11	5	5	5	5	17	14		
CLC	14					6					6	7		8	8					12	10		
PGG	13	5	5	5	5	7								12	12	6	6	6	6	21	18	5	6
KBY A																							
KBY B	11					5								15	12	6	6	6	6	18	16	14	16
KBY C	11					5								13	12	6	6	6	6	18	16	14	16
CPA																							
CPE	7													8	7					13	11	9	11
PSM																							
KAL A	7													9	9			5	5	17	15	10	11
KAL B																				8	7	5	6
JGA																							
JTG A	9					5								12	12	6	6	7	7	22	19	6	7
JTG B	17	7	7	7	7	10				5				22	21	11	11	13	13	39	34	11	14
CAW A	5													7	7					14	12		5
CAW B	11					6								14	14	7	7	6	6	28	24	9	11
PSR																				9	7		
TBT A	9					5								12	11	5	5	6	6	22	19	7	8
TBT B														5	5					9	8		
GAN																				8	7		
KLD	5													6	6					11	10		
SLDD	121	47	47	47	47	61	27	27	32	56	32	38	27	89	85	47	47	47	47	131	115	53	63
SUB TOM																							
OPERATOR	31	14	14	14	14	17	9	9	11	16	11	12	9	24	23	14	14	14	14	33	29	16	18
KTT A,B	260	180	180	180	180	192	102	102	138	196	140	166	102										
GBT A,B														186	160	150	150	160	160	248	232	198	210
CPT																							
KBT																							
JTT																							
TOTAL	1261	522	522	522	522	645	177	177	270	489	304	362	164	1137	1098	589	589	581	581	1642	1447	621	730

FROM \ TO	SM 2 A	SM 2 B	SLP A	SLP B	PLM A	PLM B	KEO	MER	CPP A	CPP B	RMG A	RMG B	TPR A	TPR B	KPG	CLC	PGG	KBY A	KBY B	KBY C	CPA	CPE	PSM	KAL A	KAL B	JGA
KT 1	11	17	14	38	6	6	8		16	26	10	6	15	18	12	6	10	13	10	10				6		
KT 2 A		6	6	14					7	12				5				5								
KT 2 B		6	6	14					7	12				5				5								
KT 2 C		6	6	14					7	11				5				5								
KT 2 D		6	6	14					7	12				5				5								
KT 2 E	5	8	7	19					9	15	5		6	7	6		5	6	5	5						
CKG A				10																						
CKG B				10																						
PLT A				9						5																
PLT B		6	6	17					5	10			6	7				5								
ANC A				6						6			7	8												
ANC B				8						8			9	10		5										
TGL				9																						
GB 1 A																										
GB 1 B																										
GB 1 C	6	9	5	13					7	12								7	5	5						
GB 1 D	6	9	5	13					7	12								7	5	5						
GB 2 A	6	9		9					6	11								6	5	5						
GB 2 B	6	9		9					6	11								4	5	5						
GB 2 C	18	27	10	26	7	7	5		19	33	15	12	8	11	12	5	13	20	15	15		7		12	6	
GB 2 D	16	24	8	24	6	6			16	29	13	11	7	9	10		11	17	13	13		6		10	5	
SM 1 A	15	28	10	23	9	9	8	6																		
SM 1 B	17	26	7	17	7	7			6	11								17	13	13		5		8		
SM 2 A	17	23		11	5	5				7								12	9	9				6		
SM 2 B	23	31	6	16	7	7			6	11	5							16	14	14		6		9		
SLP A	9	11	10	23	7	7	7	5																		
SLP B	11	18	19	44	7	7	10		8	15	5			6	5		5	13	10	10				5		
PLM A	5	8		7	8	8												6								
PLM B	5	8		7	8	8												6								
KEO		5	5	12			10																			
MER								5																		
CPP A		6		8					15	23	7	6		6	7		7									
CPP B	7	11	6	14					22	36	12	10	8	10	12	5	12	8	6	6				6		
RMG A		6		5					8	14	19	16		5	6		9									
RMG B									7	12	16	15			5		8									
TPR A				7					7	12	5		23	27	8	12	6									
TPR B		5		9					9	16	7	6	27	33	11	15	8									
KPG				6					8	15	7	6	7	9	20	5	8									
CLC				5					5	10	5		15	19	8	24	8									
PGG		6		6					9	16	11	10	6	8	9	5	28									
KBY A																		37	29	28	6	15	9	17	10	6
KBY B	12	17		11	5	5				7								23	16	16		6		7		
KBY C	12	17		11	5	5				7								23	16	16		6		7		
CPA																					12	12	7	9	6	7
CPE	8	12		7														12	9	9	5	20		7		
PSM																					5	10	8	10	7	5
KAL A	9	13		7						6								10	8	8		5	6	13	12	
KAL B	5	7																5						12	8	
JGA																								5		7
JTG A	5	8		6					6	11	7	5					6	8						8		
JTG B	9	15		12					11	20	13	10	5	6	8		11	11	8	8				13	7	
CAW A		6								6								5						9		
CAW B	6	13		6					6	12	7	6					7	10	7	7		5	5	16	9	
PSR																								7		
TBT A	5	9		6					5	9								6	5	5				7		
TBT B																										
GAN																								6		
KLD										6							5									
SLDD	47	67	32	80	27	27	29	19	44	74	47	40	47	58	47	44	54	60	47	47	24	42	24	47	27	20
SUB TOM																										
OPERATOR	14	19	11	22	9	9	10	7	14	20	16	13	14	17	14	14	16	17	16	14	9	13	9	14	9	7
KTT A,B																										
GBT A,B	192	218	148	210	134	134	148	102																		
CPT									150	197	187	178	151	161	181	136	183									
KBT																		187	173	173	60	146	105	149	120	64
JTT																										
TOTAL	513	753	332	878	257	257	235	144	466	801	477	351	361	456	281	278	420	599	450	450	121	304	173	431	226	116

FROM \ TO	JTG A	JTG B	CAW A	CAW B	PSR	TBT A	TBT B	GAN	KLD	GBDID	SLDD	SUB TOM	10 X	11 X	KTT A,B	GBT A,B	CPT	KBT	JTT	TOTAL
KT 1	10	18		9		10				6	121	21	23	13	25	49	30	33	41	1314
KT 2 A		7									47	10	11	7	17	36	35	25	29	532
KT 2 B		7									47	10	11	7	17	36	35	25	29	532
KT 2 C		7									47	10	11	7	17	36	35	25	29	532
KT 2 D		7									47	10	11	7	17	36	35	25	29	532
KT 2 E	5	8				5					61	12	13	8	21	41	26	24	30	687
CKG A											27	7	7	5	40	52	23	22	19	271
CKG B											27	7	7	5	40	52	23	22	19	271
PLT A											32	8	8	5	25	51	30	20	32	331
PLT B		6									56	12	12	8	29	54	36	29	32	599
ANC A											32	8	8	5	22	52	31	18	25	334
ANC B											38	9	9	6	23	55	33	21	30	403
TGL											27	7	7	5	46	63	25	20	14	269
GB 1 A										10	136	19	20	10	241	186	151	91	120	1292
GB 1 B										11	115	18	22	11	196	151	124	75	98	1257
GB 1 C	5	9				5				7	47	10	11	7	28	25	36	21	27	536
GB 1 D	5	9				5				7	47	10	11	7	26	25	36	21	27	538
GB 2 A	6	11		5		6					47	10	11	7	31	30	38	24	28	521
GB 2 B	6	11		5		6					47	10	11	7	31	30	38	24	28	531
GB 2 C	18	33	9	19		19	8		8	7	131	23	24	13	35	29	37	33	43	1421
GB 2 D	16	29	8	16		17	7		7	7	115	21	22	12	35	40	38	31	38	1292
SM 1 A											61	11	12	7	77	143	56	63	65	659
SM 1 B	7	13		6		8					63	13	13	8	35	31	43	22	37	697
SM 2 A	5	9		6		5					47	10	11	7	61	32	36	25	32	509
SM 2 B	7	14		10		9					67	13	14	8	35	35	41	27	40	729
SLP A											36	8	8	5	67	75	31	25	26	379
SLP B	6	12		7		7					80	15	16	8	35	33	40	28	38	888
PLM A											27	7	7	5	33	37	22	25	24	279
PLM B											27	7	7	5	33	37	23	25	24	279
KEO											29	7	8	5	47	47	25	26	23	292
MER											19	5	6	4	26	55	16	12	17	171
CPP A	6	10		5		5					44	10	10	7	32	41	20	28	26	479
CPP B	10	18		9		9			5		74	16	15	9	33	50	19	26	32	804
RMG A	7	14		6		5					47	10	11	7	46	54	27	32	25	490
RMG B	6	11		5							40	9	10	6	40	64	27	28	35	416
TPR A		7									47	10	11	7	30	64	25	24	33	458
TPR B	5	9									58	12	13	8	33	62	23	29	36	621
KPG	5	9									47	10	11	7	41	59	26	26	34	680
CLC		7									44	10	10	7	46	69	29	23	35	450
PGG	8	15		7		6			5		54	11	12	7	38	54	27	36	35	566
KBY A											70	12	13	8	83	266	55	—	74	739
KBY B	5	9		6		5					47	10	11	7	43	35	33	18	29	517
KBY C	5	9		6		5					47	10	11	7	43	35	33	18	29	517
CPA											25	6	7	5	26	76	19	25	32	274
CPE		7		7							42	9	10	6	38	57	33	24	42	430
PSM											25	6	7	5	24	77	21	22	18	270
KAL A	7	13	6	13		7					47	10	11	7	41	61	39	17	34	494
KAL B		7		6							27	7	7	5	27	47	25	22	30	273
JGA											20	6	6	4	19	48	17	25	30	187
JTG A	18	27	6	11		10	5		6		47	10	11	7	42	42	32	29	17	506
JTG B	27	44	11	20	5	17	8		11		80	15	16	9	41	59	34	26	19	860
CAW A	7	13	15	24	7	6					39	9	9	6	34	46	36	34	22	403
CAW B	14	24	24	42	11	12	5	8	7		70	14	15	9	57	68	41	31	20	741
PSR		8	8	15	13			9			32	8	8	5	29	70	30	37	24	319
TBT A	10	15	5	9		17	10				47	10	11	7	42	52	40	25	22	495
TBT B		8				10	6				26	6	7	5	27	49	26	22	21	229
GAN		7	7	13	10			16			32	8	8	5	29	68	29	39	25	317
KLD	6	13		7		5			11		32	8	8	5	31	56	38	25	21	319
SLDD	47	80	39	70	32	47	24	32	32	16	—	—	—	—	—	—	—	—	—	2873
SUB TOM											—	—	—	—	73	124	58	43	51	349
OPERATOR	14	22	12	20	11	14	8	11	11	6	—	—	—	—	—	—	—	—	—	852
KTT A,B											—	—	—	—	—	—	—	—	—	2118
GBT A,B										95	—	—	—	—	—	—	—	—	—	2254
CPT											—	—	—	—	—	—	—	—	—	1526
KBT											—	—	—	—	—	—	—	—	—	1177
JTT	160	197	167	217	118	190	130	100	140		—	—	—	—	—	—	—	—	—	1619
TOTAL	485	815	217	603	207	472	211	176	243	172	2956	608	651	402	2479	3540	2089	1652	1964	45185

Table IV-11 Number of Circuits as of 1993

FROM \ TO	KT 1	KT 2 A	KT 2 B	KT 2 C	KT 2 D	KT 2 E	CKG A	CKG B	PLT A	PLT B	ANC A	ANC B	TGL	GB 1 C	GB 1 D	GB 1 E	GB 2 A	GB 2 B	GB 2 C	GB 2 D
KT 1	114	29	29	29	29	50		14	15	42	14	39	5	15	15	69	14	14	43	48
KT 2 A	27	14	16	14	14	20				9		10		7	7	29			14	15
KT 2 B	27	16	16	16	14	20				9		10		7	7	29			16	15
KT 2 C	27	14	14	16	14	20				9		10		7	7	29			14	15
KT 2 D	27	14	14	14	14	20				9		10		7	7	29			14	15
KT 2 E	43	20	20	20	20	29		5	5	15	5	16		11	11	47	7	7	22	25
CKG A	7						6	16					6			8				
CKG B	25	6	6	6	6	11	16	41		15		7	15	5	5	29			13	15
PLT A	18					7			8	17		6				13			6	7
PLT B	51	12	12	12	12	20		10	17	60	6	17		8	8	40	6	6	19	21
ANC A	14					6				5	8	15				13			6	7
ANC B	40	11	11	11	11	19			5	15	15	35		8	9	40	6	6	21	23
TGL	12						6	17		7			14			12			5	6
GB 1 C	16	6	6	6	6	10				4		6		13	13	42	7	7	19	31
GB 1 D	16	6	6	6	6	10				6		6		13	13	42	7	7	19	21
GB 1 E	74	26	26	26	26	42		14	9	28	10	32	5	42	42	172	29	29	84	94
GB 2 A	12					7						5		7	7	28	13	13	29	31
GB 2 B	12					7						5		7	7	28	13	13	29	31
GB 2 C	35	12	12	12	12	20		6		13	5	16		19	19	62	29	29	74	83
GB 2 D	40	16	16	14	14	22		7		15	6	18		21	21	96	31	31	83	92
SM 1 A																				
SM 1 B	28	9	9	9	9	15		8		11		11		14	14	65	14	14	42	47
SM 2 A	9					5								5	5	22	5	5	15	17
SM 2 B	32	10	10	10	10	17		9		13		13		16	16	76	16	16	50	57
SLP A																				
SLP B	46	15	15	15	15	24	5	15	6	20	5	16	6	15	15	71	11	11	35	39
PLM A	5															10			5	6
PLM B	15					7		5		6		5		6	6	29	5	5	16	18
KEO	14					6		9		7						20			10	11
MER	7															13			6	7
CPP A	14	5	5	5	5	8						7		6	6	28	5	5	16	18
CPP B	24	9	9	9	9	15				8		13		10	10	46	9	9	29	33
CPP C	29	11	11	11	11	17				10	5	15		12	12	54	11	11	34	38
RMG A	5					5						5				19			13	15
RMG B	14					8						7		5	5	28	6	6	20	23
TPR A	13					7				6	6	16				18			10	11
TPR B	28	7	7	7	7	13				11	9	25		6	6	31	5	5	17	20
KPG	25	6	6	6	6	12				6		15		6	6	39	7	7	26	27
CLC	26	6	6	6	6	11				9	8	22		5	5	32	5	5	19	22
PGG	19	6	6	6	6	10				6		11		7	7	35	7	7	25	29
KBY A																				
KBY B	5					5								5	5	21			13	15
KBY C	9					5								5	5	21			13	15
KBL	6															13			7	8
CPA A																				
CPA B																				
CPE A																10			6	7
CPE B	6															13			9	10
PSM A																				
PSM B																				
KAL A	5															14			10	12
KAL B	11					6								5	5	28	6	6	21	24
JGA																6				
JTG A	8					5										20	5	5	16	18
JTG B	15	5	5	5	5	9				5		7		8	8	36	9	9	28	32
JTG C	10					6								8	5	25	6	6	19	22
CAW A																11			9	10
CAW B	16	5	5	5	5	9				5		7		8	8	40	9	9	31	34
PSR																13			9	11
TBT A	8															20			15	17
TBT B	10					5								5	5	25	6	6	19	22
GAN	5															15			11	13
KLD	7															17			13	15
SLDD	161	51	51	51	51	80	26	73	32	85	32	85	38	51	51	220	51	51	143	160
SUB TOM																				
OPERATOR	39	15	15	15	15	21	9	20	10	22	10	22	12	15	15	51	15	15	35	38
KTT A,B	216	164	164	164	164	168	94	188	138	204	136	210	116							
GBT A,B														146	146	272	180	160	242	258
CPT																				
KBT																				
JTT																				
TOTAL	1539	524	524	524	524	640	164	457	245	657	280	775	217	569	565	2422	555	555	1565	1766

FROM \ TO	SM 1 A	SM 1 B	SM 2 A	SM 2 B	SLP A	SLP B	PLM A	PLM B	KEO	MER	CPP A	CPP B	CPP C	RMG A	RMG B	TPR A	TPR B	KPG	CLC	PGG
KT 1	15	32	10	36	13	51	5	14	13	5	16	28	33	9	14	13	22	22	16	16
KT 2 A		10		11		15					5	10	11				5	6		5
KT 2 B		10		11		15					5	10	11				5	6		5
KT 2 C		10		11		15					5	10	11				5	6		5
KT 2 D		10		11		15					5	10	11				5	6		5
KT 2 E	7	16	5	18	7	25		6	6		9	15	18	5	7	5	9	11	6	6
CKG A		5		5		9														
CKG B	7	16	5	18	7	27		9	13	5		7	8							
PLT A				5		9														
PLT B	7	15		17	6	27		7	7		6	12	14		5	6	10	9	7	6
ANC A						6							5			5	8			5
ANC B	6	13		15		19		5			8	15	18	5	7	13	20	16	15	9
TGL		6		7		12			5											
GB 1 C	7	14	5	15		13		5			5	10	11					5		
GB 1 D	7	14	5	15		13		5			5	10	11					5		
GB 1 E	29	62	21	68	16	62	8	24	13	8	25	44	51	15	23	11	19	25	15	24
GB 2 A	6	13		15		9					5	9	10		5			5		5
GB 2 B	6	13		15		9					5	9	10		5			5		5
GB 2 C	18	39	13	46	7	29		13	6		15	27	31	11	16	6	10	17	9	17
GB 2 D	21	44	15	52	8	33	5	14	7	5	17	30	35	12	18	7	11	20	10	19
SM 1 A	21	44	16	48	8	25	7	15	9	8										
SM 1 B	32	62	23	69	9	33	8	20	9	8	9	17	20	7	10		6	11	5	10
SM 2 A	12	25	16	24		11		6												
SM 2 B	37	71	26	98	9	35	10	25	10	9	11	21	25	8	12		8	13	6	13
SLP A	9	15	7	17	8	24	5	9	8	6										
SLP B	17	36	12	39	20	63	6	18	16	7	9	17	21	5	6	5	9	12	6	9
PLM A	5	5		11			7	6	10											
PLM B	12	24	5	28	5	19	10	21	6	9		7	8							
KEO	6	12		14	6	20		7	15				5							
MER	5	11		13		9	5	10		9										
CPP A		10		11		9					13	20	22	5	6		6	10	5	9
CPP B	8	18	6	21		16		6			20	32	37	10	14	6	11	19	8	15
CPP C	9	21	7	24		19		7			23	37	42	11	16	8	12	21	11	18
RMG A		8		10		6					6	11	13	14	19		5	9	5	11
RMG B	5	12		15		9					9	16	19	19	25		7	13	7	17
TPR A		6		7		7					5	10	12		5	18	26	12	18	8
TPR B		10		12		12					9	16	19	6	10	26	39	21	28	14
KPG	6	16		17		14					13	22	26	10	15	10	17	44	17	20
CLC		11		13		12					9	17	20	8	13	21	26	26	61	21
PGG	6	15	5	19		11					12	21	24	14	20	7	12	22	15	48
KBY A																				
KBY B	11	21	9	26		12		9				5	6							
KBY C	11	21	9	26		12		9				5	6							
KBL	6	13	5	16		8		6												
CPA A																				
CPA B																				
CPE A	5	11		14		5														
CPE B	7	14	6	19		7		6												
PSM A																				
PSM B				6																
KAL A	7	14	6	16		6							5							
KAL B	12	25	11	34		13		8				9	11		6			5		7
JGA		7		9																
JTG A	5	11		13		7					5	9	10	5	7			6		7
JTG B	9	19	7	25		13		5			9	16	18	9	13		6	11	6	14
JTG C	6	13		16		8					6	11	13	6	5			7		9
CAW A				10									5							
CAW B	11	25	9	26		14		7			8	15	17	8	13		5	10	5	14
PSR		11		13									5							
TBT A	5	11		15		7						7	8		5					5
TBT B	6	14	5	19		9					5	9	10		6			5		6
GAN		11		16		5						5	6							
KLD		8		11		5												6		10
SLDD	62	126	51	158	34	122	26	64	48	34	51	87	101	50	71	51	80	93	93	94
SUB TOM																				
OPERATOR	17	31	15	38	11	30	9	18	14	11	15	23	26	15	19	15	21	24	24	24
KTT A,B																				
GBT A,B	170	192	186	224	150	178	124	206	172	144										
CPT											134	166	170	160	191	139	164	202	184	195
KBT																				
JTT																				
TOTAL	676	1282	531	1674	324	1257	336	595	377	268	517	901	1046	432	624	372	600	767	588	727

FROM \ TO	KBY A	KBY B	KBY C	KBL	CPA A	CPA B	CPE A	CPE B	PSM A	PSM B	KAL A	KAL B	JGA	JTG A	JTG B	JTG C	CAW A	CAW B	PSR	TBT A	TBT B	GAN	KLD
KT 1	11	11	9								5	10		9	16	11		14		9	11		6
KT 2 A															5								
KT 2 B															5								
KT 2 C															5								
KT 2 D															5								
KT 2 E	5											5		5	9	6		7			5		
CKG A																							
CKG B	6																						
PLT A																							
PLT B	5														7			5					
ANC A																							
ANC B															8	5		6			5		
TGL																							
GB 1 C															7	5		5					
GB 1 D															7	5		5					
GB 1 E	11	17	17	9			5	7			11	21		18	32	22	8	29	7	19	23	6	12
GB 2 A															8	5		6			5		
GB 2 B															8	5		6			5		
GB 2 C	13	11	11	5				5			7	15		13	24	16	6	22		16	17		9
GB 2 D	14	12	12	5				5			8	17		15	28	19	7	25	5	16	20		10
SM 1 A																							
SM 1 B	20	17	17	8			5	7			9	18		10	18	12	5	20	6	13	14		6
SM 2 A	8	7	7									7			6			7			5		
SM 2 B	26	22	22	10			8	10			13	26		13	23	16	7	28	7	15	19	6	8
SLP A																							
SLP B	12	10	10	5							5	10		7	13	8		12		7	9		
PLM A																							
PLM B	9	8	8									6			6			6					
KEO																							
MER																							
CPP A															8	6		6			5		
CPP B	5											8		8	15	10		11		7	9		6
CPP C	6	5	5								5	9		10	17	12		13		8	10		7
RMG A														5	9	6		7					
RMG B												7		8	14	9		11		5	7		7
TPR A															5								
TPR B															9	5		6					
KPG												7		7	13	8		10		5	7		6
CLC												5		5	11	7		8			5		5
PGG												9		10	18	12		15		9	9		10
KBY A	22	19	19	11	5	4	9	10	6	6	10	18	6										
KBY B	16	14	14	6								6			6			7			5		
KBY C	16	14	14	6								8			6			7			5		
KBL	6	7	7	10								5											
CPA A					8	6	7	9	5	5	6	9	7										
CPA B					6	4																	
CPE A	6	5	5				10	12				8						5					
CPE B	7	6	6				12	15				8						8					
PSM A					4	3	6	7	6	5	7	11	5										
PSM B									5	4													
KAL A	5	5	5								13	20			8	5		13			5		
KAL B	11	9	9	5				6	7	5	20	34	5	9	16	11	7	26	7	5	11	6	6
JGA											5	8	10					6					
JTG A											5	9		14	21	16		13		7	9		7
JTG B	7	6	6								9	16		21	34	25	7	23	5	13	15		12
JTG C	5										6	11		16	25	19	5	16		9	11		
CAW A											5	10		5	9	6	11	25	7		5	6	
CAW B	10	8	8					6	5		16	31	5	15	27	19	25	68	18	16	17	16	12
PSR											6	13		5	9	6	8	24	19		5	16	
TBT A											5	9		7	12	8		11		13	15		
TBT B	5										6	11		9	15	10		12		15	18		5
GAN											8	15	6	5	10	6	9	27	21	6	5	32	
KLD												6		9	18	10		12		5	7		16
SLDD	69	50	50	36	23	14	34	45	23	15	45	82	31	51	97	61	40	117	50	50	61	61	50
SUB TOM																							
OPERATOR	11	15	15	11	6	6	11	12	8	7	14	23	10	15	23	17	12	29	15	15	17	17	15
KTT A,B																							
GBT A,B																							
CPT																							
KBT	182	173	173	136	59	35	128	150	96	78	142	177	93										
JTT														156	166	154	151	235	156	193	187	166	165
TOTAL	536	449	449	253	113	72	235	307	165	129	392	735	178	480	848	585	308	975	323	471	508	334	359

FROM \ TO	SLDD	SUB TOM	10 X	11 X	KTT A,B	GBT A,B	CPT	KBT	JTT	TOTAL
KT 1	161	27	29	15	27	51	37	41	42	1509
KT 2 A	51	11	11	7	26	47	32	27	34	521
KT 2 B	51	11	11	7	26	47	32	27	34	521
KT 2 C	51	11	11	7	26	47	32	27	34	521
KT 2 D	51	11	11	7	26	47	32	27	34	521
KT 2 E	80	15	16	9	22	37	27	33	32	826
CKG A	16	7	7	5	33	65	23	19	18	247
CKG B	73	14	15	9	41	54	51	45	46	697
PLT A	32	8	6	5	33	44	35	18	22	301
PLT B	85	16	17	10	33	55	33	40	44	828
ANC A	32	6	8	5	29	48	34	17	24	306
ANC B	85	16	17	10	32	60	35	40	42	828
TGL	34	9	9	6	45	50	36	24	25	251
GB 1 C	51	11	11	7	26	26	36	32	31	520
GB 1 D	51	11	11	7	26	26	36	32	31	520
GB 1 E	220	35	37	19	37	41	41	40	37	2168
GB 2 A	51	11	11	7	37	33	32	35	35	510
GB 2 B	51	11	11	7	37	33	32	35	35	510
GB 2 C	143	24	26	16	38	46	40	38	46	1409
GB 2 D	160	27	29	15	39	38	43	43	44	1579
SM 1 A	72	12	13	8	74	122	69	64	74	711
SM 1 B	126	22	23	12	60	32	40	33	42	1161
SM 2 A	51	11	11	7	38	30	38	29	41	506
SM 2 B	156	26	28	15	47	61	48	42	48	1556
SLP A	37	8	8	6	61	62	38	24	28	380
SLP B	122	21	23	12	34	38	38	37	43	1211
PLM A	26	7	7	5	28	32	24	25	23	251
PLM B	64	13	13	8	46	23	44	36	45	626
KEO	48	10	11	7	49	49	40	37	35	448
MER	34	8	8	6	39	40	30	35	29	326
CPP A	51	11	11	7	29	42	19	29	31	515
CPP B	87	16	17	10	36	49	21	37	32	873
CPP C	101	19	19	11	36	53	21	31	35	1009
RMG A	50	11	11	7	37	58	25	31	43	482
RMG B	71	14	15	9	45	56	30	38	40	687
TPR A	51	11	11	7	41	57	27	23	35	494
TPR B	80	15	16	9	36	65	29	35	46	779
KPG	93	17	18	10	47	66	37	39	38	887
CLC	93	17	18	10	43	76	40	37	47	888
PGG	94	17	18	10	40	63	35	45	47	898
KBY A	69	12	13	8	68	230	58	—	70	673
KBY B	50	11	11	7	39	40	35	26	37	504
KBY C	50	11	11	7	39	40	35	26	37	504
KBL	36	5	5	6	32	39	30	24	35	344
CPA A	24	6	6	5	21	62	19	18	29	252
CPA B	14	4	5	4	13	31	12	20	17	130
CPE A	34	8	8	6	30	43	29	26	38	329
CPE B	45	10	10	6	36	45	36	22	47	424
PSM A	24	6	6	5	19	63	21	16	34	248
PSM B	15	5	6	4	16	39	17	20	26	173
KAL A	45	10	10	7	33	46	40	25	41	435
KAL B	82	15	16	9	51	52	48	22	33	601
JGA	31	7	8	6	24	52	27	33	42	281
JTG A	51	11	11	7	37	48	31	29	21	509
JTG B	97	16	17	10	35	51	35	30	21	967
JTG C	61	12	13	8	44	48	35	30	19	610
CAW A	40	5	9	6	33	54	40	30	20	381
CAW B	117	20	22	12	46	79	47	47	25	1129
PSR	47	11	11	7	37	68	45	45	25	472
TBT A	50	11	11	7	41	64	38	32	25	482
TBT B	61	12	13	8	45	52	38	33	25	582
GAN	61	12	13	8	40	75	48	55	26	575
KLD	50	11	11	7	41	59	41	31	26	481
SLDD	–	–	–	–	–	–	–	–	–	6178
SUB TOM	–	–	–	–	97	169	95	60	77	498
OPERATOR	–	–	–	–	–	–	–	–	–	1161
KTT A,B	–	–	–	–	–	–	–	–	–	2326
GBT A,B	–	–	–	–	–	–	–	–	–	3170
CPT	–	–	–	–	–	–	–	–	–	1705
KBT	–	–	–	–	–	–	–	–	–	1623
JTT	–	–	–	–	–	–	–	–	–	1731
TOTAL	6203	817	854	576	2389	3490	2290	2058	2280	47429

6. Choice of Standard PCM System

There are two primary order PCM systems, i.e., the 24-channel system and the 30-channel system. Both are recommended for the standard PCM system by CCITT. In the Jakarta Telephone Network, both types of PCM system have been introduced for trial: a small number of PCM system units from various manufacturers are in operation now between various junction sections.

6-1 Technical Comparison

Following is a summary of major technical differences between the two PCM systems:

(1) Encoding Law

The 24-channel system uses a mu-law encoder, whereas the 30-channel system uses an A-law encoder. It is generally considered that an A-law encoder holds economic advantages in connection with circuit making, and allows easy digital manipulation of signals. There is no coding compatibility between the two systems; therefore, the code conversion equipment must be provided on the 24-channel system side in case of direct connection between the two systems according to CCITT recommendation.

(2) Frame-Alignment

The 24-channel design uses a frame-alignment signal that is distributed among several frames, whereas the 30-channel design bunches the frame-alignment word into a separate 8-bit time-slot (TS 0). Faster recovery of frame-alignment can be realized in case of dissynchronization of bit stream by the bunched frame-alignment of the 30-channel system. Furthermore, there exists spare capacity within the framing time-slot, which enables the conveyance of other information such as alarm signals.

(3) Signalling

In the 24-channel system, the signalling information is conveyed with each speech time-slot which is called the "bit stealing technique", producing a slight reduction in speech-coding performance. In the 30-channel system, the signalling information for all channels is encoded and conveyed in a separate 8-bit time-slot (TS 16). The latter has signalling capacity to provide 4 independent 500 bit/sec. signalling channels.

(4) Spacing of Line Repeater

Since the bit streaming rate of the 30-channel system is higher than that of the 24-channel system, the maximum allowable transmission loss of the 30-channel system is smaller than that of the 24-channel system. Therefore, the spacing of single line repeater section for the 30-channel system is shorter than that of the 24-channel system. Consequently, the total number of line repeaters required for the 30-channel system is slightly bigger than that for the 24-channel system.

(5) Digital Hierarchy

The digital hierarchy of PCM system is shown below.

Digital Hierarchy	Number of Voice Channels		Bit Rate (M bit/s)	
	24 CH	30 CH	24 CH	30 CH
1	24	30	1.544	2.048
2	96	120	6.312	8.448
3	480 (672)*	480	32.064 (44.736)*	34.768
4	1440 (4032)*	1920	97.728 (274.176)*	139.264
5	5760	7680	400.352	565.000

*Note: Figures in the USA

(6) Compatibility

The 30-channel system has the advantage of 64 K bit of data signal compatibility. On the other hand, the bit stealing method of signalling in the 24-channel systems destroys code transparency which may inhibit the development of some modern services such as mixed data and speech transmission.

6-2 Adoption of 30 CH PCM System

From the viewpoint of telephony, there are no major differences between the two systems; however, there are various advantages in the 30-channel system in view of its various flexibilities as mentioned in the previous paragraph, since it is the later development than the 24-channel system. Today, most countries except Japan, USA and Canada have adopted the 30-channel system. The wide acceptance of the 30-channel system must inevitably influence the development of the digital transmission and switching systems in the future, not only for telephony but for other services such as data transmission.

After consultations with PERUMTEL, the introduction of the 30-channel PCM system has been decided for the Jakarta Telephone Network in order to expedite subsequent line engineering of a junction network.

PART V JUNCTION CABLE NETWORK PLAN

PART V JUNCTION CABLE NETWORK PLAN

On the basis of the estimated number of telex and leased circuits as well as telephone circuits, a plan for the junction cable network for the years 1987 and 1993 in the Jakarta Telephone Network has been prepared. The cost study of transmission system has been made to some extent as a guide to selection of optimum transmission system between exchanges. At the same time, it has been so planned that the existing junction cable facilities would be fully utilized. However, in this plan, the PCM transmission system has been positively introduced, aiming at the improvement of transmission quality as well as the reduction of additional cable installation. The number of proposed cable systems by the year 1987 is 20 with 22,200 pairs, and 21 cable systems with 13,800 pairs by the year 1993 after 1987. The total number of PCM transmission systems for the year 1987 is 457, and 797 for the year 1993.

In the plan for the year 1987, the basic design for all junction cable networks has been formulated in accordance with the technical and design objectives obtained from PERUMTEL's practices and determined after the consultation with PERUMTEL. The results of basic design are presented in three kinds of drawings: Loading System and PCM System Plan, Junction Cable Route Plan, and MDF Terminating and Cable Vault Plan. Finally, the amount of main works has been estimated as a result of this basic design.

1. Circuit Grouping

On the basis of the number of telephone circuits for the years 1987 and 1993 as estimated in Chapter 5 of PART IV of this report, with the number of telex and leased circuits required added thereto, the plan for the expansion of junction cables in the Jakarta Telephone Network has been made. In this plan, the optimum transmission system to each destination has been determined from the cost of transmission system as the function of distance between exchanges, on the assumption that PCM transmission system be used for junction network in addition to the cable transmission system, with full utilization of the existing cables.

1-1 Number of Junction Circuits

The circuits related to junction cable are threefold: Telephone, Telex and Leased circuits.

1-1-1 Telephone

The number of telephone circuits is calculated in Chapter 5 of PART IV of this report. Circuits which are not related to the junction cable are rejected; therefore, the number of junction circuits between exchanges is restricted as shown in Table V-1, 2 for the years 1987 and 1993, respectively. The total telephone circuits in 1987 and 1993 number 37,234 and 49,305, respectively.

1-1-2 Telex

(1) Telex Subscriber Line

The present telex network in Jakarta is shown in Figure V-1. There are 6 telex local exchanges: 5 are located in 5 telephone tandem exchanges and 1 is in KT1 Telephone Exchange. A telex subscriber residing in the same area as a subscriber of either of the above 6 telephone exchanges may be connected via local subscriber cable to each telex local exchange concerned. Conversely, a telex subscriber, who is excludedly situated from the area of a telex exchange, is connected via junction cable to the corresponding telex exchange. Therefore, the number of these telex subscribers has been taken into account when determining the junction cable pairs. Increasing rate of the number of Telex subscriber is related to telephone demand increase, correlation factor between Telex subscriber and telephone subscriber is decided by discussion with PERUMTEL. Telex subscribers for the years 1987 and 1993 in each telephone exchange area are shown in Table V-3. The total telex subscribers in 1987 and 1993 number 8,517 and 13,545, respectively.

Table V-1 Number of Local Junction Circuits as of 1987

TO / FROM	KT1	KT2 A-E	CKG A,B	PLT A,B	ANC A,B	TGL	GB1 A,B	GB1 C,D	GB2 A-D	SM1A	SM1B	SM2 A,B	SLP A	SLP B	PLM A,B	KED	MER	CPP A,B	RMG A,B	TPR A,B	KPG	CLC	PGG.	KBY A	KBY B,C
KT1	—	169	10	51	36		81	42	118	15	18	28	14	38	12	8		44	18	33	12	8	10	13	20
KT2 A-E	154	—		74	58		175	94	245	31	37	37	31	75				100	5	33	6		5	26	10
CKG A,B	18		—			14	20		22					20											
PLT A,B	60	95		—	13		47	16	60	6	7	6	6	26				20		13				5	
ANC A,B	37	64		11	—		35	10	40					14				14		35		5			
TGL	10		14			—			5					9											
GB1 A,B							—	—	424																
GB1 C,D	36	84		12			—	—	130	16	20	30	10	26				38						14	20
GB2 A-D	99	215		34	33		243	130	—	59	70	115	18	70	26	5		131	51	35	22	5	24	49	76
SM1 A										—	—	47	10	23	18	8	6								
SM1 B	16	33		5			40	22	76	—	—	43	7	17	14			17						17	26
SM2 A,B	27	37		5			64	34	127	38	43	—	6	27	24			24	5					30	46
SLP A										10	11	20	—	—	14	7	5								
SLP B	35	74	10	19	11		57	28	80	15	18	27	—	—	14	10		23	5	6	5		5	13	20
PLM A,B	12						26		30	14	16	26		14	—									12	
KED	9						14		15		5	5	5	12		—									
MER																	—								
CPP A,B	39	92		7	12		77	40	144	14	17	24	5	22				—	35	24	19	5	19	8	12
RMG A,B	19	11					40	10	88		5	6		5				41	—	5	11		17		
TPR A,B	44	75		14	44		46	22	70		5	5		16				44	18	—	15	27	14		
KPG	14	27					22	10	41					6				23	13	16	—	5	8		
CLC	14	6			13		16		22					5				15	5	34	8	—	8		
PGG	13	27					24	12	51	5	6	6		6				25	21	14	9	5	—		
KBY A																								—	—
KBY B,C	22	10					50	24	92	28	32	58		22	20			14						—	—
CPA																									
CPE	7						15		24	9	11	20		7										12	18
PSM																									
KAL A,B	7						18		57	15	17	34		7				6						15	16
JGA																									
JTG A,B	26	43		5			67	34	154	17	21	37		18				48	35	11	8		17	17	16
CAW A,B	16	6					42	14	94	9	16	27		8				24	13				7	15	14
PSR									16																
TBT A,B	9	5					33	10	70	7	8	14		6				14						6	10
GAN									15																
KLD	5						12		21									6					5		
SLDD	121	249	54	88	70	27	—	—	340	53	63	114	32	80	54	29	19	118	87	105	47	44	54	60	94
SUB TDM	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
OPERATOR	31	73	16	27	23	9	—	—	90	16	18	33	11	22	18	10	7	34	27	31	14	14	16	17	28
KTT A,B	260	—	204	334	306	102																			
GBT A,B							—	—	800	196	210	410	148	210	268	148	102								
CPT																		—	365	312	181	136	183		
KBT																								—	—
JTT																									
TOTAL	1160	1395	310	686	619	152	1264	552	3561	573	674	1172	303	811	482	225	139	823	703	707	361	254	392	329	426

TO / FROM	CPA	CPE	PSM	KAL A,B	JGA	JTG A,B	CAW A,B	PSR	TBT A,B	GAN	KLD	GBDID	SLDD	SUB TDM	10 X	11 X	KTT A,B	GBT A,B	CPT	KBT	JTT				TOTAL	TO / FROM
KT1				6		28	9		10			6	121	21	23	—	25	49	30	33	41				1200	KT 1
KT2 A-E						42			5				249	52	57	36	—	185	168	124	146				2260	KT2 A-E
CKG A,B													54	14	14	10	80	104	46	44	38				498	CKG A,B
PLT A,B						6							88	20	20	13	54	107	66	49	54				857	PLT A,B
ANC A,B													70	17	17	11	45	107	64	39	55				690	ANC A,B
TGL													27	7	7	5	46	63	25	20	19				257	TGL
GB1 A,B												—	—	—	—	—	437	—	275	166	218				1520	GB1 A,B
GB1 C,D						28			10			—	—	—	—	—	52	—	72	42	54				694	GB1 C,D
GB2 A-D		13		33		130	62		63		15	14	340	64	68	39	135	139	151	112	137				3025	GB2 A-D
SM1 A													61	11	12	—	77	143	54	63	65				598	SM1 A
SM1 B		5		8		20	8		8				63	13	13	—	35	31	43	22	37				639	SM1 B
SM2 A,B		6		15		35	16		14				114	23	25	15	76	67	77	52	72				1144	SM2 A,B
SLP A													34	8	8	—	67	75	31	25	26				341	SLP A
SLP B				5		18	7		7				80	15	16	—	33	40	38	28	35				797	SLP B
PLM A,B													54	14	14	10	66	74	46	50	48				526	PLM A,B
KED													29	7	8	5	47	47	25	26	23				282	KED
MER													19	5	6	4	28	55	16	22	17				172	MER
CPP A,B				6		44	14		14		5		118	24	25	16	65	91	—	54	56				1147	CPP A,B
RMG A,B						38	11		5				87	19	21	—	86	118	54	60	70				827	RMG A,B
TPR A,B						21							105	22	24	—	63	126	48	53	69				994	TPR A,B
KPG						14							47	10	11	7	41	59	26	26	34				460	KPG
CLC						7							44	10	10	7	46	69	29	23	35				426	CLC
PGG						23	7		6		5		54	11	12	7	38	54	27	35	35				538	PGG
KBY A	6	15	9	27	6								70	12	13	—	85	266	55	—	74				638	KBY A
KBY B,C		12		14		28	12		10				94	20	22	—	86	72	66	—	58				866	KBY B,C
CPA	—	12	7	15	7								25	6	7	5	26	76	19	25	32				262	CPA
CPE	5	—		7		7	7						42	9	10	6	38	57	33	24	42				410	CPE
PSM	5	10	—	17	5								25	6	7	5	24	77	21	22	38				262	PSM
KAL A,B		5	6	—		27	25		7				74	17	18	12	68	98	64	39	64				716	KAL A,B
JGA				5	—								20	6	6	4	19	48	17	25	30				180	JGA
JTG A,B				28		—	48	5	40		17		127	25	27	—	83	101	66	57	—				1198	JTG A,B
CAW A,B		5	5	34		58	—	18	23	8	7		109	23	24	15	87	134	77	65	42				1039	CAW A,B
PSR				7		8	23	—		9			32	8	8	5	29	70	30	37	24				306	PSR
TBT A,B				7		34	14		—				71	16	18	12	69	101	66	47	43				690	TBT A,B
GAN				6		7	20	10		—			32	8	8	5	29	68	29	39	25				301	GAN
KLD						21	7		5		—		32	8	8	5	31	58	38	25	21				308	KLD
SLDD	24	42	24	74	20	127	109	32	71	32	32	—	—	—	—	—	—	—	—	—	—				2589	SLDD
SUB TDM	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	73	—	58	43	51				225	SUB TDM
OPERATOR	9	13	9	23	7	36	32	11	22	11	11	—	—	—	—	—	—	—	—	—	—				771	OPERATOR
KTT A,B													—	—	—	—	—	—	—	—	—				1206	KTT A,B
GBT A,B												—	—	—	—	—	—	—	—	—	—				2492	GBT A,B
CPT													—	—	—	—	—	—	—	—	—				1177	CPT
KBT	60	146	105	269	64								—	—	—	—	—	—	—	—	—				644	KBT
JTT						—	384	118	320	100	140		—	—	—	—	—	—	—	—	—				1062	JTT
TOTAL	109	284	165	606	109	807	815	194	640	160	232	20	2611	551	587	259	2389	3029	2050	1616	1928				37234	TOTAL

Table V-2 Number of Local Junction Circuits as of 1993

FROM \ TO	KT 1	KT 2 A-E	CKG A,B	PLT A,B	ANC A,B	TGL	GB 1 C-E	GB 2 A-D	SM 1 A	SM 1 B	SM 2 A,B	SLP A	SLP B	PLM A,B	KED	MER	CPP A-C	RMG A,B	TPR A,B	KPG	CLC	PGG	KBY A	KBY B,C	KBL	CPA A	CPA B	CPE A,B	PSM A	PSM B	KAL	JGA	JTG A-C	CAW A,B	PSR	TBT A,B	GAN	KLD	SLDD	SUB TDM	10 X	11 X	KTT A,B	GBT A,B	CPT	KBT	JTT			TOTAL	TO / FROM
KT 1	–	166	14	58	53	5	127	119	15	32	46	13	51	19	13	5	77	23	35	22	16	16	11	18							15		36	14		20		6	161	27	29	–	27	51	37	41	42			1460	KT 1
KT 2 A-E	151	–	5	56	61		241	177	7	56	67	7	85	6	6		146	12	34	35	6	28	5								5		40	7		5			284	59	60	37	–	225	155	141	168			2377	KT 2 A-E
CKG A,B	32	35	–	15	7	21	47	28	7	21	28	7	36	9	13	5	15						6																99	21	22	14	74	99	74	64	64			863	CKG A,B
PLT A,B	69	75	10	–	29		69	65	7	15	22	6	36	7	7		32	5	16	9	7	6	5										7	5					117	24	25	15	66	99	68	58	66			1047	PLT A,B
ANC A,B	54	69		25	–		69	69	6	13	15		25	5			46	12	46	14	20	9											13	6		5			117	24	25	15	61	106	69	57	66			1061	ANC A,B
TGL	12		23	7		–	12	11		6	7		12		5																								38	9	9	6	45	50	36	24	25			337	TGL
GB 1 C-E	106	214	14	49	54	5	–	344	43	90	129	16	88	42	13	8	172	38	30	39	15	24	21	34	9			12			32		96	47	7	42	6	12	–	–	–	–	85	–	113	104	99			2252	GB 1 C-E
GB 2 A-D	99	160	13	28	55		344	–	51	109	156	15	80	32	13	5	203	67	34	47	19	46	27	46	10			10			47		141	72	5	77		19	405	73	76	43	151	148	147	151	160			3384	GB 2 A-D
SM 1 A									–		65	8	25	22	9	8																							72	12	13	–	74	123	69	64	74			638	SM 1 A
SM 1 B	28	51	8	11	11		93	117		–	92	9	33	28	9	8	46	17	6	11	5	10	20	34	8			12			27		40	25	6	25		6	126	22	23	–	40	32	40	33	42			1154	SM 1 B
SM 2 A,B	41	62	9	13	13		138	181	49	96	–	9	47	43	10	9	70	21	8	13	6	13	34	58	10			18			46		58	42	7	39	6	8	209	37	39	22	85	71	84	71	89			1884	SM 2 A,B
SLP A									9	15	24	–		14	8	6																							37	8	8	–	61	62	38	24	28			342	SLP A
SLP B	46	84	20	26	21	6	101	96	17	36	51		–	24	16	7	47	13	14	12	6	9	12	20	5						15		28	12		16			122	21	23	–	34	38	38	37	43			1116	SLP B
PLM A,B	20	7	5	6	5		51	55	17	33	48	5	26	–	6	9	15						9	16							6		6	6					90	20	20	13	74	65	68	61	68			830	PLM A,B
KED	14	6	9	7			20	21	6	12	14	6	20	7	–		5																						48	10	11	7	49	49	40	37	35			433	KED
MER	7						13	13	5	11	13		9	15		–																							34	8	8	6	39	40	30	35	29			315	MER
CPP A-C	67	140		18	40		182	218	17	49	69		44	13			–	64	44	49	25	42	11	10							22		86	30		39		13	239	45	47	28	99	144	–	97	98			2089	CPP A-C
RMG A,B	23	13			12		57	83	5	20	25		15				74	–	12	22	12	28									7		51	18		12		7	121	25	26	–	86	116	55	69	82			1076	RMG A,B
TPR A,B	45	48		17	56		61	68		16	19		19				71	21	–	33	46	22											19	6					131	26	27	–	79	122	56	58	82			1148	TPR A,B
KPG	25	45		8	15		55	65	6	14	17		14				61	25	27	–	17	20									7		29	10		12		6	93	17	18	10	47	66	37	39	38			843	KPG
CLC	26	35		9	30		42	51		11	13		12				46	21	57	26	–	21									5		23	8		5		5	93	17	18	10	43	76	40	37	47			827	CLC
PGG	19	34		6	11		49	68	6	15	24		12				57	34	19	22	15	–									9		40	15		16		10	94	17	18	10	40	63	35	45	47			850	PGG
KBY A																							–		11	5	4	19	6	6	28	6							69	12	13	–	68	230	58	–	70			605	KBY A
KBY B,C	18	10					62	56	22	42	70		24	18			22							–	12						16		12	14		10			100	22	22	–	78	80	70	–	74			854	KBY B-C
KBL	6						13	15	6	13	21		8	6									8	14	–						5								36	8	9	6	32	39	30	24	35			334	KBL
CPA A																										–		16	5	5	15	7							24	6	6	5	21	63	19	18	29			239	CPA A
CPA B																											–												14	4	5	4	13	31	12	20	17			120	CPA B
CPE A,B	6						23	32	12	25	39		12	6									13	22				–			14			13					79	18	18	12	64	88	65	58	85			704	CPE A,B
PSM A																										4	3	13	–		18	5							24	6	6	5	19	63	21	16	34			237	PSM A
PSM B											6																			–	6								19	5	6	4	16	39	17	20	26			164	PSM B
KAL A,B	16	6					52	79	19	39	69		19	8			25	6		5		7	17	28	5			6	7	5	–	5	50	46	7	25	6	6	127	25	26	16	84	98	88	48	74			1149	KAL A,B
JGA							6			7	9																				13	–		6					31	7	8	5	24	53	27	33	42			271	JGA
JTG A-C	33	40		5	7		107	175	20	43	61		28	5			97	49	6	24	6	30	12	12							56		–	64	5	64		28	199	39	41	–	116	147	101	89	–			1709	JTG A-C
CAW A,B	16	29		5	7		67	104	11	33	55		14	7			45	21	5	10	5	14	10	16				6	5		62	5	81	–	25	36	22	12	157	29	31	18	76	133	87	77	45			1381	CAW A,B
PSR							13	20		11	13						5														19		20	32	–	5	16		50	11	11	7	37	68	45	45	25			453	PSR
TBT A,B	18	5					55	65	11	25	39		16				39	11		5		11	5								31		61	24		–		5	111	23	24	15	86	117	76	65	50			1013	TBT A,B
GAN	5						15	24		11	16		5				11														23	6	21	36	21	11	–		61	12	13	8	40	75	48	55	26			543	GAN
KLD	7						17	28		8	11		5				17	13		6		10									8		34	12		12		–	50	11	11	7	41	59	41	31	26			465	KLD
SLDD	161	284	99	117	117	38	–	405	62	126	209	34	122	90	48	34	239	121	131	93	93	94	59	100	36	23	14	79	23	19	127	31	199	157	50	111	61	50	–	–	–	–	–	–	–	–	–			3856	SLDD
SUB TDM	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	97	–	95	60	77			329	SUB TDM
OPERATOR	39	81	29	32	32	12	–	103	17	31	53	11	30	27	14	11	64	34	36	24	24	24	17	30	11	8	6	24	8	7	36	10	55	41	15	32	17	15	–	–	–	–	–	–	–	–	–			1060	OPERATOR
KTT A,B	216	–	282	342	346	116																																	–	–	–	–	–	–	–	–	–			1302	KTT A,B
GBT A,B							–	860	170	192	410	150	178	330	172	144																							–	–	–	–	–	–	–	–	–			2606	GBT A,B
CPT																	–	351	303	202	184	195																	–	–	–	–	–	–	–	–	–			1235	CPT
KBT																							–	–	136	59	35	278	96	78	320	93							–	–	–	–	–	–	–	–	–			1095	KBT
JTT																																	–	386	156	380	168	165	–	–	–	–	–	–	–	–	–			1255	JTT
TOTAL	1425	1699	540	860	982	203	2201	3835	623	1276	2025	296	1150	783	362	259	1747	979	863	723	527	679	302	458	253	99	62	493	150	120	1040	168	1246	1154	304	999	302	373	3861	760	795	348	2271	3228	2229	2006	2227			49305	TOTAL

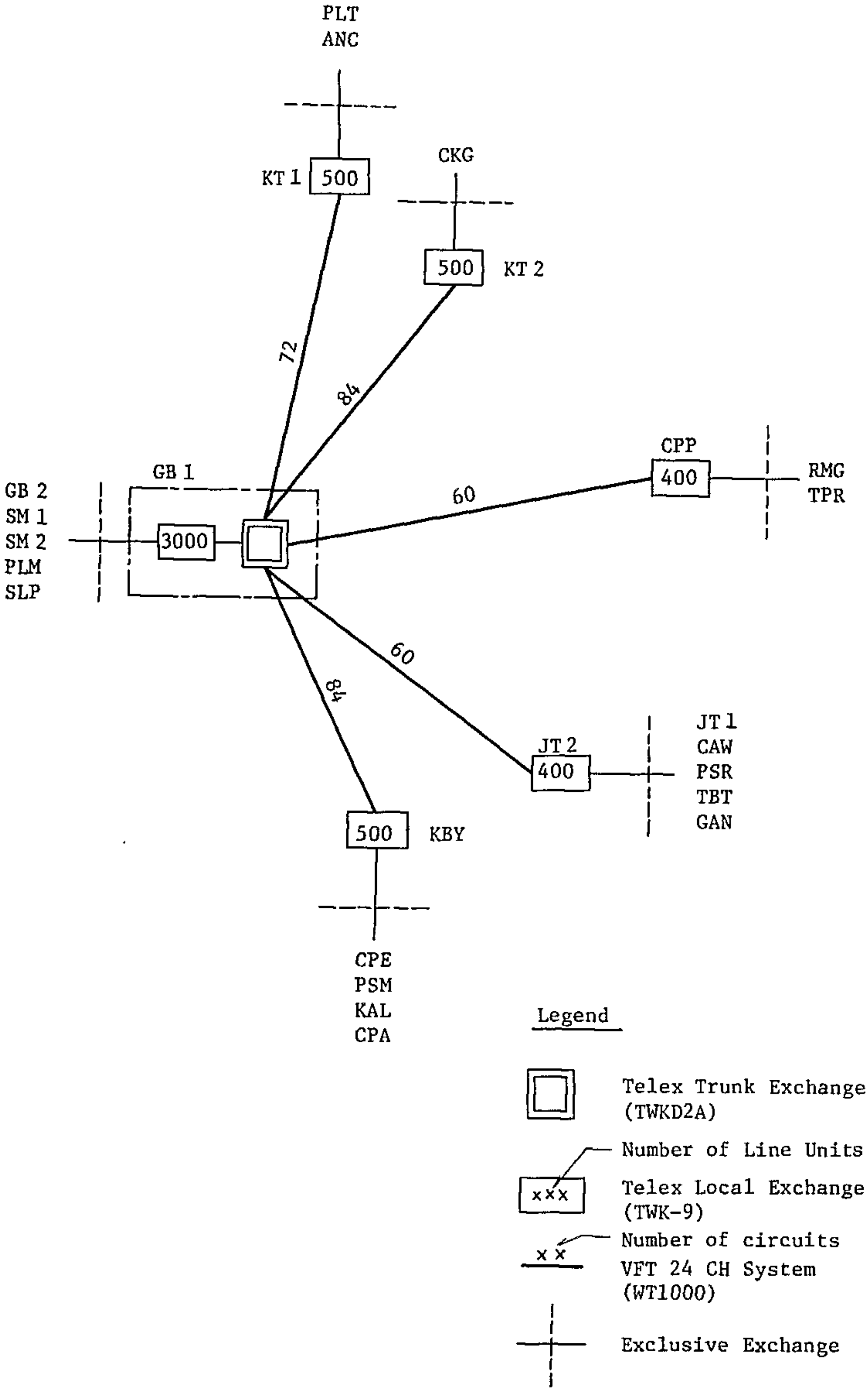


Figure V-1 Jakarta Telex Network in 1980

Table V-3 Number of Telex Subscribers

Telex Exchange	Telephone Exchange Area	Number of Telex Subscribers	
		1987	1993
KT1	KT1	412	532
	PLT	184	322
	ANC	114	217
KT2	KT2	710	908
	CKG	106	348
	TGL	60	132
GB1	GB1	1,620	19,80
	GB2	1,589	1,796
	SM1	450	828
	SM2	459	927
	PLM	107	218
	MER	23	77
	SLP	215	402
	KED	42	112
CPP	CPP	286	490
	TPR	260	383
	CLC	85	245
	KPG	69	185
	PGG	100	260
	RMG	159	290
KBY	KBY	330	458
	KAL	126	323
	PSM	27	68
	JGA	18	48
	CPE	105	248
	CPA	18	60
	KBL	31	63
JTG	JTG	338	526
	KLD	48	114
	CAW	158	356
	PSR	66	178
	GAN	70	203
	TBT	132	246
Total		8,517	13,545

(2) Telex Junction Circuit

As shown in Figure V-1, the present telex junction circuits are connected to the Jakarta Telex Trunk Exchange which is located in the Gambir I Exchange. The international telex exchange is also located in these premises. The number of telex junction circuits in 1987 and 1993 is shown below. The VFT 24 ch carrier system is applied in the telex junction circuit to economize the number of cable pairs required.

Destination	Number of Telex Junction circuits	
From/To GB 1	1987	1997
KT 1	284	430
KT 2	351	556
CPP	384	741
KBY	262	508
JTG	325	650
Total	1608	2885

1-1-3 Leased Circuit

The present number of junction cable pairs related to leased circuits is approximately 100. The other leased circuits are concerned with subscriber cable only. The present number of junction cable pairs used for leased circuits is very small in comparison with that used for telephone junction circuits.

However, in view of the increasing demand for sophisticated telecommunication services such as data transmission, the following margins are to be taken into account for leased circuits are estimated by discussion with PERUMTEL.

1) 10% of telephone junction circuits is to be of leased circuits for the junction section between the local exchanges.

2) 20% of telephone junction circuits is to be of leased circuits for the junction section between the tandem exchanges.

1-2 Study of Optimum Transmission System

The study of optimum transmission system is made to select the most economical transmission system for the Jakarta Telephone Network.

1-2-1 Types of Transmission Systems

The types of transmission systems to be adopted in the Jakarta junction cable network are threefold:

a) Non-loaded cable system
b) Loaded cable system
c) PCM 30 ch system

Introduction of optical fiber transmission system was examined; however, the system is not adopted this time. The reason is that the time is not ripe yet for the system to operate in the Jakarta Telephone Network because the system reliability and economic merit cannot exactly be as much as expected.

1-2-2 Transmission and Signalling Requirements

The transmission loss objectives and loop resistance limits are the main factors which constrict the allowable line distance of each transmission system except the PCM system. Table V-4 and Table V-5 show the maximum line distance limited by those two factors.

Table V-4 Maximum Distance Limited by Transmission Loss Objectives

Transmission System*/Loss Objectives	5.7 dB (SLDD)	6.4 dB (Suburban to Tandem)	11.4 dB (Suburban)	4.5 dB (Tandem to Local)	11.4 dB (Local to Tandem)	16.4 dB (Local)
0.4 NL	3.3 Km	3.7 Km	6.7 Km	2.6 Km	6.7 Km	9.7 Km
0.4 L	4.2	4.7	8.7	2.7	8.2	12.2
0.6 NL	5.1	5.7	10.2	4.0	10.2	14.7
0.6 L	9.4	10.7	19.6	6.2	18.5	27.5
0.8 NL	6.5	7.3	13.1	5.1	13.1	18.8
0.8 L	15.5	17.6	32.3	10.2	30.5	45.2
0.9 NL	7.7	8.6	15.4	6.0	15.4	22.1
0.9 L	20.3	23.0	43.8	13.4	40.0	59.2
PCM	In practice, no limit					

*Note: NL - Non-loaded line
L - Loaded line

Table V-5 Maximum Distance Limited by D.C. Loop Resistance

Transmission System*/Loop Resistance	700 ohms	1600 ohms (Local)	1600 ohms (SLDD)	1800 ohms (Local)	1800 ohms (SLDD)
0.4 NL	2.3 Km	5.3 Km	5.3 Km	6.0 Km	6.0 Km
0.4 L	2.2	5.2	5.0	5.9	5.7
0.6 NL	5.3	12.3	12.3	13.8	13.8
0.6 L	5.1	11.8	11.4	13.3	12.9
0.8 NL	9.5	21.9	21.9	24.6	24.6
0.8 L	9.0	20.5	19.8	23.1	22.8
0.9 NL	12.0	27.0	27.0	31.0	31.0
0.9	11.2	25.8	24.8	30.1	28.0

*Note: NL - Non-loaded line
L - Loaded line

1-2-3 Cost Comparison of Transmission Systems

Transmission system cost is a factor to be considered when selecting the optimum transmission system. The most economical system can be found by comparing the initial investment costs of various transmission systems. The material and construction costs of cable used for this calculation are based on the unit price list provided by PERUMTEL. However, the cost of PCM system is calculated on the basis of the current price in the foreign market.

The total cost of each transmission system, which is a function of distance between exchanges, is shown below.

Type of Transmission System	Cost*per Circuit in US$
0.4 NL	51 x d
0.4 L	64 x d + 20
0.6 NL	74 x d
0.6 L	87 x d + 20
0.8 NL	123 x d
0.8 L	135 x d + 20
0.9 NL	156 x d
0.9 L	169 x d + 20
PCM	10 x d + 700

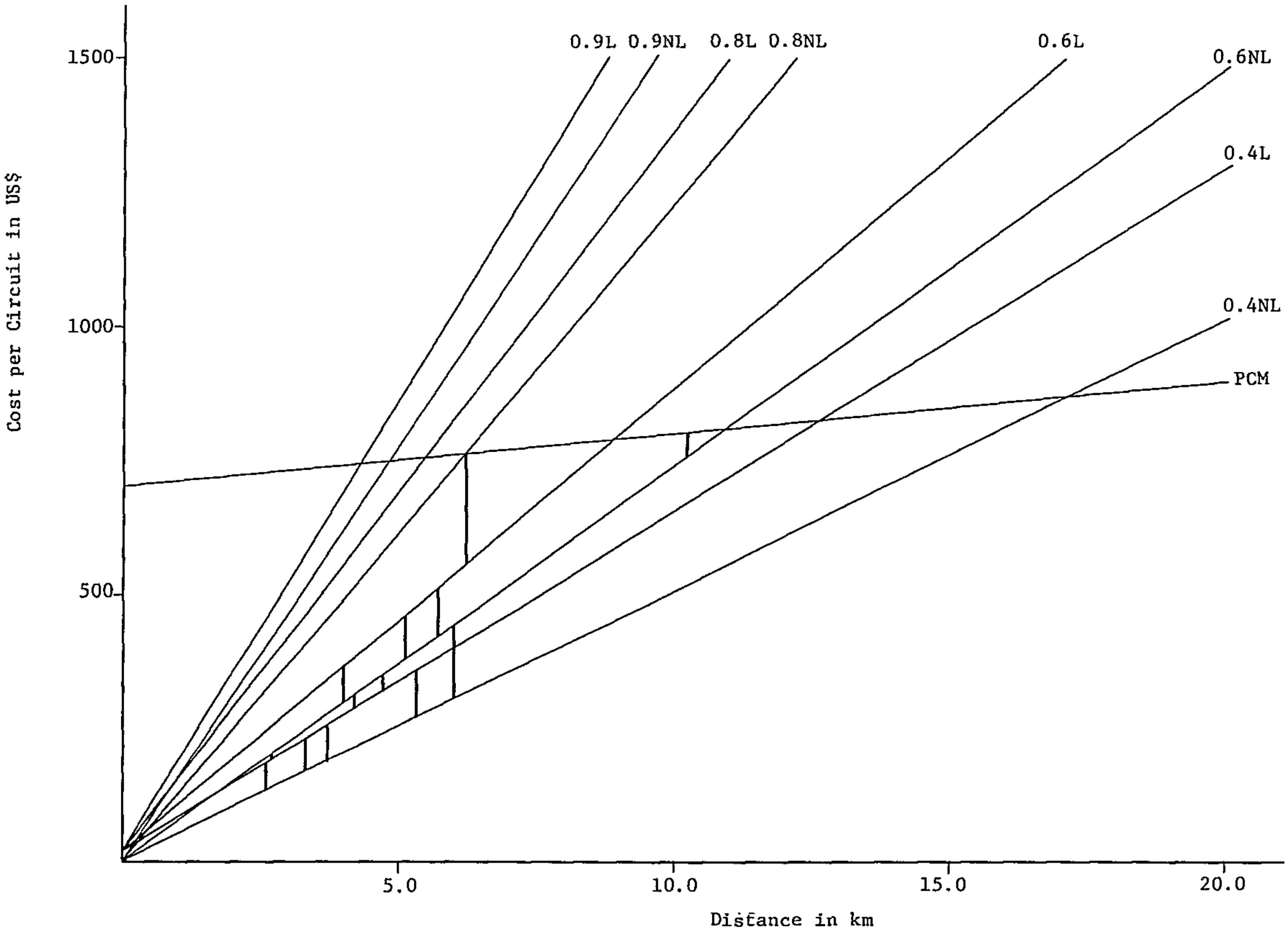
*Notes: 20 = Cost of impedance matching transformer

700 = Fixed cost of PCM transmission system per channel

d = Distance in Km

1-2-4 Optimum Transmission System

Figure V-2 summarizes the cost of each transmission system as a function of route distance, on the basis of the factors mentioned above. The cost of PCM transmission system according to distance is low, while the cost of cable transmission system is entirely proportional to the distance. Take up local high-usage circuit, for example: the distance of 11 Km is the application boundary between cable and PCM transmission systems.



Loss Objective (dB)	Loop Resistance (ohm)	Optimum Transmission System on Distance (Km)				
5.7*1	1600 1800	0.4NL 3.3	0.4L 4.2	06NL 5.1	0.6L 8.9	PCM
11.4*2	1600	0.4NL 5.3	0.6NL 10.2	PCM		
	1800	0.4NL 6.0	0.6NL 10.2	PCM		
6.4*3	1600 1800	0.4NL (0.4L) 3.7	0.4L 4.7	0.6NL 5.7	0.6L 8.9	PCM
4.5*4	1600 1800	0.4NL 2.6 (2.7)	0.6NL 4.0	0.6L 6.2	PCM	
16.4*5	1600	0.4NL 5.3	0.6NL 11.0	PCM		
	1800	0.4NL 6.0	0.6NL 11.0	PCM		

* Note:
1 - Between Local and SLDD Exchanges
2 - Local Exchange to Suburban and Area TDM Exchanges
3 - Suburban TDM Exchange to Area TDM Exchange
4 - Area TDM Exchange to Local Exchange
5 - Between Local Exchanges

Figure V-2 Optimum Transmission System on Distance

1-3 Junction Cable Network Plan

A plan for junction cable network for the years 1987 and 1993 has been prepared on condition that the existing junction cable facilities be fully utilized.

1-3-1 Existing Junction Cable Facilities

The existing junction cables are listed in Table V-6. The number of the existing junction cables is 123. The total number of cable pairs is 70,300. Out of this total, 38,930 pairs are non-loaded and 31,370 pairs loaded.

The cables, which are under installation or still in design or whose installation has been postponed, are included in the above figures and are considered as existing cables in this planning since they are definitely to be installed according to the installation schedule of PERUMTEL. Therefore, full utilization of the existing junction cables can be achieved in this planning.

1-3-2 Determination of Transmission System

The type of transmission system between exchanges is principally determined in accordance with the selection criteria for optimum transmission system in Paragraph 1-2-4 of this PART V which defines the most economical transmission system in proportion to the route distance between exchanges, depending on the transmission loss objective of each circuit category. As for route distance, a shorter route between exchanges is selected if any alternative route exists. However, in practice, the transmission system is finally decided by the following considerations:

1) Existing cables be fully used if a sufficient number of cable pairs are available even though PCM is economically feasible.
2) Priority be given to PCM for a route where the existing underground duct system is insufficient, provided that the increase of demand on that particular route is slow.
3) The accumulated number of circuits in the junction cable section concerned.
4) PCM and metallic combination circuit be made for the purpose of full utilization of the existing cables.

Table V-6 List of Existing Junction Cables (1/5)

No.	Junction Section	Cable No.	Cable Pairs	Non-Loaded	Loaded	Conductor Diameter (mm)	Date of Instal-lation	Distance (Km)
1.	GB1-GB2	001	1,200	1,200	-	0.6	*	3.8
2.		002	1,000	1,000	-	0.6	06 - 77	3.8
3.		003	800	-	800	0.6	11 - 78	3.8
4.		004	600	600	-	0.6	05 - 79	4.6
5.		005	300	300	-	0.8	02 - 78	3.8
6.		006	300	100	200	0.9	06 - 79	4.6
		Total	4,200	3,200	1,000	-	-	-
7.	GB1-KT1	011	1,200	-	1,200	0.65	Unknown	
8.		012	300	200	100	0.9	06 - 78	
9.		013	1,200	400	800	0.6	07 - 77	5.7
10.		018	800	800	-	0.8	11 - 78	
		Total	3,500	1,400	2,100	-	-	-
11.	GB1-KT2	021	600	600	-	0.8	12 - 78	
12.		022	1,200	900	300	0.6	04 - 78	
13.		023	1,200	400	800	0.6	10 - 76	
14.		024	600	-	600	0.8	10 - 76	4.6
15.		025	600	600	-	0.8	02 - 77	
16.		026	300	300	-	0.9	03 - 78	
17.		028	800	800	-	0.8	*	
		Total	5,300	3,600	1,700	-	-	-
18.	GB1-CPP	031	1,200	1,000	200	0.6	08 -78	
19.		032	1,200	400	800	0.6	*	
20.		033	400	-	400	0.8	*	6.6
21.		034	600	600	-	0.8	*	
22.		035	300	100	200	0.9	08 - 78	
23.		038	800	800	-	0.8	*	
		Total	4,500	2,900	1,600	-	-	-
24.	GB1-JTG	051	1,200	400	800	0.6	04 - 78	
25.		052	800	800	-	0.8	*	8.6
26.		053	400	-	400	0.8	04 - 77	
27.		058	800	800	-	0.8	*	
		Total	3,200	2,000	1,200	-	-	-
28.	GB1-KBY	061	1,200	400	800	0.6	07 - 76	
29.		062	1,200	400	800	0.6	09 - 76	
30.		063	800	800	-	0.8	*	8.1
31.		064	600	-	600	0.8	09 - 76	
32.		065	600	-	600	1.0	*	
33.		066	300	300	-	0.9	02 - 77	
34.		067	300	-	300	0.9	*	
35.		068	800	800	-	0.8	*	
		Total	5,800	2,700	3,100	-	-	-

*Note: Under installation or design

Table V-6 List of Existing Junction Cables (2/5)

No.	Junction Section	Cable No.	Cable Pairs	Non-Loaded	Loaded	Conductor Diameter (mm)	Date of Instal-lation	Distance (Km)
36.	GB1-SM1	071	1,200	400	800	0.6	03 - 77	
37.		072	1,000	1,000	-	0.6	06 - 78	
38.		073	600	600	-	0.8	02 - 77	5.5
39.		074	600	200	400	0.8	03 - 79	
40.		075	300	300	-	0.9	05 - 78	
		Total	3,700	2,500	1200	-	-	-
41.	GB1-SLP	081	600	600	-	0.8	02 - 77	
42.		082	400	-	400	0.8	05 - 76	7.0
43.		083	300	200	100	0.9	03 - 79	
		Total	1,300	800	500	-	-	-
44.	KT1-KT2	101	1,200	900	300	0.6	07 - 78	
45.		102	600	300	300	0.8	01 - 77	
46.		103	400	-	400	0.8	01 - 77	2.4
47.		104	300	100	200	0.9	06 - 78	
		Total	2,500	1,300	1,200	-	-	-
48.	KT1-ANC	111	400	400	-	0.6	*	
49.		112	600	400	200	0.8	10 - 78	7.2
50.		113	300	100	200	0.9	*	
		Total	1,300	900	400	-	-	-
51.	ANC-TPR	121	600	400	200	0.8	*	5.9
52.	KT1-PLT	131	600	300	300	0.6	08 - 76	
53.		132	400	-	400	0.8	08 - 76	4.5
54.		133	300	100	200	0.8	09 - 79	
		Total	1,300	400	900	-	-	-
55.	KT2-CPP	201	800	-	800	0.8	03 - 80	
56.		202	600	600	-	0.8	08 - 78	6.8
57.		203	300	200	100	0.9	01 - 78	
		Total	1,700	800	900	-	-	-
58.	KT2-CKG	221	300	300	-	0.8	*	14.9
59.		222	300	-	300	1.0	09 - 78	
		Total	600	300	300	-	-	-
60.	CPP-TPR	311	600	300	300	0.6	08 - 78	
61.		312	600	300	300	0.8	*	10.1
62.		313	300	100	200	0.9	04 - 78	
		Total	1,500	700	800	-	-	-
63.	CPP-KPG	331	1,200	800	400	0.6	*	
64.		332	300	-	300	0.8	*	8.0
65.		333	300	300	-	0.9	*	
		Total	1,800	1,100	700	-	-	-

*Note: Under installation or design

Table V-6 List of Existing Junction Cables (3/5)

No.	Junction Section	Cable No.	Cable Pairs	Non-Loaded	Loaded	Conductor Diameter (mm)	Date of Instal-lation	Distance (Km)
66.	CPP-RMG	341	800	400	400	0.8	02 - 79	
67.		342	300	300	-	0.8	03 - 78	6.9
68.		343	300	100	200	1.0	04 - 80	
		Total	1,400	800	600	-	-	-
69.	KBY-JTG	501	600	200	400	0.8	07 - 78	
70.		502	800	400	400	0.8	11 - 78	
71.		503	300	-	300	0.9	*	12.2
72.		504	300	300	-	0.9	08 - 78	
		Total	2,000	900	1,100	-	-	-
73.	JTG-KLD	511	400	200	200	0.6	*	
74.		512	400	200	200	0.8	*	5.0
75.		513	300	100	200	0.9	03 - 80	
		Total	1,100	500	600	-	-	-
76.	JTG-CAW	521	800	300	500	0.6	11 - 78	
77.		522	800	400	400	0.8	*	0.8
78.		533	300	300	-	0.9	10 - 78	
		Total	1,900	1,000	900	-	-	-
79.	PSR-CAW	531	200	30	170	1.0	11 - 77	5.7
80.	PSR-JTG	541	400	-	400	0.8	*	
81.		542	400	200	200	0.8	10 - 78	11.7
82.		543	300	100	200	0.9	09 - 78	
		Total	1,100	300	800	-	-	-
83.	PSR-GAN	551	300	100	200	0.9	12 -77	4.2
84.	JTG-GAN	561	200	-	200	0.9	*	15.1
85.	JTG-KAL	571	400	200	200	0.8	*	9.3
86.		572	300	200	100	0.9	07 - 78	
		Total	700	400	300	-	-	-
87.	JTG-TBT	581	1,200	900	300	0.6	11 - 77	
88.		582	800	800	-	0.8	04 - 79	
89.		583	600	-	600	0.8	05 - 79	4.5
90.		584	300	200	100	0.9	01 - 80	
		Total	2,900	1,900	1,000	-	-	-
91.	KBY-SM1	601	400	400	-	0.6	01 - 77	
92.		602	300	-	300	0.8	*	3.8
		Total	700	400	300	-	-	-

*Note: Under installation or design

Table V-6 List of Existing Junction Cables (4/5)

No.	Junction Section	Cable No.	Cable Pairs	Non-Loaded	Loaded	Conductor Diameter (mm)	Date of Instal-lation	Distance (Km)
93.	KBY-KAL	611	600	600	-	0.8	02 - 79	
94.		612	800	-	800	0.8	03 - 80	
95.		613	300	-	300	0.9	10 - 77	7.7
96.		614	300	300	-	0.9	05 - 78	
		Total	2,000	900	1,100	-	-	-
97.	KAL-PSM	621	800	400	400	0.8	2 - 79	
98.		622	300	200	100	0.9	9 - 77	4.9
		Total	1,100	600	500	-	-	-
99.	CPE-KBY	641	800	400	400	0.8	2 - 79	
100.		642	800	-	800	0.9	*	
101.		643	300	300	-	0.9	6 - 77	7.7
102.		644	300	-	300	0.9	8 - 78	
		Total	2,200	700	1,500	-	-	-
103.	CPE-CPA	651	300	-	300	0.9	6 - 80	
104.		652	300	300	-	0.8	7 - 77	9.3
		Total	600	300	300	-	-	-
105.	SM2-KBY	681	300	300	-	0.9	*	5.6
106.	SM1-SLP	701	400	200	200	0.8	1 - 79	
107.		702	300	100	200	0.9	12 - 78	6.8
		Total	700	300	400	-	-	-
108.	SM1-SM2	712	400	400	-	0.6	9 - 78	
109.		713	300	100	200	0.8	1 - 79	2.5
		Total	700	500	200	-	-	-
110.	SM1-PLM	722	400	100	300	0.8	07 - 79	
111.		723	300	300	-	0.9	04 - 78	6.5
		Total	700	400	300	-	-	-
112.	SLP-CKG	831	300	100	200	0.9	06 - 79	
113.		832	400	400	-	0.8	04 - 79	10.1
		Total	700	500	200	-	-	-
114.	JTG-KT2	911	800	-	800	0.6	*	
115.		912	300	200	100	0.8	*	12.5
116.		913	300	-	300	0.9	2 - 79	
		Total	1,400	200	1,200	-	-	-

*Note: Under installation or design

Table V-6 List of Existing Junction Cables (5/5)

No.	Junction Section	Cable No.	Cable Pairs	Non-Loaded	Loaded	Conductor Diameter (mm)	Date of Instal-lation	Distance (Km)
117.	JTG-CPP	921	600	600	-	0.6	8 - 78	
118.		922	800	400	400	0.8	9 - 78	
119.		923	600	-	600	0.8	5 - 78	9.3
120.		924	300	100	200	0.9	18 - 78	
		Total	2,300	1,100	1,200	-	-	-
121.	GB1-SM2	931	800	600	200	0.6	8 - 79	7.3
122.	GB1-PLM	941	1,200	900	300	0.6	3 - 79	10.9
123.	KT2-SLP	991	300	300	-	0.9	Unknown	7.1
	Grand Total		70,300	38,930	31,370	-	-	-

*Note: Under installation or design

The procedure of determining a transmission system is shown in Figure V-3. The breakdown of transmission systems by destinations of the circuits to all destinations appears in ANNEX I "Circuit Grouping".

1-3-3 Junction Cable Network Plan

The junction cable network plan is shown in Figure V-4.

(1) Number of Proposed Cables

When planning a new junction installation, it is preferable that the proposed cable holds capacity to cover the demand for more than 5 years ahead of the starting time of operation. For the purpose of an efficient use of an underground duct system, it is desirable to select the maximum pair size of cable which the size of duct permits. In this planning, the size of cable pairs is so selected that it will be most economical in terms of demand in both 1987 and 1993.

The number of proposed cables for each junction cable section is shown in Table V-7, which can be summarized as follows:

Year	Number of Proposed Cable Pairs	Number of Proposed Cables
1987	22,200	20
1993	13,800	21

(2) Number of PCM System

The number of PCM systems for the year 1987 is 457 systems, and 797 systems for the year 1993. Details of the PCM system network plan for the year 1987 in the Jakarta Telephone Network are shown in Figure V-5. The number of major PCM equipment in each telephone exchange is shown in Table V-8.

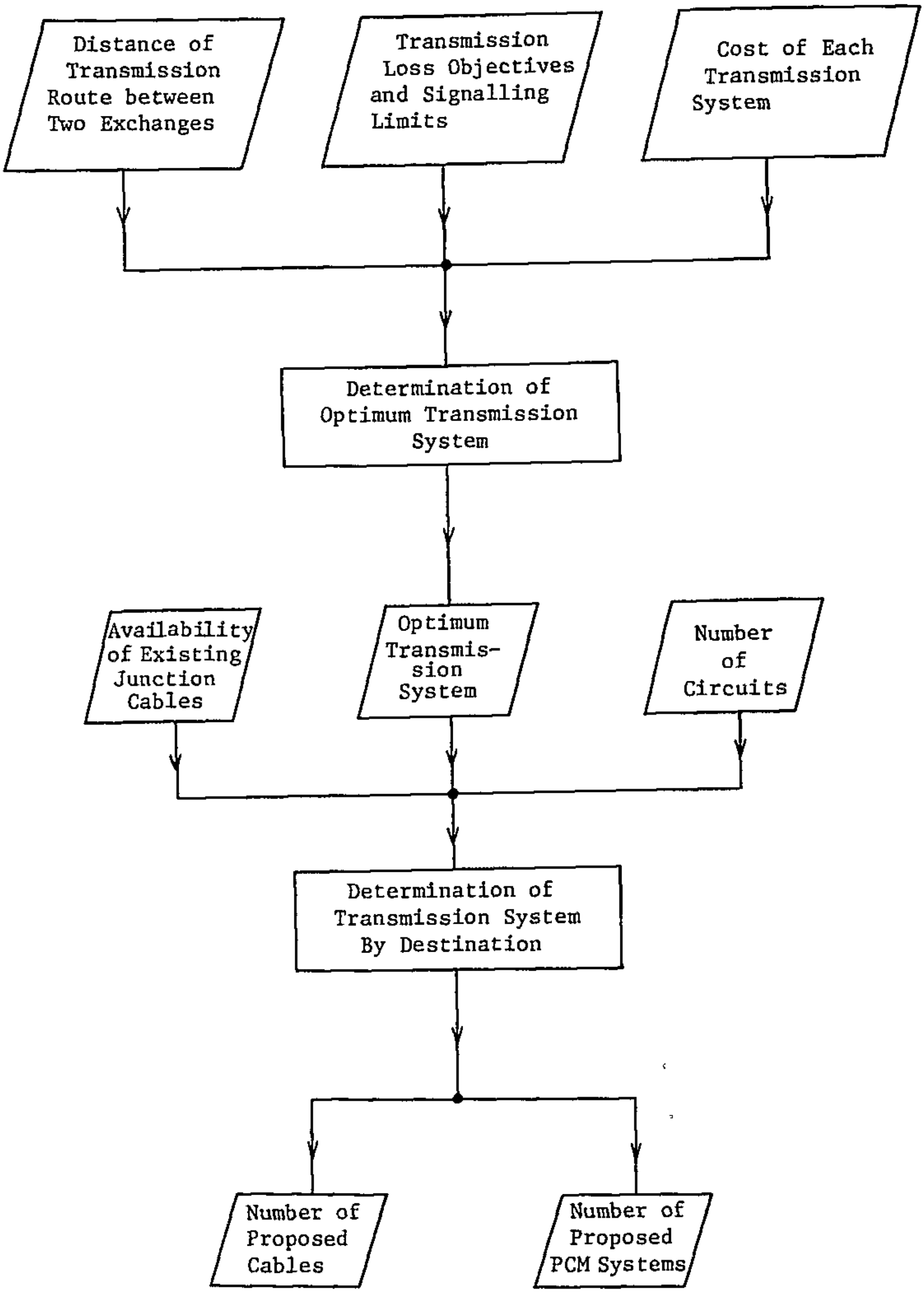


Figure V-3 Determination of Transmission System

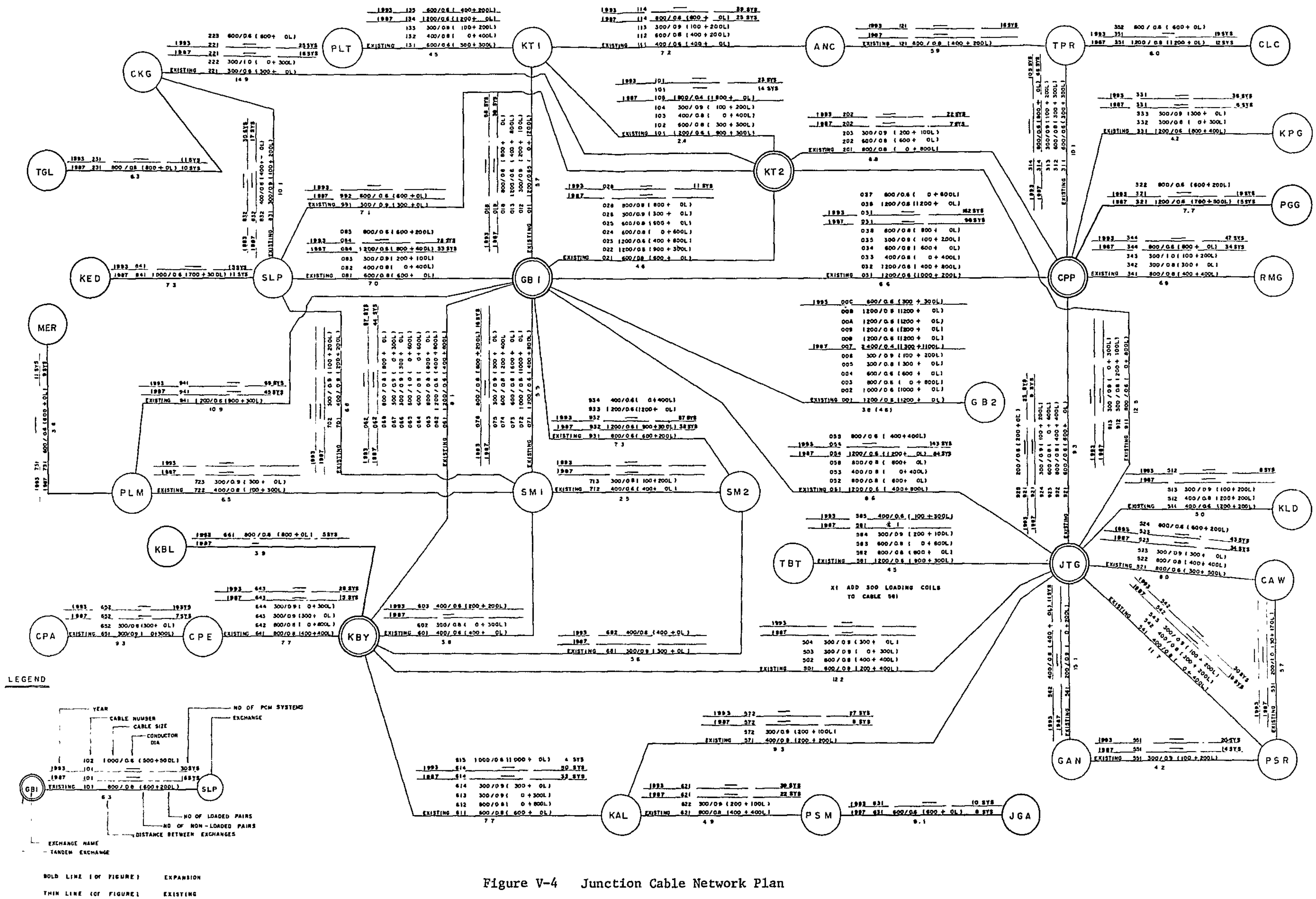


Figure V-4 Junction Cable Network Plan

Table V-7 Number of Proposed Junction Cables

Section No.	Junction Section	Number of Proposed Junction Cable 1987 Pairs	Conductor Diameter (mm)	1993 Pairs	Conductor Diameter (mm)	Remarks
00	GB1 - GB2	2,400x1	0.4	600x1	0.6	*1
		1,200x4	0.6	1,200x1	0.6	*1
03	GB1 - CPP	-	-	600x1	0.6	*1
05	GB1 - JTG	1,200x1	0.6	800x1	0.6	*1
07	GB1 - SM1	-	-	800x1	0.6	*1
08	GB1 - SLP	1,200x1	0.6	800x1	0.6	*1
10	KT1 - KT2	1,800x1	0.4	-	-	*1
11	KT1 - ANC	800x1	0.6	-	-	*1
13	KT1 - PLT	1,200x1	0.6	600x1	0.6	*1
22	KT2 - CKG	-	-	600x1	0.6	*1
23	TGL - CKG	800x1	0.6	-	-	*2
31	CPP - TPR	800x1	0.6	-	-	*1
35	TPR - CLC	1,200x1	0.6	600x1	0.6	*2
34	CPP - RMG	800x1	0.6	-	-	*1
32	CPP - PGG	1,200x1	0.6	800x1	0.6	*2
52	JTG - CAW	-	-	800x1	0.6	*1
56	JTG - GAN	-	-	400x1	0.6	*1
58	JTG - TBT	-	-	400x1	0.6	*1
60	KBY - SM1	-	-	400x1	0.6	*1
61	KBY - KAL	-	-	1,000x1	0.6	*1
63	PSM - JGA	600x1	0.6	-	-	*2
66	KBY - KBL	-	-	800x1	0.6	*2
68	SM2 - KBY	-	-	400x1	0.6	*1
70	SM1 - SLP	-	-	400x1	0.6	*1
73	PLM - MER	600x1	0.6	-	-	*2
84	SLP - KED	1,000x1	0.6	-	-	*2
92	JTG - CPP	-	-	200x1	0.6	*1
93	GB1 - SM2	1,200x1	0.6	1,200x1	0.6	*1
				400x1	0.6	*1
99	KT2 - SLP	600x1	0.6	-	-	*1
	Total	22,200(20)*3	-	13,800(21)*3	-	

*Note: 1. Existing cable route
2. Proposed cable route
3. Number of cables

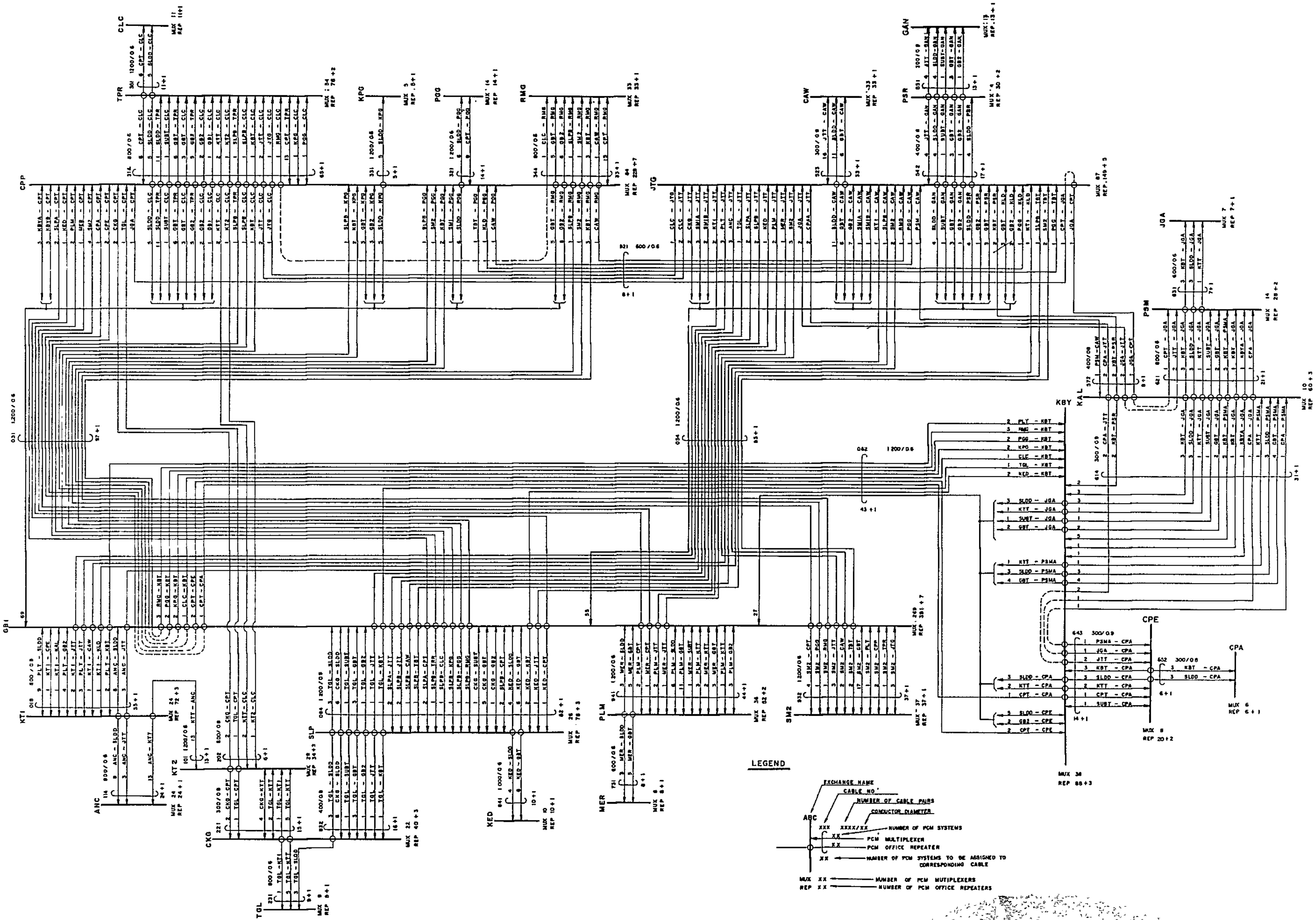


Figure V-5 PCM System Network Plan as of 1987

Table V-8 Number of Major PCM Equipment

No.	Exchange	PCM Multiplexer		PCM Office Repeater	
		1987	1993	1987	1993
1.	KT1	24	53	75	120
2.	KT2	28	57	37	81
3.	CKG	22	43	43	66
4.	ANC	24	51	25	55
5.	TGL	9	10	10	11
6.	CB1	269	398	398	691
7.	SM1	-	15	-	16
8.	SM2	37	66	38	67
9.	SLP	26	42	81	121
10.	PLM	36	58	54	80
11.	KED	10	12	11	13
12.	MER	8	10	9	11
13.	CPP	84	167	235	414
14.	RMG	33	46	34	47
15.	TPR	54	85	78	140
16.	KPG	5	35	6	36
17.	CLC	11	18	12	19
18.	PGG	14	18	15	19
19.	KBY	38	66	91	174
20.	KBL	-	4	-	5
21.	CPA	6	15	7	16
22.	CPE	8	12	22	44
23.	PSM	14	29	30	49
24.	KAL	10	33	63	120
25.	JGA	7	9	8	10
26.	JTG	87	154	154	285
27.	CAW	33	42	34	43
28.	PSR	4	10	32	50
29.	GAN	13	29	14	31
30.	KLD	-	7	-	8
	Total	914	1,594	1,616	2,842

2. Design Standard

A description is made here of a design standard for junction cable network. This standard is based on PERUMTEL's Fundamental Plan 1972, Outside Plant Installation Design Principles and Engineering Instructions, PART IV "TECHNICAL OBJECTIVES" of this report, and the result of full discussions between PERUMTEL and JTP '79.

2-1 Underground Duct System

2-1-1 Route Selection

The underground duct route must be selected on the basis of field survey results, city planning data and other relevant information. In addition, all technical implications in the construction and maintenance aspects must also be taken into full consideration.
In case the provision of new underground duct facilities is necessary, the appropriate route selection should be made in due consideration of the following:

1) Roads with the shortest distance for the underground route.
2) Roads which will not be disused or discontinued as a result of city planning, etc.
3) Roads not crossed by rivers, bridges, railways and so on.
4) Roads with few buried facilities and where underground plant construction work can be easily carried out.
5) Roads which are wide and do not cause serious obstruction to the traffic during construction work.
6) Unpaved roads.

2-1-2 Number of Ducts

(1) Number of Ducts

The number of ducts is determined by the required number of cables. The required number of junction and trunk cables should meet the requirements given in the long term plan. In addition, the appropriate number of subscriber cables should be taken into account in the case of duct routes where subscriber cables are also present.
Therefore, the number of ducts is calculated by multiplying the total required number of cables by the demand variation factor of 1.5 and raising fractions to the unit.

(2) Spare Ducts

Spare ducts are to be provided as specified below, in accordance with the number of ducts:

Number of Ducts	Spare Ducts
1 - 15	1
16 - 30	2
31 - 45	3
46 or more	4

(3) Ducts in Entrance Section

The minimum number of ducts entering into the exchange is 48. The number of ducts in excess of this minimum limit is to be determined by case-by-case computation. The said minimum number of ducts in the entrance section does not apply to the mobile exchange.

2-1-3 Type of Duct

(1) Type of Duct

The duct consists principally of a pipe made of "Polyvinyl Chloride (PVC)". However, the steel pipe is also used in case of shallow burying.

(2) Duct Size

Diameter of duct is either 50 mm or 100 mm.

(3) Span Length between Manholes

The span length between manholes is to be so determined that it will best suit the cable branching, cabinet location, road shape, etc. Maximum length is as follows:

Shape of Span	Maximum Length (m)
Straight	200
Curved	100

2-1-4 Duct Arrangement

The standard duct arrangement will be as shown in Figure VI-1 of PART VI of this report in accordance with the number of ducts required.

2-1-5 Duct Location

If the sidewalk and the roadway are clearly distinguishable, the duct must occupy the sidewalk, while in the case of a road without sidewalk the duct should be installed on the edge of either side of the roadway.

2-1-6 Manhole

A manhole is constructed at a place where the following activities have to be carried out:

Cable jointing, cable branching, accommodation of PCM line repeater housing and loading coil, and installation and maintenance work. A manhole must be large enough to accommodate the following:

a) Required number of ducts
b) One or two workmen
c) Splicing cases
d) Loading coils
e) PCM or other repeater housings

Manhole types and their dimensions are shown in Table VI-1 and Figures VI-2 and 3 of PART VI of this report. A manhole where the repeater housings and loading coils are located requires a spacing of 100 cm between its base and lowest bearer. If the existing manhole cannot accommodate PCM line repeater housing and loading coil, an appropriate manhole must be constructed at a place adjacent to the existing manhole. For the manholes where the duct route also serves for subscriber cable distribution, appropriate coordination to the subscriber cable network plan should be made for determining the type of manhole.

2-2 Cable Specifications

2-2-1 Type of Cable

The type of proposed junction cable is the jelly-filled, polyethylene insulated and sheathed, and unit quad type cable, in principle. This type of cable is accommodated in the underground duct system. The proposed cable for the PCM transmission system is preferred to be of the screened core, jelly-filled, and polyethylene insulated and sheathed type, because it enables the full use of cable pairs for PCM application with a smaller number of line repeaters.

At the following places the direct buried cable with steel tape armouring is employed:

1) Where the change of cable route may be required in the future as a result of road and/or river improvement.

2) Where the underground duct system is not proper because of the pending road planning.

2-2-2 Number of Cable Pairs

The number of cable pairs for the proposed junction cables is shown below:

Conductor Diameter (mm)	Number of Cable Pairs
0.4	300, 400, 600 800, 1000, 1200 1600, 1800, 2400
0.6	300, 400, 600 800, 1000, 1200

2-2-3 Electrical Characteristics of Cables

The electrical characteristics of cables in terms of direct current loop resistance and line attenuation at 800 Hz classified by conductor diameters are shown below:

Conductor Diameter (mm)	Loop Resistance (ohm/Km)	Line Attenuation at 800 Hz (dB/Km)	
		Non-loaded	Loaded
0.4	300	1.69	1.26
0.6	130	1.11	0.56
0.8	73	0.87	0.34
0.9	58	0.74	0.26
1.0	46	0.66	0.21

A detailed calculation of cable attenuation appears in Paragraph 4-1 of PART IV of this report. In case of a loaded cable, loop resistance of 7 ohms per loading coil must additionally be taken into account, depending on the number of coils.

2-3 Impedance Matching

2-3-1 Combination of Cables

The following order of line connections has to be taken into account for the purpose of smoother matching, when different junction cable sections are connected in tandem:

1) To combine the same conductor diameters all the way through, if possible.

   Example: 0.4 + 0.4 + 0.4
   0.6 + 0.6 + 0.6

2) To combine the same type of cable systems all the way through, if possible.

   Example: 0.6(loaded) + 0.4(loaded) + 0.6(loaded)
   0.6(non-loaded) + 0.6(non-loaded) + 0.4(non-loaded)

3) The "(loaded) + (non-loaded) + (loaded)" configuration should be avoided in order to minimize the reflection points.

2-3-2 Application of Impedance Matching Transformer

The characteristic of impedance differs from one cable to another. The difference of impedance between non-loaded and loaded lines is sometimes not negligible when they are connected in tandem without the use of impedance matching transformer. In order to obtain better return loss performance and reduce the effect of talker echo, the impedance matching transformer should be applied as specified below:

1) For the circuit of local connection the impedance matching transformer is not applied at the junction point. Therefore, the additional loss caused by impedance mismatching, which may be in the value of 0.5 dB at each reflection point, must be taken into account.

2) For the circuits which form a part of inter-local connection, the impedance matching transformer should be applied at the junction point between non-loaded and loaded lines.

3) For any loaded circuits which are extended to a PCM or other carrier system in the local junction network, the impedance matching transformer should be applied at the termination point.

2-4 Loading Design

2-4-1 Type of Loading System

The type of loading system adopted in Indonesia is featured as follows:

1) Inductance of loading coil 80 mH
2) Nominal loading spacing (So) 1500 m

2-4-2 Loading Spacing

The following rules are applicable to the loading spacing design:

1) Spacing design of each junction cable section should be made independently.

2) Loading system should not be used for the junction cable section of short distance (approximately 3 Km or less) because of small merit.

3) The layout of loading spacing should begin from the ends of both exchanges with the exception of the following cases:

   a) In a junction cable section where all circuits in the cable are terminated in the exchange. (No transit circuit in terms of both traffic and cable routes.)

   b) In a junction cable section where the precise location of the proposed exchange is unknown.

   In the above two cases, the layout of loading spacing should begin only from the other side of an exchange which is already in existence.

4) The length of junction cable in the loading spacing is defined as the length from MDF of one exchange to that of the other exchange.

5) The length for the calculation of spacing is the length of the duct, while in the cable vault section the length of the cable sheath is used for calculation.

2-4-3 Deviation of Loading Spacing

The main factors to be considered in laying out a loading system are maximum deviations respectively from the nominal and average spacings, and end section terminals to obtain better return loss performance. The maximum deviations of spacing are defined as follows:

(1) Deviation of average spacing ($\overline{S}$) from nominal spacing (So)

$$\frac{So - \overline{S}}{So} \times 100 \leq \pm 5\%$$

where

$$\overline{S} = \frac{S_1 + S_2 + \cdots\cdots + S_n}{n} = \frac{\sum_{i=1}^{n} Si}{n}$$

(2) Deviation of average spacing ($\bar{S}$) from individual spacing (Si)

$$\frac{\bar{S} - Si}{\bar{S}} \times 100 \leq \pm 5\%$$

(3) Deviation of average half spacing ($\bar{S}/2$) from individual half spacing (Si/2)

$$\frac{\bar{S}/2 - Si/2}{\bar{S}} \times 100 \leq \pm 5\%$$

2-4-4 Compensation of Loading Spacing

Loading coil cannot always be laid out at the desired points due to physical construction problems. Build-out capacitor (BOC) is used for the purpose of compensation in order to obtain the electrical equivalent of nominal length.

It is desirable to place build-out capacitor at the middle of the deficient section in order to obtain higher return loss.

2-4-5 Balancing Joint

Balancing joint is required to reduce crosstalk between pairs within a quad. The main factor to cause crosstalk is the non-uniformity of cable structure and material. At the present time of planning, the balancing joint is required for loaded pairs only and at the middle of each loading section.

2-4-6 Cable Unit Assignment for Loaded Pair

In principle, the loaded lines will be allocated from the inner unit of cable in order to use the outer unit for PCM circuit. In other words, the priority in cable unit assignment will be given to PCM circuits and/or other carrier systems when they coexist in the same cable.

2-5 PCM Line Engineering

Primary order PCM transmission system can be applied by any type of symmetrical pair cable. In determining the repeater spacing, it must be assured that a given error rate is not exceeded. The possible maximum spacing on a given cable depends on the transmission attenuation and crosstalk of the cable, on the gain of the line repeater and on the number of PCM systems to be employed in the cable at the end of the planning period. However, in order to facilitate installation, the spacings of line repeaters are usually made shorter than the possible maximum length.

2-5-1 Error Performance

In the case of PCM transmission, a parameter which may be used as a measure of line repeater performance is the bit error rate (BER).

An error rate of 1×10^{-6} is considered as tolerable for high quality PCM telephone transmission.

2-5-2 PCM Pair Assignment

The PCM pair assignment for cable is closely related to the PCM repeater spacing design in terms of characteristics of near-end crosstalk of the cable concerned.

The type of cable used in Indonesia is polyethylene insulated and sheathed unit quad type telephone cable. Each 10 basic units of cables having 400 - 1,200 pairs are stranded to form main units of 100 pairs and these main units are stranded again in layers to the core.

"Go" and "Return" pairs for PCM transmission systems are assumed to be allocated in the mutually different main units. PCM pairs are assumed to be contained only in the three basic units of the 100-pair main unit. The three basic units are allocated in the center of the cable layer, so that the outer cable layer consisting of 7 basic units makes an effective shielding layer.

Pair assignment is illustrated in Figure V-6 and unit assignment is shown in Figure V-7.

In case where PCM is applied to 300 pairs cable, PCM is assumed to be applied only to the two main units of 50 pairs. Pair assignment is shown in Figure V-8.

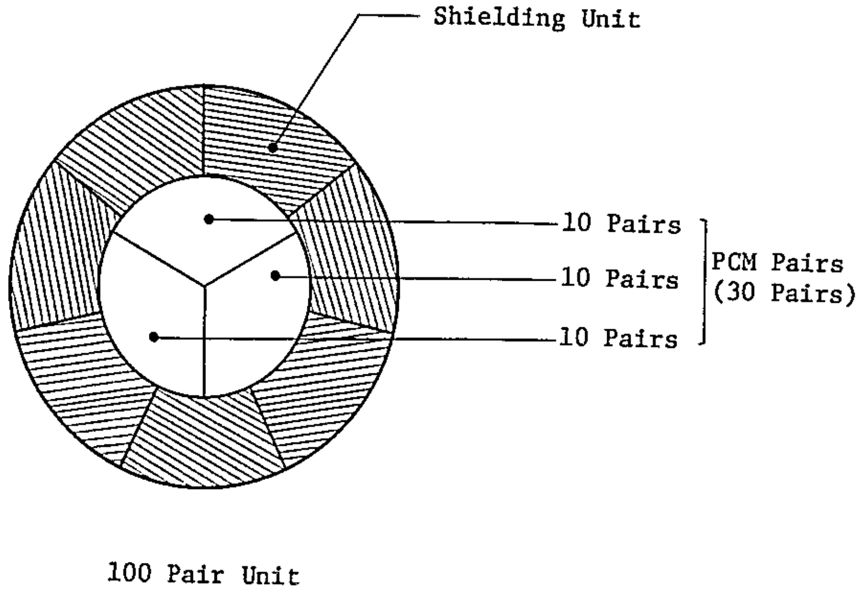
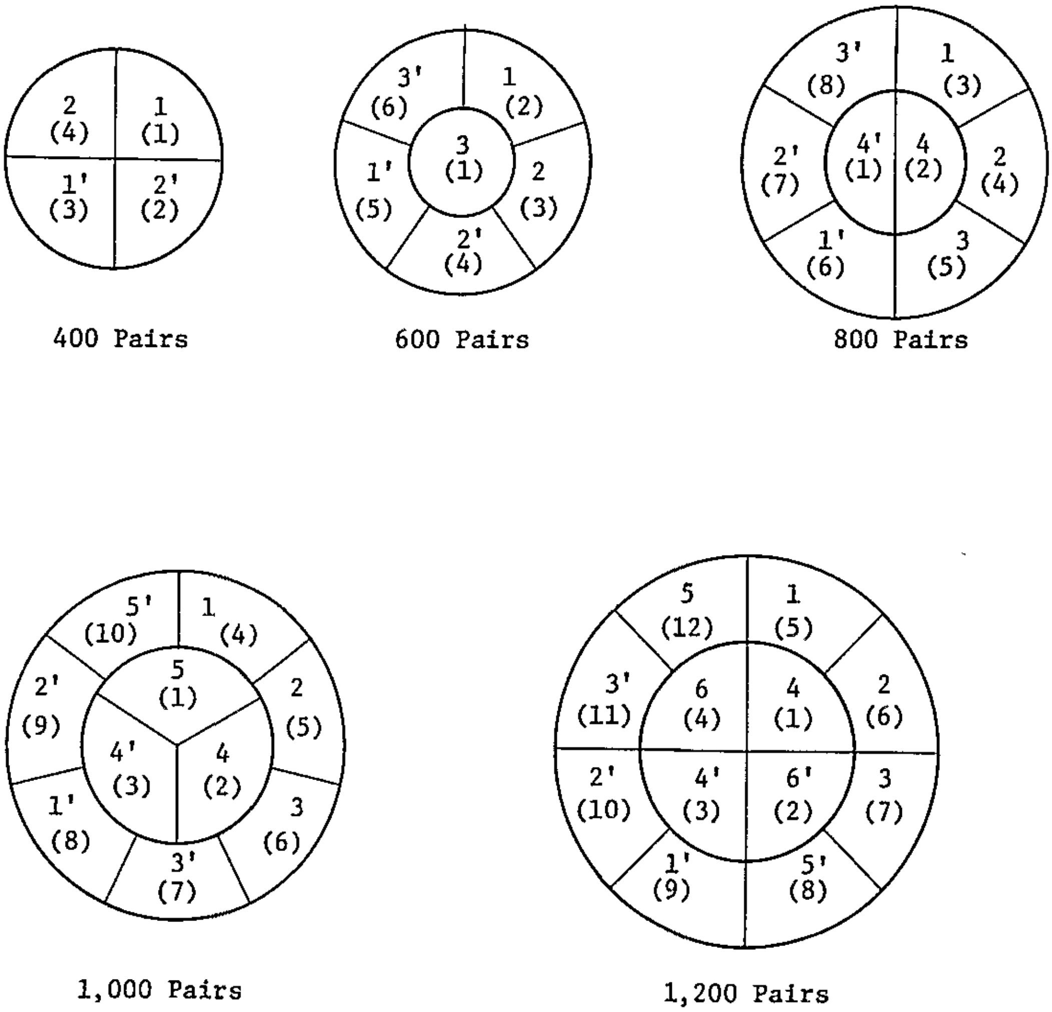


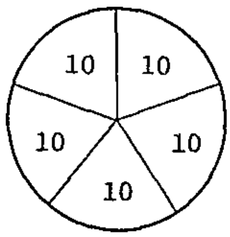
Figure V-6 PCM Pair Assignment



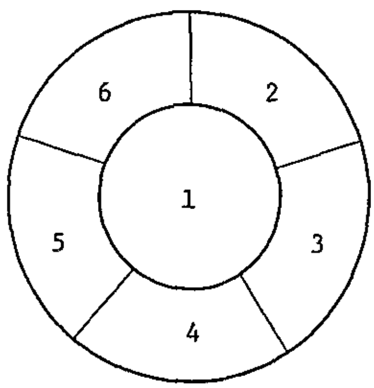
Legend

1,2,3... : Unit for PCM "Go" Pair
1',2',3'... : Unit for PCM "Return" Pair
(1),(2),(3)... : Unit Number of Cable

Figure V-7 PCM Unit Assignment



50 Pair Unit



300 Pairs

Legend

2 : Unit for PCM "Go" Pair

4 : Unit for PCM "Return" Pair

1,3,5,6 : Shielding Unit

Figure V-8 PCM Pair Assignment for 300 Pair Cable

When PCM is applied to the existing cables, care must be exercised for the following:

1) If the cable pairs to be assigned for PCM operation are inductively loaded, the loading coils must be removed from such pairs.
2) On junction cables, or on subscriber cables converted for PCM application, the cables should be thoroughly inspected for bridged taps. These must be removed, as they present large impedance irregularities at carrier frequency.

2-5-3 Line Repeater Spacing Determined by AGC Operation Range

(1) Maximum Line Repeater Spacing (d MAX)

The cable loss of a regenerator section is restricted by the preamplifier gain of the regenerative repeater. The value of 40 dB at a frequency of 1024 KHz is assumed to be the maximum allowable cable loss of a regenerator section. Maximum repeater spacing (d MAX) is determined by the following formula:

$$d\ MAX \leq \frac{G}{(1 + \alpha \times \Delta t)\ (1 + 3\delta)\ Lo}$$

where:

d MAX = Maximum line repeater spacing in Km

G = Maximum gain of regenerator in dB

α = Temperature coefficient of cable attenuation (2×10^{-3} per ^{o}C)

Δt = Cable temperature variation range from $20^{o}C$ ($10^{o}C$ in Jakarta)

Lo = Mean value of cable attenuation in dB per Km at 1024 KHz and at $20^{o}C$

δ = Standard deviation of Lo, including manufacturing deviation and cable map error (0.03)

Consequently, d MAX is calculated as follows:

Lo x d MAX = 40/(1+0.002x10)(1+3x0.03) = 35.98 dB

Attenuation of cable at 1024 KHz (Lo) by conductor diameter is shown below:

Conductor Diameter (mm)	Attenuation (dB/Km)
0.4	29.12
0.6	20.74
0.8	17.18
0.9	15.88
1.0	14.05

Therefore, the maximum repeater spacing by AGC operation range (d MAX) for each conductor diameter of cable is as follows:

Conductor Diameter (mm)	d MAX (Km)
0.4	1.24
0.6	1.73
0.8	2.09
0.9	2.27
1.0	2.56

(2) Repeater Spacing for Terminal Regeneration Section (d END)

The distance between a PCM terminal or office repeater and the nearest line repeater in the receiving direction of transmission should be made shorter than that of the nominal section, to reduce the effect of impulsive noise from the exchange. To obtain the given error rate for this section, an electrical length of 20 dB is assumed. Repeater spacing adjacent to exchange (d END) is determined by the following formula:

$$d\ END \leq \frac{20}{(1 + \alpha \times \Delta t)\ (1 + 3\delta)\ Lo}$$

Therefore, d END is calculated as follows:

$$Lo \times d\ END = 20/(1 + 0.002 \times 10)(1 + 3 \times 0.03)$$
$$= 18.0\ dB$$

d END for each conductor diameter of cable is shown below:

Conductor Diameter (mm)	d END (Km)
0.4	0.62
0.6	0.87
0.8	1.05
0.9	1.13
1.0	1.28

2-5-4 Line Repeater Spacing Restricted by Near-End Crosstalk (NEXT)

The maximum repeater spacing restricted by near-end crosstalk is expressed by the following formula:

$$(Mn + 1.2) - 2.33\sigma - (1 + \alpha \times \Delta t)(1 + 3\delta)Lo \times d - (10\log n + 2.5) \geq S(\varepsilon)$$

where:

Mn = Mean near-end crosstalk in dB at half the bit rate (1024 kHz - 30 CH sys)

σ = Standard deviation of Mn (2.9 dB)

$S(\varepsilon)$ = Signal-to-noise ratio causing regenerator to ensure bit error rate objective of 1×10^{-9}

n = Ultimate number of PCM systems

α = Temperature coefficient of cable attenuation (2×10^{-3} per ^{o}C)

Δt = Cable temperature variation range from $20^{o}C$

Lo = Mean value of cable attenuation in dB per Km at 1024 kHz and $20^{o}C$

δ = Standard deviation of Lo, including manufacturing deviation and cable map error (0.03)

Assuming that $S(\varepsilon)$ is 30 dB, the restriction by NEXT effect in single cable operation is then expressed as follows:

$$Lo \times d = \frac{Mn - 10\log n - 38.057}{1.118}$$

The value of Mn varies, depending upon PCM pair assignments. Mn of polyethylene insulated cable at 1024 KHz for various pair assignments are shown below:

	Pair Assignment	Mn (dB)
a)	Non-adjacent unit	98
b)	Adjacent unit	91
c)	Non-adjacent layer	73
d)	Adjacent layer	62
e)	In the same layer	56

The relations between maximum repeater spacing and number of PCM transmission systems restricted by NEXT are shown in Figure V-9. Table V-9 shows a PCM line repeater spacing in Km by conductor diameter in accordance with the number of PCM systems to be employed, on condition that mean near-end crosstalk is 90 dB.

2-5-5 Power Feeding

Line repeaters are powered by a direct current through the phantom circuit of two pairs used for PCM transmission.

The maximum permissible power feeding distance is given by the following formula:

$$d \leq \frac{E - n \times V}{(1 + \alpha \times \Delta t)\ R \times I}$$

where:

d = Power feeding distance (Km)

E = Power supply voltage (V)

I = Feeding current (A)

V = Drop voltage per line repeater (V)

n = Number of line repeaters

R = Resistance of phantom loop (ohm/Km)

α = Temperature coefficient (ohm/^{o}C)

Δt = Variation of temperature (^{o}C)

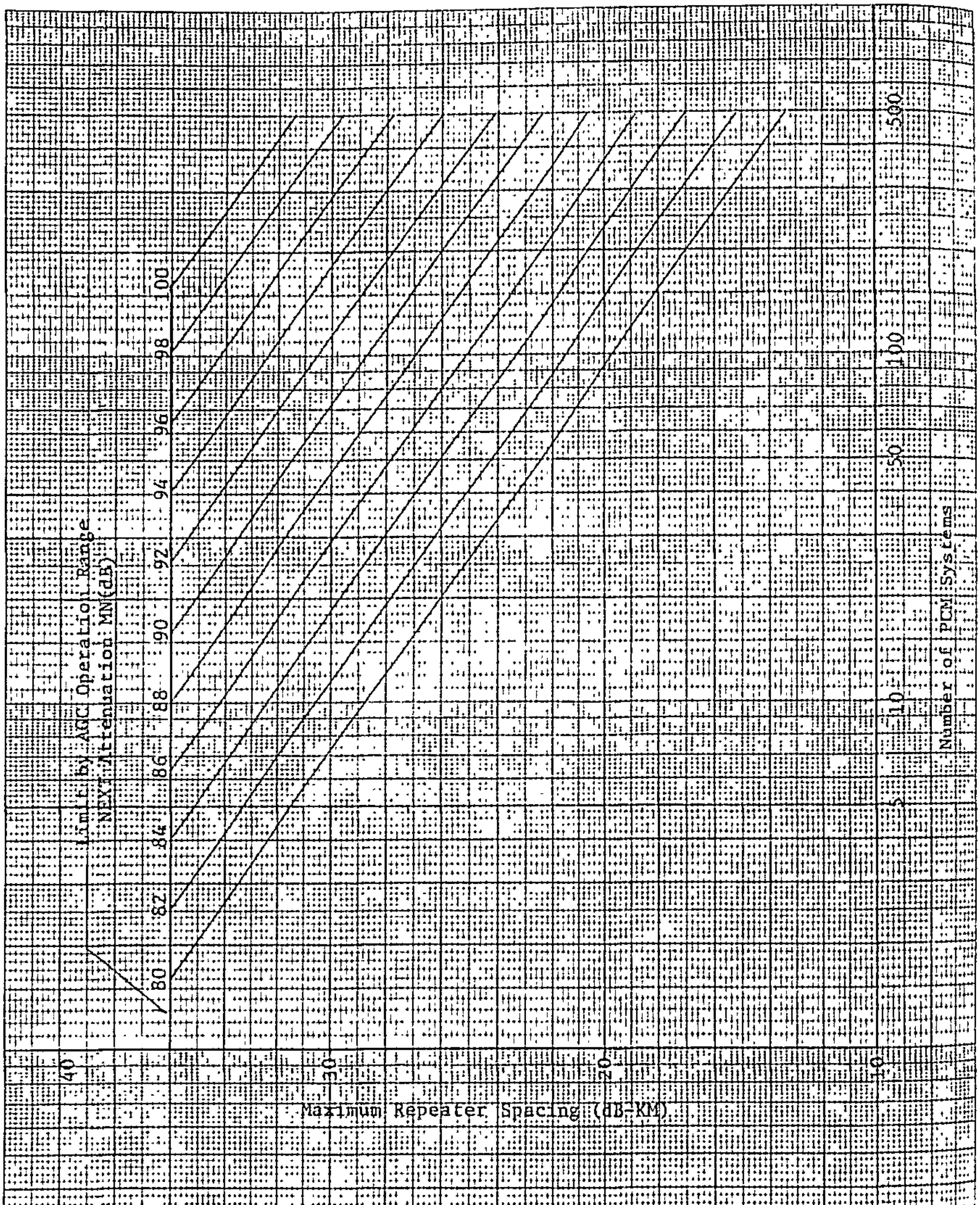


Figure V-9 -- Maximum Repeater Spacing by NEXT

Table V-9 PCM Repeater spacing Restricted by Near-End Crosstalk Effect with Adjacent Unit Assignment

Number of PCM Systems	Lo x d (dB x Km)	d NEXT in Km				
		0.4 mm	0.6 mm	0.8 mm	0.9 mm	1.0 mm
1 - 36	32.72	1.12	1.58	1.90	2.06	2.33
37 - 72	30.01	1.03	1.45	1.75	1.89	2.14
73 - 108	28.43	0.98	1.37	1.65	1.79	2.02
109 - 144	27.31	0.94	1.32	1.59	1.72	1.94
145 - 180	26.43	0.91	1.27	1.54	1.66	1.88
181 - 216	25.72	0.88	1.24	1.50	1.62	1.83
217 - 252	25.12	0.86	1.21	1.46	1.58	1.79
253 - 288	24.60	0.84	1.19	1.43	1.55	1.75
289 - 324	24.14	0.83	1.16	1.41	1.52	1.72
325 - 360	23.73	0.81	1.14	1.38	1.49	1.69

Note: The following values are assumed for the calculation:

1) Mn = 90 dB
2) S(ε) = 30 dB
3) σ = 2.9 dB
4) Δt = $10^{o}C$

2-5-6 Provision of PCM Spare System

In order to minimize non-functioning time in the case of line repeater fault, a hot reserve PCM repeatered line should be installed for every route. For each route, it is sufficient to provide a single reserve line independent of the number of PCM systems in service. The concept of a PCM spare link is shown in Figure V-10.

2-5-7 Number of Cable Pairs for PCM System

Number of cable pairs for one PCM system is 2 pairs: 1 pair for "Go" direction and 1 pair for "Return" direction. In addition, the pairs for supervisory, ordering and alarm sending are necessary. Therefore, the number of cable pairs (N) for PCM system will be as follows:

$$N = 2n + 3 + \alpha$$

where:

n = number of PCM systems

α = miscellaneous pairs as required

2-6 PCM Inside Plant Engineering

Following are some remarks on inside plant design for the introducion of PCM system:

2-6-1 Signalling Conversion

Signalling conversion is necessary between switching and PCM multiplexer equipments when a conventional channel associated signalling is used. Equipments for signalling conversion are usually prepared in conjunction with a PCM multiplexer equipment. The type of signalling converter may differ depending upon the line signallings to be used. Sequences of line signallings depending upon the connections between the various types of switching systems in the Jakarta Telephone Network are shown in Table IV-3, 4, 5 and 6 in PART IV of this report.

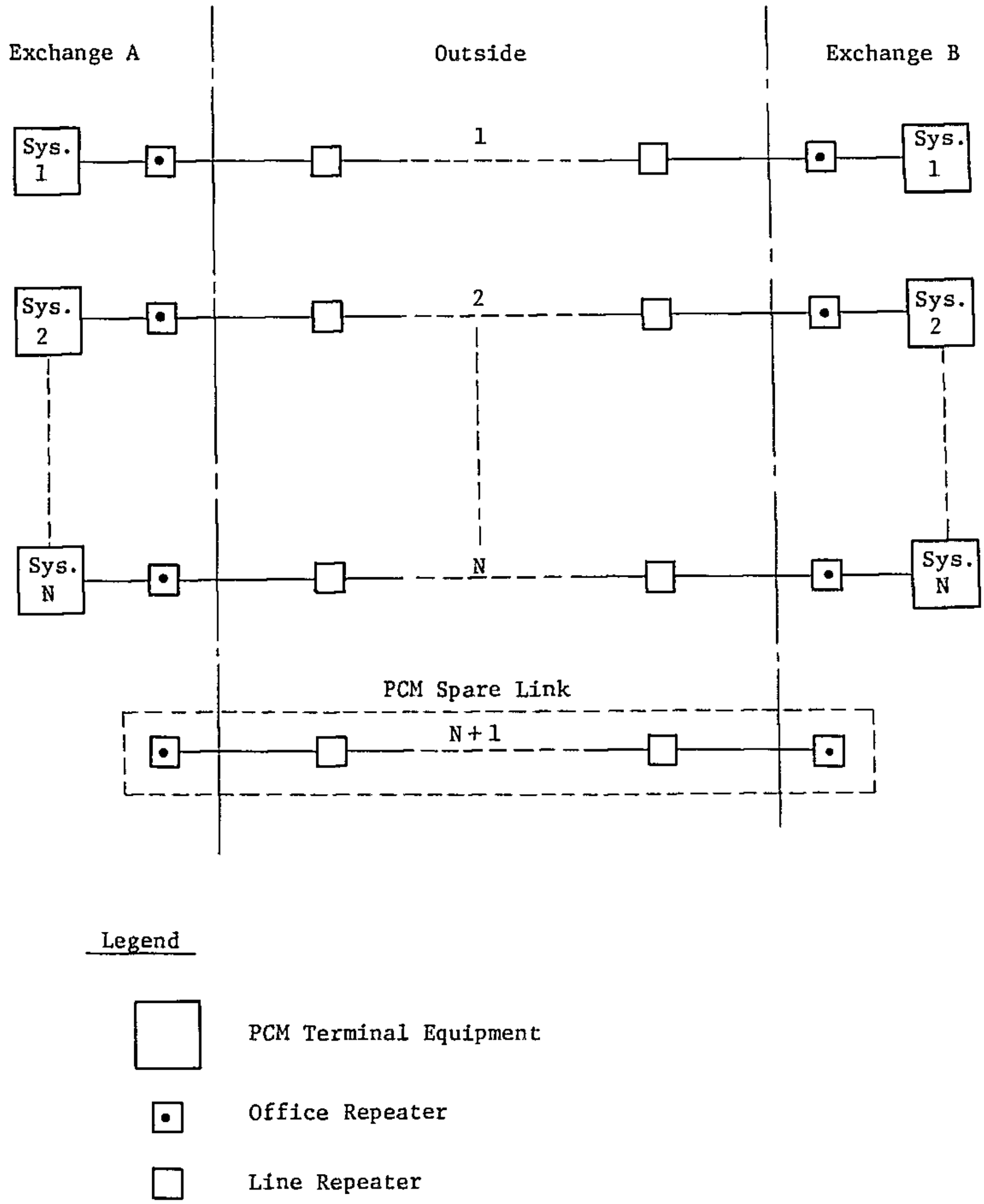


Figure V-10 Provision of PCM Spare Link

2-6-2 Wiring of PCM Equipments

The general wiring configuration of PCM equipments at terminal and intermediate exchanges appears in Figure V-11.

Except at the exchange without a through system, it is convenient to place the digital distribution frame (DDF) between office repeater and multiplexer for the purpose of easier maintenance and operation.

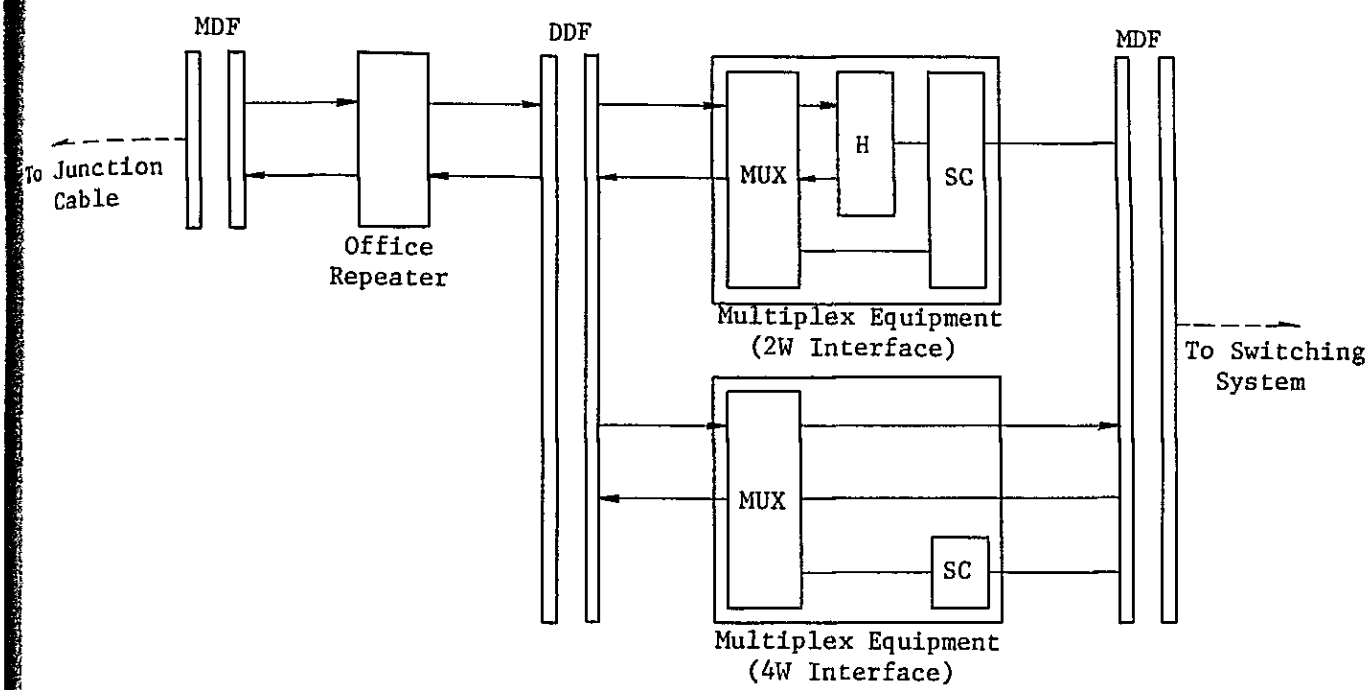
2-6-3 Location of PCM Equipments

It is preferable to install PCM equipments at a place near the MDF and free from dirt and dust. Most of the telephone exchanges in Jakarta have a room for a transmission system near the MDF. In the exchanges where this particular space is not available, PCM equipments should be placed in a switching room. It is also preferable to have the space for the PCM equipments large enough to cover the required ultimate number of PCM systems.

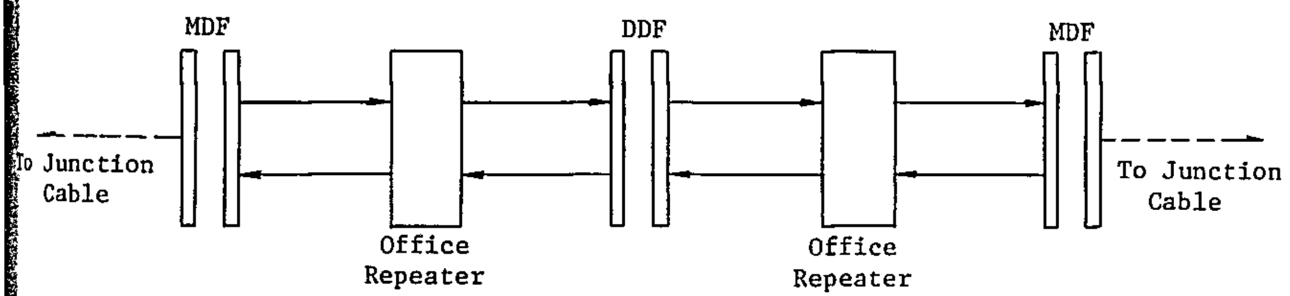
2-6-4 Power Supply to PCM Equipments

The input power to PCM equipments may be derived from a power plant of the existing switching system which is either DC -48V or DC -60V. However, caution must be taken with respect to the capacity of the existing power equipment in order that a considerable increase in power consumption as a result of the installation of PCM equipments will not disturb the power supply for the switching system.

(1) Terminal Exchange



(2) Intermediate Exchange



Legend

MUX : PCM Multiplexer

H : Hybrid Coil

SC : Signalling Converter

DDF : Digital Distribution Frame

Figure V-11 Typical Wiring Arrangement of PCM System

3. Basic Design

The basic design of the junction cable for the year 1987 in the Jakarta Telephone Network is carried out on the basis of the Junction Cable Network Plan in Chapter 1 of PART V of this report.

The technical criteria of basic design are followed in the Design Standard in Chapter 2 of this PART V.

Even though the plant records of the existing junction cable were known to be highly reliable, a field survey was conducted for some junction routes to confirm those records. A field survey for the proposed cable route was also made.

Furthermore, the design policy of PERUMTEL has been conscientiously observed as a guideline for the plan following the engineering discussions with PERUMTEL.

3-1 Design Policy

3-1-1 Selection of Cable Route

(1) Route for Existing Exchange

The existing underground duct systems are fully utilized for installing additional cables, provided a sufficient number of such cable ducts are vacant.

On the other hand, if the existing duct systems cannot accommodate any additional cable installation, either of the following alternatives has to be considered: to increase the number of cable ducts on the existing duct route, or to construct another duct route.

The choice between these two alternatives depends on the following factors:

a) Regulations of the municipality
b) Technical constraints
c) Trend of demand increase
d) Promotion of juncton route diversity
e) Long-term cable route plan

1) In the following cases, the increase of ducts in the existing manhole may be economically feasible:

a) The number of proposed cables is comparatively small.
b) Modification of the existing manhole is not necessary in connection with the duct increase.

2) The provision of a new junction cable route is more advantageous in the following cases as well as in the reverse to the abovementioned cases:

   a) Location of a manhole along the junction route can be so designed as to obtain the ideal spacing for PCM line repeater and loading.
   b) Ample dimensions of manhole to accommodate PCM line repeater and loading coil.
   c) Reliable network can be achieved in terms of transmission route diversity.
   d) Redundancy of unexpected demand.

The final choice between the two alternatives mentioned above has been made for each junction cable section concerned after the field survey in coordination with the subscriber cable expansion plan.

(2) Route for Proposed Exchange

The new junction cable route for proposed exchanges has been established after the comparative study of several alternative routes. Especially the existing duct route availability and the physical reference for construction have been investigated during the field survey.

3-1-2 Loading Design

The basic design of loading spacing for the junction cable network plan determined in Paragraph 1-3 of this PART V has been made, based on the design standard "Loading Design" in Paragraph 2-4 of this PART V. The following assumptions underlie the basic design of loading spacing:

1) In case the addition of a loading coil is required to the existing loaded cable, the proposed loading points are determined to coincide with the existing loading points, even if the deviation of loading coil spacing exceeds the limited value.
   In this case, the deficient loading sections have been compensated by use of build-out capacitor (BOC).

2) The necessity of a balancing joint for the junction cable is mostly dependent on the quality of cable. However, in case the well balanced cable is introduced in the future, such a joint will not be required. The balancing joint has been conceived in this planning due to the absence of details concerning the quality of proposed cables.

3) In case the existing loaded units have to be de-loaded to assign PCM circuits to them, the free loading coils have been connected to other vacant units.

3-1-3 PCM Design

The basic design of PCM unit assignment and line repeater spacing for the number of PCM systems determined in Paragraph 1-3 of this PART V has been made, based on the design standard "PCM Line Engineering" in Paragraph 2-5 of this PART V. The following assumptions underlie the basic design of PCM line repeater spacing:

1) Maximum number of PCM line repeaters to be contained in one PCM repeater housing be 36.

2) Ultimate number of PCM systems in each corresponding cable be the multiple of 36, nearest to the figure in 1993 estimated by JTP '79.

3) Electrical characteristics of the proposed cable be the same as those of the existing cable. (This is because the type of the proposed cable is unkonwn.)

4) Investigation of several existing manholes has been carried out. Change of repeater spacing may be necessary at the time of the detailed design because of the impractical installation of line repeater housing discovered during the thorough field survey of manholes.

3-2 Outline of Basic Design

The basic design covers the entire junction cable network in Jakarta, including the junction cables for the proposed exchanges. The following three kinds of design drawings are used in the basic design:

a) Loading and PCM system plan

b) Junction cable route plan

c) MDF terminating and cable vault plan

These drawings are presented in the attached Annex II "Junction Cable Network Basic Design."

Figure V-12 shows the junction cable network in Jakarta.

3-2-1 Proposed Cable

20 expansion cables are proposed in this planning. In particular, the proposed cables between Gambir I and Gambir II Exchanges, estimated to be five in number, will result in the expansion of a new underground duct route to overcome the shortage of the existing vacant ducts.

Also, a new duct route between Gambir I and Semanggi II Exchanges has been established for the same reason as above.

The other existing duct plants are expected to provide sufficient vacant ducts for the installation of proposed cables under the present condition or after the minor-scale civil construction.

The proposed junction cable (J-105) between Kota I and Kota II Exchanges is partially occupied by the existing cable which is a free cable and has no possibility to be used as a subscriber cable in the future.

3-2-2 PCM Application

The basic design of PCM line repeater spacing for the introduction of 457 PCM systems, the target figure for 1987, has been completed.

Details of this design appear in the drawing of ANNEX II, "Loading and PCM System Plan," which can be summarized as follows:

1) Number of junction cables, to which PCM transmission system is applied, is 30, i.e., 18 existing and 12 proposed, cables.

2) Number of PCM line repeater housings is 230.

3) Number of PCM line repeater units is 4,769.

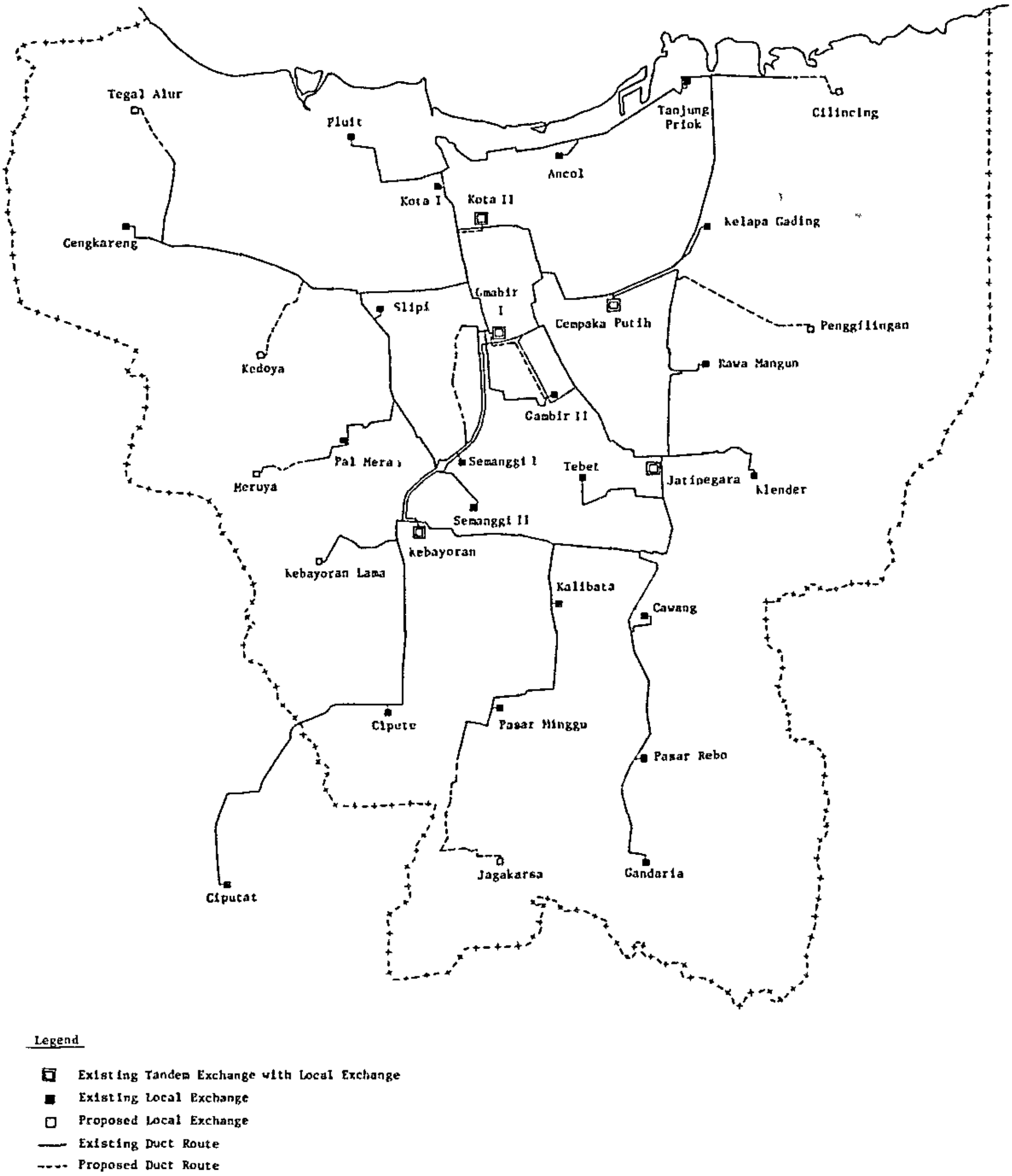


Figure V-12 Junction Cable Network in Jakarta

3-3 Amount of Main Works

A calculation has been made for the amount of main works required for the basic design of junction cable network.

3-3-1 Cable Work

(1) Cable

1) The amount of proposed cables between the existing exchanges is as follows:

Conductor Diameter (mm)	Number of Cable Pairs	Number of Cables	Cable Length (m)
0.4	2,400	1	3,452.0
0.4	1,800	1	2,373.0
0.6	1,200	8	42,020.9
0.6	800	3	24,110.0
0.6	600	1	7,049.0
Total	-	14	79,004.9

The breakdown of cables by junction cable section is listed in Table V-10.

2) Amount of proposed cables between the existing and proposed exchanges is as follows:

Conductor Diameter (mm)	Number of Cable Pairs	Number of Cables	Cable Length (m)
0.6	1,200	2	12,587.0
0.6	1,000	1	6,784.0
0.6	800	1	5,796.0
0.6	600	2	11,168.0
Total	-	6	36,335.0

The breakdown of cables by junction cable section is listed in Table V-11.

Tavle V-10 Amount of Proposed Cables between Existing Exchanges

No.	Junction Section	Cable No.	Cable Pair	Conductor Diameter (mm)	Cable Length (m)
1.	GB1 - GB2	007	2,400	0.4	3,452.0
2.	ditto	008	1,200	0.6	3,452.0
3.	ditto	009	1,200	0.6	3,452.0
4.	ditto	00A	1,200	0.6	3,452.0
5.	ditto	00B	1,200	0.6	3,452.0
6.	GB1 - JTG	054	1,200	0.6	9,053.0
7.	GB1 - SLP	084	1,200	0.6	6,973.0
8.	KT1 - KT2	105	1,800	0.4	2,373.0
9.	KT1 - ANC	114	800	0.6	7,150.0
10.	KT1 - PLT	134	1,200	0.6	4,445.9
11.	CPP - TPR	314	800	0.6	10,064.0
12.	CPP - RMG	344	800	0.6	6,896.0
13.	GB1 - SM2	932	1,200	0.6	7,741.0
14.	KT2 - SLP	992	600	0.6	7,049.0
	Total	-	16,800	-	79,004.9

Table V-11 Amount of Proposed Cables between Existing and Proposed Exchanges

No.	Junction Section	Cable No.	Cable Pair	Conductor Diameter (mm)	Cable Length
1.	CKG - TGL	231	800	0.6	5,796.0
2.	CPP - PGG	321	1,200	0.6	7,105.0
3.	TPR - CLC	351	1,200	0.6	5,482.0
4.	PSM - JGA	631	600	0.6	7,930.0
5.	PLM - MER	731	600	0.6	3,238.0
6.	SLP - KED	841	1,000	0.6	6,784.0
	Total	-	5,400	-	36,335.0

(2) Loading Pair

1) Number of loading pairs between the existing exchanges is 2,100 pairs. The breakdown of loading pairs by junction cable section is listed in Table V-12.

2) Number of loading pairs between the existing and proposed exchanges is 800 pairs. The breakdown of loading pairs by junction cable section is listed in Table V-13.

3-3-2 PCM Work

The amount of PCM work is divided into two categories:
PCM systems between the existing exchanges, and those between the existing and proposed exchanges. The breakdown of PCM multiplexers and office repeaters is listed in Table V-14, and the breakdown of PCM line equipments is listed in Table V-15.
They are summarized as follows:

Description	Quantity (1)*1	Quantity (2)*2	Total
a) PCM Multiplexer	642	272	914
b) PCM Office Repeater	1,068	548	1,616
c) PCM Line Repeater Housing	163	57	220
d) PCM Line Repeater Unit	3,169	1,600	4,769

*Note: 1. PCM systems between the existing exchanges

2. PCM systems between the existing and proposed exchanges

Table V-12 Amount of Proposed Loaded Pairs between Existing Exchanges

No.	Junction Section	Cable No.	Cable Pair	Conductor Diameter (mm)	Distance (Km)	Loaded Pair	Loading Point	Type of Loading Coil (Pair)	Number of Loading Coils	Remarks
1.	JTG - TBT	581	1,200	0.6	4.5	300	3	300	3	*1
2.	GB1 - GB2	007	2,400	0.6	3.5	1,100	3	1,200	3	*2
3.	GB1 - SLP	084	1,200	0.6	7.0	400	5	400	5	*2
4.	GB1 - SM2	932	1,200	0.6	7.8	300	6	300	6	*2
	Total	-	-	-	-	2,200	-	2,000	17	-

*Note: 1 Existing cable
2 Proposed cable

Table V-13 Amount of Proposed Loaded Pairs between Existing and Proposed Exchanges

No.	Junction Section	Cable No.	Cable Pair	Conductor Diameter (mm)	Distance (Km)	Loaded Pair	Loading Point	Type of Loading Coil (Pair)	Number of Loading Coils
1.	CPP - PGG	321	1,200	0.6	7.1	500	5	600	5
2.	SLP - KED	841	1,000	0.6	6.8	300	5	300	5
	Total	-	-	-	-	800	10	900	10

Table V-14 Amount of PCM Equipments

No.	Exchange	PCM Multiplexer (1)*1	(2)*2	Total	PCM Office Repeater (1)*1	(2)*2	Total
1.	KT1	23	1	24	74	1	75
2.	KT2	17	11	28	24	13	37
3.	CKG	12	10	22	14	29	43
4.	ANC	24	0	24	25	0	25
5.	TGL	0	9	9	0	10	10
6.	GB1	195	74	269	288	110	398
7.	SM2	36	1	37	37	1	38
8.	SLP	19	7	26	33	48	81
9.	PLM	28	8	36	29	25	54
10.	KED	0	10	10	0	11	11
11.	MER	0	8	8	0	9	9
12.	CPP	47	37	84	132	103	235
13.	RMG	32	1	33	33	1	34
14.	TPR	36	18	54	37	41	78
15.	KPG	0	5	5	0	6	6
16.	CLC	0	11	11	0	12	12
17.	PGG	0	14	14	0	15	15
18.	KBY	25	13	38	62	29	91
19.	CPA	6	0	6	7	0	7
20.	CPE	7	1	8	21	1	22
21.	PSM	5	9	14	6	24	30
22.	KAL	10	-	10	31	32	63
23.	JGA	0	7	7	0	8	8
24.	JTG	70	17	87	135	19	154
25.	CAW	33	0	33	34	0	34
26.	PSR	4	0	4	32	0	32
27.	GAN	13	0	13	14	0	14
	Total	642	272	914	1,068	548	1,616
		(321)*3	(136)*3	(457)*3			

*Note: 1 PCM systems between the existing exchanges

2 PCM systems between the existing and proposed exchanges

3 Number of PCM systems

Table V-15 Amount of PCM Line Equipments (1/2)

No.	Junction Section	Cable No.	Cable Pair	Conductor Diameter (mm)	PCM System (1)*1	PCM System (2)*2	PCM System Total	Distance (Km)	PCM Repeater Station	PCM Line Equipment Quantity: Housing (1)*1	Housing (2)*2	Housing Total	Repeater Unit (1)*1	Repeater Unit (2)*2	Repeater Unit Total	Remarks
1.	GB1 - KT1	018	800	0.8	35	1	36	5.7	4	4	0	4	140	4	144	Existing Cable
2.	GB1 - CPP	031	1,200	0.6	57	41	98	6.6	6	12	6	18	342	246	588	"
3.	GB1 - KBY	062	1,200	0.6	29	15	44	8.1	7	7	7	14	203	105	308	"
4.	KT1 - KT2	101	1,200	0.6	14	0	14	2.4	2	2	0	2	28	0	28	"
5.	KT2 - CPP	202	600	0.8	3	4	7	6.8	4	4	0	4	12	16	28	"
6.	KT2 - CKG	221	300	0.8	7	9	16	14.9	9	9	0	9	63	81	144	"
7.	CPP - KPG	331	1,200	0.6	0	6	6	8.0	3	0	3	3	0	18	18	"
8.	JTG - CAW	523	300	0.9	34	0	34	8.0	5	5	0	5	170	0	170	"
9.	JTG - PSR	542	400	0.8	18	0	18	11.7	7	7	0	7	126	0	126	"
10.	PSR - GAN	551	300	0.9	14	0	14	4.2	3	3	0	3	42	0	42	"
11.	JTG - KAL	572	300	0.9	6	3	9	9.3	5	5	0	5	30	15	45	"
12.	KBY - KAL	614	300	0.9	19	13	32	7.7	5	5	0	5	95	65	160	"
13.	KAL - PSM	621	800	0.8	6	16	22	4.9	3	3	0	3	18	48	66	"
14.	KBY - CPE	643	300	0.9	14	1	15	7.7	4	4	0	4	56	4	60	"
15.	CPE - CPA	652	300	0.8	7	0	7	9.3	6	6	0	6	42	0	42	"
16.	SLP - CKG	832	400	0.8	7	10	17	10.1	6	6	0	6	42	60	102	"
17.	JTG - CPP	921	600	0.6	2	7	9	9.3	7	7	0	7	14	49	63	"
18.	GB1 - PLM	941	1,200	0.6	29	16	45	10.9	8	8	8	16	232	128	360	"
	Subtotal	-	-	-	300	143	443	-	94	97	24	121	1,655	839	2,494	-

* Note: 1. PCM systems between the existing exchanges

2. PCM systems between the existing and proposed exchanges

Table V-15 Amount of PCM Line Equipments (2/2)

No.	Junction Section	Cable No.	Cable Pair	Conductor Diameter (mm)	PCM System (1)*1	PCM System (2)*2	PCM System Total	Distance (Km)	PCM Repeater Station	PCM Line Equipment Quantity: Housing (1)*1	Housing (2)*2	Housing Total	Repeater Unit (1)*1	Repeater Unit (2)*2	Repeater Unit Total	Remarks
19.	GB1 - JTG	054	1,200	0.6	75	9	84	9.1	7	21	0	21	525	63	588	Proposed Cable
20.	GB1 - SLP	084	1,200	0.6	26	27	53	7.0	6	6	6	12	156	162	318	"
21.	KT1 - ANC	114	800	0.6	25	0	25	7.2	6	6	0	6	150	0	150	"
22.	CKG - TGL	231	800	0.6	0	10	10	5.8	4	0	4	4	0	40	40	"
23.	CPP - TPR	314	800	0.6	37	29	66	10.1	8	16	0	16	296	232	528	"
24.	CPP - PGG	321	1,200	0.6	0	15	15	7.1	5	0	5	5	0	75	75	"
25.	CPP - RMG	344	800	0.6	33	1	34	6.9	5	5	0	5	165	5	170	"
26.	TPR - CLC	351	1,200	0.6	0	12	12	5.5	4	0	4	4	0	48	48	"
27.	PSM - JGA	631	600	0.6	0	8	8	8.0	6	0	6	6	0	48	48	"
28.	PLM - MER	731	600	0.6	0	9	9	3.3	3	0	3	3	0	27	27	"
29.	SLP - KED	841	1,000	0.6	0	11	11	6.8	5	0	5	5	0	55	55	"
30.	GB1 - SM2	932	1,200	0.6	37	1	38	7.8	6	12	0	12	222	6	228	"
	Subtotal	-	-	-	230	135	365	-	65	66	33	99	1,514	761	2,275	-
	Total	-	-	-	530	278	808	-	159	163	57	220	3,169	1,600	4,769	

*Note: 1 PCM systems between the existing exchanges

2 PCM systems between the existing and proposed exchanges

3-3-3 Underground Duct System Work

(1) Manhole

Manhole Type	Quantity (1)*1	(2)*2	Total
S-1	-	92	92
S-1R	-	17	17
S-2	28	1	29
S-2R	6	-	6
S-3	20	2	22
S-3R	4	2	6
S-4	3	-	3
S-4R	1	-	1
T-1	1	6	7
T-2	2	-	2
Total	65	120	185

*Note: 1. Between the existing exchanges: The number of existing manholes, where PCM repeater housing or loading coil will be accommodated, is 98. In case the accommodation is impossible, the expansion of the existing manhole or the construction of the S-1 type manhole at the place adjacent to the existing manhole will be required.

2. Between the existing and proposed exchanges: The number of existing manholes, where PCM repeater housing or loading coil will be accomodated, is 7 in relation to the provision of new cable route. In case the accommodation is impossible, the expansion of the existing manhole or the construction of the S-1 type manhole at the place adjacent to the existing manhole will be required.

(2) Duct

Number of Ducts	Length (m) (1)*1	(2)*2	Total
4	-	7,778.0	7,778.0
6	-	6,090.0	6,090.0
8	1,081.9	1,770.0	2,851.9
10	1,022.8	840.0	1,862.8
16	589.0	-	589.0
20	4,126.5	-	4,126.5
24	70.0	550.0	620.0
28	3,370.0	-	3,370.0
30	350.0	-	350.0
48	-	170.0	170.0
Total	10,610.2	17,198.0	27,808.2

*Note: 1 Between the existing exchanges

2 Between the existing and proposed exchanges

PART VI SUBSCRIBER CABLE NETWORK PLAN

PART VI SUBSCRIBER CABLE NETWORK PLAN

Telephone demand in the city of Jakarta is considered to increase further in the future. To cater for such demand increase, the subscriber cable network expansion is necessary. In this Part, the design standard which establishes the subscriber cable basic design and the outline of the expansion works for the 5 local exchanges are presented.

The basic design of 5 exchanges was formulated for Kota I, Kota II, Pluit, Gambir I and Jatinegara I Exchanges at the request of PERUMTEL.

1. Design Standard

The design standard set forth herein is for the basic design of subscriber cable network. This standard is based on PERUMTEL's Fundamental Plan 1972, Outside Plant Installation Design Principles and Engineering Instructions, and the result of full discussions between PERUMTEL and JTP '79.

1-1 Structure of Subscriber Cable Network

The structure of subscriber cable network is twofold. One is the cabinet system. The other is the direct service system. The cabinet system is adopted in principle.

1-1-1 Cabinet System

The cabinet system uses cross-connecting cabinets on the cable line and makes jumper connection of primary and secondary cables in the cabinet. The main advantage of this flexible network is that the primary cable pairs are saved and the section of the network can be developed independently.

1-1-2 Direct Service System

The primary cable pairs are extended rigidly from the MDF to the DP. This system is applied in the area nearest to the exchange and in the building area.

1-2 Cabinet Area

The cabinet area is a unit area to control the telephone demand and facilities for effective use and to realize suitable expansion of the telephone facilities. To achieve this purpose efficiently, the area must be defined on a long term basis. The cabinet area thus determined should, through the administration of design, construction and maintenance, contribute to the effective utilization of the system.

1-2-1 Determination of Cabinet Area

Firstly, the exchange area is divided into provisional cabinet areas, using rivers, railways, highways, etc., as boundaries. Subsequently, in consideration of the existing outside plant and roads, administrative blocks and terms of location, the cabinet areas are established in the final form in which the sum of demand estimates 15-20 years from now will be 600 or 300.

If the establishment of cabinet areas is impossible because the town planning, road planning, etc., for the future are still pending, the cabinet areas are to be established in the future. In this case, the temporary distribution areas are used. The size of temporary distribution areas should be such as will suit the local geography.

1-2-2 Location of Cabinet

One cabinet is used in each cabinet area. The cabinet is to be located on the exchange side in the cabinet area. The cabinet location is required to be near the manhole or handhole. Furthermore, the cabinet location must be the place where the secondary cable pairs can be economically distributed and where the cabinet relocation in the future will not be required.

1-2-3 Type of Cabinet

(1) Cabinet Capacity

The cabinet capacity comprises the following two categories:

1) 1,600 pairs

The cabinet of 1,600 pairs capacity is used when the total demand estimate 15-20 years later is 600.

2) 800 pairs

The cabinet of 800 pairs capacity is used when the total demand estimate 15-20 years later is 300.

(2) Terminal Block and Stub Cable of Cabinet

1) The terminal block of the cabinet must have capacities for 200 pairs and 100 pairs. In both cases, the stub cable is to be the jelly-filled cable.

2) The terminal block stub cable connection to primary and secondary cables must be carried out in the handhole.

1-3 Underground Duct System

The underground duct system must be economical. In consideration of its safety, maintenability and workability, it is designed by the following criteria:

1-3-1 Route Selection

The underground duct route must be selected on the basis of field survey results, city planning data and other relevant information. In addition, all technical implications in the construction and maintenance aspects must also be taken into full consideration.

(1) Utilization of Existing Underground Facilities

The design should be carried out as in the following manner so as to achieve full utilization of the existing outside plant facilities:

1) If there are sufficient vacant ducts other than spare ducts, the proposed cables are to be installed in such vacant ducts.

2) When no vacant ducts are available, the replacement of the existing small pair cable with larger pair cable may be a solution. However, this depends on the individual cases.

Decision should be made after careful examinations of relevant factors such as cost study, operational and installation conditions.

(2) Provision of New Underground Duct Route

In case the provision of new underground duct facilities is necessary, the appropriate route selection should be made in due consideration of the following:

1) Roads which will allow the shortest distance for the underground duct route;
2) Roads where the cabinets can be easily constructed;
3) Roads which will not be disused or dicontinued by city planning, etc.;
4) Roads not crossed by rivers, bridges, railroads, and so on;
5) Roads with few buried facilities and where underground plant construction work can be easily carried out;
6) Roads which are wide and do not cause serious obstruction to the surface traffic during construction work;
7) Unpaved roads.

1-3-2 Duct

(1) Number of Ducts

The number of required ducts consists of the number of duct cables and spare ducts.

1) Number of Duct Cables

The number of subscriber cables, which covers the demand 20 years ahead, is assumed to be the required number of cables to be accommodated in the ducts.

If both subscriber and junction cables exist together in the duct route concerned, the number of both these cables is to be taken into account.

Therefore, the number of duct cables is calculated by multiplying the total required number of cables by the demand variation factor of 1.5 and raising fractions to the unit.

2) Spare Ducts

Spare ducts are to be provided as specified below, in accordance with the number of ducts.

Number of Ducts	Spare Ducts
1 - 15	1
16 - 30	2
31 - 45	3
46 or more	4

3) Ducts in Entrance Section

The minimum number of ducts entering into the exchange is 48. The number of ducts in excess of this minimum limit is to be determined by case-by-case computation. The said minimum number of ducts in the entrance section does not apply to the mobile exchange.

(2) Type of Duct

The duct consists principally of the pipe made of Polyvinyl Chloride (PVC). However, the steel pipe is also used in case of shallow burying.

(3) Duct Size

Diameter of duct is either 50 mm or 100 mm.

(4) Span Length between Manholes

The span length between manholes is to be so determined that it will best suit the cable branching, cabinet location, road shape, etc. Maximum length is as follows:

Shape of Span	Maximum Length (m)
Straight	200
Curved	100

(5) Duct Arrangement

The standard duct arrangement will be as shown in Figure VI-1 in accordance with the number of ducts.

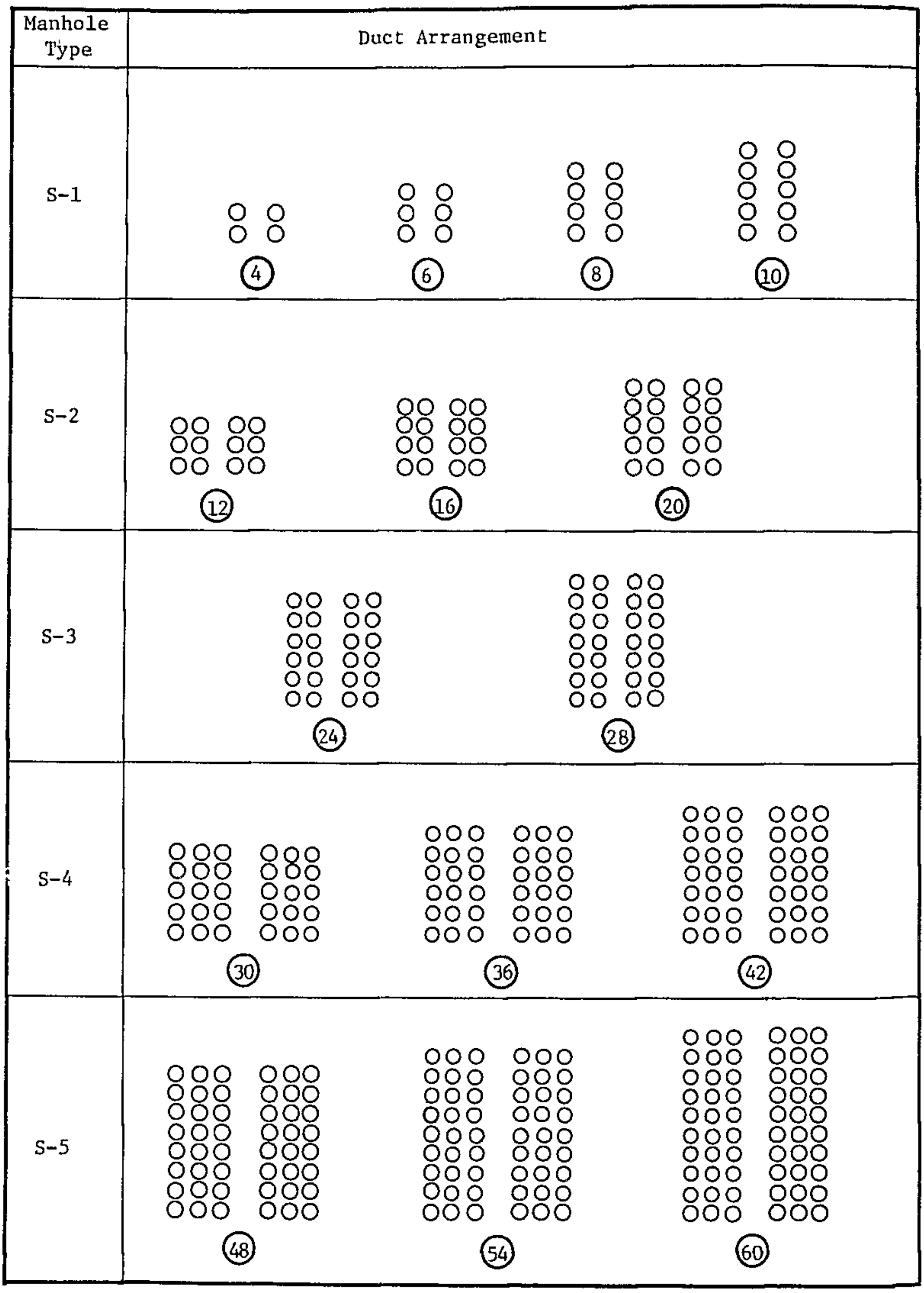


Figure VI-1 Duct Arrangement

(6) Duct Location

If the sidewalk and the roadway are clearly distinguishable, the duct must occupy the sidewalk, while in the case of a road without sidewalk the duct should be installed on the edge of either side of the roadway.

1-3-3 Manhole and Handhole

(1) Manhole

A manhole is constructed at a place where cable jointing, cable branching, accommodation of PCM repeater housing and loading coil, and installation and maintenance work are necessary. A manhole is to be large enough to accommodate the following:

a) Required number of ducts
b) One or two workmen
c) Splicing or jointing cases
d) Loading coils
e) PCM or other repeater housings

Manhole types and their dimensions are shown in Table VI-1 and Figures VI-2 and VI-3. A manhole where the repeater housings and loading coils are located requires a spacing of 100 cm between its base and lowest bearer. For the manholes where the duct route also serves as junction and trunk cable route, appropriate coordination with the junction cable network plan should be made in determining the type of manhole.

If the existing manhole cannot accommodate PCM repeater housing and loading coil, the existing manhole must be expanded or an appropriate manhole must be constructed at a place adjacent to the existing manhole concerned.

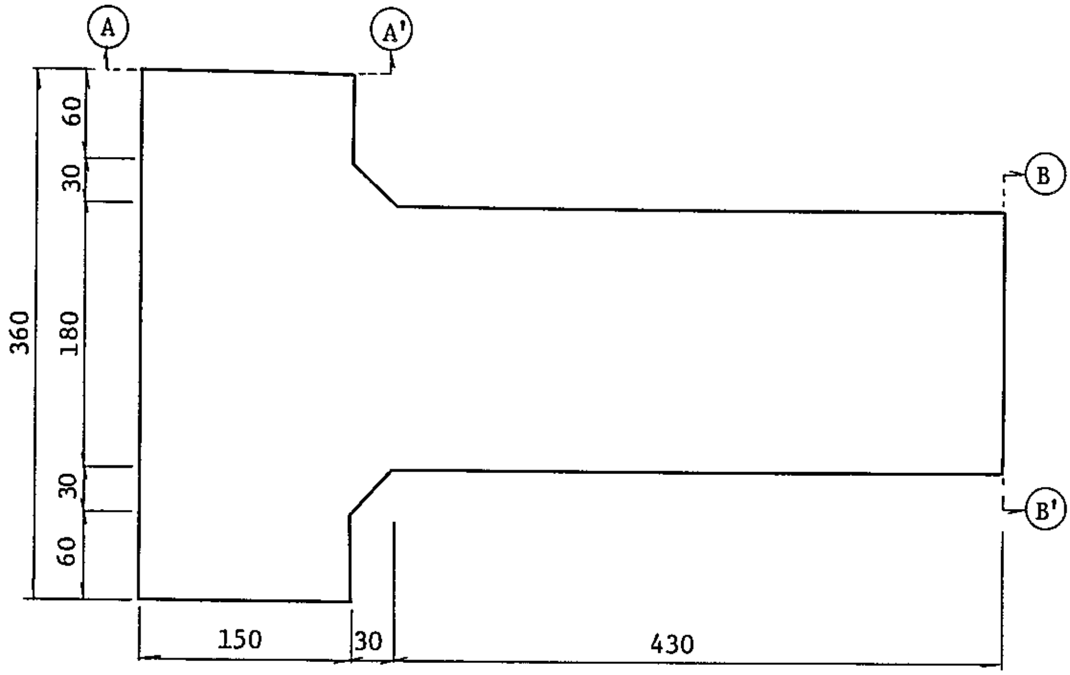
(2) Handhole

A handhole is to be provided between a manhole and a cabinet. Jointing between stub cable of terminal block and primary/secondary cable is made in the handhole. A handhole must be located on the sidewalk and, on roads without sidewalk, it should be located at the edge of either side of the roadway.

Table VI-1 Dimensions of Standard Manholes with Number of Ducts

Manhole Type	Number of Horizontal Ducts	Number of Vertical Ducts	Number of Ducts	Length (cm)	Width (cm)	Height (cm)	Remarks
S - 1	2	5	2 - 10	250	120	180	
S - 1R	2	5	2 - 10	250	120	230	*
S - 2	4	5	12 - 20	400	150	180	
S - 2R	4	5	12 - 20	400	150	230	*
S - 3	4	7	22 - 28	400	150	230	
S - 3R	4	7	22 - 28	400	150	280	*
S - 4	6	7	30 - 42	500	180	230	
S - 4R	6	7	30 - 42	500	180	290	*
S - 5	6	10	44 - 60	500	180	290	
S - 5R	6	10	44 - 60	500	180	340	*

*Note: For PCM repeater housings and loading coil installation



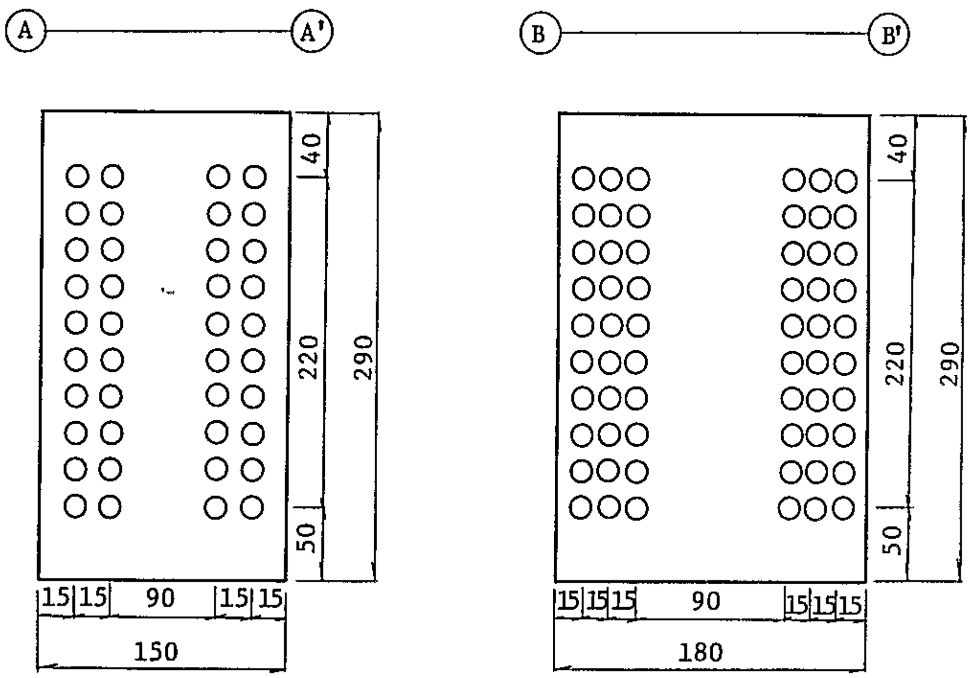


Figure VI-2 Dimensions of T-1 Type Manhole

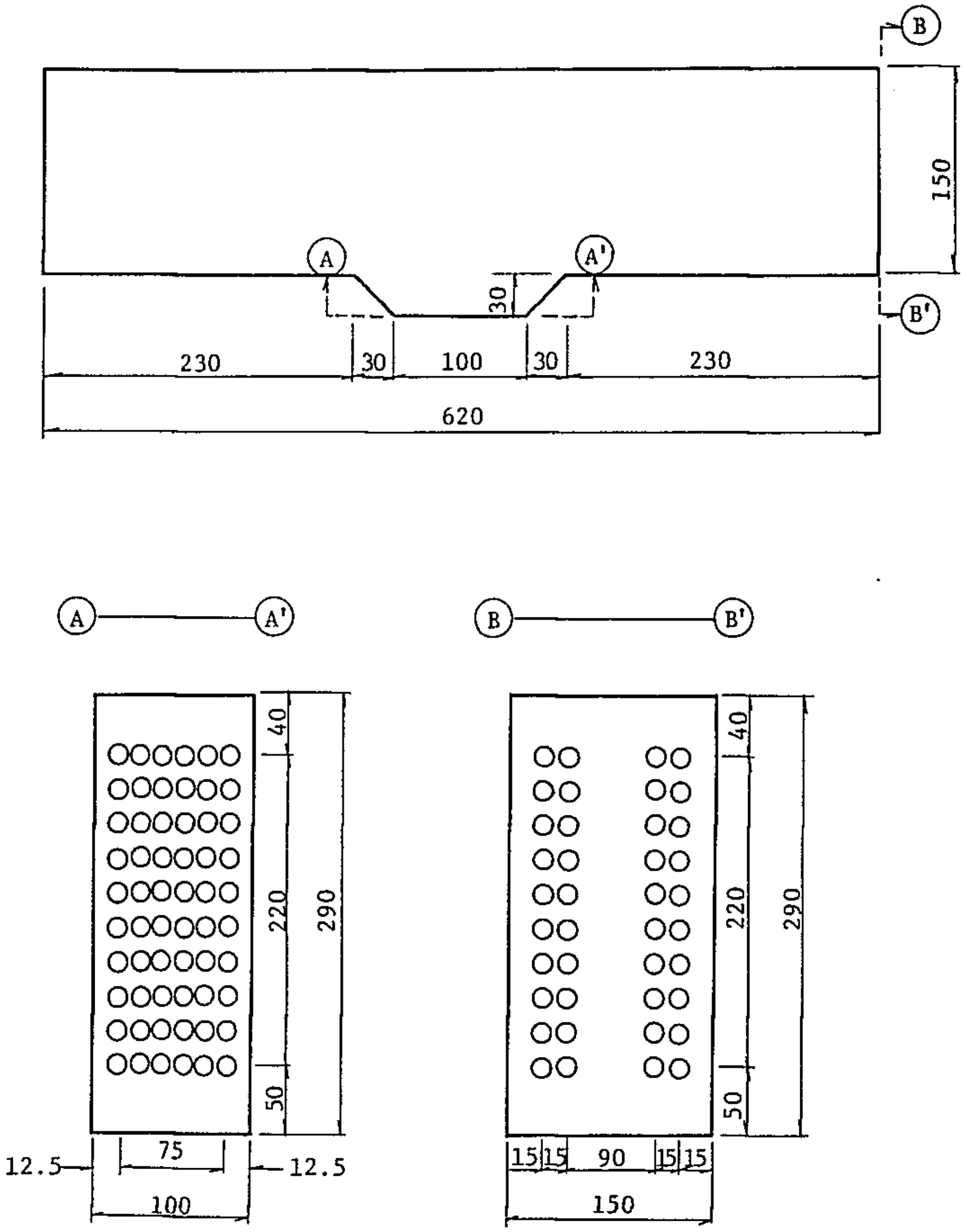


Figure VI-3 Dimensions of T-2 Type Manhole

1-4 Subscriber Cable Specifications

The type of cable to be installed, the number of cable pairs and the conductor diameter are determined by the following criteria:

1-4-1 Type of Cable

(1) Primary Cable

The type of proposed cable is the jelly-filled, polyethylene insulated and sheathed, and unit quad type cable. This type of cable is accommodated in the underground duct system.
At the following locations, however, the direct buried cable with steel tape armouring is employed:

1) At places where the change of cable route may be necessary as a result of road and/or river improvement.

2) At places where the underground cable system is not proper because of the pending road planning.

(2) Secondary Cable

The type of proposed cable is the jelly-filled, polyethylene insulated and sheathed, and unit quad type cable with steel tape armouring. Usually this type of cable is directly buried in the ground.
In the following cases, however, aerial cable, which is the polyethylene insulated and sheathed, unit quad and self-supporting type cable, is used:

1) At places where the change of cable route may be necessary as a result of road and/or river improvement.

2) At places where direct burying is not proper because of indistinctness of road planning.

1-4-2 Number of Cable Pairs

(1) Primary Cable

The number of cable pairs for the proposed cable is shown in the list below.

Conductor Diameter (mm)	Number of Cable Pairs
0.4	200, 300, 400, 600, 800, 1,000, 1,200, 1,600, 1,800, 2,400
0.6	200, 300, 400, 600, 800, 1,000, 1,200
0.8	200, 300, 400, 600

(2) Secondary Cable

The number of cable pairs for the proposed cable is shown in the list below:

Type of Cable	Conductor Diameter (mm)	Number of Cable Pairs
Direct buried cable	0.4	10, 20, 30, 50, 100, 200, 300, 400
	0.6	10, 20, 30, 50, 100 300, 400
	0.8	10, 20, 30, 50, 100, 200
Aerial cable	0.4	10, 30, 50, 100, 200
	0.6	10, 30, 50, 100, 200
	0.8	10, 30, 50, 100,

1-4-3 Electrical Characteristics of Cables

The electrical characteristics of cables in terms of direct current loop resistance and cable attenuation at 800 Hz classified by conductor diameters are shown in the list below:

Conductor Diameter (mm)	Loop Resistance (ohm/Km)	Line Attenuation at 800 Hz (dB/Km)
0.4	300	1.69
0.6	130	1.11
0.8	73	0.87

For details of cable attenuation calculation, refer to Paragraph 4-1 of PART IV of this report.

1-5 Determination of Conductor Diameter

The conductor diameter of cable is determined by two electrical parameters: the transmission loss in terms of reference equivalent of a local system and the signalling limit of the switching system concerned in terms of direct current loop resistance. The most economical diameter is selected to meet both these requirements.

1-5-1 Transmission Loss and Signalling Objectives

(1) Transmission Loss

The transmission loss in terms of reference equivalent of a local system used in Indonesia is as follows:

a) Sending reference equivalent (S.R.E.) 10.3 dB

b) Receiving refernce equivalent (R.R.E.) 1.7 dB

(2) Signalling

The signalling limit in terms of direct current loop resistance is classified as follows in the Jakarta Telephone Network, depending on the switching system concerned:

Type of Switching System	Maximum Loop Resistance (ohm)
a) EMD	1500
b) PRX 205	1800
c) MCX	1700

1-5-2 Combination of Different Conductor Diameters

A combination of different conductor diameters between primary and secondary cables should be made for the purpose of an economical design of the subscriber loop plant. However, such combination in the primary and secondary cable sections respectively should be avoided. In addition, all secondary cables in a cabinet should be of the same conductor diameter.

1-5-3 Maximum Length of Subscriber Line

The maximum length of a subscriber line is determined by the objective of the sending reference equivalent (S.R.E.) which is 10.3 dB. Assuming that S.R.E. of the telephone set is 0.87 dB, the S.R.E. given for the subscriber line section is 10.3 dB - 0.87 dB = 9.43 dB. Therefore, the design should be made not to exceed the above value.

For the purpose of practical cable design the following values are adopted:

Conductor Diameter (mm)	S.R.E. of Cable (dB/Km)	Maximum Cable Length (Km)
0.4	3.16	2.9
0.6	1.67	5.6
0.8	1.13	8.3